

Vendor Efficiency Evaluation regarding Product Delivery in Indonesian Logistic Service Providers

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The use of vendors is one solution to expand the area of delivery of goods, which has been done by most Indonesian logistic service providers (LSP). Periodic evaluations need to be completed to ensure the efficiency of vendors who have collaborated. The research approach used in this study is quantitative-exploratory, data is collected through reports of one well-known LSPs in Indonesia for 5 vendors, the official BPS website and structured questionnaires. Data is processed using Data Envelopment Analysis (DEA) and Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) methods. The results show that there are 4 vendors are running efficiently and 2 vendors are running inefficiently with 1 of the vendors being recommended as best in delivering goods.

Keywords: *Vendor Evaluation, Efficiency, DEA; Topsis, LSP.*

Introduction

The current logistics industry in the South-East Asian region has been growing since the ASEAN Economic Community (AEC) was effectively established in 2015. AEC created a single market in the region, enhancing opportunities on business and labour force. In addition to AEC, the development of e-Commerce also contributed to the growth of express shipping services. The rapid growth of e-commerce also occurs in Indonesia. In the Projection and Penetration Chart for Indonesian Digital Buyers (2018) projects the number of Indonesian digital buyers has reached 31.6 million buyers in 2018 and will increase to 43.9 million in 2022. The High Projection and Penetration Charts of Indonesian Digital Buyers has been caused by an increase in the number of internet users (Databoks.co.id, 2018).



E-commerce industry has contributed to the growth of logistics companies in Indonesia. Ease, convenience and promotional discount of transactions offered by e-commerce have switched consumer behaviour from completing offline to online purchases of products. In addition, there are several e-commerce sites in Indonesia that simplify the purchasing of goods from abroad. Therefore, the number of e-commerce retail purchased in Indonesia has rapidly grown, to 8,59 billion rupiah in 2018 and predicted to increase to 117,7 trillion in 2022 which is a rise of about 133,5% in four years (databoks.co.id, 2018).

Currently the logistics sector will contribute by optimising technical excellence and processes to improve the efficiency and effectiveness of the delivery process. Strong economic growth has encouraged industrial development in Indonesia, rising by more than 14.2% or 1.408 trillion (US\$ 216.25 billion) in 2012 compared to just 1.233 trillion (US\$ 134.46 billion) in 2011.

This case gives the domestic logistics industry a competitive opportunity to draw Indonesia's leading logistics service providers.

Strong economic growth in Indonesia has helped pave the way for industrial growth from just 1.35 trillion rupiah in 2012 to 1.8 trillion rupiah (US\$ 216.25 million) in 2012. It provides a competitive opportunity to draw leading logistics service providers in Indonesia to market logistics. As shown in fig.1, currently in Indonesia, the amount of transportation can reach more than 200 million tons per year and yet typically uses road-based vehicles.

The express shipping sector has been the most affected by the growth of the e-commerce industry. The Vice President of Marketing of an express shipping company in Indonesia has conveyed around 80% of their revenue in 2018 are from e-commerce and the marketplace. Furthermore, their amount of revenue is rising by around 30% every year (Okezone.com, 2018).

Large and wide Indonesian territories constitute a great challenge for express shipping companies to cover all areas of Indonesia, especially remote regions. In fact, most have poor infrastructure, difficult geographical contours and high transportation costs. On the other hand, there are several considerations for potential customers in choosing an express shipping company, including, price, service variations, on time delivery, coverage area, etc.

These challenges are also faced by XYZ, one of well-known LSP companies in Indonesia. XYZ tries to expand their coverage area, chiefly to cover all remote areas throughout Indonesia. Therefore, XYZ co-operates with several local shipping vendors to enlarge the shipping area of their company. The objective of this study is to discover the variables that affect the input

and output of shipments using vendors at the LSP which have been running efficiently and recommend the best vendor .

Literature Review

Research conducted by Haldar (2017) uses the method of Data Envelopment Analysis (DEA), the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) and Linear Programming (LP). The research shows how an organisation can systematically and structurally improve the process of evaluating decision making and selecting 3PL vendors by considering the variables in this study. Subsequently, long-term partnerships can also be evaluated using this model. Two of the three methods in the study (DEA, TOPSIS) were adapted by the authors . In addition, several variables were also adapted by them.

