

Investigating The Efficiency of Individual-Explicit Knowledge in The Telecommunication Sector of An Emerging Economy

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Abstract: This study investigated efficiency in the utilization of the individual-explicit knowledge of a firm. The sample included 42 customer service centers (CSCs) of the four most active Global System for Mobile Communications (GSM) organisations in Lagos State and FCT, Nigeria. The research adopted the input-oriented data envelopment analysis model to determine the extent to which individual-explicit knowledge, as a vital input resource to telecommunications firms, is efficiently utilized by the CSCs to improve the firms' values. The study revealed that 10 CSCs, representing 23.8 percent of those studied, were technically efficient using the constant returns to scale model. In contrast, the variable returns to scale model showed that 22 CSCs, or 52 percent of them, were technically inefficient. The results suggest that, with less than 50 percent of the total number of CSCs in Nigeria's telecommunications industry being inefficient, there is a large volume of operational inefficiency, especially concerning the utilization of individual-explicit knowledge. As such, the telecommunications industry could benefit from managerial intervention, especially in building the capacity of the customer desk officers in the CSCs to attend promptly and accurately to customers' queries. Also, the study established that a viable strategic direction would be that organizations in the telecommunications industry renew their focus on a balanced mix of supervisor-subordinates in each CSC. This study contributes to operations management and the organizational knowledge management literature by showcasing the data envelopment analysis methodology as a legitimate tool for improving understanding of the investigations into the efficiency of individual-explicit knowledge. This study offers practical implications for firm managers about specific activities and units of their firm that contribute the most to the organization, and other specific units/activities that are less productive. The study also provides directions for future studies.

Keywords: organizational knowledge, individual-explicit knowledge, developing economies, operational efficiency, data envelopment analysis

JEL Classification: M1, M2

Introduction

Individual-explicit knowledge (IEK) includes the firm's conceptual skills and cognitive capabilities (Lam, 2000). An individual's formal education and the knowledge gained from training programs could serve as indicators of his/her explicit knowledge (that is, IEK) (Fei, Chen & Chen, 2009; Maran, Arokiasamy & Maimunah, 2009; Ibidunni, Ibidunni, Olokundun & Akinbola, 2017). Abdul Kadar, Abul and Loo-See Beh (2015) and Sahar (2019) suggested that training enhances individuals' know-how, improves their workplace skillfulness and supports their efficiency in pursuance of organizational objectives. In the same vein, individual employees' educational levels are an integral part of their explicit knowledge that could aggregate into the organization's operational efficiency (Nonaka, 1994; Gibson Consulting Group, 2011). Moreover, the fact that individual-explicit knowledge can achieve high levels of efficiency across industry sectors like banking, higher education institutions, and hospitality industries cannot be undermined (Seleim, Ashour & Khalil, 2005; Paradi & Zhu, 2013; Rossi, 2014).

Individual-explicit knowledge helps firms to leverage the benefits of human cognitive capabilities to achieve efficiency for the firms, especially in terms of costs and time savings and to build customers' confidence in the organization (Kotur & Anbazhagan, 2014; Alabar, Egena & Gbande, 2014; Feyzia, Rezaib & Ghorbanianc, 2017). Existing studies, for example by Hu, Hsu, Hsiao and Tsao (2019) and Khan, Adnan, Jan and Jamal (2020), carried out in relatively more developed economies, demonstrated the significance of individual-explicit knowledge to firms' operational efficiency. However, this present research has identified a significant

gap in the literature resulting from a dearth of existing studies (Asbari, Wijayanti, Hyun, Purwanto & Santoso, 2019; Lei, Gui & Le, 2021) that failed to adopt objective (free of human bias) methodology such as data envelopment analysis (DEA) to investigate the utilization of individuals' explicit knowledge in the firms. By objectivity, we imply that DEA, as an operations research technique, broadens managerial views about a holistic perspective for decision-making, taking into consideration a larger dataset and a bias free perspective of the firm's resources utilization and optimization. The observation of the gap identified in this study is essential for two main reasons. First, IEK has its roots in a typological perspective of overall organizational knowledge (Fei et al., 2009; Sedziuviene & Vveinhardt, 2010; Odhon'g & Omolo, 2015). The main emphasis of scholars who view organizational knowledge from a typological perspective is to support our understanding of the interconnectedness between humans and technology in the knowledge creation and dissemination process. This assertion is especially true for low-technology economies, where significant human efforts support technology adoptions (Ibidunni, Abiodun, Ibidunni & Olokundun, 2019). Consequently, in investigating IEK using DEA as an objective measure, this study is focused on benchmarking employees' knowledge utilization of the decision-making units (in this case, the customer service centers of telecommunications firms) of their organization, especially concerning explicit knowledge's utilization. So, managers are better informed about which activities or units of the firm contribute the most to the organization, and which ones are less productive.

