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Service operations efficiency and competitive orientations in the telecommunication industry: a data envelopment analysis approach

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Abstract Customers service centres have become a veritable tool for connecting with subscribers and projecting distinctive capabilities in competition in the telecommunication industry. Consequently, operational efficiency of these units is an essential variable in the design and adoption of cost leadership and differentiation strategies. This study is based on data obtained from twenty-five (25) customers service centres spread across four telecommunication service providers. Data envelopment analysis methodological approach was utilized to estimate efficiency of these service centres, types of scale and identify critical resources for improving performances. Results indicate an average technical efficiency scores range of 50.5%-80.2%, suggesting substantial waste of resources and weak capacity for pursuit of cost leadership strategy with scale efficiency scores range of 60.5%-86.4%. The study also found that 36% of these facilities are operating under increase returns to scale (IRS) regime, 40% (decreasing returns to scale, (DRS) and 24% under constant returns to scale regime. Furthermore, customers service personnel were identified as critical input variable to be given pre-emptive priority to change to enhance operations and capacity to strive for cost leadership, therefore, it is suggested that telecommunication firms invest more resources on technology to enhance capabilities of the service personnel for improved efficiency as well as for effective pursuit of cost leadership and differentiation strategies.

Keyword: Cost Leadership, Differentiation, Efficiency, Customers Service, Data Envelopment Analysis, Scale.

1 Introduction

Emerging competitive dynamics in the Nigerian telecommunication industry demand assortment and variation of tactics that align with subscribers' culture and shifting sophistications of their lifestyles. It has become more evident that competing firms require

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strategic thinking and proactiveness in their operations, and tactical approach that modify service operations in order to retain subscribers and sustain their loyalty. Strategic thinking in operations have become essential tools for sustained competitive advantage in the industry. On this wise, Porter's model of competitive strategies, which combines competitive advantage and competitive scope dimensions, is an intuitively attractive framework to guide thinking for strengthened operations.

Cost leadership and differentiations are two of the strategies indicated in Porter's model. Low cost strategy requires efficient economies of scale in production or service to secure comparatively lower prices than competitors. Differentiation is the ability to provide unique and superior value, product quality, special features and customers service or after-sales-service. Organisational adaptations of these strategies demand creativity in internal operations and competitive conduct. It requires developing capability by configuring and building an excellent network in accordance with market demand and product configuration strategy to create successful pattern of operations [1].

Quest for competitive edge demand that firms adopt tactics that enable them to function at higher levels of efficiency in their operations [2]. However, competitive advantage is built on something distinctive that a firm has, and the ability to sustain competitive advantage is key to success in the marketplace [3]. Customers service centres have become a vehicle for connecting with subscribers and projecting distinctive capabilities in competition in the telecommunication industry. A noticeable feature, however, is that effective management of these centres has become complex and challenging as a result of varieties of services demanded by customers, advances in information communication technology, cultural sensitivity of customers and activities of customers advocates. Customers retention, satisfaction and loyalty are thought to be enhanced by support system offered by customers service centres [4]. Thus, customers service centres play vital role in ensuring service providers competitiveness and success through building long term relationship with customers, the provision of information and resolving problems.

People, knowledge and talent are germane in customers service centres operations. It is of benefit that the operations manager maintains a balance of people, process and technology for effective results. The argument is that excellent customers service orientation and customers centred culture create competitive advantage [5]. Efficiency of customers service is advantageous to service providers because of resource savings and enhanced capacity to extend demand-responsive services to more customers. Therefore, operations of customers service centres, potentially, have implications for both cost leadership and differentiation strategies. Cost leadership demand cost savings, waste reduction, elimination and avoidance of redundancy in business processes, and these are the central theme in efficiency [6]. Operational efficiency is germane in the face of strong competition, turbulent and unstable market that stems from prompt technological development [7]. Internal structure and processes need to focus on maximally achieving objective while offering quality in value addition to shape competitive orientation: enhance lower service costs and differentiation of firm's offerings in terms of uniqueness and superior value.

The focus of the present research is to estimate the operational efficiency of customers service centre of four telecommunications firms located in the same geographical environments as well as identify critical resources for improving performances of these service centres. The current effort is intuitively useful given the existing competition, 'liability of obsolescence' and difficulty service organization encounter in improving operations effectively while securing substantial cost savings without compromising quality [7,8]. Empirical evidences of the performance of these customer service centres will add to

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the literature and guide management in choice of critical resources for securing the edge in competition and increasing in profit. A framework grounded in prudential principles of increased productivity and efficiency is required to increase organizational performance and compete in a turbulent and technologically active business environment.

