Engineering and Technology Journal e-ISSN: 2456-3358

Volume 09 Issue 08 August-2024, Page No.- 4950-4957

DOI: 10.47191/etj/v9i08.46, I.F. – 8.227

Identification of Operator Selection Factors from the Perspective of Indonesian Sea Transportation Users

Reni Karno Kinasih[1*], Nabila[2], Elhazri Hasdian[3], Hendy Yusman Firdaus[4], Sumarmi[5]

[1,2,3,4,5] Civil Engineering Department, Engineering Faculty, Universitas Mercu Buana, Indonesia

ABSTRACT: This study seeks to evaluate the key factors influencing the selection of sea transportation operators from the perspective of freight forwarders in Indonesia. Employing the Analytic Hierarchy Process (AHP), a Multi-Criteria Decision-Making (MCDM) method, the research identified and analyzed four primary criteria—reliability, cost, responsiveness, and IT orientation and communication—along with 12 sub-criteria across three operators. Data were gathered through expert interviews, concentrating on the determinants in choosing sea transportation operators. The findings challenge conventional assumptions, revealing that cost is not the predominant factor for Indonesian freight forwarders when selecting a sea transportation operator. Instead, IT orientation and communication responsiveness emerged as the most critical factor, followed by reliability and cost. The insights derived from this study can inform strategic enhancements in sea transportation services in Indonesia, particularly for routes to the eastern regions, by aligning operator services with the expectations and preferences of freight forwarders.

KEYWORDS : transportation operator, shipping line, sea transportation, freight forwarder

1. INTRODUCTION

The market share for goods transportation is predominantly held by road transport, a situation exacerbated by imbalances in infrastructure development and transportation demand. This imbalance has led to significant negative impacts on the existing transportation system. Data from the Central Statistics Agency of the Republic of Indonesia for the period 2012-2016 reveal a substantial increase in the number of vehicles, with an annual growth rate of 6.48 percent [1]. Transitioning goods transportation from road to rail and sea is anticipated to mitigate these adverse effects.

The island of Java, particularly the North Coast corridor, plays a crucial role in Indonesia's transportation network, with Jakarta and Surabaya being pivotal hubs for goods transport. This corridor significantly influences the development of the Archipelago Pendulum (including Belawan, Makassar, and Sorong) and serves as the primary economic and industrial hub for the nation.

The rise of globalization has intensified global trade, presenting challenges in selecting the most effective mode of transportation for industries. Sea transport is recognized as the most efficient mode for handling large volumes of goods compared to other transportation options.

Regional and international trade involves multiple stakeholders, including shippers, customs authorities, shipping services, land transportation providers, warehousing operators, and technical and administrative personnel. Freight forwarding plays a vital role in this ecosystem by managing documentation and selecting transportation operators, thereby simplifying technical and administrative processes for both sellers and buyers [2].

Despite the critical importance of sea transportation to Indonesia—a country comprised of numerous islands—research in this field remains underexplored. Previous studies have primarily examined shipping line selection from the perspective of shippers [3][4]. This study aims to address this gap by focusing on the perspective of freight forwarders.

In Pakistan, key factors in choosing a shipping line include reliability, cost, responsiveness, IT orientation, and communication [5]. Conversely, in India, cost is the most influential factor in a forwarder's decision [3]. For Taiwanese shippers, financial stability, reliability, and accuracy in document handling are paramount, with integrated logistics and shipment timing also being significant [6][7]. In East Asia—specifically Japan, Korea, and Taiwan—the most critical factors include low cost, door-to-door service capabilities, immediate response, customer relationship management, IT systems, and network services [8]. In China, the primary considerations are the level of goods damage, shipment time reliability, and the ability to provide multimodal transportation [9]. In Surabaya, Indonesia, the main influencing factors are the completeness and reliability of service facilities, adherence to international standards, corporate reputation, and customer orientation [10].

Given that existing research predominantly addresses the perspective of shippers, this study seeks to fill the gap by evaluating shipping line selection criteria from the freight forwarder's viewpoint. The study will assess variables such as reliability, cost, responsiveness, and IT orientation, with a framework outlined in Table 1 that includes 12 sub-criteria for evaluation.