Second, apart from the fact that the robustness of knowledge utilization's discourse in the literature has insufficiently supported

an objective view of firms' knowledge resources, the well-established assertions of past studies lack their generalization and applicability to low-technology economies. Scholars have primarily focused on economies where assurances about, and the confidence level in, technology were high. Whereas, in developing economies, like Nigeria, because of the low level of technological sophistication of the knowledge-based facilities in these economies, there tends to be massive reliance on the complementary roles of humans and technology to resolve customer complaints (Radwan and Pellegrini, 2010; Osabuohien & Efobi, 2012; Jegede, Ajayi and Allo, 2016; Adebajji et al., 2018). For this reason, much of the interactions between customers and operators, especially in high technology-driven industries like telecommunications, depend on the individual intelligence of the employees in the telecommunications organizations (Agbim, Owutuamor & Oriarewo, 2013; Ruiz, Sanchez De Pablo, Muñoz & Peña, 2018; Wang, Mei & Feng, 2020). Whereas, the telecommunications industry in developing economies, like Nigeria, is very strategic because (i) Nigeria accounts for one of the largest telecommunications markets in the African region (Nigerian Communications Commission, 2018), (ii) the telecommunications market in Nigeria makes a significant contribution to employment and the emergence of a technology-driven society (Adi, 2015; Nigerian Communications Commission, 2018). In this study, our goal is to improve the understanding about organizational units (customer service centers - CSCs) that efficiently and effectively utilize the firms' investments in individual-explicit knowledge for productive outcomes, and identify the CSCs which are less productive through benchmarking procedures. Consequently, this study aims to investigate the

efficiency of individual's explicit knowledge in Nigeria's telecommunications firms using data envelopment analysis.

Literature Review

Individual Explicit Knowledge in Organizations

Organizational knowledge management theorists suggest that knowledge can be broadly categorized into tacit and explicit dimensions, which employees engage in, enhancing organizational value (Nonaka & von Krogh, 2009; Norashikin, Amnah, Fauziah & Noormala, 2014). Tacit knowledge involves using highly personalized understanding and intuitions about present issues that relate to the organization's work processes (Wang & Wang, 2012; Goodall & Baker, 2015). On the other hand, explicit knowledge involves codified knowledge, which can quickly be learnt and copied by organizational members (Tsoukas & Vladimirou, 2001; Odhon'g & Omolo, 2015). The importance of explicit knowledge is made manifest by the continuous emphasis made by knowledge management theorists and practitioners to ensure that organizations strive to document all forms of employee knowledge, to ease the transferability of knowledge across the organization (English, English, Solomon, Valentine, Bieak & Turner, 2006). According to Fei et al., (2009), organizational knowledge consists of tacit and explicit knowledge dimensions, which individuals and groups in the firm engage with to accomplish job tasks. Despite the vast attention given to group knowledge dimensions in organizations, there is still a need to understand how work systems, designed around an individual employee's productivity, are accomplished through the dimensions

of his/her respective explicit knowledge. In other words, this study focused on explaining how the individual explicit knowledge of employees contributes to a firm's operational efficiency.

Individual explicit knowledge consists of codified aspects of personalized knowledge. It includes education and training, which are not necessarily unique to individuals, yet are essential to the fulfillment of organizational tasks (Tsai, 2001; Fei et al., 2009; Suraj & Ajiferuke, 2013; Igbaekemen, 2014). According to Lam (2000), it could also include an individual's conceptual skill. Kotur and Anbazhagan (2014) observed that education, as a form of individual explicit knowledge, does not merely consist of an employee having undertaken some sort of formal education. Instead, it reflects that such individuals have undergone the necessary training that enhances their mental capacity for the effective and efficient delivery of job tasks. Odhon'g and Omolo (2015) studied the importance of investment in human capital for organizational performance. Their study reported that the training and educational backgrounds of individual employees in the firm are vital to the organization's industry performance. In their view, these two dimensions have a strong influence on the rate at which organizational members can express their knowledge and skills in their job tasks.

