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Application of Multi-Objective Optimization on the Basis of Ratio Analysis Method for Evaluating Service Delivery in Hospitals within Lagos State

Sulaimon Olanrewaju Adebisi^{a, *}, Nkechi Efenure^a

^a University of Lagos, Nigeria

Abstract

The importance of customer service cannot be over-emphasized as quality service delivery is relevant across all business sectors including the healthcare sector. To ensure growth and continuity, it is therefore vital for businesses to identify the factors that influence service quality in their organizations and improve on them. This study aims to ascertain key factors that influence customers' perception of the quality of services received from hospitals within Lagos state and evaluate the performance of these hospitals using a multi-objective optimization technique. A structured questionnaire was deployed to patients and medical experts within Lagos State and the data retrieved was analyzed using MOORA. The results highlight the gap between customers' expectations and hospital performance. However, both parties agree that the most important factor was the reliability dimension. The results generated provide essential contribution to the development of enhanced policies designed to shrink the existing performance gap and improve customer satisfaction.

Keywords: healthcare, hospital, service quality, MOORA.

1. Introduction

The effectiveness of service delivery in any organization depends on many micro and macro-environmental factors hence to ensure the provision of quality services, an organization needs to identify and incorporate the key factors that influence quality service delivery. Due to the competitive and unforgiving nature of healthcare that gives little or no room for errors, numerous healthcare providers have been forced to acknowledge the importance of quality healthcare as the main basis for enhancing customer satisfaction (Kwabena et al., 2017). Since healthcare is a costly, globally used service that massively influences a nation's economy and the quality of life of its people (Berry, Bendapudi, 2007), healthcare providers are being increasingly pressured to change from seller-oriented to customer-oriented operating models (Owusu et al., 2017; Giovanis, 2018). Consequently, commendable progress has been made in the level of responsiveness to customers following increased focus on important factors such as the provision of quality healthcare, value for money and patient satisfaction (Ndubisi, 2012).

Lately, the prevalence of medical errors in Nigeria and beyond has been a high-interest area in the healthcare sector however, most of these errors, injuries and accidents are preventable. One of the major conclusions from the Institute of Medicine's (now called the National Academy of

* Corresponding author

E-mail addresses: soadebisi@unilag.edu.ng (S. Olanrewaju Adebisi), n.alumona@yahoo.com (N. Efenure)

Medicine) report in 1999 states that majority of medical errors do not result from the recklessness of an individual or the activities of a particular group of people but can mostly be blamed on faulty systems, procedures and circumstances. Akinbode, Sokefun and Aremu (2019) state that good health remains one of the basic needs of an individual irrespective of their status in the society. It is therefore urgent to assess the performance of healthcare providers and develop a systemic approach for health management procedures through which the healthcare system can reach its full potential.

Theoretical Framework

Human-Becoming Theory

The Human-Becoming Theory is a concept in healthcare that concentrates on the quality of life of the patient. It views the patient not as one aspect of a whole (the hospital), but as a person – a unitary being in continuous interaction with his or her environment. Hence to ensure the delivery of quality healthcare services, the needs and expectations of the patient must be put into consideration. This theory was first proposed by Parse R.R. in 1981 and was called Man-Living health but was renamed in 1992 to The Human-Becoming Theory. This theory emphasizes the importance of recognizing the patient's contribution to healthcare. It involves earning the patient's trust and establishing a mutual understanding of care procedure to facilitate healing which is the ultimate aim of healthcare (Parse, 1992). Several studies also corroborate this theory by emphasizing the importance of patient satisfaction in healthcare (Oyatoye et al., 2016; Mosadeghrad, 2013; Akinbode et al., 2019; Kwabena, et al., 2017).

Sociological Theory

The sociological theory is a set of ideas that provides an explanation for the behaviour of the human society (Sociological Theories, 2015). In relation to healthcare, the sociological theory highlights the influence of the culture and social background of a society on the quality of their health and health care processes. This theory largely originates in Talcott Parsons' 1951 article titled "Theorizing of the Doctor-Patient Relationship" (Cockerham, Scambler, 2009). There are three approaches to the sociological theory:

- The Interactionist Approach expounds that the conditions classified as health and sickness are social constructs as they are determined based on historical, cultural, and sometimes situational perspectives. For example, alcoholism which was viewed as a vice in the 19th century is viewed as a disease today.
- The Functionalist Approach states that good health and effective health care are crucial factors in the ability of a society to function appropriately.
- The Conflict Approach emphasizes how health and health care reflect inequality and competition among social groups (Amzat, Razum, 2014).