Table 1. Framework of research

Criterias	Sub-Criterias	Goal
Reliability (C1)	Goods security and integrity	Selection of sea transportation operator by the user
	Security of shipping data	
	Efficiency of transshipment and timeliness	
Cost (C2)	Reasonable freight charges	
	Reasonable local origin charge	
	Avalibility of credit facility	
Responsiveness(C3)	Rapid response time	
	Various service of product	
	Special delivery facility	
	Availability of special delivery services	
IT orientation and communication (C4)	Online tracking facilities	
	Timely issuance of B/L and freight invoices	
	Online container booking facilities	

Understanding the primary factors that influence freight forwarders' decisions when selecting sea transportation operators is crucial for enhancing the effectiveness of sea transportation in Indonesia. This knowledge will serve as a valuable reference for future improvements in the maritime transport sector, particularly concerning routes to and from the eastern regions of Indonesia, which are abundant in marine natural resources. Addressing these factors aims to bridge the gap between the expectations of freight forwarder users and the services provided by sea transportation operators. This effort is essential for aligning operational practices with the needs of stakeholders and ensuring more efficient and responsive maritime logistics.

2. METHODOLOGY

Multi-Criteria Decision Making Methode(MCDM)

The origins of Multi-Criteria Decision Making (MCDM) can be traced back to Benjamin Franklin (1706-1790), who pioneered a decision-making approach that considered two conflicting factors—pros and cons—incorporating both subjective and multi-attribute dimensions. Through a systematic scoring process, Franklin successfully facilitated critical decision-making [10].

MCDM has since been applied across various contexts [11], particularly in addressing complex problems that are difficult to quantify [12]. Beck and Hofmann (2012) differentiated MCDM from traditional Decision Making (DM) by highlighting that MCDM is specifically designed to handle multi-dimensional and conflicting criteria, whereas conventional DM approaches focus on optimal problem-solving [13]. Nayak and Souza (2018) further emphasized that MCDM often employs statistical or quantitative techniques to manage and analyze data [13].

MCDM techniques are generally classified into two main categories: Multi-Attribute Decision Making (MADM), which deals with discrete patterns, and Multi-Objective Decision Making (MODM), which addresses continuous patterns, including hybrid approaches that combine both [14]. The structure of MCDM is thus categorized into two primary discussion areas: MADM and MODM. Figure 1 illustrates the structural modifications of MCDM and the MCD-model, as presented by Jaya et al. (2020).

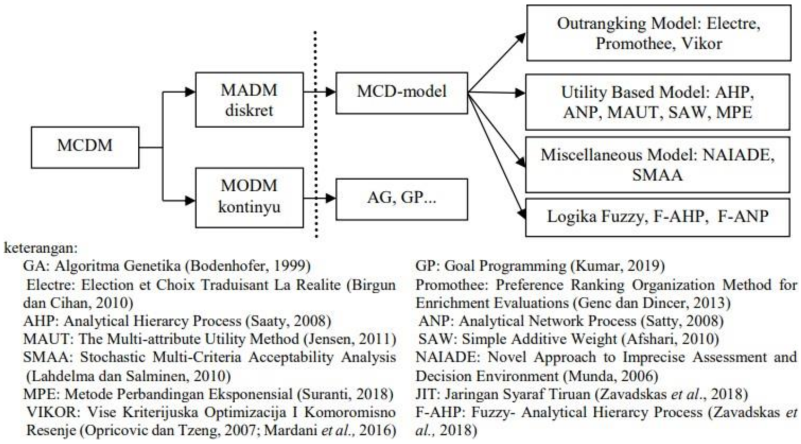

Figure 1. Structure modification MCDM and MCD-model

Source: Jaya, et.al (2020)

In this study, data were collected through interviews and closed-question questionnaires administered to seven operational directors from freight forwarding companies with a minimum of five years of specialized experience. The data were subsequently processed using the Analytic Hierarchy Process (AHP) method. Developed by Thomas L. Saaty, AHP is a decision-making system that structures complex problems with multiple criteria into a hierarchical framework [15].

The application of AHP in this research emphasizes the quality of the respondents' data rather than the quantity [15]. Consequently, scoring within AHP requires input from experts who possess substantial expertise and influence in decision-making processes. These experts are critical as they possess deep knowledge and understanding of the information needed for accurate decision-making.