2 Service production in the customers service support system

2.1 Customer service support system

A customer's service support system could be defined as comprising all organisational resources that are devoted to producing customers care actions. The customers service centre provides an organised environment for providing customers care services. And, customers care services is defined as any effort, whether in personal care or through intersectoral initiatives that are focused primarily on promoting, restoring or maintaining customers service or product experience. Therefore, customers service support system can be described as a production entity consisting of components or subdivisions oriented towards improvement of customers satisfaction or service experience. On this level, the customers service centre and services are considered as parts of the input domain in the customers services support system.

2.2 Service production process

The implication of the foregoing is the need to define the boundary of the customers support system as a production entity. Therefore, within the purview of production theory, resources within the boundaries are customers care resources which constitute the systems inputs used to provide care services in order to improve customers experience. Customers care or support actions of the system produces outputs which are expected to produce a change in customers experience and satisfaction. Azeem et al. argued that to achieve long-term success in an environment characterised by intense competition, organisation need to prioritise accelerating the organisational capabilities driven by "knowledge and innovation" in order to maintain competitive advantage [9]. Hayes, asserted that when firms focuses on the needs of its clients, and connect with them those clients are more likely to be pleased with the service they get and more likely to recommend to other potential clients [10]. Therefore, a customer's service orientation establishes both the perception and the reality of greater value in the market with regard to the goods and services offered.

Microeconomic theory of production provides the framework for our evaluation of local efficiency of customers care facilities where resources utilized in the production process are transformed or converted into desirable outputs [11]. According to Banjoko, production is primarily concerned with the transformation or conversion of inputs into finished goods and services [12]. However, in broad operations management sense, production process may take a variety of forms: manufacturing, services, transportation and supply [13]. Resources inputs and outputs are flows [14], that is, a certain amount of inputs used overtime to generate varying output quantities.

2.3 Cost leadership and differentiation strategy

Porter's 1980s extant literary work on generic strategy framework enjoy wide applications probably due to its link with the firm's performance and overlap with other typologies [7].

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The framework identified generic strategies adaptable by firm to compete as cost leadership, differentiation and focused strategy. Cost leadership involves seeking competitive advantage through cost minimization, operation is made more economical and costs are kept low to gain dominance in competition by offering lower prices to consumers [15]. Cost leadership approach is of much prominence in price sensitive economies more common in transition economies [16]. Differentiation strategy seeks competitive leadership through unique products or services, inputs and superior human resource activities which culminates in customers loyalty and willingness to pay for value. Differentiation of products or services expresses the creativity within the enterprise and capacity to offer unique, sometimes, difficult to imitate products or services [17] The firm is able to leverage of her uniqueness for competitive advantage.

2.4 Data envelopment analysis

Data envelopment analysis has emerged as one of the most popular approaches for performance measurement in service organisations with significant applications in both profit and non-profit making in contemporary public and private organisations [18]. It has been applied with credible results in different domains since its emergence: health [19-21] education, financial institutions [22-24], Insurance [25], energy efficiency [26], suppliers' selection [27] military units, hotels, courts, telecommunication sectors among others [28]. The appeal of this methodological approach to efficiency measure derives from its ability to handle multi-inputs and multi output situations by reducing these to the single 'virtual' input and single 'virtual' output irrespective of differences in measurement units and the requirement for standardization [29]. It has remained a veritable tool for estimating multi-product technology functions and to assess the managerial performance of selected decision-making units that utilizes multiple resources in turning out multiple products [30].

The approach estimates production frontiers and efficiency measurement using linear programming techniques rather than regression [31]. It constructs a piece-wise linear production frontier based on observed best practice. Charnes et al. proposed a model that assumes constant returns to scale (CRS) to derive global technical efficiency of the units in relations to others. This can be decomposed into pure technical efficiency and scale efficiency [30]. However, the model's assumption is considered rather restrictive because it is unlikely that constant returns to scale will apply globally [32]. Banker, et al modified the original DEA model for technologies exhibiting variable returns to scale at different points on the production frontier [33]. Thus, Banker et al.'s model measures pure technical with scale efficiency being the ratio of the output of Charnes et al.'s model and Banker et al. [34].

