Bayode Olusanya Babatunde, PhD
Department of Business Administration, Faculty of Management Sciences,
Osun State University, Nigeria
bayode.babatunde@uniosun.edu.ng

Adeniran Rahmon Tella, PhD
Department of Business Administration, Faculty of Management Sciences,
Osun State University, Nigeria
adeniran.tella@uniosun.edu.ng

Theophilus T. Onewo
Department of Business Administration, Faculty of Management Sciences,
Osun State University, Nigeria
theophilus.onewo @uniosun.edu.ng

EFFICACY OF SUPPLIERS PERFORMANCE EVALUATION IN A DYNAMIC BUSINESS ENVIRONMENT USING DATA ENVELOPMENT ANALYSIS (DEA)

Received: June 6, 2021
Accepted: November 4, 2021
https://doi.org/10.46458/27121097.2021.27.164

Review

Abstract

Supplier performance evaluation plays a vital role in the creating an effective business survival especially in pessimistic business environment. More also, evaluation of supplier performance is important for an enterprise to survive in a competitive local and global market. The study x-rays the benefit of data envelopment analysis in evaluating the performance of decision-making units (DMUs). DEA is a mathematical programming tool applied in performance measurement. A case scenario is presented to show the efficiency of the selected suppliers' selection and the most competent in ranking order. The DMUs results demonstrated that the model has the capacity to measure effectiveness, efficiency and most preferred supplier for business sustainability in an unstable business environment.

The DMUs model can be used by decision makers to select the most efficient and economical business partner (supplier) for business survival.

Keywords*: Supplier, Performance Evaluation, Data Envelopment Analysis model, decision-making units*

JEL: M20, M21, M31

1. INTRODUCTION

The business arenas where most of the organizations operate today require a critical study before a decision can be made. One of the areas of the decision is Supplier performance evaluation. Today, supplier performance is a major area of concern that needs to be reviewed periodically for organization to drive glowing amidst of other competitors. (Babatunde *et al,* 2015). Supplier performance evaluation is a system of examining the supplier's activities with an organization or client in terms of quality of material supplied, quantity, price, reliability, effectiveness, communication, time delivery. The right evaluation and selection of these factors are keen to organization success (Santoso & Besral, 2018).

Organisation needs to interact with suppliers to make sure that they have the best and quality materials at all time in the production centre. The capabilities of suppliers to satisfy these factors serve as key resources in the development of the buyer's own capabilities and dependability by the organization. The suppliers are therefore monitored by the companies in order to ensure improved proficiencies in their respective operations. The supplier debates are interestingly on the practices of supplier relationship management and greatly admired by practitioners and academicians. Managers have as a resulted of this realizes the need for the change to a more strategic relationship as against the traditional adversarial relationship (Morrissey & Pittaway, 2004; Veludo *et al*., 2004). An effective supplier performance measurement framework should be identified for easy adaptability, reliability, efficient and effective delivery, this allows the suppliers to get feedback and measure their performance.

Supplier selection has consequently become one of the most fundamental and important decision in the process of purchasing and procurement, due to the difficulty level involved in the multi-criteria decision-making process from drawing significant attention in the literature and practise (Boran, 2009). Evaluation of supplier is a major emphasis area in business today and since it has formed a major concern in business operations, and for business sustainability in the

present-day dynamic environment, organization needs to review it periodically. This study therefore applied Data envelope analysis to showcase the efficacy of supplier performance in a dynamic business environment.

2. LITERATURE REVIEW

Supplier Performance Evaluation

Supplier selection is the result of the efficiency and effectiveness of the policies and procedures that the Procuring and Disposing Entities adopt during supplier selection Basheka (2008). Kariuki (2013) quoting Chitkara (2005) posit performance as the level of achievement of a set expectation. Most famously used supplier performance indicators include the level at which quality is met by the supplier, cost expectation and time of procurement though suppler performance is in tandem with the pre-arranged goals or objectives which are the combinatory of the task parameters (Mutava, 2012).

Performance measurement as cited in Malik *et al (*2018) is important for all functional division in companies, especially operation management which directly impact on business in the process efficiency includes purchase and raw material inventory. Simple efficiency ratio, that is: Output/Input be measured on individual variable that is employee, supplier machine, and room.