Various techniques are available for policy-making based on MCDM methods, which can sometimes cause confusion among researchers [13]. The choice of technique depends on factors such as data processing methods, availability of attributes and data, and the preferences of policymakers [16]. The suitability of an MCDM technique is context-dependent, reflecting the specific conditions and objectives of the research [17]. Thus, the selected method should align with the conceptual framework and goals of the study.

AHP is particularly effective for ranking alternatives when decision criteria are diverse. Developed in 1970, AHP provides a robust tool for managing multi-criteria elements both qualitatively and quantitatively. It allows policymakers to prioritize criteria, arrange problems hierarchically, and assign numerical values to facilitate comparisons. The process culminates in the systematic management of values to derive logical priorities, policy selections, optimizations, and performance measurements.

There is no specific formula for the number of respondents in AHP; however, a minimum of two respondents is generally considered adequate [15]. The AHP problem-solving process involves the following steps:

1. Define the problem, objectives, criteria, and alternatives.
2. Construct the objective hierarchy.
3. Score the criteria and alternatives through pairwise comparisons, using a scale from 1 to 9 to express relative importance, as detailed in Table 2.

Table 2. Pair comparison scoring scale

Importantance intensity	Description	Explanation
1	Both elements are equally important	Both elements has the same influence to the objective
2	One element is more important than the other	Experience and scoring more supporting one element than the other
5	One element is more important than the other	Experience and scoring are strongly supporting one element than the other

Importantance intensity	Description	Explanation
7	One element is absolutely important than the other	One element is strongly supported and dominantly seen in the practice
9	One element is absolutely important than the other	The proof supporting one element toward the other has the highest level of confirmation which is likely reinforcing
2, 4, 6, 8	Scoring between two close determing value	This score is given if there are two compromises between two choces
The opposite	If in the i get one value compared to j, so j has the opposite value compared to i	

4. Constructing the Pairwise Comparison Matrix (PCM)

To evaluate the consistency of the Pairwise Comparison Matrix (PCM), it is necessary to calculate the Consistency Ratio (CR). Saaty’s method, based on a sample of 500 comparisons, provides a benchmark for assessing consistency. If numerical judgments are randomly selected from the scale of 1/9, 1/8, ..., 1, 2, ..., 9, the average consistency for matrices with various measurement scales can be determined.

Measuring consistency is critical to ensure the reliability of decision-making outcomes. A high level of consistency indicates that the judgments made are coherent and dependable, thereby enhancing the credibility of the decision process. Conversely, a low consistency ratio suggests that the decision is based on inconsistent or unreliable judgments, which could undermine the validity of the final conclusions. Thus, ensuring a satisfactory level of consistency is essential for robust and credible decision-making.

To assess the consistency of the Pairwise Comparison Matrix (PCM), two key metrics are used: the Consistency Index (CI) and the Consistency Ratio (CR).

1. Consistency Index (CI). This metric is calculated using the formula:

Consistency Index (CI) with the formula CI = (λmaks − n)/(n-1)........... (1)

Consistency Rasio with the formula CR = CI/IR....... (2)

where:

λmaks = represents the largest eigenvalue of the matrix.

n = denotes the number of attributes or criteria.

2. Consistency Ratio (CR). This metric is derived from the Consistency Index and is calculated as follows:

Consistency Rasio with the formula CR = CI/IR........(2)

The Consistency Index (CI) measures the extent to which the judgments in the PCM align with the theoretical expectations, while the Consistency Ratio (CR) provides a normalized measure by comparing CI to IR. A CR value below 0.10 is generally considered acceptable, indicating that the matrix judgments are consistent. Higher CR values suggest potential inconsistencies that may need to be addressed to improve decision-making reliability. The list of Indeks Random Consistency (IR*)* can be seen in table 3, for each measurement of matrix has consistency index value.

Table 3. Index consistency

Matrix Measurement	***Consistency Index***
1, 2	0.00
3	0.58
4	0.90
5	1.12
6	1.24
7	1.32
8	1.41
9	1.45

Matrix Measurement	***Consistency Index***
10	1.49
11	1.51
12	1.48
13	1.56
14	1.57
15	1.59

3. RESULT AND DISCUSSION

RESULT

Definition of problem

The first step in *AHP* deining the problem, which can be determined in this research as follows:

a. The objective: Choosing sea transportation operator criterias : Reliability, cost, responsiveness and IT orientation and communication
b. Alternative : Operator 1, Operator 2 and operator 3

Structure of objective hirarcy

The objective hierarchy is established using the framework outlined in Table 1. Figure 2 illustrates the structure of this hierarchy. Once the hierarchy is constructed, element priorities are determined through pairwise comparison, which involves evaluating the relative importance of elements using a matrix based on a predefined scoring scale.

