INTERNATIONAL JOURNAL OF HEALTHCARE MANAGEMENT
2020, VOL. 13, NO. 3, 193–200
https://doi.org/10.1080/20479700.2017.1397379

Performance role models among public health facilities: An application of data envelopment analysis

Abolaji Joachim Abiodun[a] and Kenneth Sola Adeyemi[b]

[a]Department of Business Administration, College of Management Sciences, Federal University of Agriculture, Abeokuta, Nigeria;
[b]Department of Accounting and Finance, Kwara State University, Malete, Ilorin

ABSTRACT

Governments increased burden for health care provision demand that researchers devote resources to addressing the concern of stakeholders on the efficient utilization of health resources. This present study seeks to address the issue of efficiency in the hospitals subsector. The study based on data obtained on 29 public hospitals utilized data envelopment analysis (DEA) methodology to identify the efficiency rating and role model or peers among hospitals operating in similar low-resource environment. Results of data analysis indicate that substantial degree of inefficiency exists in the health system with only 48.3% of the facilities being technically efficient. In addition, eight of the hospitals in the study qualify to serve as role models for others in order to improve on the overall performance of the hospital sector and maximize efficiency savings in the system. The study suggests detailed analysis of the characteristics, operation environment, and other attributes of the role model hospitals and the need to strengthen the link between performance and rewards. In addition, planning models that improve on the geographical distribution of the facilities need to be considered.

ARTICLE HISTORY
Received 16 March 2017
Accepted 3 October 2017

KEYWORDS
Hospitals; peers; role model; data envelopment analysis; efficiency

Introduction

Performance evaluation of health care facilities should be of prime interest to governments, donor agencies as well as those who shape and manage the health system. Indeed, governments and health systems managers in Africa are expected to indicate active interests in performance evaluation of health resources entrusted to their care for health care delivery. This is because countries in the region are faced with difficult economic conditions and limited resources to finance the rising demand for health care services required by the increasing population. In the past, problematic health situations were solved by providing additional resources, however, this approach has become economically unrealistic to sustain because of resource demand for developmental programmes in other sectors. Consequently, achieving and improving efficiency in the operations of key institutions in the health sector has remained a key problem area.

Besides, there have been increased public pressures demanding for accountability in the use of public resources. These pressures are expected given the renewed interests of donor agencies on the use of health resources and the evident managerial deficiencies in the acquisition, deployment, and utilization of available health resources. The pervasive managerial weakness in the health system often render additional funding necessary but insufficient for the provision of desirable health care. However, assuming that resource in-flow to the health sector can be guaranteed or increased with the assistance of donor or development agencies there is, however, the renewed realization that inefficiency in government health programme is a major problem in Africans health system [1].

Therefore, the problem of efficiency is of profound interest to all health sector participants: government, planners, management, donor agencies, and healthcare customers because higher efficiency hold the key to greater productivity and better services without expenditure of more financial and real resources. Indeed, with the low level of mechanization and automation in Africa inefficient use of scarce resource exact penalty both in economic terms and forgone health benefits [2]. Therefore, evaluation of the performances of health care institutions in the production of health services have become a subject of intense research interest in literature [3].

The resource constraints and evident waste in the system have made it imperative that assessment of efficiency should be considered crucial in the process of functional evaluation of the health sector. Indeed, efficiency in resource usage should be rational response to the paucity of health resources in the system; and a core strategy for extension of healthcare coverage. Prudential management principles entrenched in performance

CONTACT Abolaji Joachim Abiodun abiodunaj@funaab.edu.ng; abolaji.abiodun@covenantuniversity.edu.ng Department ofBusiness Administration, College of Management Sciences, Federal University of Agriculture, Abeokuta, 234, Nigeria

metrics are required as rational framework for the allocation of scarce health resources among care facilities. Indeed, absence of empirical evidences of the comparative performance of facilities in the hospital sector have remained a concern for health policy makers and planners There have been difficulties in using such comparative performance index as inputs in the development of effective resource allocation models in the sector. There is therefore an evident need to fill knowledge gaps as relate to the level of efficiency in the hospital subsector.