It is important to note that income inequities along social class, race and ethnicity etc. are also reproduced in our health care and inevitably, the health of the citizens. Studies from the perspective of the sociological theory show that individuals from poorer social backgrounds are more likely to become ill however, their limited resources make them unable to access adequate health care thereby making it more challenging for them to become well.

Economic Theory

The Economic Theory addresses the basic problem of how to attain efficiency, that is allocating limited resources to satisfy unlimited demands. For example, a hospital administrator would be concerned with the challenge of organizing resources (finances, medication etc.) to ensure the organization remains profitable. The AMA Bureau of Medical Economics was established in 1931 to study all economic matters affecting the medical profession. However, a seminal 1963 article by Kenneth Arrow- "Uncertainty and the Welfare Economics of Medical Care," is often credited with giving rise to health economics as a discipline. His theory drew conceptual distinctions between health and other goods such as healthcare as a commodity, the nature of demand, supply conditions, pricing, market forces etc. (Kenneth, 1963). On a broader note, this theory encompasses the value of health to an economy, the demand for and the supply of healthcare, relevant planning, budgeting and monitoring mechanisms. Several research studies have established a positive correlation between healthcare spending by the government and the economic indicators of income – GDP and labor productivity (Ragupathi, Ragupathi, 2020; Dieleman et al., 2018; Raheem et al., 2014).

The theories outlined above prove relevant to understanding the relevance of healthcare to society. The key components of quality health care however, still remains a complex and multi-faceted concept. Some studies highlight the importance of political commitment through increased

health financing by the government (Dieleman et al., 2018; Raheem, et al., 2014). Patel and Kannampalil (2014) underlined the importance of technological factors in the performance of hospitals, while other studies emphasized the significance of quality service delivery in hospitals to a successful universal health coverage (Raifman et al., 2017; Borgonovi, Compagni, 2013; Agier et al., 2016; Alshamsan et al., 2017). Nevertheless, decision making with the aim of satisfying the customer has proven to be a focal point in the health sector today.

Patient Satisfaction

Patients have specific needs which prompts them to seek the services of a hospital or healthcare institution. They also have expectations of the kind of services they hope to receive. Consequently, they tend to run a mental comparison of the services received versus their expectations, especially when there are costs involved (such as time, money etc.) and there are alternative options available. Customer expectations encompass several aspects including desired service (wished for) level and predicted service level (anticipated) which may differ from the organization's actual performance (Ukessays, 2018). From an organizational point of view, Woodside, Frey and Daly (1989) opine that an organization's performance is influenced by the customers' negative complaints and/or positive service experience hence to ensure patient satisfaction, hospitals need to respond effectively to patients' needs and expectations as this is essential to improving the quality of health care provided. Various studies also corroborate this argument by emphasizing the importance of patient satisfaction in healthcare (Oyatoye et al., 2016; Akinbode et al., 2019; Kwabena et al., 2017). Therefore, to ensure increased patient satisfaction, it is important to identify their service delivery priorities. This can be achieved by analyzing all the factors that impact service delivery in hospitals and identifying the essential factors that influence service quality. Several studies have been carried out globally to identify these key factors and numerous models have been proposed however, due to the intangibility of the concept under discussion, these remain fragmented proposals as no consensus has been reached globally.