DEA was similarly applied by Zhou et al. (2008), to assess the profitability and operating performance of ten leading 3PL providers in China. A hybrid model of fuzzy AHP–TOPSIS was proposed by Buyukozkan et al. (2008) to select the most appropriate strategic alliance partner in the value chain of logistics. Hamdan and Rogers (2008) used a DEA-based approach to determine the efficacy of a team of 19 3PL warehousing logistics operators (decision-making units–DMUs) in the United States. Timeliness, flexibility, practicality are used to evaluate and select 3PL in order to compete with other 3PL. These are the findings of research conducted by Raut. Data Envelopment Analysis (DEA) and Analytic Network Process (ANP) are the methods used in the journal and also adapted by the authors.

Joo (2013) conducted a study that became the basis for determining the input and output variables used in this study. This research, which uses the Data Envelopment Analysis (DEA) method, advises management to streamline operating costs, minimise costs that can be reduced and improve supervision to maximize the profits that a Company might obtain. This study also uses Narkhede et. al.'s research (2017) to determine input variables. This study selects 20 20 factors that influence the selection of 3PL vendors in the cement industry and 3 main factors which include the experience of handling the same product, management quality, and information technology capacity.

As discussed earlier, the implementation of methodologies, evaluation criteria and problems are varied in some studies which focus on selecting the best logistic service provider. In addition, approaches and methods require large amounts of data and use of another quantitative technique, causing it to be very complex to select the best LSP.

Methodology/Materials

The research approach in this study uses an associative quantitative method where the research aim is to discover those variables that affect the input and output of shipments using vendors at the LSP, which have been running efficiently and recommend the best LSP vendor. The unit of analysis intended in this study consists of monthly and yearly reports of well-known Indonesian Logistic Service Providers (LSP) through documentation study. The time horizon used is cross sectional study. The data collection method used is report and documentation study of monthly and 2018 annual report of Indonesia's LSP. Measurement of data input include coverage areas (Llamazares, 2015:153), pickup and delivery cost (Joo et.al, 2013:256), and other expenses (Joo et.al, 2013:256). Data output measured by target achievement (Haldar, et. 2017), Gross profit and delivery cost per kilogram (Joo et.al, 2013:256). Data was analysed using two methods: data envelopment analysis (DEA) using DEA-solver learning version 8.0 to analyse the efficiency of LSP and TOPSIS 6 stages used to give rank and recommendation of the best LSP related to efficiency.

Data envelopment analysis (DEA)

Cooper et.al (2000) and Golany and Roll (1989) discuss the general application procedure of their studies. This study guides efficiency with constant returns to scale (CRS) and variable returns to scale (VRS) estimation. The CRS formulation is as follows:

$$\min \theta - \varepsilon (\sum_{i=1}^m s_i^- + \sum_{i=1}^s s_r^+) \dots\dots\dots (1)$$

Subject to:

$$\sum_{j=1}^n x_{ij} \lambda_j + s_i^- = x_{i0} \dots\dots\dots (2)$$

$$\sum_{j=1}^n y_{rj} \lambda_j - s_r^+ = \varphi y_{r0} \dots\dots\dots (3)$$

$$\lambda_j \geq 0 \dots\dots\dots (4)$$

X_{ij} and Y_{rj} are levels of the i th input and r th yield, separately, for DMU j . N is the quantity of DMUs., a positive number (non-Archimedean) utilised as a lower bound to data sources and yields. λ_j indicates the commitment of DMU j in determining the effectiveness of the appraised DMU j_0 (a point at the envelopment surface). S_i^- and S_i^+ are slack factors proxying additional investment funds in input I and additional increases in yield r . i_0 is the spiral productivity factor that shows the conceivable decrease of contributions for DMU j_0 . If i_0^* (ideal arrangement) is equivalent to one and the leeway esteems are both equivalent to zero, at that point DMU j_0 is said to be effective. At the point when S_i^- and S_i^+ take positive qualities at the ideal arrangement, one can reason that the relating info or yield of DMU j_0 can further improve once input levels have been contracted to the extent i_0^* .