A survey conducted by Business Day in 2011 indicated that the Nigerian banks supplier selection method has consistently being based on referrals, identifying employee contacts and local supplier on-board. This indicates that an informal sourcing practice which results into driving poor quality products and services into the financial supply chain. The Edcomm Group Banker's Academy (EBA) in 2011 for instance developed sets of courses on the essence of quality vendor selection for various Nigeria's financial services companies that can move organization toward goal accomplishment.

In the supplier evaluation process, the list of suppliers with their profiles is crucial and their various records of operations (Sari, 2019).); Competency – competency of the suppliers is required, Commitment - Supplier needs to provide evidence that it is committed to high quality standards, Cost – economic value of the supplier must be identified, Consistency – supplier ensure that it consistently provides high quality goods and services. Communication –Effective communication is highly required in this case for such to be qualified as a supplier.

3. EMPIRICAL STUDIES

Sipos (2019) Efficiency Analysis of Supplier Performance Measurement System, the study investigated the effects of the special, face to face supplier performance measurement system. The effects on different areas and the nexus with supplier in the aftercare period was examined in this study. The relation between the communication and reaction modes at the procurement side was also deeply discussed. The study found that in all industrial, non-industrial, service sectors there is a need for supplier evaluation, but it is necessary to set up a company or area specific evaluation criteria and system separately.

Momanyi and Munturi (2018) in their Paper Influence of Supplier Evaluation Criteria on Performance of Suppliers in Public Entities in Kenya A Case of Public Entities in Kisii County. The purpose of this study was to find out the influence of supplier evaluation criteria on performance of suppliers in public institutions in Kisii County. The study adopted descriptive research design. The study targeted all procurement departments in public institutions. The finding revealed that a positive and significant relationship between supplier evaluation criteria and supplier performance in institutions. Thus, increasing efficiency in supplier selection and evaluation criteria will result to increase supplier performance.

Santoso and Besral (2018). Their study examined the priority of criterial of evaluation and consistency of supplier performance. Analytical Hierarchy Process (AHP) was used to determine the priority of criteria, sub-criteria that compared global priority and the level of consistency. The order of importance of criteria on the results of this research is Quality (.290), an accuracy of delivery (0.279), price (0.238) and Service (0.193). The result also indicated that there is consistence in the respondents' answers based on the analysis.

Malik, Efendi S. & Zarlis. (2018). Data Envelopment Analysis (DEA) Model in Operation Management. The major objective of the study was to use DEA to test the relative efficiency of the academic departments in the faculty of economics of the State Agrarian University of Moldova. Twelve inputs and two outputs which strongly influence the efficiency of the academic departments were selected. Seventy-one lecturers formed the respondents. The period of the study was between 2009 – 2014. The department of foreign languages was the top performer while the department of economy and international economic relations had the lowest score. It was suggested that this department intensify their research and teaching activities.

Improving the procurement effectiveness of the supplier and getting collaboration fluency can be used through the buyer and supplier well managed partnership

(Grudinschi et al., 2014). One of the relevant procurement processes for a project to be successful is the selection of the most efficient supplier which integral for the supply chain effective management and suppliers have significant role in the overall performance of the project (Araújo et al., 2017; Rao et al., 2017).

Dey, Prasanta & Bhattacharya, Arijit & Ho, William. (2014) Strategic supplier performance evaluation: A case-based action research of A UK manufacturing organisation. This research proposes both leading factors (organisational practices, risk management, environmental and social practices) and lagging factors for supplier evaluation and demonstrated a systematic method for identifying those factors with the involvement of relevant stakeholders and process mapping. The integrated analytical model utilized in this study combines Quality Function Deployment and the Analytic Hierarchy Process method for suppliers' performance evaluation. The effectiveness of the method has been demonstrated through number of validations (e.g, focus group, business results, and statistical analysis). Additionally, the study reveals that enhanced supplier performance triggers a positive impact on operational and business performance of client organisation. Paranitharan, Azharudeen, Navas, and Abuthakeer (2014) in their study application of Data envelope analysis or Power Project Suppliers Performance Measurement in India'' demonstratedthe application of Data Envelopment Analysis (DEA) in evaluating the performance measures of suppliers in leading engineering firm in the energy sector. The performance indicators were revealed through DEA.