Performance measurement tools which measure and compare performances of health facilities should be a precursor and credible hope for improving management, ensuring prudent rationalization of resource allocation and mobilization of additional resources. In this dimension, data envelopment analysis (DEA) fill a useful gap for estimating multi-product technology functions and assessment of managerial performance of health facilities that utilizes multiple resources to turn out multiple outputs. Therefore, the focus of the current study is to utilize DEA in estimating the efficiency of public hospitals and identify peer facilities to serve as role model for improving the inefficient hospitals within the same low-resource environment. This study, therefore, has theoretical and practical usefulness in assisting managers to maximize efficiency savings in the health systems through role modelling or benchmarking better performers within the same context. The focus on the hospital sector in the context of the study is quite significant. According to Mackee and Henley [4] hospital services can reduce poverty levels and promote economic development through minimizing mortality in the populace.

Literature review

DEA was developed in operations research and management science for measuring efficiency of decision making units (DMU) and is suitable for use on both public and private sectors. It has proved a veritable tool for estimating multi-product technology functions and assessment of managerial performance of DMU that utilizes multiple resources in producing multiple outputs [5]. DEA is an alternative non-parametric technique for efficiency measurement which utilizes mathematical programming model formulation rather than regression [6]. It constructs a piece-wise linear production frontier based on observed best practice. This methodology is based on the radial measure of efficiency developed by Farrel [7] which corresponds to the coefficient of resource utilization defined by Debreu [8].

Daraio and Simar [9], posited that the linear programming approach has been accepted as a computational method for measuring efficiency since the work of Dorfman et al. [10].

DEA 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 units: DEA circumvents the problems of specifying an explicit form of the production function [6,11] instead, a best practice function is built empirically from observed inputs and outputs [12]. Structurally, DEA model follows the linear programming model pattern (objective, set of constraints, and non-negativity bound):

Objective function minimize $\theta_0\lambda_0$

Subject to:

$$\sum_{n=1}^{n} y_{nj}\lambda_n \geq y_{oj} \quad \begin{matrix}\text{(Output Constraint)}\\ j = 1, 2, \ldots m.\end{matrix}$$

$$\theta_0 X_{oj} \geq \sum_{n-1}^{n} X_n i\lambda_n \quad \begin{matrix}\text{(Input Constraint)}\\ (i = 1, 2, \ldots N)\end{matrix}$$

$$\sum_{n=1}^{n} \lambda_n \leq 1 \quad \text{(Scale Constraint)}$$

$$\lambda_n \geq 0 \quad \begin{matrix}\text{(Non} - \text{negativity Constraint)}\\ (n = 1, 2, \ldots N)\end{matrix}$$

The Scale Constraint is adjusted according to the assumption required for the study. A variable returns to scale (VRS) frontier [13]; (the BCC Model) is obtained by substituting the Scale Constraint of the linear programme with $\sum_{j=1}^{n} \lambda_j = 1$

DEA is based on the assumption of convexity, that is, for any two feasible points their convex combination is equally feasible. Peers or benchmarks which are reference for comparisons are DMU that are on the frontier or the best performing practice frontier. A DMU is a benchmark or peers for others if at the optimal value of θ^*, the weight $\lambda^* \neq 0$ for the benchmarking DMU [14]. The non-zero optimal λ_j^* represents the benchmark for a specific DMU under.

DEA in hospital efficiency studies in Africa

DEA approach has been applied to health facilities in relatively few cases in Africa. This is quite discouraging given the scarcity of resources in the continent and the economic implications of inefficient use of health resources in the region. The concentrations of studies are more in southern African region than elsewhere in the continent. Kirigia [15] used DEA approach in studying primary health care clinics in Kwazulu-Natal province in South Africa and, in 2002 did another study using DEA methodology to assess the technical efficiency of 54 public hospitals Kenya. The study identified inefficient hospitals and provided the magnitudes of specific inputs reduction or output needed to attain technical efficiency. Prior to these studies Zere [16] investigated hospital efficiency in

South Africa using DEA and DEA based malmquist productivity index. Furthermore, in 2006, Zere [17] leading other researchers assessed the technical efficiency of 30 district hospitals in Namibia using DEA. Findings from the study suggested the presence of substantial degree of pure technical and scale efficiency with increasing returns to scale being the predominant form of inefficiency observed.

In addition, Masiye [18] investigated the Zambian health system performance using the DEA methodology. He found that significant resources are wasted in the health system with input congestion and size of the health facilities been source of the inefficiency observed in the health system. It seems worrisome that size could be a problem or cause of resource wastage in any health system in Africa viewed against the obvious need to expand health service provision to a significant proportion of the needy population .However, size could be a problem if for political expediency there are inappropriate distribution or location of hospitals facilities. In addition, research evidences exist of hospital efficiency study in Botswana [19].