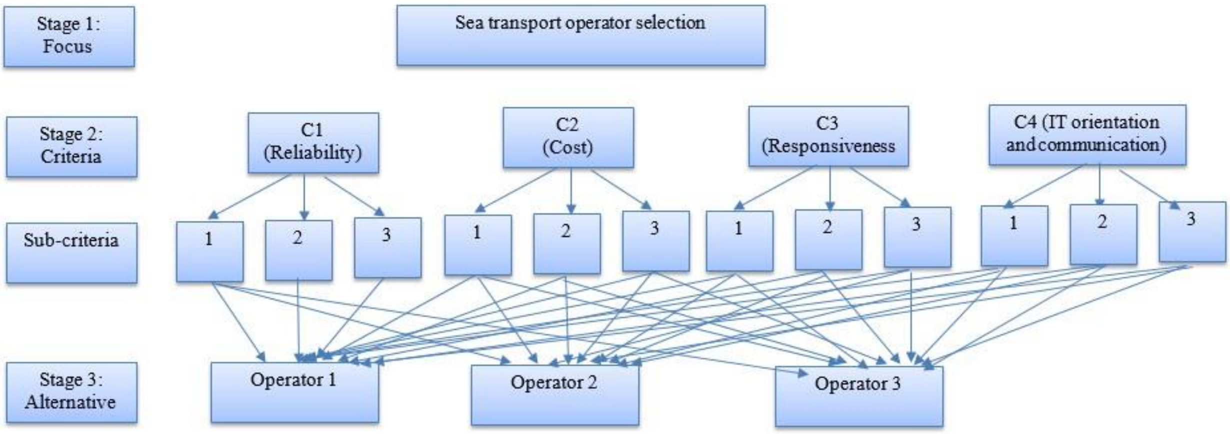

Figure 2. Structure of objective hierarchy

Pairwise ComparisonMatrix (PCM)

The experts' (policy makers') assumptions are quantified using Saaty's scale, as shown in the table. The largest scale, represented by the blue column with the number 6, indicates that experts consider C4 to be six times more important than C1. Consequently, in the row for C1, the value 6 is recorded, while in the row for C4, the reciprocal value of 1/6 (approximately 0.167) is entered. This process is applied consistently across all rows.

Eigenvector

An eigenvector is derived from each pairwise comparison. The eigenvector value for each row is obtained by dividing the conversion scale of the expert's opinion by the total scale across the criteria. To ensure accuracy, the sum of the average values must equal 1. If the sum of the average equals 1, it indicates that the calculations have been performed correctly and are consistent.

Table 5. Eigenvector

Criterias	C1	C2	C3	C4	Amount	Average
C1	0,5008	0,4615	0,5333	0,4615	1,9572	0,4893
C2	0,1652	0,1538	0,1333	0,1538	0,6063	0,1516
C3	0,2504	0,3077	0,2667	0,3077	1,1324	0,2831
C4	0,0836	0,0769	0,0667	0,0769	0,3041	0,0760
			Check			1

Consistency Ratio

The Consistency Ratio (CR) is calculated as the ratio of the Consistency Index (CI) to the Random Index (RI). The CI is determined using a standard formula. In this case, the resulting CR value is 0.0045951, which is below the threshold of 0.1, indicating that the data is consistent. This suggests that the responses from the experts were consistent.

Alternative Ratio Matrix

The subsequent step involves calculating the matrix of alternative ratios for each criterion. The tables below present the results of these calculations.

a. Alternative Ratio Matrix for Each Reliability

Tabel 6. Consistency Ratio

Lamda Max	**4,0124068**
CI	0,0041356
CR = CI/IR	0,0045951

Tabel 7. Pairwise of Reliability criteria

Reliability	*Operator* 1	*Operator* 2	*Operator* 3
Operator 1	1	0,5	3
Operator 2	2	1	5
Operator 3	0,333	0,2	1
Total	**3,333**	**1,7**	**9**