Mohanty and Gahan (2013). The study aimed at measuring supplier performance in terms of trust and commitment, effectiveness in aftersales services, technical competency, and responsiveness. This research work was carried out in the discrete manufacturing industry in India. It was concluded that manufacturing companies must include performance parameters like effectiveness in aftersales service, responsiveness of the supplier and trust and commitment of suppliers. If all these parameters are tested on suppliers and based on this supplier listing will be done, it would meet the organizational requirement and ultimately supply chain effectiveness.

Data Envelope Analysis (DEA) has been demonstrated a compelling technique to conquer the previously mentioned impediment. Narasimhan et al. (2001) proposed a procedure for viable provider execution assessment dependent on DEA. Prasad et al., (2012) created provider execution - proficiency score network utilizing DEA for recognizing likely providers for an organization. Radfar and Salahi (2014) utilized fluffy DEA for provider assessment and Preference Ranking organization Method for Enrichment Evaluation (PRoMETHEE) model for provider determination.

Simpson, Penny & Siguaw, Judy & White, Susan (2002). Measuring the Performance of Suppliers: An Analysis of Evaluation Processes. The result shows that less than half of the responding firms have a formal supplier evaluation process in place, and that quality, supplier certification, facilities, continuous improvements, physical distribution factors, and channel relationship factors were the factors most commonly included in supplier evaluation programs.

Materials and Methods

In this study the best supplier was selected by using Data Envelopment Analysis (DEA). Still rolling company Osogbo was selected to evaluate their suppliers' performance. It is a "data oriented" approach for evaluating the performance of a set of peer entities via decision making units (DMUs) which convert multiple inputs into multiple outputs. The population considered was regular suppliers for the past five years in the company.

Suppliers Performance Parameters used in this study

Different measurement was used to evaluate the performance of five selected suppliers. The first Metric indicator is cost (Co1 - Co5) as input and supply variety and quality of good supplied as outputs). Another metric indicator of suppliers' performance is commitment to quality (Co6 - Co10) as input and quality of good supplied as outputs). Lead time, Trust and communication (C11 – C15) indicators as input and quality of good supplied, time to market and customer satisfaction as outputs).

There are two types of linear programming used to evaluate the performance of DMUs in this study. The first method is BCC model by Banker, Charnes dan Cooper (1984), which described the resources to be used to get the optimal result and CCR model by Charnes, Cooper dan Rhodes (1978). which defined the relationship between performance and variables INPUT – OUTPUT. Taking into consideration that the primary data used in the assessment are categorical obtained according to the Likert scale (Co1 – Co15). Malik, Efendi, and Zarli (2018) explained that efficiency of the decision-making units (DMU) can be defined as a weighted sum of outputs over the weighted sum of inputs as shown in the equation:

$$SE_0(u, v) = \sum_r OU_P \, y_{r0} \,/\, \sum_r IN_P \, x_{io} \qquad (1)$$

Where
SE_0 : Supplier efficiency
OU_p : weight attached to the output, r = 1,2 3.
IN_p : weight attached to the input, i = 1, 2, 3.

$$\min \varepsilon SEo - \varepsilon \left(\sum_{i=1}^{5} s_i^- + \sum_{r=1}^{3} s_r^+\right) \quad (2)$$

Subject to:

$$\sum_{j=1}^{5} x_{ij} \beta_j + s_i^- = SE\, x_{i0} \quad (3)$$

$\beta_j \geq 0, j = 1, 2, 3, 4, 5.$

For the BCC model:
Where: s_i^- and s_r^+: are slack variables used to convert the inequalities to equiva
SEo is the radical (input reducing) measure of technical efficiency (Kao, 2008).