However, studies in health care efficiency have been quite limited elsewhere outside the southern Africa sub-region. Ghana and Sierra Leone furnished a ready example of countries outside the southern region that have cases of studies on health care efficiency. Kwakey [20] effort in Ghana is more of a pioneering study on health or hospital efficiency in the West African sub-region. He employed DEA to measure the relative efficiency of 20 selected hospitals in Ghana in 2004. His study was followed by Osei et al. [21] which was based on data from of public health centres and 17 public hospitals in Ghana. The study offered empirical evidence on the performances of these facilities; however, the sample size was quite small to allow for generalization of the result for the whole country. There was another study conducted based on a larger sample size. [22] The study based on a sample size of 89 health centres showed that as much as 65% of these facilities were technically inefficient, that is, using resources that they did not actually need. Similarly, Renner, et al., [23] applied DEA to measure both the technical and scale efficiency of a sample of public peripheral units in Sierra Leone the study revealed that 59% of the 37 peripheral health units were technically inefficient and 65% been scale inefficient. In recent time, however, there have been studies using data envelopment methodology in Uganda [24] Cameroun [17], Burkina Faso [25] with further studies in South Africa [26]. Further research efforts are expected to remedy the dearth of attention to health care efficiency studies in the continent.

However, in terms of choice of both output and input variables most of the efficiency studies in Africa utilized quantitative data such as number of outpatients, inpatients, among others. Attention seems not to have been given to quality variables or those that fully capture the range of hospital functions such as health promotion activities, preventive and protective care; and hospitals roles in responding to society's needs. There had not been much attention in reflecting procedural complexity, however, efforts in Ghana included preventive care activities such as immunization, ante-natal care, family planning, among others, as an input to provide a fairly realistic view of hospital outputs [21,22].

Some other studies adopted a narrower view of hospital output. For example, Kwakey [20] and Zere's [14] studies proxied output variables using only outpatient visits and inpatient days; and recurrent hospital expenditure, number of beds and staff as inputs. Kirigia et al. [27] study in Kenya included a more detailed classification of hospital output into dental care services, paediatric, and maternity admissions. In addition to human resource variables cost of drugs and consumables were employed as input variables. The mission of facilities under review and data availability seems to influence inputs and output choice. For example, study on health centres in Zambia used only number of outpatient visits an output and number of clinical officers, nurses, and support staff as input [28]. The argument was that health centres provide only three key services and that cases that require inpatient care are referred to the hospitals.

Non-labour expenditures and number of staff were the major inputs utilized in hospital facilities study in Zambia while laboratory tests and surgical admission were included as outputs [18]. Studies on hospital efficiency in Africa are constrained by data availability in the choice of both input and output variables. Poor records and health management information system have been an issue of concern in the health system of most countries in the African sub-region. Perhaps, this explains researchers' inadequate attention to health care efficiency studies in the sub-region.

Materials and method

Data for this study relate to public hospitals under the oversight of the ministry of health in Ogun State, Nigeria. Administratively, the sampled hospitals in the study are in the secondary-tier of the health care delivery system in Nigeria; thus, the care mix can be assumed to be fairly comparable to derive a more robust result. Public hospitals rather than private-owned hospitals which are profit-oriented constitute our unit of analysis. The exclusion of private-owned hospitals in the study is purposeful consistent with the opinion that studying the efficiency of public hospitals is essential [29]. Indeed, public hospitals are not only dominant but a prime resource consuming agent in the health system, therefore their performance and resource utilization have become a key determinant of the overall performance of the health system. The study assumes that these hospitals or health facilities being of similar organizational form produce similar type of health care services [30]. In addition, these are more homogeneous in terms of ownership, service orientation, profit status, financing, payment system, and other legal and regulatory frameworks. Therefore, it is reasonable to assume homogeneity in the range of health service public facilities provide and similarity in the production process. This facilitates desired comparison in DEA literature.

Performance role modelling using DEA are inevitably retrospective because most performance monitoring relies on historical data [3]. Application of DEA in this study requires data on the operations of these health facilities with respect to the composition of health resources employed and output derived from each facility. Data utilized for the study was obtained from the state ministry of health, Ogun state where data on these facilities are centralized (the ministry has both administrative and planning oversight of these hospitals). The input data required for the study relate to those employed to generate services as well as output data which reflect the general scope of the facility's health care activities. The choice of both input and output data for the study was guided by data availability and previous studies in Africa subregion [22,30–32]. Specifically, input data for the study include number of beds, doctors, nurses, and health attendants in each facility while number of outpatients, inpatients, deliveries, and ante-natal care in each facility were used as proxy for output variables.