Service Quality

Service quality in the health industry is a complex and multi-faceted concept defined by the subjective view of all stakeholders including the recipients (patients), practitioners and policy makers. Several factors have been acknowledged to influence a patient's hospital choice including cost of treatment, quality of services, convenient administrative procedures, hospital image and health insurance coverage (Saeed, 1998) and numerous studies have been carried out to identify which factors are important enough to influence the quality of healthcare service delivery globally (Mosadeghrad, 2013; Andaleeb, 2000). In Nigeria, the SERVICOM index is generally used to evaluate service quality. The five dimensions considered and their assigned weights as follows- Service delivery (30 %), Timeliness (24 %), Information (18 %), Professionalism (16 %) and Staff attitude (12 %). Endeshaw (2019) identified and discussed some of the most prominent models proposed globally for the evaluation of service quality in the healthcare industry-

Donabedian's Model

The Model of Care was first proposed by Donabedian in a 1966 article where he opined that improving the quality of healthcare service and delivery required reviewing both the technical and interpersonal quality of healthcare services rendered. He further clarified that technical care refers to the medical treatment aspects of patient care, while interpersonal care involves communicating with the patient about his or her treatment. He proposed that the quality of healthcare service be measured using three points – Structure (hospital settings, staff qualifications and managerial systems of the establishment), Process (healthcare practices) and Outcome (survival rate of patients). This model considers the following dimensions for measuring the quality of healthcare services: efficacy, effectiveness, efficiency, optimality, acceptability, legitimacy and equity.

SERVQUAL Model

The SERVQUAL model (also called the RATER model which stands for its five service factors) is a multi-dimensional research instrument designed to study customer expectations and perceptions of a service along five dimensions that are believed to represent service quality- reliability, assurance, tangibles, empathy and responsiveness (Wikipedia, 2021). This model, introduced by Parasuraman, Zeithaml and Berry (1988) is applicable across several industries and widely accepted in the healthcare industry for assessing the quality of service delivery despite controversies about its validity and reliability. Here, the customer (in this case patients) satisfaction level is derived by measuring the discrepancy (or gap) between customers' expectations (P) and their perception of the services received (E) (Oyatoye et al., 2016).

Healthqual Model

This model developed by Camilleri and O'Callaghan in 1998 is an adaptation of the SERVQUAL model developed specially for the healthcare sector. It draws inspiration from the previously discussed models (Donabedian and SERVQUAL) and identifies six major dimensions for measuring the quality of service delivery in hospitals namely – Admission processes, Attitudes of medical staff (doctors), Attitudes of nursing officers, Ward/hospital environment, Patients' amenities/facilities and discharge planning/ coordination.

PubHosQual Model

This model was developed by Aagja and Garg in 2010 to measure the quality of public hospitals in India and identify areas requiring specific improvement. It measures 24 items grouped into five dimensions of service quality- Admission, Medical service, Overall service, Discharge process and Social responsibility. Its limitations however stem from the fact that the model does not consider the technical aspects of healthcare services. Also, the structure for public hospitals differs from country to country.

HospitalQual Model

Itumalla, Acharyulu and Shekhar developed this model in 2014 mainly to monitor, control and improve service quality for in-patients in an Indian public hospital. This model is useful to hospital managers for monitoring, controlling and improving the quality of services rendered to in-patients only. A thorough review of available literature reveals that the SERVQUAL model is most widely accepted and is usually modified to suit the context or practice in the country (or region) of study.

Conceptual Framework

As earlier suggested, the process of evaluating the quality of healthcare provided is often faced with uncertainties (Laroche et al., 2005; Andaleeb, 2001). Therefore, to overcome the ambiguities related to human judgements, Multi-criteria Decision-Making Models (MCDM) have been introduced in such performance evaluations (Shaffi et al., 2016). Multi-Criteria Decision-Making (MCDM) techniques are typically employed when finding the best solution from a set of given alternatives with multiple criteria to consider (Hafezalkotob et al., 2019). Several researchers have studied the use of other MCDM techniques such as AHP (Oyatoye et al., 2016), TOPSIS (Shaffi et al., 2016), DES model (Lucidi et al., 2016) to analyze service delivery in the healthcare industry. However, this study aims to contribute to existing literature by adopting the Multi Objective Optimization Based on Ratio Analysis (MOORA) method for analysis. An MCDM problem is composed of a finite set of alternatives represented as:

$$A = A_i$$

{where $i = 1, 2, \dots, m$ }, m being the number of the alternatives. These alternatives are then evaluated according to certain criteria, denoted as $C = C_j$ {where $j = 1, 2, \dots, n$ }, where n is the number of the criteria. The criteria can have different domains and may represent a cost (which one is looking to minimize) or a benefit (which one is looking to maximize). Also, each criterion is assigned an importance weight, represented as $W = w_j$ {where $j = 1, 2, \dots, n$ }. These weights are normalized to add up to one, i.e., $\sum_{j=1}^n (w_j = 1)$. This data is then organized in a decision matrix ($M^{m \times n}$) where each element ' x_{ij} ' represents the value of the alternative ' A_i ' with respect to the criterion ' C_j '. The matrix ' M ' and the vector of weights ' $W = \{w_1, w_2, \dots, w_n\}$ ' represent the fundamental inputs (Ceballos et al., 2016).