Model 2 VRS formulation is:

$$\min q_0 = \varphi + \varepsilon (\sum_{i=1}^m s_i^- + \sum_{i=1}^s s_r^+) \dots\dots\dots (5)$$

Subject to:

$$\sum_{j=1}^n x_{ij} \lambda_j + s_i^- = x_{i0} \dots\dots\dots (6)$$

$$\sum_{j=1}^n y_{rj} \lambda_j - s_r^+ = \varphi y_{r0} \dots\dots\dots (7)$$

$$\lambda_j \geq 0 \dots\dots\dots (8)$$

This model varies from Model (1) by incorporating the supposed convexity constraint, $\lambda_j=1$ which forestalls any insertion point developed from the watched DMUs from being scaled up or down to shape a reference point, which is not reasonable under VRS. In this model, the arrangement of χ values limit i_0 to i_0^* and distinguish a point inside the VRS model the information levels of which mirror the most reduced extent of i_0^* . At i_0^* , the information levels of DMU j_0 can be consistently contracted without influencing yield levels. Accordingly, DMU j_0 has effectiveness equivalent to i_0^* . The response to Model (2) is outlined as following: DMU j_0 is pareto-productive if $i_0^*=1$ and $S_r^{+*}=0, r=1 \dots s, S_r^{-*}=0, i=1 \dots m$. Specialised efficiencies evaluated under VRS are alluded to as unadulterated specialised information productivity as they are the net after effects of any scale impacts.

Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS)

TOPSIS use to rank the potential 3PLs obtained through DEA and select the most efficient ones according to the given criteria. TOPSIS, developed by Hwang and Yoon (1981), is a decision technique based on simple geometric concepts: the best alternative exhibits the shortest distance from the PIS and the farthest distance from the NIS in a Euclidean sense. The decision matrix x has dimensions $m*n$ where m is the number of alternatives (the maximally efficient suppliers), with the generic element d_{ij} with $i _ 1 [\dots], m$ and $j _ 1 [\dots]$ and n takes the corresponding performance values against the j th criterion. The TOPSIS technique consists of the following six steps.

- Step 1:** construct the normalised performance matrix.
- Step 2:** create the weighted normalised performance matrix.
- Step 3:** determine the best ideal solution (A_+) and worst ideal solution (A_-).
- Step 4:** calculate the distance between best ideal solution and each alternative i .
- Step 5:** calculate the relative closeness of each alternative to the worst ideal solution.
- Step 6:** rank the alternatives according to their preference order.

Vendor with the highest S_{iw} value is ranked as first, the following as second, and similarly, all others are ranked with the vendor having lowest S_{iw} value ranked as last.

Results and Findings

To show the effectiveness of the adopted approach for optimal 3PL vendor evaluation and selection, the explained model was tested regarding the data provided by a well-known Logistic service provider for their vendor on shipping delivery to two islands in Indonesia, Sumatera and Java Island. The selection and allocation were made amongst 20 vendors in 3 branch hubs including Medan, Jakarta and Surabaya. After conducting an evaluation interview with the 5 top management teams as informants, 6 vendors were selected based on active shipping and good commitment of SLA. To evaluate the efficiency three input and three output criteria were used in this research. The input criteria consisted of coverage area, pickup and delivery cost and other expenses. The output criteria considered for the study were Gross Profit, Delivery cost per Kg and target achievement.

Coverage area is the level or scope of a place. Based on the scope of shipping, the port has different capabilities, cargo handling procedures and terminal handling fees (Llamazares, 2015: 153). This is the same as the coverage area that can be reached by existing vendors. Not all vendors have the same coverage area, one must have advantages in reaching their area. Pick-up and delivery expenses are the sum of the basic costs and additional costs (Joo, Keebler, & Hanks, 2013: 256). The base fee must be paid to the vendor based on shipping weight. Additional costs include the amount of costs other than basic costs such as toll fees, additional labour and special handling costs. Other expenses consist of additional costs that are not included in the cost of pickup and delivery and only reflect costs directly related to the delivery of goods (Joo, Keebler, & Hanks, 2013: 256).