The DEA model was used under the assumptions VRS. The VRS assumes the performance of each of the hospital is dependent on their scale of operations. This agrees with the suggestions that if uncertainty exists in the selection of appropriate scale variable VRS is safer in terms of obtaining a more robust result [33]. Furthermore, in line of earlier studies [21,22,30–32,34] an input orientation version of DEA is employed for analysis. It is assumed that facilities have limited control over the volume of their output. There is no linkage between staff earnings and output, thus no incentive for inducing demand for health.

Generally, we may not expect Public hospitals to undertake aggressive search for patients in the name of increasing output, in essence, cost minimization might be a noble objective to aspire to. Consequently, the input minimizing model was imposed for the hospitals. In line with the study's objective it was considered worthwhile identifying the number of times that an efficient hospital serve as peers for the inefficient hospitals. This approach enables us to classify hospitals as either self-evaluator, that is, those that are not peers or role model for other hospitals; or active comparators.

Results and discussions

Descriptive statistics

These hospitals on average, employed 4 Doctors and 20 staff nurses with a mean beds capacity of 37 beds. This suggests poor resource endowment in the health system with possible implications for economic activities in societies characterized by low level of mechanization and automations of significant percentage of their economic activities (Agriculture is the main economic activities among rural populace in the context of this study, and these are largely non-mechanized Table 1.).

The average number of inpatients treated stood at 1,080 patients. However, outpatients activities, on the average, was higher at 4,335 patients, perhaps the relatively few beds spaces are responsible. The minimum and maximum level of input and activities level indicate that expansion or otherwise of health activities among these facilities may be required to cope with demand of a growing and increasing population.

The data set indicate these facilities do not have considerable share of deliveries (child birth) in their activities portfolio. Ante-natal care activities are as low as 121 patients and as high as 5,321 attendants in some. The minimum and maximum level of deliveries (child birth) and ante-natal care in the activity profile of these public hospitals indicate uneven distribution of these activities among the facilities. It is evident that these hospitals seem not to have considerable share of these activities in their profile (This, however, may provide insight to the multiplications of traditional birth attendants and private clinics to fill the gaps). The evident problem, then, for public hospitals are that of overcrowding of patients in some areas and under-utilization of facilities in others which magnify the problem of wastages and inefficient use of resources [35]. The human resource perspective of the espoused scenario may provide subtle explanation for the incessant demand for increased remunerations from the hospital sector. Health personnel, on account of work load, may be justified in their demand for improved and equitable remuneration. Further, a cursory view of the analysis suggests a need for the oversight organ to examine the geographical distributions of these hospitals as some of these hospitals may be operating at near or full capacity while others are possibly operating far below capacity due to poor distribution pattern. The un-favourable patients-to-staff ratio that exists in the health system can be discerned from the summary data.

Pure technical efficiency of the facilities

It is evident that out of the 29 public hospitals included in the sample, 15 hospitals representing 51.7% of the

Table 1. Descriptive statistics of input and output data.

	Beds	Doctors	Nurses	Health attendant	Inpatient	Outpatient	Deliveries	Ante-natal
Mean	36.54	3.07	19.89	9.3	1080.43	4334.46	249.29	1154.57
Median	24.5	2	10.5	6	526.5	2816	100	623.5
Sum	1023	86	557	251	30252	121365	6980	32328
Minimum	8	1	1	1	41	532	24	121
Maximum	186	15	15	61	11346	40165	1619	5321
Standard deviation	36.32	3.38	25.95	12.02	2078.89	7280.24	367.37	1359.39

Source: Computed from raw data.

sample are deemed to be operating inefficiently relative to other hospitals. These hospitals are not operating at technically efficient levels. The average score of the inefficient hospitals ($n = 15$) is 64.9%. This is indicative that the inefficient hospitals can, on the whole, reduce health resources input consumption by 35% without reducing their collective outputs. It is evident from the Table 2 that the DMU 13 and DMU 29 with efficiency scores of 16.7% and 22.4% respectively are the most inefficient hospitals relative to others. The high variability in observed performance across the sample provides reasonable evidence that the health system suffer significant losses in resources [15,17,18,22]. This constitutes a drain on government ability to expand health services to cover larger population due to operating inefficiency of existing health facilities. The hospital in DMU 7, DMU 17, and DMU 27 are weakly efficient given the possible input reduction indicated in their peer groups, therefore, in cases where these facilities are identified as peers they may not be the best benchmarking or role model, however, lessons may be drawn in the analysis of their operations by the inefficient hospital, for example, it may be possible to reduce some inputs while maintaining operations at the current level or some human resource issues can be improved on to enhance their output profiles.