Data envelopment analysis (DEA), typically, establishes a best practice group and quantifies the amount of potential improvement possible for each inefficient unit, that is, DEA indicates the level of resources savings and/or services improvements possible for each inefficient unit. It circumvents the problem of specifying the explicit form of the production function [35, 36]. Instead, the best practice function is built empirically from observed inputs and outputs [37]. The comparability of the performance of among decision making units in data envelopment analysis facilitates forming a cone on peers. Peers are the firms or decision-making units that are on the frontier or the best performing practice frontier. These firms are used as the reference of comparisons for inefficiently performing firms.

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3 Materials and methods

The study utilized a cross sectional research design to collect data for estimating relative efficiency of the customers service centres. Data were collected from 25 customers service centres spread across four main telecommunications service providers in Lagos, Nigeria. Besides ownership, management styles and practices which display variations, range of services offered, service environment and social and economic characteristics of customers in these centres are similar. The choice of Lagos is justified on the premise on active subscribers, presence of major networks customer service centres and active competition between these firms in the market domain.

Three input resources and output, for which complete data were obtained, were utilized in the Data envelopment analysis model. Inputs to the model include the number of the human elements or personnel in the service delivery in each service centre (this was not classified into categories: managerial, technical or clerical staff). Operations in the customers service centre are dependent on a mix of personnel who are emotionally intelligent to preserve the reputation and image of their organisations while handling the array of unexpected and divergent behaviours of the clients. Therefore, investments in trainings of these personnel were included as an input variable in the model; and expenditures on technology deployed in the service centre. Furthermore, to preserve homogeneity, a main requirement in data envelopment methodology, the model is limited to similar services provided in these customers service centres across the telecommunication providers. The model's output variables consist of numbers of clients, cases resolved at the centre, and innovations in service orientations at the centre. The model was utilized for the computation of the technical and scale efficiency of these facilities and nature of scale efficiency. Further analysis sought to identify resources that can be considered critical in improving performances of these service centers.

The study utilized both Charnes et al (constant returns to scale) model [30] and Banker, Charnes and Cooper (BCC) [33] or variable returns to scale model to assess efficiency of these service centres.

In the dual form, the models are of the form below:

$$
\begin{aligned}
&\text{(Objective function) Min } \theta_0 \lambda_o \\
&\quad s.t. \\
&\sum_{n=1}^{N} y_{nj} \lambda_n \geq y_{oj},\ j = 1, 2, \ldots m, \text{(Output Constraint)} \\
&\theta_0 X_{oj} \geq \sum_{n=1}^{N} X_{ni} \lambda_n, i = 1, \ldots, N, \text{(Input Consttraint)} \\
&\sum_{n=1}^{n} \lambda_n \leq 1 \qquad \text{(Scale Constraint)} \\
&\lambda_n \geq 0, n = 1, \ldots, N, \ \left(\text{Non} - \text{negativity Constraint}\right)
\end{aligned}
\tag{1}
$$

The variable returns to scale frontier [33]; (the BCC Model) is obtained by substituting the scale constraint of the linear program $\sum_{j=1}^{n} \lambda_j = 1$ in model (1).

The study is also interested in the sensitivity of customers service centre's efficiency status to changes in individual input values. This is to guide managerial actions that will not

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jeopardize specific operation. Therefore, using Chen and Zhu's approach, model (2) is applied to examine the sensitivity of the efficiency status of individual centre to changes in inputs [38].

Min Z_k
s.t.

$$\sum_{\substack{j=1 \\ j \neq 0}}^{25} \lambda_j X_{kj} \leq Z_k X_{ko}$$

$$\sum_{\substack{j=1 \\ j \neq 0}}^{25} \lambda_j X_{ij} \leq X_{io} \qquad i \neq k \tag{2}$$

$$\sum_{\substack{j=1 \\ j \neq 0}}^{25} \lambda_j y_{rj} \geq y_{ro}$$

$$\sum_{\substack{j=1 \\ j \neq 0}}^{25} \lambda_j = 1 \qquad -\text{VRS Constraints}$$

$\lambda_j \geq 0 \; \forall_j = 1, 2, \ldots, 25$ Non Negativity Constraint

Consequently, we are able to identify the system's inputs that are critical measures of performance.

4 Results and discussions

The following section presents the summary statistics of efficiency estimates of the customers service centres across the telecommunications providers. The average of the technical and pure technical efficiency estimates are presented with the scale efficiency estimates against service providers in Table 1.