Ng and Feldman (2013) and Kotur and Anbazhagan (2014) suggested that the extent to which individuals engage their explicit knowledge dimensions, such as their educational levels, could impact their effectiveness in executing fundamental job tasks. It also shows their openness to demonstrating organizational citizenship behavior and the avoidance of practices that could be detrimental to the organization's success and overall

productivity. The viewpoints are that individuals' engagements of explicit knowledge at the workplace can benefit firms' internal and external interests, such that customers derive optimal benefits from their transactions with the organizations through their employees. In a comparative analysis carried out by Kotur and Anbazhagan (2014), employees with superior education levels have a greater passion for delivering quality outputs in their jobs than individuals with lower levels of education. Scholars have also argued that training is an indicator of an individual's explicit knowledge and the extent to which the overall organization encourages its members to continuously learn (Niazi, 2011; Moses, 2013; Awodoyin, Osisanwo, Adetoro & Adeyemo, 2016).

Consequently, Dhar (2015) suggested that organizational managers should approach the organization's training needs from a multi-dimensional perspective. These include: Ensuring that strategies are in place to motivate employees to participate in, and have easy access to, training opportunities. Employees should be encouraged to realize, in practical terms, the benefits attached to training exercises. They also argued that organizations should support the employees' willingness to receive training. Shaheen, Naqvi and Khan (2013), in their research, demonstrated the importance of training, to improve individual explicit knowledge, on the performance of teachers in public schools. Salas, Tannebaum, Kraiger and Smith-Jentsch (2012) opined that the way organizations go about designing, communicating, and implementing training programs are significant aspects of focusing attention. This claim was in support of explicit knowledge, which is derived and expressed by individual employees through training, can have a significant effect on organizational outcomes. In their

opinion, training programs should be skillfully planned and monitored before, during and after the training exercise.

Individual Explicit Knowledge in Customer Service

Organizational value is represented by employees' capabilities to adequately satisfy the interest of their firm's customers, especially during the customer service process (Taghizadeh, Rahman & Hossain, 2018). In achieving this, typically, employees depend on the existing knowledge management system of the firm, or in other cases, they have to engage their understanding of the processes required for the task (Guchait, Namasisvayam & Lei, 2011). This study's primary focus is on the employees' engagement in understanding the processes required to fulfill the expectations of customers, especially in situations where the firm's existing knowledge base does not capture the systematic procedures required for the task at hand. This situation is not uncommon in emerging economies that operate fast-growing high technology-driven industries, like telecommunications. Situations arise where the existing knowledge management system of the firm is inadequate to support its customers' needs for service efficiency and effectiveness. Hence, the employees' explicit knowledge about the queries raised by customers play a critical role at such times.

Data Envelopment Analysis as a Measure of Organizational Knowledge Efficiency

Over time, scholars in the field of operations research have argued that the efficiency of firms' operations can be determined us-

ing either data envelopment analysis (DEA), stochastic frontier evaluation (SFE) or regression analysis on the direct attributes of performance. In the literature, most authors support data envelopment analysis because it is a more straightforward mathematical technique that examines how firms achieve their efficiency objectives when using multiple inputs to turn out multiple outputs (Mecit & Alp, 2014). Therefore, because in reality, organizations, mostly medium and large firms, like in the telecommunications industry, are generally characterized by multiple inputs and outputs, data envelopment analysis is an appropriate means of determining their operational efficiency.

The present study investigates the efficiency of individual-explicit knowledge within telecommunications firms in a developing economy, like Nigeria, characterized by a low technology rate. Given the low technology conditions, the firms rely on their employees' conceptual skills and cognitive capabilities as additional sources to ensure smooth operations and responsiveness to customer queries. Hence firms operate by leveraging the duality of technology and trained personnel (Ibidunni, Abiodun, Ibidunni & Olokundun, 2019). Therefore, concerted efforts and investment are often channelled into acquiring employees who are believed to have the minimum standard of educational skills that are required to operate the available technology, and on continuous improvements in the technology that can support more effective and efficient business processes as well as on training the employees for improved performance (Agbim, Owutuamor & Oriarewo, 2013). Nonetheless, organizational knowledge and operations management literature is generally lacking in explaining the efficiency of the domain of the individual-explicit knowledge of firms, primarily within settings

where technology is not capable of performing all the firms' operations. DEA's objective methodology is perceived in this study to be a viable technique for enhancing this necessary understanding.

Data envelopment analysis (DEA) is a mathematical, linear programming technique that measures the efficiency performance of functional units of organizations known as decision making units (DMUs). In 1978, Charnes, Cooper and Rhodes (CCR) suggested that the efficiency of decision-making units (DMUs) can be measured based on their constant returns to scale (CRS). Decision-making units are independent functional units, departments or whole organizations that form part of the study elements in the data envelopment analysis (El-Mashaleh, Rababeh & Hyari, 2010). The constant returns to scale of a DMU imply that it is operating at an optimal scale. This assertion is such that the outputs from the DMU are proportionate to its inputs.