Table 2 above contains the efficiency reports of the hospitals as well as the peer weights of benchmark facilities. An analysis of the hospitals and the number of times each efficient hospital serves as benchmark hospital for others are contained in Table 3. DEA identifies the hospitals which have been referenced with each hospital thereby facilitating comparison.

Table 3 indicates that twelve of the efficient hospitals are self-evaluator which indicates that excluding them does not impact on the efficiency scores of other hospitals in the state. Eight hospitals are reference hospitals or role models for others. This suggests that excluding these hospitals from our analysis does have impact on the scores of other hospitals. This type of information about comparators facilitates further investigation of hospital characteristics and operating practices which can be helpful in improving health care delivery.

It is evident from the peer count column that some of the apparently efficient hospitals do not appear in the peer groups for other hospitals (self-evaluators). There is, therefore, the possibility of these hospitals

Table 2. Result of VRS model: pure technical efficiency.

DMU	Hospital (DMU description)	Efficiency	Peer weights			
1	GHI, Iberekodo	1.00	$\lambda_1 = 1.00$			
2	Community hospital, Isaga	1.00	$\lambda_2 = 1.00$			
3	State hospital, Sokenu	1.00	$\lambda_3 = 1.00$			
4	Oba Ademola hospital	1.00	$\lambda_4 = 1.00$			
5	Ransome Kuti hospital	1.00	$\lambda_5 = 1.00$			
6	GH, Ota	1.00	$\lambda_6 = 1.00$			
7	GH, Itori	1.00	$\lambda_2 = 0.17$	$\lambda_{15} = 0.024$	$\lambda_{16} = 0.806$	
8	GH, Ifo	0.85	$\lambda_5 = 0.09$	$\lambda_{15} = 0.85$	$\lambda_6 = 0.006$	
9	GH, Ogbere	1.00	$\lambda_9 = 1.00$			
10	GH, Ijebu-Ife	0.986	$\lambda_2 = 0.624$	$\lambda_5 = 0.349$	$\lambda_{15} = 0.027$	
11	GH, Ijebu-Igbo	0.946	$\lambda_2 = 0.246$	$\lambda_5 = 0.149$	$\lambda_{15} = 0.605$	
12	GH, Atan	1.00	$\lambda_{12} = 1.00$			
13	GH, Ijebu-Ode	0.163	$\lambda_2 = 0.184$	$\lambda_5 = 0.277$	$\lambda_6 = 0.078$	$\lambda_9 = 0.129$
14	GH, Iperu	0.866	$\lambda_2 = 0.581$	$\lambda_5 = 0.226$	$\lambda_6 = 0.31$	$\lambda_9 = 0.16$
15	GH, Ikenne	1.00	$\lambda_{15} = 1.00$			
16	GH, Ilishan	1.00	$\lambda_{16} = 1.00$			
17	GH, Imeko	1.00	$\lambda_2 = 0.296$	$\lambda_{15} = 0.192$	$\lambda_{16} = 0.512$	
18	GH, Ipokia	0.725	$\lambda_1 = 0.45$	$\lambda_2 = 0.365$	$\lambda_{12} = 0.11$	$\lambda_{15} = 0.08$
19	GH, Idiroko	0.657	$\lambda_1 = 0.095$	$\lambda_2 = 0.537$	$\lambda_{15} = 0.367$	
20	GH, Owode-Egba	0.664	$\lambda_1 = 0.328$	$\lambda_2 = 0.359$	$\lambda_{15} = 0.086$	$\lambda_{16} = 0.22$
21	GH, Odeda	1.00	$\lambda_{21} = 1.00$			
22	GH, Odogbolu	.814	$\lambda_1 = 0.131$	$\lambda_2 = 0.677$	$\lambda_9 = 0.116$	$\lambda_{15} = 0.08$
23	GH, Ala-Idowa	0.76	$\lambda_1 = 0.511$	$\lambda_2 = 0.171$	$\lambda_9 = 0.011$	$\lambda_{15} = 0.31$
24	GH, Omu	0.79	$\lambda_1 = 0.376$	$\lambda_2 = 0.299$	$\lambda_9 = 0.307$	$\lambda_{15} = 0.018$
25	GH, Ibiade	0.771	$\lambda_1 = 0.541$	$\lambda_{12} = 0.452$	$\lambda_{15} = 0.007$	
26	GH, Isara	0.518	$\lambda_2 = 0.815$	$\lambda_{15} = 0.185$		
27	GH, Ode-Lemo	1.00	$\lambda_{15} = 0.189$	$\lambda_{16} = 0.811$		
28	GH, Aiyetoro	.635	$\lambda_1 = 0.271$	$\lambda_2 = 0.40$	$\lambda_{12} = 0.246$	$\lambda_{15} = 0.08$
29	GH, Ilaro	0.224	$\lambda_1 = 0.004$	$\lambda_2 = 0.846$	$\lambda_{15} = 0.15$	

GH (General hospital)

Table 3. Role models and peer counts.