Multi-Objective Optimization on the Basis of Ratio Analysis (MOORA)

The MOORA method, one of the most categorical decision-making techniques (relatively new in MCDM literature), was first introduced by Brauers and Zavadskas in their work on public privatization in 2006. It is a multi-objective optimization technique that can be successfully applied to solve various types of complex decision-making problems in the business environment and has been used in several research endeavours (Raika, 2019). This multiple attribute decision making (MADM) approach was used to attain the best solution among given discrete alternatives with conflicting objectives and was proven to be a more robust approach over the Minkowski and TOPSIS, Euclidean distance metric and the Tchebycheff min max metric (Brauers, Zavadskas, 2006). Research shows that in the early phases of development, multiplicative forms of generating dimensionless numbers were explored however with later stages the ratio analysis approach was implemented.

In MOORA, performing multi response optimization or multi objective optimization is done by satisfying both the constraints and the feasible solution. Hafezalkotob et al., 2019 notes that the MOORA method makes use of both the ratio system and reference point method in providing solutions. It also satisfies the seven conditions to be considered over other MADM or MODM

techniques and proves to be the best MADM approach for computing optimal decisions within less computational time and no introduction of additional parameters such as ‘v’ in VIKOR and ‘ξ’ in the Grey Relational Analysis – GRA method. The merits of the MOORA method over other MADM approaches is shown in Table 1 which shows that MOORA proves to be the best alternative with high simplicity, less computational time and basic mathematical calculations.

Table 1. Comparison of MOORA Method and other MADM Methods

MADM Method	Computational Time	Simplicity	Mathematical Calculations Required
MOORA	Very high	Very simple	Minimum
AHP	Very less	Very critical	Maximum
ANP	Moderate	Moderately critical	Moderate
GRA	Very high	Very critical	Maximum
VIKOR	Less	Simple	Moderate
GTA	Very high	Very critical	Maximum
ELECTRE	High	Moderately critical	Moderate
DEA	Very high	Very critical	Maximum
TOPSIS	Moderate	Moderately critical	Moderate
PROMTHEE	High	Moderately critical	Moderate

Note: Comparison of MOORA with MADM approaches (Karuppana, Sekar, 2016)

The concept of the MOORA method is based on various assumptions.

The Assumption of Cardinal Numbers

The use of cardinal numbers in computation is deemed to be more robust than one based on ordinal numbers as it is assumed that the use of ordinal numbers offers limited possibilities Arrow stated in a 1974 article: “Obviously, a cardinal utility implies an ordinal preference but not vice versa”. It also accommodates the conversion of nominal scales such as excellent, good, fair etc. to dimensionless numbers which are typically obtained using the four essential operations of arithmetic – addition, subtraction, multiplication and division (Brauer, Zavadskas, 2006).

The Assumption of Discrete Choices

This involves the use of several well-defined and possible alternative choices which have been pre-identified while a continuous case generates alternative choices from a continuous set of options throughout the entire process.

The Assumption of Attributes

This refers to the value (of the objective) being measured. Keeney and Raiffa (1993) shared an example where the aim – to reduce sulfur dioxide emissions (the objective) was measured using tons of sulfur dioxide emitted per year (the attribute). This implies that an objective and a corresponding attribute always go together. An attribute should always be measurable (Brauers, Zavadskas, 2006).

Application of the MOORA Method for Analysis

According to Brauers and Zavadskas (2006), computations using the MOORA method typically begin with an initial data matrix showing various alternatives to different objectives:

$$X = x_{ij} \dots \dots \dots (1)$$

(x_{ij} represents the response of alternative j to objective i , $i = 1, 2, \dots, n$, “ n ” are the objectives and $j = 1, 2, \dots, m$, “ m ” are the alternatives).