Nevertheless, practically, this might not always be the case. Therefore, in 1984, Banker, Charnes and Cooper (BCC) proposed that the efficiency of organizations should consist of technical and scale dimensions, measured by the variable returns to scale (VRS). VRS suggests that the output level derived from inputs in a production or conversion process will depend on each organization's technical factors.

Returns to scale are the proportionate increase in outputs caused by an increase in input resources (Samuelson & Nordhaus, 2005). In the DEA, an organization can have three situations of returns to scale. They are increasing returns to scale (IRS), decreasing returns to scale (DRS) and constant returns to scale. This implies that organizational efforts to increase inputs may yield either

constant, increasing or decreasing returns in the output level (El-Mashaleh, Rababeh & Hyari, 2010). Increasing returns to scale (IRS) result when an increase in input leads to a more than proportionate increase in output. However, when increasing inputs result in a downward slope of the production curve, there is a lower output rate, then there is a decreasing return to scale (DRS) situation. Constant returns to scale (CRS) occur when an increase in the input results in an exact or proportionate increase in output. Mecit and Alp (2014) suggested that CRS and VRS can have their input and output orientations. Fugate et al., (2010) examined logistics performance based on efficiency at 336 firms. The research showed logistics efficiency is strongly correlated with logistics performance. As such, logistics performance is a second-order construct consisting of logistics efficiency. Shirouyehzad, Mokhatab and Berjis (2017) applied data envelopment analysis to assess the performance of organizations. The study applied knowledge management indicators as an input factor. However, there is a dearth of empirical research, especially within Nigeria, that used data envelopment analysis to show organizational knowledge efficiency in the telecommunications industry. The efficiency of organizational knowledge refers to management's ability to use the firm's knowledge-based resources to create outputs that maximize the firm's efficiency objectives. By the principles of operational efficiency, the organization's management can use the tacit and explicit knowledge of individuals and groups in the firm to maximize outputs. Therefore, our expectation from this present study is that the data envelopment results will reflect efficiency in the use of telecommunications employees' individual-explicit knowledge dimensions.

Methodology

The research design adopted for this study was descriptive research. The use of a descriptive research design rests on the fact that the populations for the study are known, theories are not newly explored or determined, and the research study attempts to describe the relationships among the research variables (Lenzholzer & Brown, 2016; Rogge-ma, 2017). The sample size for this research included all 42 customer service centers of the four GSM firms operating in Nigeria’s Lagos State and FCT (Onuzuruike, 2009). The GSM sub-sector is pivotal to the telecommunications industry in Nigeria because it has the highest number of subscribers (98.07 percent), thus serving as the primary driver of growth (Ndukwe, 2004, 2011). Data envelopment analysis was used to examine the efficiency of the individual-explicit knowledge of the telecommunications firms. DEA was adopted because it is the most popular method of measuring production/service units (Siti & Umi, 2017). Through its data envelopment analysis programmer (DEAP), DEA can reflect technically efficient inputs-outputs in any unit of the organization, which could serve as benchmarks for other less technically efficient units. Consequently, measuring operational efficiency was based on the input and output factors relating to the firms and their customer service centers. These factors included the number of employees in each customer service center, the total expenditure on employee training, the total expenditure on technology, the average number of customers attended to daily, the average number of customers with resolved cases and the number of innovations produced.

This study adopted three input and three output factors (Ibidunni, Abiodun, Ibi-

dunni & Olokundun, 2019) against a total of 124 DMUs to satisfy this condition. The input and output measures determined for this study were selected based on their ability to represent knowledge, resources and knowledge outcomes. The following notations are defined to guide the analysis.

$$\text{Min } S_1^- + S_2^- + S_3^- + S_1^+ + S_2^+ + S_3^+$$

Subject to:

Input constraints:

$$\sum_{j=1}^{29} \lambda_j x_{1j} + S_1^- = \theta x_{10} - \text{estimated number of employees (i.e., first input) available in CSC } j$$

$$\sum_{j=1}^{29} \lambda_j x_{2j} + S_2^- = \theta x_{20} - \text{estimated expenditure on employee training (i.e., second input) in CSC } j \text{ in a year}$$

$$\sum_{j=1}^{29} \lambda_j x_{3j} + S_3^- = \theta x_{30} - \text{estimated expenditure on new technology (i.e., third input) in CSC } j \text{ in a year}$$

Output constraints:

$$\sum_{j=1}^{29} \lambda_j y_{1j} - S_1^+ = y_{10} - \text{average number of customers attended to daily (i.e.first output) in CSC } j$$

$$\sum_{j=1}^{29} \lambda_j y_{2j} - S_2^+ = y_{20} - \text{average number of customers with resolved cases (i.e. second output) in CSC } j$$

$$\sum_{j=1}^{29} \lambda_j y_{3j} - S_3^+ = y_{30} - \text{average number of innovations produced (i.e., third output) in CSC } j$$