Table 1 Average efficiency of customers service centres by Telecommunication service providers

Variables	M	G	A	N
Technical	.699	.620	.802	.505
Pure Technical	.802	.854	.908	.811
Scale	.864	.723	.864	.605

NB: M. G, A, N (The identity of these firms which are veiled in this study can be obtained from the author)

Technical efficiency, which indicates customers service centers' success in producing maximum output from a set of inputs or the overall efficiency of these facilities for each of the telecommunications providers show under-performance across the four service providers. The result compares with an earlier study by Ibidunni et al. [39]. On the average, the technical efficiency scores ranged from 50.5%-80.2%. This suggests substantial waste of resources with the average wastage in resources reaching almost half of the current resources been utilized 49.5% by N. The best performing service providers, in term of the customers service centres

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network, indicate an average resource loss of 19.8%. The result, however, is consistent with what exist in an earlier study [40]. These resources wastages are substantial enough to, potentially, constrain capacities for service expansion with the inefficiency been passed over to subscribers.

In theory, the technical efficiency model or constant returns to scale assume all the customers service centres are operating at optimal scale; and a production process in which the optimal mix of inputs and outputs is independent of the scale of operations however, it is more unlikely this holds for all the facilities. Therefore, technical efficiency scores derived from the CRS model were decomposed into components: scale inefficiency and pure technical efficiency. The pure technical efficiency (PTE) or variable returns to scale which assumes the performance of each customers service centres being dependent on their scale of operations is indicated.

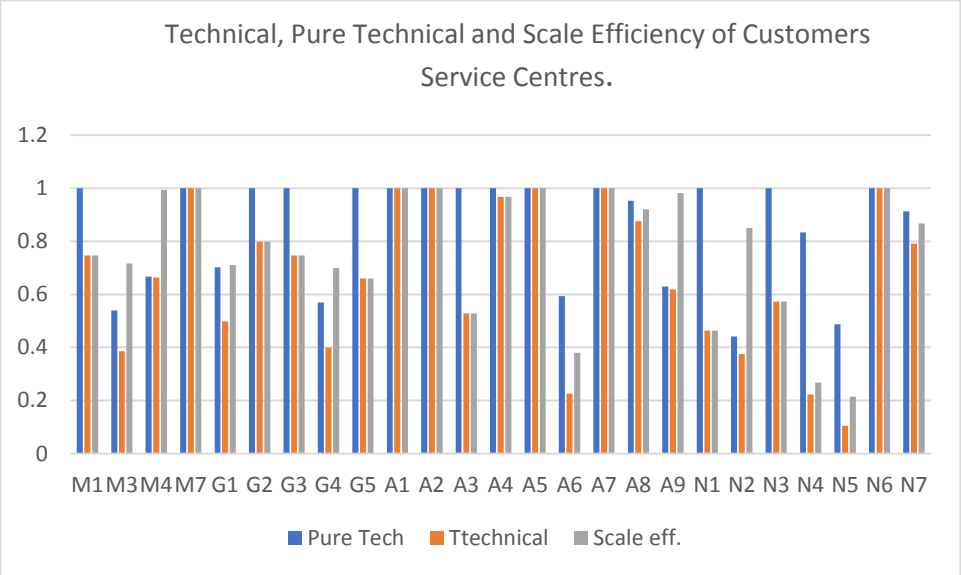


Fig. 1 Efficiencies

Figure 1 shows the PTE and SE average scores for all the customers service centres. In general, these facilities were more 'pure technically efficient' than 'scale efficient'. The Scale efficiency measures organizational success in choosing an optimal set of inputs with a given set of input-output prices or costs. The nature of the pure technical efficiency could be due to high level of concentration of the service centres and the lack of competition since subscribers that are locked-in with a provider would have to use their customers service centre. It is suggested that market power and concentration would lead to inefficiency because on the absence on incentives to minimize wastages [41]. The variation in efficiency with respect to the scale of operations, which is related to economies of scale, gives an average of scale efficiency scores range between 60.5%-86.4%.

A beak down of the overall pattern of scale efficiency of these customers service centres (Fig 2) indicate that about 36% of these facilities are operating under increase returns to scale (IRS) regime, 40% with decreasing returns to scale (DRS) and 24% with constant returns to scale (CRS). Comparatively, in the line of earlier studies [40, 42] the market leaders, providers M and G have more of their facilities under the decreasing returns to scale regime. However, we may plausibly infer possible reasons for the scale efficiency scores of the A and N to their relatively lower coverage, small average asset size and their relatively 'troubled'

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history. This relates to Maharazu, et al study that hinged the poor performance on indicators such as call drop rate, call set success rate and channel congestion. The service centres operating under constant returns to scale had no scale inefficiency; and, in all, 76% of the customers service centres are not operating under the most productive scale size.