S/n	Name	Peers and benchmarks facilities	Number of times referred
1	GH, Iberekodo	GH, Iberekodo	11
2	Community hospital, Isaga	Community hospital, Isaga	11
3	State hospital, Sokenu	State hospital, Sokenu	1
4	Oba Ademola hospital, Ijemo	Oba Ademola hospital, Ijemo	1
5	Ransome Kuti hospital, Asero	Ransome Kuti hospital, Asero	1
6	GH, Itori	GH, Itori, CH, Isaga, GH Ikenne, GH, Ilishan	2
7	GH, Ifo	R Kuti, Asero, GH, Ota, GH, Ikenne,	0
8	GH, Ogbere	GH, Ogbere	5
9	GH, Ijebu-Ife	GH, Ikenne, R Kuti, Asero, CH, Isaga	0
10	GH, Ijebu-Igbo	GH, Ikenne, R Kuti, Asero, CH, Isaga	0
11	GH, Atan	GH, Atan	2
12	GH, Ijebu-Ode	CH. Isaga; R Kuti hosp.; GH. Ota; GH. Ogbeere;	0
13	GH, Iperu	CH. Isaga; R Kuti hosp.; GH. Ota; GH. Ogbeere	1
14	GH, Ikenne	GH, Ikenne	13
15	GH, Ilishan	GH, Ilishan	2
16	GH, Imeko	Community hospital, Isaga	0
17	GH, Ipokia	GH. Iberekodo, Comm. Hosp. Isaga; GH. Ikenne.	0
18	GH Idiroko	GH. Iberekodo, Comm. Hosp. Isaga; GH Ikenne.	0
19	GH, Owode-Egba	GH. Iberekodo, Comm. Hosp. Isaga; GH. Ikenne; GH. Ilishan.	0
20	GH, Ode-Lemo	GH, Ikenne, GH Ilishan	0
21	State hospital, Ilaro	Gh. Ikenne; GH Iberekodo; Comm Hos, Isaga	0
22	GH, Odeda	GH, Odeda	1
23	GH, Odogbolu	GH Iberekodo. Comm. Hos, Isaga, GH, Ogbeere, GH, Ikenne	1
24	GH, Ala-Idowa	GH Iberekodo. Comm. Hos, Isaga, GH, Ogbeere, GH, Ikenne	1
25	GH Omu	GH Iberekodo. Comm. Hos, Isaga, GH, Ogbeere, GH, Ikenne	1
26	GH, Ibiade	GH Iberekodo. GH, Atan, GH, Ikenne	0
27	GH, Isara	GH Iberekodo. GH, Ikenne	0
28	GH, Ota	GH, Ota	2
29	GH, Aiyetoro	GH Iberekodo. Comm. Hos, Isaga, GH, Atan, GH, Ikenne	0

Source: Estimates from DEA model.

being deemed efficient by default. However, it is far more likely that the hospitals DMU 9, DMU 15, DMU 1, and DMU 2 are truly efficient because they are peers or benchmarks (evaluators) for four or more hospitals in the sample. Hospitals which appear only in two or three peer groups provide a scope for them to improve their efficiency even though they may, currently, have received efficiency score of 100 per cent.

Traditionally, in improving performance it is required that we identify the peer groups, set benchmarking goals, and implement benchmarking recommendations [36]. In the tradition of Linear Programming model DEA handles benchmarking goals as it calculate slacks that specify the amount by which inputs and outputs must be improved for the hospital to become efficient. The peer group or benchmarks for DMU17 are DMU 1, DMU 2, and DMU 15. DMU 17 will learn much from the analysis of the operations of these facilities. The hospital needs to evaluate the operations of members of the peer group to determine what changes it can make in reducing some inputs while maintaining the services offered.