Scales: constraint (CRS, VRS) $\sum_{j=1}^{29} \lambda_j = 1$

Table 1. Input and Output Measures for Productivity of Telecommunication Firms

Measures	Mean	Standard Dev.	Max	Min
Inputs				
Number of employees	20.72	24.01	120	5
Estimated expenditure on employee training	6,837,353	22,285,624.43	125,000,000	30,000
Estimated expenditure on new technology	9,150,138	32,395,067.28	175,000,000	1,000
Outputs				
Number of customers attended to daily	269.5	766.99	5,000	10
Number of customers with resolved cases	92.02	87.96	400	5
Number of innovations produced	9.70	9.56	50	1

This study used a total of 42 customer service centers in Lagos State and FCT. Therefore, the study consists of 42 decision-making units (DMU).

The table above shows that employees in the customer service centers range from between 5 to a maximum of 120. Moreover, in some centers, only 10 customers were attended to; others have as many as 50 customers' cases to resolve daily. Resolved customer complaints cases range from 5 to 400. Firms in the telecommunications industry incur massive expenditure on employee training and new technology, with average costs of 6,837,353 naira (USD 17,922.29) and 9,150,138 naira (USD 23,984.63), respectively.

Consequent to the cumbersome task involved with manually formulating and solving 42 DEA models representing each decision making unit included in this study, we utilized a proven alternative for solving the model. Therefore, the software used for the programming and the running of the DEA models in the study is DEA Frontier, a DEA add-in for Microsoft Excel. This software permits modeling with different scale constraints: variable returns to scale (VRS) and constant returns to scale (CRS).

For each DMU's VRS and CRS, this study generated and explained the input ef-

iciency scores. The implication of focusing on input efficiency is that the research presented situations of increasing, decreasing or constant returns to scale, as applicable to each DMU in such a way that allowed for the identification of the DMUs where additional input resources could enhance their operational efficiency.

Results of Input-oriented Constant Returns to Scale Model: Pure Technical

Table 3 shows the result of the input-oriented constant returns to scale (CRS) based on the pure technical efficiency of the four telecommunication firms' customer service centers in Lagos State and FCT. The table's efficiency results indicate that one of three types of scale efficiency (increasing, decreasing and constant) exists in each of the customer service centers. From the table, all the customer service centers of MTN in Lagos State have increasing returns to scale (IRS), while MTN's CSCs in FCT have constant returns to scale. Four CSC belonging to Globacom have IRS, two have CRS, and three have DRS. The statistics show that six CSCs belonging to Airtel have IRS, three have CRS, and two have DRS. Moreover, nine CSCs belonging to Etisalat have IRS, three have CRS, and one has DRS.

For the CSCs that have IRS, this implies that the firms' customer service centers are actively utilizing most of the resources allocated to them to achieve the operational functions of the organization. More so, the results indicate that these CSCs still can utilize additional resources. For example, up to 67.7 percent and only about 15 percent each of the input resources invested in customer service centers 1, 3 and 6 respectively by MTN are utilized by the CSCs. Therefore, if the firm employs or redeploys more employees, spends more on employee training and new technology, there are still chances that the firm's technical efficiency will improve be-

yond its present state. Therefore, the implication of these figures calls attention to the fact that situations occur where slack resources exist annually or monthly, due to non-usage. From the table presented, it is evident that although MTN Customer Service Center 2 experienced increasing returns to scale, it has most of its slack from expenditure on employee training. It translates that the customer service centre could still achieve more operational efficiency if it incurs more expenditure on staff training programs. Other firms' customer service centers have efficiency scores of 1.000. By implication, they have constant efficiency because, according to the statistics,