Input

- Lead time x_1
- Quality /Cost of material supplied x_2
- Trust / reliability x_3

Output

- Quality products (y_1)
- Customer satisfaction (y_2)
- Time to market (y_3)

Table 1: Performance Indicators measurement

Performance Variables	Output
Quality of Materials Variable	Quality Products (%)
Operational Performance Variable	Customer Satisfaction (%)
Trust and communication Variable	Time to Market (Delivery) (%)

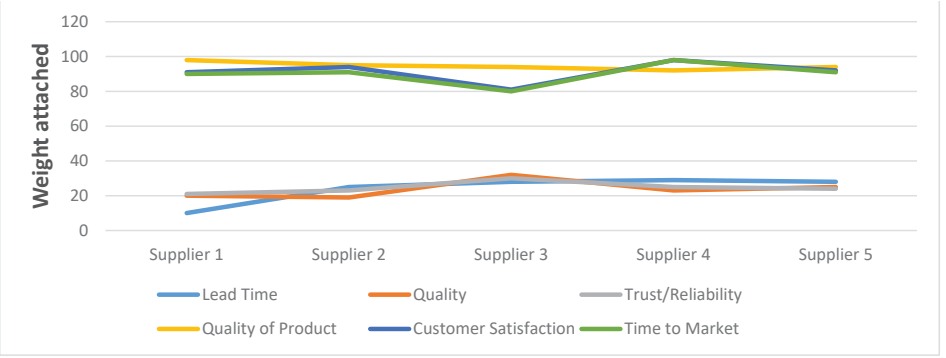
Table 2 show inputs and outputs data from 5 DMUs. These data were analyzed using BCC model and linear programming model was used to run the analysis (LINDO software)

Table 2: Data Obtained

DMU	X_1	X_2	X_3	Y_1	Y_2	Y_3
1	10	20	21	98	91	90
2	25	19	23	95	94	91
3	28	32	30	94	81	80
4	29	23	25	92	98	98
5	28	25	24	94	92	91

Source: Researchers' computation, (2021).

Figure 1. Graphical representation of performance flow measurement.



Source: Researchers' computation, (2021).

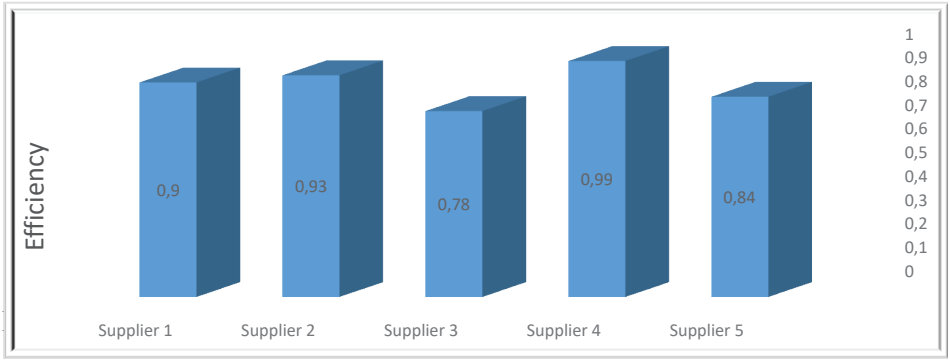
This figure 1 denoted the relationship between performance indicators measurement of the selected suppliers as lead time, quality of material supplied and trust/reliability with performance output in term of quality of product produced, customer satisfaction and time to market. The relationship is so keen and strictly associated.

Table 3: DEA Efficiency

Suppliers	Compressed DEA		
			Efficiency (
S1	0.1907	0.1716	0.90
S2	0.3117	0.2812	0.93
S3	0.1295	0.1026	0.78
S4	0.2639	0.2815	0.99
S5	0.2131	0.2160	0.84

Source: Researchers' computation, (2021).

Figure 2 depicts the DEA efficiency of the suppliers. From the table 3, the supplier with higher efficiency (ie. supplier 4) is selected as best supplier. For this case study supplier 4 is selected as best supplier.



Source: Researchers' computation, (2021).

In this study, DEA efficiency is described in figure 2. The information provides additional information to the results in table 2. The most efficient supplier based on the quality of materials, operational Performance of the material supplied, trust and level of communication is supplier four (S4) with 0.99. The value to the least supplier is 0.78 supplier 3.