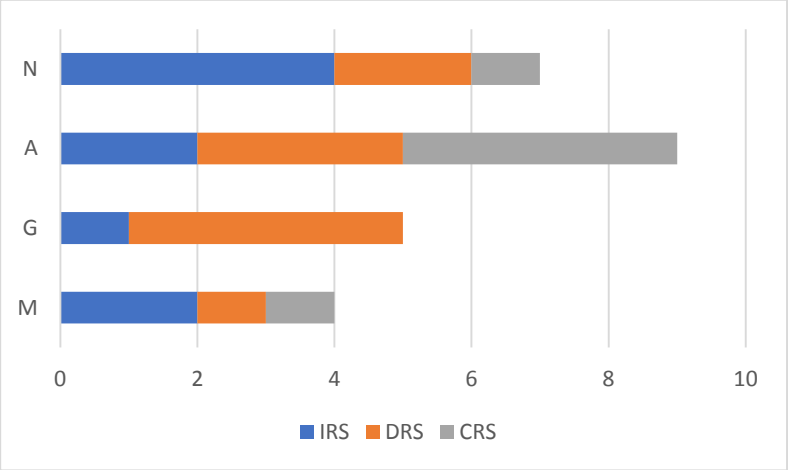


Fig. 2 Scale type by Telecomm providers

These have consequences both for competition and cost burden subscribers may have to bear. Perhaps, the nature of economies of scale provides insight to the competitive tactics and conduct in the telecommunication sub sector.

4.1 Identifications of critical resources

It is reasonable that management or decision makers in these customers service centres be interested in sensitivity of each centre's efficiency status to changes in individual input values, this information is useful to inform managerial actions that will not jeopardise specific centre's operations. Further analysis identifies resources in each centres that management need to maintain the best practice for the efficient care centre and best practice for the inefficient ones. Resources whose changes in value affect performance are considered critical. Results in Table 2 indicate 8 or 32% of the customers service centres spread across the telecommunications providers indicates 'infeasible' for the three inputs suggesting that the magnitude of these inputs have nothing to do with their efficiency status. These inputs cannot be considered as critical to their efficiency status of these centres because changes in these inputs do not change their efficiency classification. This result suggests that some measures must be considered in groups for these sets of service centres.

70.5% of the service centre show that inefficiency exists in personnel input; and Personnel is considered as critical measures for these facilities because their efficiency status can be improved if this input is given pre-emptive priority to change. It will be required to decrease personnel input in these facilities in order to reach the performance frontier.

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Table 2 Critical measures of customers service centre's performance

Centres	Personnel	Training	Techin	Crit Measure	Centres	Personnel	Training	Techin	Crit. measure
M1	Infeasible	Infeasible	Infeasible		A5	1.30872	Infeasible	1.67403	Techin
M3	0.53132	0.06141	0.02135	Personnel	A6	0.23406	0.11294	0.5932	Techin
M4	0.59043	0.04183	0.32198	Personnel	A7	2.49322	Infeasible	Infeasible	Personnel
M7	Infeasible	Infeasible	Infeasible		A8	0.94723	0.22237	0.5315	Personnel
G1	0.68813	0.025	0.0125	Personnel	A9	0.54874	0.03634	0.27233	Personnel
G2	Infeasible	Infeasible	1.90492	Techin	N1	Infeasible	Infeasible	5.31972	Techin
G3	Infeasible	Infeasible	Infeasible		N2	0.41385	0.06	0.02708	Personnel
G4	0.45287	0.11465	0.09709	Personnel	N3	1.75491	Infeasible	Infeasible	Personnel
G5	1.10056	Infeasible	Infeasible	Personnel	N4	0.83333	0.24542	0.70833	Personnel
A1	Infeasible	Infeasible	Infeasible		N5	0.40742	0.42857	0.25	Training
A2	Infeasible	Infeasible	Infeasible		N6	Infeasible	Infeasible	Infeasible	
A3	Infeasible	Infeasible	Infeasible		N7	0.88068	0.44651	0.66568	Personnel
A4	Infeasible	Infeasible	Infeasible						