Conclusions and recommendations

The study has identified eight hospitals that are fully efficient to serve as benchmarks or role models for others. However, the best role model hospitals are those of DMU 2, DMU 1, DMU 8, and DMU 14, each of these hospitals can serve as role model or benchmark for improving others in order to maximize efficiency savings for the inefficient facilities. Other hospitals can learn from some aspects of their operations and seek to identify weakest area of their performance.

Furthermore, in the wake of the present performance of some of these hospitals which qualifies them to serve as benchmarks or role models, it may be profitable for management to consider undertaking a detailed analysis of the hospital characteristics, operating environment, and other attributes that seemed to have prompted the efficiency performance of those hospitals. An investigation of the input profile of peer groups vis-a vis the inefficient hospitals will reveal areas that require most attention in health inputs adjustment of the inefficient facilities.

Performance evaluation of these hospitals, however, may involve a multi-disciplinary approach to unearth the performance problems. For example, focusing on human resource dimension, it is likely that some critical health personnel (for example, doctors) may have been in a position for years or have been denied promotion; therefore, frustrations may have set in. In addition, some of the personnel maybe near retirement age, therefore, have lost motivation to effectively treat patients or are more attune to administrative matters, therefore, have lost the zeal for active duty performance or incentives are considered low vis-a-vis workload. In addition, there could be family–work conflict, perception of perks and salaries may be lower than is considered acceptable or prevalence of 'dual practice' in the sector. In such cases, a multidisciplinary approach is required not only to discern the problem but to proffer required solutions that will proactively affect input resources to enhance performance. The results of DEA has significantly narrowed the span of attention to troubled facilities or area of performance concern in the system.

In the context of the study, a new service planning model that stress the relative autonomy of hospitals may be considered. Increased autonomy for hospital managers on determinations or changing of scope of health services offered has the potential of making public hospitals to become similar to those in the market system. It is intuitively compelling to reason that the more managerial decisions are under the control of hospital managers, the more incentive exists to improve on efficiency performance. This could extend to giving hospital managers more voice in personnel matters such as recruitment, transfer, among others. Strengthening the link between rewards and performance may be a reasonable option to consider. A responsive approach which strengthens the link between reward and work load should be considered. Health policy makers and planners may need to consider planning models that improve on the geographical distribution of both existing and new hospitals within the subsector, this has the long-term potential benefits of affecting patterns of patients distribution among the hospitals; and may serve to even-out work load among facilities and health personnel in the hospital system.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

This work was supported by Self-funded, no external funding.

Notes on contributors

Abolaji Joachim Abiodun, Ph.D., is a Senior Lecturer in the Department of Business Administration, Federal University of Agriculture, Abeokuta. His research interests include Health Care Management, Operations Research and Business Policy.

Prof Kenneth Sola Adeyemi is in the Department of Accounting & Finance, Kwara State University, Ilorin. His research focus include Corporate Governance, Operations Research and Health Care Management.