Gross profit can be indicated by the difference in shipping costs per kilogram minus the amount of pickup and delivery costs with other costs. This indication is consistent with the definition of Gross Profit according to Joo, Keebler, & Hanks (2013: 256), that is income minus all registered expenses. Chargeable weight are shipping costs charged to customers per kilogram (Joo, Keebler, & Hanks, 2013: 256). These shipping costs can be set based on actual weight (actual weight) or dimensions. When costs are determined, the item will be first calculated and once it can be determined whether actual weight or dimensions are greater, the cost is calculated. In this study, all items are considered to be 1 kg. The target achievement is a percentage of services with targets provided to vendors (Haldar, et. 2017). The achievement of these targets is indicated by quality, delivery, performance history, procedural compliance, operating control, attitude, impression and reciprocal agreement.

The 6 vendors to be evaluated include V1, V2, V3, V4, V5, V6. Hence, the total number of vendors (m)=6. total number of input criterion (p)=3. Total number of output criterion (q) = 3. Total number of criterion (n) = $p+q$ = 6. TEcrs are the efficiency values of the Constant Return to Scale model and TEvrs are the efficiency values of the Variable Return to Scale model. This

value is processed using the input approach where the analysis aims to reduce input to improve efficiency. Furthermore, the efficiency value of the Constant Return to Scale model is divided by the efficiency value of the Variable Return to Scale model so that it gets the SE or Scale of Efficiency value. The SE value indicates the level of efficiency of each vendor. Vendors that have an SE value of one (1) indicate that the vendor has been relatively efficient. Meanwhile, vendors who have an SE value of less than one (<1) show less than optimal efficiency (Filardo, Negoroe, Kunaifi: 2017).

The number of existing vendors equals $F=6$ that evaluated and selected vendors was tested by carrying out a case study under multiple sourcing. First, the level of optimisation was applied using the DEA method and the output delineated efficient and inefficient vendors. Inefficient vendors with a score less than 1 are eliminated and efficient vendors will be continued to be processed using TOPSIS with a criteria score of 1.00. Table I below shows the output of DEA. Thus, efficient vendors are 2, 3,4 and 5, while inefficient ones include 1 and 6 with ascore less than 1. The normalised input performance values of efficient suppliers have been collected in Table II while weighted performance values are presented in Table IV.

Table 1: The DEA output

DMU	Vendors	Branch Hub	TEcrs	TEvrs	SE (TEcrs/TEvrs)
1	TEI	Medan	0.89	1	0.89
2	MTL	Medan	1	1	1
3	DAH	Jakarta	1	1	1
4	DER	Jakarta	1	1	1
5	TLC	Surabaya	1	1	1
6	MLC	Surabaya	0.88	1	0.88

Table 2: Performance values of efficient vendors for each criterion

No	Vendor	Coverage Area	P&D Expense	Other Expenses	Gross Profit	Chargeable Weight	Target Achieved
1	MTL	0,47	0,29	0,50	0,23	0,26	0,55
2	DAH	0,57	0,78	0,50	0,65	0,68	0,52
3	DER	0,59	0,38	0,50	0,72	0,68	0,40
4	TLC	0,33	0,41	0,50	0,02	0,11	0,52

Based on table I, 4 Vendors exist with an SE value of 1, which indicates that the collaboration between the company and four vendors can be classified as cooperation with maximum efficiency. Furthermore, based on the value on each vendor branch hubs, the Medan branch hub can use MTL vendors, Surabaya branch hubs can use TLC vendors and Jakarta branch hubs can use DAH and DER vendors.

TEI and MLC vendors have a Scale of Efficiency value of 0.89 and 0.88 which show that the value is below one (<1) indicating that co-operation between companies and vendors is classified as less efficient. Therefore, the Surabaya and Medan branch hubs are advised to provide guidance and consolidation with MTL and TLC vendors. Vendors who already have a maximum level of efficiency (MTL, DAH, DER and TLC), proceed to the TOPSIS stage to obtain vendor efficiency ratings based on the shipping route.