A ratio system is then used in which each response of an alternative on an objective is compared to a denominator computed using the square root of the sum of squares of each alternative for each objective i.e.

$$N x_{ij} = \frac{x_{ij}}{\sqrt{\sum_{j=1}^m x_{ij}^2}} \dots \dots \dots (2)$$

($N x_{ij}$ is a dimensionless number representing the normalized response of alternative j to objective i). The normalized responses of each alternative to the objectives are found in the interval [0,1].

When maximizing, the responses are summed up but subtracted when minimizing-

$$N y_j = \sum_{i=1}^{i=g} N x_{ij} - \sum_{i=g+1}^{i=n} N x_{ij} \quad \dots\dots\dots (3)$$

($i=1, 2, \dots, g$ for all objectives to be maximized; and $i=g+1, g+2, \dots, n$ for all objectives to be minimized, $N y_j$ = the normalized assessment of alternative j with respect to all objectives).

$N y_j$ is then ranked ordinally to show the final preference.

Introduction of Ratios in a Reference Point Theory

The normalized decision matrix (equation 5) is applied in this reference point method. The Tchebycheff Min-Max metric is then used to select the highest co-ordinate amongst all the objectives (for maximization cases) and the lowest point (for minimization cases) where:

$$\text{Min} \{ \max |r_i - N^{x_{ij}}| \} \dots\dots\dots (4)$$

where $i=1, 2, \dots, n$ are the objectives, $j=1, 2, \dots, m$ are the alternatives, r_i = the i^{th} coordinate of the maximal objective reference point and $N^{x_{ij}}$ = the normalized objective i of alternative j (Brauers, Zavadskas, 2006). These steps are summarized in the figure below:

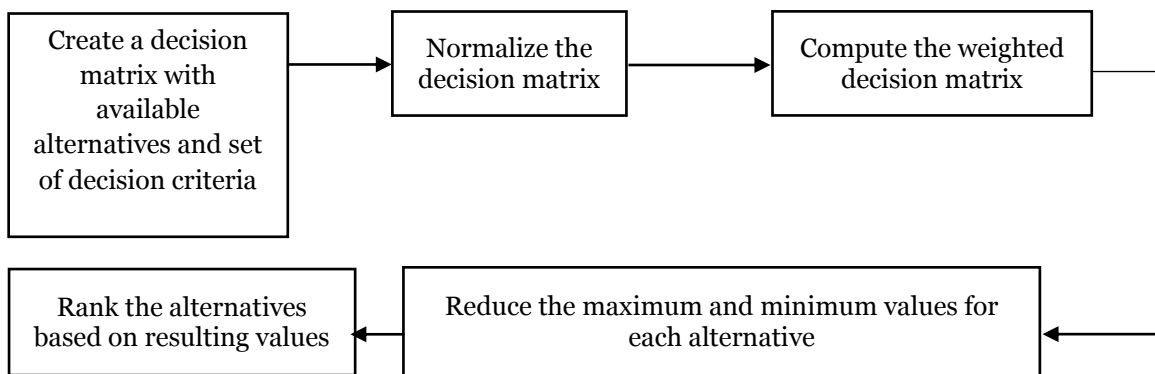


Fig. 1. Flowchart of the MOORA Process
Source: Limborg et al. (2018)

The MOORA method was enhanced to MULTIMOORA (Multi-Objective Optimization on the basis of a Ratio Analysis plus the full MULTiplicative form) by introducing the full multiplicative form. The final integrative ranking is then calculated using Dominance Theory (Brauers, Zavadskas, 2010).

Due to its wide acceptance and relative ease of use, MOORA analysis has been employed in several research studies. Brauers and Zavadskas (2009) asserts that the MOORA method is the most robust multi-objective method as it satisfies the first six conditions of robustness and is the only method to partially satisfy the seventh. A review of available literature shows that MOORA is relevant across various industries including the manufacturing sector (Perez-Dominguez et al., 2018), finance (Gorener et al., 2013), economics and governance (Brauers, Zavadskas, 2006), education (Mesran et al., 2017), real estate (Brauers, Zavadskas, 2009), health (Tasci, Gorener, 2016; Abdi, 2018) and etc. This provided a strong basis for the use of MOORA analysis in this research study.