The critical nature of personnel input is, however, expected because customers service revolves around frontline personnel-customers interactions; expectations are created and interpreted [43] However, four of the service centre have technology investments as a critical measure of their performance (G2, N1, A5, A6) while only one service centre (N5) indicate that inefficiency exist in training investments. Expectedly, inefficiency in the trainings will indicate customers service personnel low ability in performing service related duties, which potentially jeopardize the purpose of the centre, image and reputations of the firm [44]. Deficiency in technology and trainings will negatively impact on organizational environment and contextual variables that sustain work behaviour for effective customers service

5 Managerial implications

The telecommunications industry remains a growth industry; however, it is faced with several operational challenges which impede efficient operations in developing countries. Some of these challenges are regulatory and institutional; however, competition and profit motives demand that firms in the industry orient their operations to efficient and prudential principles of resource management. The scale inefficiency patterns suggest the need for managerial action in terms of planning and examination of managerial failures. One plausible managerial action is to downsize service centres exhibiting decreasing returns to scale in order to shift resources towards those facilities under increasing returns to scale in order to yield efficiency gains in operation. The result will be enormous industry resource savings that could be employed profitably in the industry to expand facilities or deployed to strengthen the market position of the telecommunication provider.

Analysis of operations of the customers service centres decomposed their efficiencies to pure technical and scale efficiency: the generally low efficiency scores are related to input wastage. The scale efficiency in two or three of the firms been lower than pure technical efficiency (PTE) suggesting existing inefficiencies are related to scale. Comparatively, firm‘A’ customer’s service centres over-performed other firms in terms of pure technical (PTE) and technical efficiency (SE) and only at par with one of the firm in scale efficiency scores. A

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policy implication that the firm's customers service centres' managerial approach can be benchmarked by others to improve and enhance the industry performance, and hedge against passing the costs of providers inefficiency on subscribers.

Further analysis identifies resources in each centres that management need to maintain the best practice for the efficient as well as for the inefficient centres. These resources are critical to improving performance of the service centres and management can integrate this information to modify their approaches and competitive orientations. In line of expectations, personnel are indicated as a critical resource useful to inform managerial actions in 50% of the service centres. This has implication for policy to improve efficiency and guide strategic thinking and proactiveness in operational approach in pursuit of specific competitive orientation that are consistent with the corporate mission. Further, telecommunication providers will need to invest more resources on technology to enhance the capabilities of the service centres' personnel. This has potential to enhance efficiency and prudential operations of the service centres; efforts need to be directed on improving the technical efficiency and scale efficiency. Managerial side of these will have to emphasise on how scale efficiency can be improved.

6 Conclusions and suggestions for further studies

This study provides insight on the use of DEA as a tool to analyse organization's operational efficiency and identify critical operations inputs for securing improved performance. The thrust is to aid managerial decisions and secure comparatively better internal efficiency to enhance positions in pursuit of an effective strategic approach to operations. Information obtained from the study can guide to identify the weak areas in operations, the effect of size on their scale of operations and input variable to be given pre-emptive priority to change to enhance operations and capacity to strive for cost leadership in sphere of operation.

Future studies may focus of utilizing more range of inputs and output variables, and service facilities to enhance generalizability. The usefulness of the current study potentially holds out hope of application of the approach to other industries to improve units and organizational performance, and provide insights to competitive behaviours or modifications of competitive tactics.

References

1. Khaddam, A. A., Irtaimeh, H. J., Badar, B. S., (2020). The effect of supply chain management on competitive advantage: The mediating role of information technology. Uncertain Supply Chain Management, 8, 547 – 562. DOI: https://doi.org/10.5267/j.uscm.2020.3.001.
2. Nicholson, J. R, Stevens, J. A. (2022). REIT operational efficiency: External advisement and management. The Journal of Real Estate Finance and Economics, Springer, 65(1), 127 – 151. DOI: 10.1007/s11146-021-09818-4.
3. Hossain, M. S., Hussain, K., Kannan, S., Kunju Raman Nair, S. K. (2021). Determinants of sustainable competitive advantage from resource-based view: implications for hotel industry. Journal of Hospitality and Tourism Insights, 5(1), 79–98. DOI: https://doi.org/10.1108/JHTI-08-2020-0152.
4. Ducic, A., (2018), Efficiency measurement of co-workers in contact center, Undergraduate thesis, University of Belgrade, Faculty of Oranizational Science, September 2018.
5. Anning-Dorson, T., Nyamekye, M. B., (2020), Be flexible: Turning innovativeness into competitive advantage in hospitality firms. International Journal of Contemporary Hospitality Management, 32(2), 605 – 624. DOI: https://doi.org/10.1108/IJCHM-12-2018-1014