Table 8. Eigen Factor of Reliability

Reliability	*Operator* 1	*Operator* 2	*Operator* 3	Amount	Average
Operator 1	0,3	0,294118	0,333333	0,92745	0,309150327
Operator 2	0,6	0,588235	0,555556	1,74379	0,581263617
Operator 3	0,1	0,117647	0,111111	0,32876	0,109586057
		Cek			1

Table 9. Consistency Ratio

Lamda Max	**3,0049237**
CI	0,0024619
CR = CI/IR	0,0042446

b. Altenative Ratio Matrix in the Criteria of Cost

Table 10. Pairwise criteria of Cost

Cost	*Operator* 1	*Operator* 2	*Operator* 3
Operator 1	1	0,166667	0,166667
Operator 2	6	1	2
Operator 3	6	0,5	1
Total	**13**	**1,666667**	**3,166667**

Table 11. Eigen Factor criteia of Cost

Cost	*Operator* 1	*Operator* 2	*Operator* 3	Jumlah	Rata-rata
Operator 1	0,0769231	0,1	0,052632	0,23	0,076518219
Operator 2	0,4615385	0,6	0,631579	1,693	0,56437247

Operator 3	0,4615385	0,3	0,315789	1,077	0,359109312
		Cek			1

Table 12. Consistency Ratio

Lamda Max	**3,0725371**
CI	0,0362686
CR = CI/IR	0,062532

DISCUSSION

The consistency calculations yielded a satisfactory level of consistency (below 0.1), indicating that the experts provided reliable responses. Consequently, the data can be considered a valid reference. Based on the four predetermined criteria, three sea transportation operators were evaluated. The ranking of each operator is presented in the table 13.

Table 13. Recapitulation of Average Scores

Operator	Average Score	Ranking
Operator 1	0.18540	3
Operator 2	0.60523	1
Operator 3	0.20937	2

Source: *Data Calculation*

Operator 2 achieved the highest ranking, securing the top position across all evaluated criteria (reliability, cost, responsiveness, IT orientation, and communication). Operator 3 ranked second, while Operator 1 ranked last.

Table 14. Average Value of Examined Criteria

Operator	Reliability	Cost	Responsiveness	IT orientation and communication
Operator 1	0,30915	0,07652	0,05981	0,07377
Operator 2	0,58126	0,56437	0,65827	0,64339
Operator 3	0,10959	0,35911	0,28192	0,28284

Source: *Data Management*

The analysis of the average values for each criterion reveals that the most critical factor influencing the choice of sea transportation operator is responsiveness. This criterion includes aspects such as fast response time, a variety of service options, and the provision of special delivery facilities, with an average score only 0.01488 higher than the second most important criterion—IT orientation and communication. This suggests that companies should prioritize online tracking capabilities to monitor the position of vessels, timely issuance of Bills of Lading and freight invoices supported by IT systems, and the provision of online container booking facilities.

Reliability, with an average score of 0.58126, is the third most important criterion. This includes sub-criteria such as cargo security and integrity, data security during shipping, and timely transshipment efficiency. Surprisingly, cost emerged as the least influential criterion in the selection of sea transportation operators by freight forwarders. This finding contrasts with research conducted in other developing countries, where cost is often the primary consideration, as seen in studies from India [3], Japan, Korea, and Taiwan [8]. Similarly, research by Andilas et al. (2018) in Indonesia found that cost was not a primary factor; instead, completeness of service facilities, reliability, international standardization, company reputation, and customer orientation were more influential [2].

The emphasis on cost as a decision-making factor in many aspects of life in developing countries makes the shift in orientation towards other aspects an interesting subject for further research. This shift may be driven by positive experiences, such as the ease of tracking goods or passengers, as facilitated by logistics companies and online transportation services, or the convenience of booking and invoicing systems in other transportation modes. These factors may have altered the societal paradigm, making cost less of a priority. Conversely, the shift could also be attributed to negative experiences with low competency and service quality among Indonesian sea transportation operators, such as difficulties in tracking goods, container booking challenges, slow operator responses, or delays caused by prolonged transshipment processes.

4. CONCLUSION

The key conclusions drawn from this research are as follows:

1. Cost is not the primary criterion in the selection of sea transportation operators. Instead, the criteria in order of importance are IT orientation and communication, responsiveness, reliability, and finally, cost.
2. Freight forwarder companies, as users of sea transportation services, expect operators to have robust IT systems that facilitate real-time tracking, timely distribution of essential documents such as Bills of Lading (B/L) and freight invoices, and user-friendly container booking processes.
3. It is recommended that sea transportation operators invest in and develop reliable IT and communication infrastructure to meet the expectations of their users effectively.