4. CONCLUSION

Decisions of evaluation and selection of a supplier is an important part of upstream distribution management. In today's business arenas, supplying high quality products with minimum cost provides optimal result for effective operational performance of an organisation. Trust and regular communication between the supplier and organisation make supplier to be resourceful among others especially in a competitive business environment. DEA aids to evaluate and compare suppliers using different criteria which can offer a more robust tool to select right supplier. The results revealed that supplier 4 has the most efficient operations with highest level of trust, reliability and quality of product supplied to the market. Regular communication between the supplier 4 and the organization resulted to operational efficiency and customer satisfaction. Future study should embrace comparative analysis of suppliers performance evaluation among service and manufacturing companies. The scope of this study can also be distended to cover more suppliers in manufacturing industry.

REFERENCES

1. Araújo, M. C. B., Alencar, L. H., & Miranda Mota, C. M. (2017). Project procurement management: a structured literature review. *International Journal of Project Management*, 35(3), pp 353-377.
2. Babatunde B., Bamiduro J., & Gbadeyan R. (2015). Supply chain management practices and market performance: Evidence from selected major marketers of petroleum products in Nigeria. *The Pacific Journal of Science and Technology 17* (1), pp129-139.
3. Banker, R. D., Charnes, A. & Copper, W. W. (1984). Some model for estimating technical and scale inefficiencies in data.
4. Basheka, B. C. (2008). Procurement planning and accountability of local government procurement systems in developing countries: evidence from Uganda.
5. Boran, F.E. (2009). A multi-criteria intuitionistic fussy group decision making for supplier solution with TOPSIS method. Expert systems with Application. *Journal of scientific research*, 36, 11363-11368.
6. Charnes A, Cooper W W, & Rhodes E (1978). Measuring the efficiency of decision making units. *European Journal of Operational Research*, 2, pp 429–444.
7. Chitkara, K, K. (2005) Construction Project Management: Planning, Scheduling, and Controlling. Tata McGraw Hill Publishing Company Ltd.
8. Dey, Prasanta., & Bhattacharya, Arijit., & Ho, William. (2014). Strategic supplier performance evaluation: A case-based action research of A UK manufacturing organisation. *International Journal of Production Economics.* 10.1016/j.ijpe.2014.09.021
9. Grudinschi, D., Sintonen, S., & Hallikas, J. (2014). Relationship risk perception and determinants of the collaboration fluency of buyer-supplier relationships in public service procurement. *Journal of Purchasing and Supply Management,* 20(2), 82-91. http://dx.doi. org/10.1016/j.pursup.2014.03.004.
10. Kariuki, J.N. (2013). The effect of strategic innovation on performance of mobile telecommunication firms in Kenya. *Inf0rmati0n Sciences*, 8(2), pp 811-818.
11. Malik, M., Efendi, S. & Zarlis, M. (2014). Data envelopment analysis (DEA) of model in operation management 4th International conference on operational research of publishing material science and engineering 300
12. Morrissey, B., & Pittaway, L., (2004). A study of procurement behaviour in small firms. *Journal of Small Business and Enterprise Development*, 11(2), pp 254-262.