[Downloaded from ijaor.ir on 2026-11-27]

[DOI: 10.71885/ijorlu-2023-1-639]

6. Bartuševičienė, I., Šakalytė, L. E., (2013). Organizational assessment: Effectiveness vs. efficiency. Social Transformations in Contemporary Society, 1(1), 45 – 53.
7. Islami, X.; Mustafa, N., Latkoviki, M.T. (2020). Linking Porters Generic Strategy to firm performance, Future Business Journal, 6(1), 1-15. 3 https://doi.org/10.1186/s43093-020-0009-1.
8. Sherman, H. D., Ladino, G., (1995) Managing bank productivity using data envelopment analysis (DEA). Interfaces, 25(2), 60-73. http://dx.doi.org/10.1287/inte 25..2.60
9. Azeem, M., Ahmed, M., Haider, S., Sajjad, M., (2021). Expanding competitive advantage through organizational culture, knowledge sharing and organizational innovation. Technology in Society, 66(c), DOI: https://doi.org/10.19044/esj.2022.v18n12p237.
10. Hayes, B. E., (1997) Measuring Customer Satisfaction: Survey Design, Use, and Statistical Analysis Methods. ASQC Quality Press, Milwaukee, WI.
11. Frank. R.H., (1997) Micreconomics and Behaviour, 2nd edition, McGraw Hill Inc.
12. Banjoko, S. A., (2005). Production and Operations Management (Revised Edition). Lagos, Pumark Educational Publishers
13. Ray, W., (1999) Production and Operations Management, London: Cassel Educational Limited.
14. Pindyck, R. S., Rubbinfield, D. L., (2005). Microeconomics, Pearson Education, United Kingdom.
15. David, F. R, (2017) Strategic management: concepts and cases. Pearson Prentice Hall, Upper Saddle River.
16. Baroto, Mas Bambang., Muhammad Madi Bin Abdullah and Hooi Lai Wan.2012. Hybrid Strategy: A New Strategy for Competitive Advantage. International Journal of Business and Management, 7(20),120.
17. Hesterly W., Barney, J., (2010) Strategic management and competitive advantage, Pearson education, Pearson Prentice Hall, New York.
18. Emrouznejad, A., Yang, G. L., (2018) A survey and analysis of the first 40 years of scholarly literature in DEA: 1978-2016, Socio-Economic Planning Sciences, 61 (1): 4-8.
19. Valdmanis, V. G., (1990). Ownership and technical efficiency of hospitals. Medical Care, 28(6), 552 – 561.
20. Amole, B. B., Oyatoye, E. O., Alabi-Labaika, A. B., Adebiyi, S. O., (2016). Data envelopment analysis for estimating health care efficiency in the southwest teaching hospitals in Nigeria. Journal of Economics and Business Research, 22(2), 143 – 160.
21. Ahmed, S., Hasan, M. Z., MacLennan, M., et al. (2019). Measuring the efficiency of health systems in Asia: A data envelopment analysis. BMJ Open, 9(e022155). DOI: https://doi.org/10.1136/bmjopen-2018-022155.
22. Sherman, H. D., (1984). Hospital efficiency measurement and evaluation. Empirical test of a new technique. Medical Care, 22(10): 922 – 938.
23. Aggelopoulos, E., Georgopoulos, A., (2017). Bank branch efficiency under environmental change: A bootstrap DEA on monthly profit and loss accounting statements of Greek retail branches. European Journal of Operational Research, 261(3), 1170 – 1188. DOI: https://doi.org/10.1016/j.ejor.2017.03.009
24. Henriques, I. C., Sobreiro, V. A., Kimura, H., Mariano, E. B., (2020). Two-stage DEA in banks: Terminological controversies and future directions. Expert Systems with Applications, 161(113632), 1 – 31.
25. Kaffash, S., Azizi, R., Huang, Y., Zhu, J., (2020). A survey of data envelopment analysis applications in the insurance industry 1993 – 2018. European Journal of Operational Research, 284(3), 801 – 813. DOI: https://doi.org/10.1016/j.ejor.2019.07.034.
26. Khoshroo, A., Emrouznejad, A., Ghaffarizadeh, A., Kasraei, M. and Omid, M. (2018) Sensitivity analysis of energy inputs in crop production using artificial neural networks, Journal of Cleaner Production, 197(1), 992 – 998. DOI: https://doi.org/10.1016/j.jclepro.2018.05.249.
27. Izadikhah, M., Saen, F., (2018). Assessing sustainability of supply chains by chance-constrained two-stage DEA model in the presence of undesirable factors. Computers & Operations Research, 100, 343 – 367. DOI: https://doi.org/10.1016/j.cor.2017.10.002.
28. Bowlin, W. F., (1998). Measuring Performance: An introduction to data envelopment analysis (DEA). The Journal of Cost Analysis, 15(2), 3 – 27. DOI: https://doi.org/10.1080/08823871.1998.10462318.
29. Sodani, P. R., Madnani, G. M K. (2008). Measuring hospital performance through data envelopment analysis: Understanding basic concepts to help novice researchers. Journal of Health Management, 10(1), 129 – 142. DOI: https://doi.org/10.1177/097206340701000108.
30. Charnes, A., Cooper, W. W., Rhodes, E., (1978) Measuring the efficiency of decision making units. European Journal of Operational Research, 2(6), 429 – 444. DOI: https://doi.org/10.1016/0377-2217 (78)90138-8.
31. Ray, S.C., (2004) Data envelopment analysis: Theory and techniques for economics and operations research (New York: Cambridge University Press).