Table 2: Results of Input-oriented CRS Model: Pure Technical

S/N	DMU Name	Efficiency score	Type of Scale	S/N	DMU Name	Efficiency score	Type of Scale
1	MTLCSC 1	0.677	Increasing	22	ALCSC 4	0.886	Increasing
2	MTLLCSC 2	0.565	Increasing	23	ALCSC 5	0.635	Increasing
3	MTLCSC 3	0.149	Increasing	24	ALCSC 6	1.103	Decreasing
4	MTLCSC 4	0.475	Increasing	25	ALCSC 7	1.000	Constant
5	MTLCSC 5	0.970	Increasing	26	ALCSC 8	0.601	Increasing
6	MTLCSC 6	0.151	Increasing	27	ALCSC 9	0.450	Increasing
7	MTLCSC 7	0.525	Increasing	28	AFCSC 1	0.683	Increasing
8	MTFCSC 1	1.000	Constant	29	AFCSC 2	1.000	Constant
9	MTFCSC 2	1.000	Constant	30	ELCSC 1	0.366	Increasing
10	GLCSC 1	0.415	Increasing	31	ELCSC 2	0.250	Increasing
11	GLCSC 2	1.000	Constant	32	ELCSC 3	0.155	Increasing
12	GLCSC 3	0.200	Increasing	33	ELCSC 4	0.082	Increasing
13	GLCSC 4	1.097	Decreasing	34	ELCSC 5	0.175	Increasing
14	GLCSC 5	1.500	Decreasing	35	ELCSC 6	1.000	Constant
15	GLCSC 6	0.326	Increasing	36	ELCSC 7	1.000	Constant
16	GLCSC 7	0.950	Increasing	37	ELCSC 8	1.000	Constant
17	GFCSC 1	1.000	Constant	38	ELCSC 9	1.446	Decreasing
18	GFCSC 2	2.587	Decreasing	39	ELCSC 10	0.233	Increasing
19	ALCSC 1	1.000	Constant	40	EFCSC 1	0.350	Increasing
20	ALCSC 1	0.318	Increasing	41	EFCSC 2	0.169	Increasing
21	ALCSC 3	1.443	Decreasing	42	EFCSC 3	0.622	Increasing

Note: (i) MTLCS C = Firm 1, Lagos State, customer service center. (ii) MTFCSC = Firm 1, FCT, customer service center. (iii) GLCS C = Firm 2, Lagos State, customer service center. (iv) GFCSC = Firm 2, FCT, customer service center. (v) ALCSC = Firm 3, Lagos State, customer service center. (vi) AFCSC = Firm 3, FCT, customer service center. (vii) ELCSC = Firm 4, Lagos State, customer service center. (viii) EFCSC = Firm 4, FCT, customer service center.

they are presently using up 100 percent of all the input resources at their disposal. The customer service centers in this category include: MTF CSC 1 and 2, GLCSC 2, GFCSC 1, ALCSC 1 and 7, AFCSC 2, and ELCSC 6, 7 and 8. Thus, CSCs with constant returns to scale can serve as the benchmarks for their less efficient counterparts.

However, there were also cases of decreasing returns to scale (DRS). Typically efficiency is optimized when the overall efficiency score is 1.000 (that is, 100 percent). In any customer service center, DRS implies that such CSCs are not yielding outputs that are proportionate to the resources invested in them. Therefore, every additional input made into the CSCs continues to decrease their overall efficiency. The situation where input resources are underutilized by customer service centers represents a slack situation. For example, whereas GLCSC 4 and 5 were experiencing decreasing returns to scale, the slack might be traceable to the employees not fully maximizing the gains from training with the needs of the organizations, especially in the areas of innovation and time lags in resolving customers' complaints. To guide how resources should be utilized in the customer service centers, the DMU frontier model provides a benchmark that displays certain other DMU's, so the others can copy their operations, in other to enhance operational performance.

Results of Input-oriented Variable Returns to Scale Model: Pure Technical Efficiency

Table 4 shows the results of the input-oriented variable returns to scale (VRS) for the pure technical efficiency of the four telecommunications firms' customer service

centers in Lagos State and FCT. The result of the variable returns to scale assumes that the firms' inputs do not always yield direct and proportionate outputs due to environmental factors that could make efficiency vary. Therefore, whereas the CRS assumes that the production process's resources will yield directly proportionate outputs, the VRS makes assumptions for the possibility of variations. In reality, the assumptions of the VRS hold because all the factors invested in the firms will not always produce directly proportionate outcomes.

Table 4 shows the result of the input-oriented VRS technical efficiency of the customer service centers of the telecommunications firms. A total of 20 CSCs representing 48 percent of the DMUs were proven to be technically efficient. Six CSCs belonging to MTN (MTFCSC) were technically efficient, four CSCs owned by Globacom (GLCSC) were technically efficient, Airtel (AFCSC) has three technically efficient CSCs, and seven CSCs belonging to Etisalat (ELCSC) were technically efficient. It suggests that they fully utilized all the input resources invested in them by the firms' headquarters. Among the most technically inefficient DMUs, according to the table, are GLCSC 4 (33 percent), GLCSC 6 (25 percent), GLCSC 7 (39 percent), ALCSC 6 (16 percent), ELCSC 1 (17 percent) and ELCSC 5 (25 percent). Interestingly, the DMUs with these lowest efficiency scores are all in Lagos State, the commercial capital of Nigeria.