References

[1] Akin JS, Birdsall N, Ferranti D. Financing health services in developing countries: an agenda for reform. Washighton (DC): World Bank Policy Study; 1987.
[2] Yawel BL. Total factor productivity in Uganda's District Referral Hospitals, Makerere University, Unpublished paper; 2006. byawe@fema.mak.ac.ug
[3] Hollingworth B, Street A. The market for efficiency analysis of health care organisations. Health Econ. 2006;15(10):1055–1105.
[4] Mackee M, Healy J. The role of hospitals in a changing environment. Bulletin of World Health Organ. 2000;78 (6):803–810.
[5] Charnes A, Cooper WW, Rhodes E. Measuring the technical efficiency of decision making units. Eur J Oper Res. 1978;2(6):429–444.
[6] Ray S. C. Data envelopment analysis: theory and techniques for economics and operations research. Cambridge: Cambridge University Press; 2004.
[7] Farrel M.J. The measurement of the productive efficiency. J Roy Stat Soc A (General). 1957;120(3):253–290.
[8] Debreu G. The coefficient of resource utilization. Econometrica: Journal of Econometric Society. 1951: 273–292.
[9] Daraio C, Simar L. Advanced robust and non parametric methods in efficiency analysis: methodological and applications. New York: Springer Science & Business Media; 2007.
[10] Dorfman R, Samuelson P, Solow R. Linear programming and economic analysis Courier Corporation; 1958.
[11] Sowlati T. 2001 Establishing the practical frontier in data envelopment analysis. Unpublished PhD Dissertation: University of Toronto; 2001.
[12] Norman M, Stocker B. Data envelopment analysis: the assessment of performance John Wiley & Sons Inc; 1991.
[13] Banker RD, Conrad RF, Strauss RP. A comparative application of DEA and translog methods: an illustrative study of hospital production. Manage Science. 1986;32(1):30–44.
[14] Zhu J. Quantitative models for performance evaluation and benchmarking. NewYork: Springer science; 2009.
[15] Kirigia JM, Sambo LG, Scheel H. Technical efficiency of public clinics in Kwazulu-Natal province of South Africa. East Afr Med J. 2001;78(3):1–14.
[16] Zere E. 2000 Hospital Efficiency in Sub-Saharan Africa: Evidence from South Africa. UNU World Institute for Development Economic Research, Helsinki, Finland: working Paper no. 187.
[17] Zere E, Shangula K, Mandlhate C, et al. Technical efficiency of district hospitals: evidence from Nambia using DEA. Cost Effect Res Allocat. 2006;4(1):5.
[18] Masiye F., et al. Investigating health system performance: an application of DEA to Zambia hospitals. BMC Health Serv Res. 2007;7(1):58.
[19] Walker D, Mohammed R. L. Producing services efficiency: a review of measurement tools and empirical application. Monograph: Oxford Policy Institute; 2004.
[20] Kwakeye E. Relative efficiency of some selected hospitals in Accra-tema metropolis in Emrouznejad A, Pedinovki V (Eds) DEA and performance management medicare hospital mortality. Inquiry. 2004;29 (1):55–65.
[21] Osei D, d'Almeida S, George MO, et al. Technical efficiency of public hospitals and health centres in Ghana: a pilot study. Cost Eff Resour Alloc. 2005;3(1):9.
[22] Akazili T, Adjuik M, Jehu-Appiah C, et al. Using DEA to measure the extent of technical efficiency of public health centres in Ghana. BMC Health Serv Res. 2008;8(1):11.
[23] Renner A, Kirigia JM, Zere EA, et al. Technical efficiency of peripheral units in Pajehun district of Sierra Leone: a DEA application. MBC Health Serv Res. 2005;5(1):77.
[24] Mujasi PN, Asbu EZ, Puig-Junoy J., et al. How efficient are referral hospitals in Uganda: A DEA and tobit regression approach. BMC Health Serv Res. 2016;16 (1):230.), DOI 10.1186/s12913-016-1472-9
[25] Marschall P, Flessa S., et al. Assessing efficiency of rural health centres in Burkina Faso: an application of data envelopment analysis. J Public Health (Bangkok). 2009;17(2):87–95.
[26] Mbonigaba J, Oumar SB., et al. 2014 The relative efficiency of South Africa municipalities in providing public health care, ERSA working paper 474; 2014.

[27] Kirigia JM, Emrouznejad A, Sambo LG, et al. Using data envelopment analysis to measure the technical efficiency of public health centres in Kenya. J Med Syst. 2004;28(2,):155–166.
[28] Masiye F, Kirigia J.M, Emouznejad A, et al. Efficient management of health centres human resources in Zambia. J Med Syst. 2006;30(6):473–481.
[29] Masiye F, Kirigia J.M, Emouznejad A, et al. Efficient management of health centres human resources in Zambia. J Med Syst. 2006;30(6):473–481.
[30] Zamo- Akono C, Ndjokou M, Song-Ntamack S. Institutions and hospital efficiency in Cameroon: a data envelopment analysis. J African Dev. 2013;15(1):45–71.
[31] Abiodun A J, Adeyemi K S., et al. Data envelopment analysis methodology: a case for application in developing countries, babcock. J Manag Soc Sci. 2013;11 (1):60–71.
[32] Kirigia J M, Okorosobo T., et al. Health facility efficiency analysis. Harare: WHO/AFRO Health Economics Capacity Strengthening Workshop; 2005; May, 2000.
[33] Galagedera DUA, Silvapulle P. Experimental evidence on robustness of DEA analysis. J Oper Res Soc. 2003;54:654–660.
[34] Kirigia JM, Emrouznejad A, Sambo LG. Measurement of technical efficiency of public hospitals in Kenya using data envelopment analysis. J Med Syst. 2002;26 (1):39–45.
[35] Abiodun AJ. Patients satisfaction with quality attributes of primary health care services in Nigeria. J Health Manag. 2010;12(1):39–54.
[36] Dash U, Vashnavi SD, Muraleedharan VR, et al. Benchmarking the performance of public hospitals in Tamil Nadu: an application of DEA. J Health Manag. 2007;9(1):59–74.