ACKNOWLEDGEMENT

This research was funded by LPPM Universitas Mercu Buana.

REFERENCES

1. R. Kristiana, "Analisis Pengukuran Kualitas Kinerja Infrastruktur Lrt Jakarta Selama Kondisi Pandemi Covid-19," Jurnal Teknik Sipil, vol. 10, no. 1, pp. 85-94, 2020.
2. D. D. Andilas, A. Tanza and Y. Valencia, "Faktor-Faktor Pemilihan Jasa Pelayaran di Surabaya," Jurnal Manajemen .
3. V. Kannan, S. K. Bose and N. G. Kannan, "An evaluation of ocean container carrier selection criteria: an Indian shipper's perspective," Management Research Review, vol. 34, no. 7, pp. 754-772, 2011.
4. T.-C. Lirn and R.-D. Wong, "Determinants of grain shippers' and importers' freight transport choice behaviour," Production Planning & Control, vol. 24, no. 7, pp. 575--588, 2012.
5. B. Iqbal and D. A. Siddiqui, "Factors Influencing Selection of Container Shipping Lines in," ARCHIVES , vol. 7, no. 1, pp. 35-44, 2014.
6. J.-L. Lu, "Investigating Critical Factors That Influence Shippers And Internasional Freight Forwarders Preferences in Carrier Selection Using Integrated Hierarchical Information Integration Approach," Journal of Marine Science and Technology, vol. 21, no. 2, pp. 182-190, 2013.
7. T.-C. Ho, R.-H. Chiu and C.-C. Chung, "Key Influence Factors for Oceans Freight Forwarders Selecting Containers Shipping Line Using The Revised Dematel Approach,"Journal of Marine Science and Technology, vol 25, no. 3, pp 299 -310, 2017
8. S. T. Huang, E. Bulut and O. Duru , "Service quality evaluation of international freight forwarders: an empirical research in East Asia," Journal of Shipping and Trade, vol. 4, no. 14, pp. 2-16, 2019.
9. L. Shen, K. Mathiyazhagan, D. Kannan and W. Ying, "Study on analysing the criteria's for selection of shipping carriers in Chinese shipping market using analytical hierarchy process," International Journal of Shipping and Transport Logistics, vol. 7, no. 6, pp. 742- 757, 2015.
10. International Society on Multiple Criteria Decision Making, International Society on Multiple Criteria Decision Making E News, Austria, 2020.
11. M. Ehrgott and J. R. Figueira, Trends in Multiple Criteria Decision Analysis, New York, Springer, 2020.
12. M. Velasquez and P. T. Hester, "An analysis of multi-criteria decision making methods," International Journal of Operations Research, vol. 10, no. 2, pp. 56-66, 2013.
13. R. Jaya, E. Fitria, Yusriana and R. Ardiansyah, "Implementasi Multi Criteria Decision Making (MCDM) pada Agroindustri: Suatu Telaah Literatur,"Jurnal Teknologi Industri Pertanian, vol. 30, no. 2, pp. 234 - 243, 2020.
14. A. Daghouri, K. Mansouri and M. Qbadou, "Information system performance evaluation and optimization using AHP and TOPSIS: Construction industry case," in 4th International Conference on Optimization and Applications (ICOA), Morocco, 2018.
15. Y. Jumaryadi, D. Firdaus, B. Priambodo and ZP.Putra, "Determining the Best Graduation Using Fuzzy AHP," in IEEE , Yogyakarta,2020.
16. T.L.Saaty,Decision Making for leader :The Analytical Hierarchy Process for, Pittsburgh: University of Pittsburgh, 1993.
17. D. Sabaei, "A review of multi-criteria decision making methods maintenance delivery," Procedia CIRP, vol. 37, pp. 30-35, 2015.
18. H. Polatidis, D. Haralambopoulos and G. Munda, "Selecting an Appropriate Multi- Criteria Decision Analysis Technique for Renewable Energy Planning,"Energy Sources. Part B Economics, Planning and Policy, vol. 1, pp. 181-193, 2006.