Table 3: The weighted normalised performance values of efficient suppliers for each criterion

No	Vendor	Coverage Area	P&D Expense	Other Expense	Gross Profit	Chargeable Weight	Target Achieved
1	MTL	2,07	1,22	0,79	1,07	1,16	2,69
2	DAH	2,53	3,35	0,79	2,99	3,02	2,51
3	DER	2,61	1,63	0,79	3,29	2,99	1,95
4	TLC	1,46	1,74	0,79	0,11	0,47	2,51

Considering the weighted performance values, the weighted normalised PTPK (Column 3) ranges from a value of 1.46 for Vendor TLC (lowest coverage) to 2.61 for Vendor DER (highest coverage); P&D Expense (Column 4) ranges from a value of 1.22 for Vendor MTL (offering the smallest expenses) to 3.35 for Vendor DAH (the largest expenses); Other Expense (Column 5) has the same value for each vendor 0.79; Gross Profit (Column 6) varies from 0.11 for Vendors TLC (the lowest profit) to 3.29 for Vendor DER (the highest profit); target achieved (Column 8) varies from 1.95 for Vendor DER (lowest percentage of target achieved) to 2.69 for Vendor MTL (highest percentage of target achieved); Chargeable Weight (Column 7) varies from 0.47 for Vendor TLC (lowest Chargeable weight) to 3.02 for Vendor DAH (highest chargeable weight).

Table 4: TOPSIS output with the closeness of efficient suppliers to the worst ideal solution

No	Vendor	Branch Hub	S_i^+	S_i^-	S_{iw}	Rank
1	MTL	Medan	3,29	1,83	0,36	3
2	DAH	Jakarta	0,65	4,83	0,88	1
3	DER	Jakarta	1,38	4,39	0,76	2
4	TLC	Surabaya	4,21	1,20	0,22	4

The results of the TOPSIS second-level optimisation are shown in Table V. The ranks of vendors are shown in the last column. With respect to TOPSIS ranking, vendor DAH is the most preferred, followed by DER, MTL and TLC. As a result, the best service provider is vendor DAH with the highest weight score of 0.88 compared to other vendors.

Conclusion

A systematic two-level hierarchical technique is proposed that uses the best of each method for evaluating and selecting vendors of logistic service providers in Indonesia. Firstly, DEA method was used to seclude inefficient and efficient ; second, TOPSIS method was implemented to recommend the best vendors based on rank. The approach used in this study can distinguish between efficient and inefficient vendors in a multiple sourcing context that provides other benefits such as avoiding confusion between efficient and effective LSP vendors . The hierarchical approach also avoids the drawbacks of the individual methods of DEA or TOPSIS: it overcomes the well-known inability for DEA to discriminate between efficient and effective vendors, as well as the TOPSIS method's difficulty in distinguishing between efficient and inefficient partners. Furthermore, a case study is reported to showcase the effectiveness of the two-step method.

In conclusion, evaluating and selecting a vendor can improve the decision-making process in an organisation regarding systematically structuring the framework by using the two-step hierarchical model . This study's main contribution is to provide an easy and flexible design that can be used to structure and solve problems of this kind. The study also tackles long term collaboration by limiting the number of vendors. Future research perspectives in this area may include recursive methodology and expanding the method to fuzzy techniques and combining it with the qualitative area. Real data for the case study was considered difficult to obtain and the requirements for input and output may not be useful to them. As a result , more experiments can be carried out with appropriate criteria and by using research surveys so further criteria can be obtained. In addition, an in-depth analysis should be performed to determine weights while using this method for specific sector. Failure to address these factors will affect the outcome for selecting the best vendor. This study makes a distinctive contribution, in terms of theoretical gains, by combining criteria and handling multi-item/multicriteria modelling using a two-step hierarchical model. The study provides a resource for supporting decisions for vendor business intelligence in further studies within the multiple sourcing strategy perspective.

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