Based on the DEA results, this study identified a significant relationship between individual-explicit knowledge and operational efficiency.

Discussion

This research aimed to investigate efficiency in the utilization of individual-explicit

Table 3: Results of Input-oriented VRS Model: Pure Technical Efficiency

S/No	Name of DMU	Efficiency score	S/No	Name of DMU	Efficiency score
1	MTLCSC 1	0.82403	22	ALCSC 4	0.41111
2	MTLLCSC 2	1.00000	23	ALCSC 5	0.52116
3	MTLCSC 3	0.50204	24	ALCSC 6	0.15809
4	MTLCSC 4	0.42598	25	ALCSC 7	0.88889
5	MTLCSC 5	1.00000	26	ALCSC 8	0.62366
6	MTLCSC 6	1.00000	27	ALCSC 9	0.42041
7	MTLCSC 7	1.00000	28	AFCSC 1	1.00000
8	MTFCSC 1	1.00000	29	CAFSC 2	1.00000
9	MTFCSC 2	1.00000	30	ELCSC 1	0.17723
10	GLCSC 1	1.00000	31	ELCSC 2	0.34265
11	GLCSC 2	1.00000	32	ELCSC 3	1.00000
12	GLCSC 3	0.53913	33	ELCSC 4	0.83333
13	GLCSC 4	0.33280	34	ELCSC 5	0.25278
14	GLCSC 5	1.00000	35	ELCSC 6	1.00000
15	GLCSC 6	0.24869	36	ELCSC 7	1.00000
16	GLCSC 7	0.38500	37	ELCSC 8	1.00000
17	GFCSC 1	1.00000	38	ELCSC 9	1.00000
18	GFCSC 2	0.52236	39	ELCSC 10	0.50469
19	ALCSC 1	1.00000	40	EFCSC 1	0.81853
20	ALCSC 1	0.82773	41	EFCSC 2	1.00000
21	ALCSC 3	0.86750	42	EFCSC 3	1.00000

Note: (i) MTLCS C = Firm 1, Lagos State, customer service center. (ii) MTFCS C = Firm 1, FCT, customer service center. (iii) GLCS C = Firm 2, Lagos State, customer service center. (iv) GFCS C = Firm 2, FCT, customer service center. (v) ALCS C = Firm 3, Lagos State, customer service center. (vi) AFCS C = Firm 3, FCT, customer service center. (vii) ELCS C = Firm 4, Lagos State, customer service center. (viii) EFCS C = Firm 4, FCT, customer service center.

knowledge in Nigeria's telecommunications industry. The knowledge-based measures used in this research included input resources such as the number of managers and other cadres of employees in each customer service center, the total expenditure on employee training, the total expenditure on technology; and outputs such as the average number of customers attended to daily, the average number of customers with resolved cases and the number of innovations produced. This research work contributes to the fields of operations management and organizational knowledge management by developing a knowledge-based approach for the opera-

tional efficiency of organizations, using DEA as the method to examine the relationships in the telecommunications industry of an emerging economy: Nigeria.

The results gathered from using DEA on knowledge-based factors from the input-oriented constant returns to scale (CRS) and variable returns to scale (VRS) revealed that 10 (23.8 percent; based on CRS) and 20 (48 percent; based on VRS) customer service centers were technically efficient. These efficient decision-making units (DMUs) are more efficient at using the number of employees they have, their experience from training activities, and expenditure on new technology to gen-

erate greater numbers of customers attended to daily, and those with resolved queries and profitable innovations. Although the authors did not posit any hypothesis about the number of DMUs that could have been technically efficient in their utilization of their employees' explicit knowledge, the results appear to be quite surprising and we underestimated our expectation. The Nigerian telecommunications industry is considered a regional leader in the African telecommunications market (Agbim, Owutuamor & Oriarewo, 2013) with vast infrastructure and investment across the industry. Hence, we assumed that the industry would be very conscious of its operational procedures, especially related to utilizing human capital for higher levels of organizational and industry-wide productivity. However, the results projected in our analysis depict that less than the average of the total number of CSCs included in the present study utilize their employees' expertise to achieve efficient results for their firms.

The results also indicated that customer service centers that were technically inefficient could further enhance their efficiency, taking into account specific knowledge-based input and output measures. In these customer service centers, particular focus should be given to balancing the ratio of supervisor-subordinates, training requirements that are relevant to the productivity of both the supervisor and the other employees in the CSCs, and setting up measurement and accountability procedures that consistently value the contribution of each CSC to the overall performance scale of the firm. Maintaining operational efficiency through individual-explicit knowledge can be achieved if managers continue maintaining the resource inputs, such as the ratio of supervisor-subordinate employees in the customer service centers and the number of employees sent for training.