13. Mohanty, M. K., & Gahan, P. (2013). Supplier performance measurement in discrete manufacturing industry-empirical study on Indian manufacturing sector, *Journal of Business Economics and Management* 14(2), pp 330–347.
14. Momanyi A.N. & Munturi W. (2018). Influence of Supplier Evaluation Criteria on Performance of Suppliers in Public Entities in Kenya A Case of Public Entities in Kisii County *International Journal of Social Sciences and Information* Technology issn 2412-0294 iv(x), 217-226.
15. Narasimhan, R., Talluri, S., & Mendez, D. (2001). Supplier evaluation and rationalization via data envelopment analysis: an empirical examination. *Journal of Supply Chain Management*, *37*(2), pp 28-37.
16. Paranitharan, K. P., Azharudeen, J. M., Navas, R. K., & Abuthakeer S. S. (2014). Application of Dea for project supplier performance measurement in India – A case annals of faculty of engineering Hunedoara. International Journal of Engineering. Tome XII (August) ISSN: 1584-2673 101-108
17. Prasad, K. G. D., Subbaiah, K.V., Ra0, C. V. G., & Ra0, K.N. (2012). Pr-0vider assessment thr0ugh inf0rmati0n envel0pment examinati0n. Diary 0f Supply Chain Management Systems, 1(2), pp 1-11.
18. Radfar, R., & Salahi, F. (2014). Evaluation and ranking of suppliers with fuzzy DEA and PROMETHEE approach. *International Journal of Industrial Mathematics*, *6*(3), pp189-197.
19. Rao, C., Xiao, X., Goh, M., Zheng, J., & Wen, J. (2017). Compound mechanism design of supplier selection based on multi-attribute auction and risk management of supply chain. Computers & Industrial Engineering, 105, pp 63-75.
20. Santoso. D. & Besral, A.M. (2018). Supplier performance assessment using analytical hierarchy process method. *Journal of synergy*, 22 (1) 37-44. Doaj. org/toc/2460-1217
21. Simpson, Penny & Siguaw, Judy & White, Susan (2002). Measuring the Performance of Suppliers: An Analysis of Evaluation Processes; *Journal of Supply Chain Management* 38, 29 - 41 DO – 10.1111/j.1745-493X.2002. tb00118.x JO –
22. Sipos, (2019). Efficiency Analysis of Supplier Performance Measurement System Pollack Periodica; *An International Journal for Engineering and Information Sciences* DOI: 10.1556/606.2019.14.3.22 14(3), pp 235–246
23. Sirbu, A., Cimpoies, D, & Racul, A. (2016). Use of data envelopment analysis to measure the performance efficiency of Adelademu Department. *Journal of Agriculture and Agricultural science proceeding* 10 (2016), 578-585.

24. Veludo M., D.K. Macbeth & S. Purchase, (2004). Partnering and relationships within an international network context. Int. Market. Rev., 21(2), pp 142-157.
25. Sari, J. (2019). Carter's 10 cs of supplier evaluation. Retrieved May 30th, 2021 from toolsher; https://www.toolshero.com/strategy/carters-10-cs-of-supplier-evaluation
26. The Edcomm, (2011). Edcomm Group Banker's Academy log onto www.bankersacademy.com.212.631.9400.

Bayode Olusanya Babatunde, PhD
Department of Business Administration, Faculty of Management Sciences,
Osun State University, Nigeria
bayode.babatunde@uniosun.edu.ng

Adeniran Rahmon Tella, PhD
Department of Business Administration, Faculty of Management Sciences,
Osun State University, Nigeria
adeniran.tella@uniosun.edu.ng

Theophilus T. Onewo
Department of Business Administration, Faculty of Management Sciences,
Osun State University, Nigeria
theophilus.onewo @uniosun.edu.ng

UČINKOVITOST OCJENE PERFORMANSI DOBAVLJAČA U DINAMIČKOM POSLOVNOM OKRUŽENJU KORIŠTENJEM ANALIZE OMEĐIVANJA PODATAKA (DEA)

Primljen: 6. lipnja 2021.
Prihvaćen: 4. studenog 2021.
https://doi.org/10.46458/27121097.2021.27.164

Pregledni rad

Sažetak

Procjena performansi dobavljača igra vitalnu ulogu u stvaranju učinkovitog poslovnog opstanka, posebno u pesimističkom poslovnom okruženju. Štoviše, procjena performansi dobavljača važna je za opstanak poduzeća na konkurentnom lokalnom i globalnom tržištu. Studija rendgenski pokazuje korist od analize omeđivanja podataka (DEA) u ocjenjivanju izvedbe jedinica za donošenje odluka (DMU). DEA je matematički programski alat koji se primjenjuje u mjerenju performansi. Predstavljen je scenarij slučaja koji pokazuje učinkovitost odabira odabranih dobavljača i onih koji su rangirani kao najkompetentniji. Rezultati DMU-a pokazali su da model ima sposobnost mjerenja efektivnosti, učinkovitost, efikasnost i najpoželjnijeg dobavljača za održivost poslovanja u nestabilnom

poslovnom okruženju. Model DMU-a mogu koristiti donositelji odluka za odabir najučinkovitijeg i najekonomičnijeg poslovnog partnera (dobavljača) za poslovni opstanak.

Ključne riječi*: dobavljač, ocjena učinkovitosti, DEA, jedinice za donošenje odluka*

JEL: M20, M21, M31