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[DOI: 10.71885/ijorlu-2023-1-639]

32. Ray, S., (2007). Are Some Indian Banks too Large? An Examination of Size Efficiency in India Banking. Journal of Productivity Analysis, 27(1), 41-56.
33. Banker, R.D., Charnes, A., Cooper, W.W., (1984) Some models for estimating technical and scale inefficiencies in data envelopment analysis. Management Science, 30, 1078-1092. DOI: https://doi.org/10.1287/mnsc.30.9.1078.
34. Debnath, R. M., Shankar, R., (2008). Measuring performance of Indian banks: An application data envelopment analysis. International Journal of Business Performance Management, 10(1), 57 – 85. DOI: https://doi.org/10.1504/IJBPM.2008.015921
35. Sowlati, T., Paradi, J. C., (2004). Establishing the "practical frontier" in data envelopment analysis. Omega, 32(4), 261 – 272. DOI: https://doi.org/10.1016/j.omega.2003.11.005.
36. Porter ME (1985) Competitive advantage creating and sustaining superior performance. Free Press, New York.
37. Norman, M., Stoker, B., (1991). Data Envelopment Analysis: The assessment of performance. New York, USA, Wiley.
38. Chen, Y., Zhu, J., (2003). DEA models for Identifying Critical Performance Measures, Annual of Operations research, 124 (1-4): 225-244.
39. Ibidunni, A.S., Abiodun, J.A., Ibidunni, O.M., Olokundun, M.A., (2019), 'Using explicit knowledge of groups to enhance firm productivity: A data envelopment analysis application', South African Journal of Economic and Management Sciences 22(1), a2159. https://doi.org/10.4102/sajems.v22i1.2159.
40. Abiodun, A.J., Ibidunni, A.S., Salami, A.O., Ojeaga, P., (2018), 'Benchmarking performance of customers' service centers in the telecommunication industry: An application of data envelopment analysis', Lasu Journal of Business Review 4(2), 294–303.
41. Fekri, S., Milad, A. S., Izzeldin, B., (2008). Decomposition of efficiency using DEA window analysis: A comparative evidence from Islamic and conventional banks. Benchmarking An International Journal, 25(6), 1681 – 1705. DOI: http://dx.doi.org/10.1108/BIJ-12-2016-0183.
42. Maharazu M.K., Ajibesin A.A., Kasim M.1, Sa'idu M.B.1 and Isa A., (2021) Performance evaluation of mobile network operators in Nigerian using data envelopment analysis, Science World Journal, 16(3), 219-225.
43. Susskind, A. M., Kacmar, K. M., Borchgrevink, C. P., (2003). Customer service providers' attitudes relating to customer service and customer satisfaction in the customer-server exchange. Journal of Applied Psychology, 88(1), 179 – 187. DOI: https://doi.org/10.1037/0021-9010.88.1.179.
44. Abiodun, A.J, Adeyemi, K.S., Oyeniyi, O.J., Olayiwola, A.O., (2015). Do reputation and image matter for recommendations and switching intentions in the telecommunication industry, Asian Pacific Journal of Management Research and Innovation, 11(2), 134-142.

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