Consistent training of the employees is an essential measure of knowledge-based input and could enhance their absorptive capacity, and by extension, improve the operational efficiency of the organization (Suraj, 2012; Olunifesi & Ishola, 2013; Igbaekemen, 2014; Ibidunni, Olokundun, Motilewa, Atolagbe & Osibanjo, 2018). The importance of this to a firm's efficiency is that it results in a better output at its customer service centers. Such an output will capture the quality attention given to the customers who visit the customer service centers with their complaints. Quality attention in this sense includes the employees' ability to patiently listen to the customers' complaints and offer solutions that meet their queries (Oghojafor, Ladipo, Ighomerebo & Odunewu, 2014; van der Heiden, Pohl, Manser & van Genderen, 2015; Ibidunni Ibidunni, Oke, Ayeni & Olokundun, 2018; Mofokeng & Chinomona, 2019). This way, the employees would have demonstrated knowledge-based solutions. It is also important to note that the customer service centers with the lowest efficiency are in Lagos State. This may mean that the firms' concentration on customer service centers in Lagos State and their expectations appear to be overestimated, probably because Lagos State is Nigeria's commercial capital and is densely populated. It is also interesting to identify that this study's statistical results were not peculiar to a particular firm but cut across Globacom, Airtel and Etisalat, leaving out the market leader, which is MTN. It may also mean that the market leader takes operational efficiency issues very seriously and deals with them as a strategic issue, more so than the other industry players.

Implications

The results of this study have important implications for both theory and practice.

Implications for Theory

This study brings to the fore the application of data envelopment analysis in investigating the efficient utilization of individual-explicit knowledge in the telecommunications industry. As an operations research technique, data envelopment analysis supports a more objective view of a firm and its utilization. Hence, DEA's application to individual knowledge utilization positions the firm for a more holistic and unbiased view of knowledge utilization within the firm. Consequently, this study extends the theory about the methodological analysis of employees' knowledge utilization by applying the DEA technique.

Implications for Practice

The study also has exposed to practitioners that there is the frequent underutilization of employees' explicit knowledge for achieving organizational goals and enhancing performance. Subsequently, measures are required to tighten any loose ends, especially in ensuring the proper staff distribution across the firms' customer service centers, coupled with ensuring proper employee engagement strategies.

Conclusion and Further Studies

This research work investigated the efficiency of individual explicit knowledge in Nigeria's telecommunications firms using data envelopment analysis. The critical role of understanding individuals' contributions to a firm's productivity objective is of particular interest to developing economies like Nigeria, where there is still a heavy reliance on human to human interactions, due to the low

levels of technological sophistication. This study emphasized a viewpoint of managerial intervention, especially in building the capacity of customer desk officers of the firm to attend promptly and accurately to customers' queries. Also, this study concludes that organizations in the telecommunications industry can achieve more efficient outcomes by focusing on a balanced mix of supervisor-subordinates in each CSC, providing the necessary training requirements relevant to the productivity of both the supervisor and the other employees in the CSC and consistently measuring the contribution of each CSC to the overall performance scale of the firm. The essence of these should be on minimizing waste while still maximizing yields from the firm's investments.

Consequently, the findings established by this study contribute significantly to the theory and practice of organizational knowledge management by directing researchers and practitioners' attentions toward the mobilization and utilization of individual employees' explicit knowledge dimensions for enhancing efficiency with the firms' operations. This assertion is more critical in a time when the competitive dynamics in the telecommunications industry are increasingly narrowing their lenses on customers, and telecommunications organizations, especially in emerging economies like Nigeria, which must pay attention to ensure that their customer service centers render quality services. More so, the ability of the employees to apply their knowledge to resolving customers' complaints and to achieving efficiency in their organizations' operations form a strategic part of the firms' activities. Thus, the outcomes from this research contribute items of significant value to the strategy and knowledge management literature by highlighting specific activities that have implications for the firms' abilities

to increase value. For example, the study recommends that many customer service centers of the telecommunications firms hold resource inputs constant. At the same time, supervisors and other administrative employees in the organizations should pay more attention to using the benefits from their previous training and the technology available at their disposal to enhance their abilities to resolve customer complaints.

Moreover, employees in the customer service centers that are operationally inefficient should be set targets that ensure

an increased number of resolved customer complaints. However, this study has a limitation, mainly because the evidence was derived from a developing economy's single geographic coverage. An investigation from a cross-country perspective could produce more insightful results and help understand the characteristics of knowledge utilization among developing economies, mostly where a triangulation methodology that combines quantitative and qualitative designs is adopted.

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