2. Methods

A descriptive survey research design was adopted where data was collected from patients of public and private hospitals across Lagos State, Nigeria. Considering the vast and varied population, the sampling technique employed for this study is the non-probability convenience sampling method. To determine the sample size, the Cochran (1963) equation was adopted using the formula below:

$$n_0 = \frac{Z^2 p(1-p)}{e^2}$$

Where n_0 = sample size

Z = the abscissa of the normal curve that cuts off at the tails

p = the estimated proportion of an attribute that is present in the population

e = the acceptable sampling error

At 95 % confidence level, $Z = 1.96$. Assuming $p = 0.5$ and $e = 0.05$, the sample size for this study was computed as:

$$n_o = \frac{(1.96)^2 \times 0.5 (1-0.5)}{(0.05)^2} = 384.16$$

Hence the appropriate sample size for this study is determined to be 384. It is expected that this population size would generate sufficient data for the purpose of this study.

A structured questionnaire was the research instrument of choice and this was administered electronically (online survey) as it offers respondents anonymity while providing the researcher an opportunity to gather data from a large portion of the population. The online survey technique also helps ensure that the research is credible. The questionnaire was divided into two sections – A and B. Section A contained simple multiple-choice questions to enable the researcher retrieve relevant demographic data from the respondents such as age, gender, employment status, educational qualification etc while Section B consists of questions relating to the customer preference, expectation and experience across the quality dimensions. Section B explores the following SERVQUAL quality dimensions:

Table 2. Dimensions of Service Quality

Dimensions	Factors
Tangibles	Physical facilities, equipment and appearance of staff.
Reliability	Ability to execute the agreed service reliably and correctly.
Responsiveness	Readiness to assist to patients and provide prompt service.
Assurance	Employees' expertise and courteousness, ability to inspire trust and confidence in patients.
Empathy	Care and personalized attention offered to customers by the hospital.

Source: Tazreen, 2012

These were evaluated across three components- Desired service level, Expected service level and Patient's perception of the hospital's actual service performance. The service discrepancy or gap was measured by subtracting the value obtained for customers' (patients) perception of the hospital's performance from their expectations. A total of 392 responses were received however upon initial analysis, only 386 were found usable as respondents were also required to confirm if they have received care from a hospital in Lagos state within the past one year. This represents a satisfactory response rate as the required sample size is 384.

To measure the reliability and internal consistency of the survey instrument, the researcher employed Cronbach's Alpha Statistic which is commonly used to prove that surveys which were developed for research purposes are actually acceptable. The formula for calculating Cronbach's alpha is given as:

$$\alpha = \frac{k}{k-1} \left(1 - \frac{\sum V_i}{V_t} \right)$$

Where k = the number of scale items

V_i = the sum of variance associated with item i

V_t = the sum of variance associated with the total scores observed

Cronbach's Alpha reliability coefficient typically ranges between the values of 0 and 1 and any value from 0.70 and above is generally accepted. Due to the large population size, Cronbach's alpha was computed across only one of the three criteria used in this study. The result obtained indicated good internal consistency of the items in the scale as the value obtained was above the threshold of 0.70 as shown below:

Table 3. Calculation of Cronbach's Alpha

Criterion	Number of Items	Cronbach's Alpha
Hospital's Actual Performance	10	0.856

Source: Survey Research, 2021

The process of analysis involved five stages as follows: (i) Creating the decision matrix (ii) Normalizing the decision matrix (iii) Computing the weighted decision matrix (iv) Reducing the maximum and minimum values for each alternative (v) Ranking the alternatives based on the resulting scores.

3. Results and discussion

The patients' demographic characteristics are presented in [Table 4](#) below:

Table 4. Demographic Data

Variables	Frequency	Percentage (%)
Gender		
Female	234	61
Male	152	39
Total	386	100
Age		
18-29	70	18
30-44	278	72
45-59	19	5
60 and above	19	5
Total	386	100
Educational Qualification		
Secondary School Certificate	25	7
Undergraduate Degree	158	41
Postgraduate Degree	171	44
Other	32	8
Total	386	100
Occupation		
Paid professional employment	266	69
Self-employed professional	63	16
Unskilled worker	0	0
Petty trader	6	2
Student/ Unemployed	51	13
Total	386	100
Hospital Type		
Public Hospital	301	78
Private Hospital	85	22
Total	386	100

Source: Survey Research, 2021

Findings reveal that majority of the respondents are female with 61 % of respondents were female (234 respondents) while the remaining 39 % were male (152 respondents). Majority of the respondents (278 respondents) were between the ages of 30 to 44 representing 72 % of the population. The age brackets of 45 to 59 and 60 and above were represented by 19 respondents

each both accounting for 10 % of the responses received. Further analysis indicates that about 90 % of the population fell between the ages of 18 to 45. This is a positive indicator for this study as the younger generation is known to have higher customer service expectations and considerable buying power hence organizations who are looking to grow by retaining existing customers and attracting new ones will do well to satisfy these customer expectations (Microsoft, 2017). 44 % of the respondents have a post graduate degree (masters' degree or higher), while 41% of respondents (158) have an undergraduate degree (a bachelors' degree, HND etc.). 7 % of the respondents have completed their secondary school education while the remaining 8 % represent those whose highest qualification is a type of certification course such as computer training, hair dressing, electrical works etc. thereby implying that majority of the respondents have the capacity to understand the requirements of the questionnaire and provide viable responses. The results also indicate that most of the respondents (60%) were in paid professional employment, 16 % were self-employed professionals while 13 % were either students or unemployed and have no source of income. The remaining 2 % were petty traders. Analysis of the viable feedback retrieved show that 301 respondents receive care from private hospitals while the remaining 85 respondents receive care from public hospitals. This is quite apt as there are four times more registered private hospitals in Lagos state (955) than public hospitals (208); private hospitals tend to have more patients overall compared to public hospitals due to their proximity and less rigorous procedures.

Analysis of the SERVQUAL Quality Dimensions

In section B, respondents were required to provide feedback on the SERVQUAL quality dimensions across the following measures: desired service level, expected service level and their perception of the hospital's performance. The average value of responses received was computed for each alternative then further analysed to generate an average score which will be used to represent the quality dimensions as displayed in Table 5.

Table 5. Respondents Feedback on the SERVQUAL Quality Dimensions

Dimension	Description	Desired Service Level	Expected Service Level	Hospital's Service Performance
Reliability	Provision of accurate medical reports	8.61	7.37	6.26
	Provision of required treatment	8.86	7.47	6.05
	Average Value	8.74	7.42	6.16
Assurance	Hospital is trustworthy	8.53	7.45	6.71
	Expert medical staff	8.61	7.46	6.60
	Average Value	8.57	7.46	6.65
Tangibility	Hospital environment is clean and organized	8.93	7.85	7.15
	Availability of standard equipment	8.45	7.32	6.20
	Average Value	8.69	7.59	6.67
Empathy	Warm and caring attitude of staff	8.46	7.47	6.11
	Affordable service charges	8.12	7.44	5.70
	Average Value	8.29	7.46	5.90
Responsiveness	Prompt service	9.11	7.38	5.46
	Willingness of staff to attend to patients' queries	8.59	7.45	5.77
	Average Value	8.85	7.41	5.62

Source: Survey Research, 2021

The results above indicate that the respondents' desired service level is generally higher than both the expected service level and the perception of the hospital's service performance. The Responsiveness dimension received the lowest rating amongst all the quality dimensions (5.62) while the Tangibility dimension received the highest rating (6.67) implying that most respondents believe their hospitals perform quite satisfactorily in this dimension. A quick review of the Hospital's Service Performance column in table 5 ranks the SERVQUAL quality dimensions from highest score to the lowest score as follows:

- Tangibility dimension – 1st (highest score)
- Assurance dimension – 2nd
- Reliability dimension – 3rd
- Empathy dimension – 4th
- Responsiveness dimension – 5th (Lowest score)

For the final question, respondents were asked to rank the SERVQUAL dimensions from most important to least important, the results are displayed below:

Table 6. Respondents' Ranking of the SERVQUAL Dimensions

Rank	Reliability	Assurance	Tangibility	Empathy	Responsiveness
First	30 %	18 %	16 %	18 %	18 %
Second	38 %	16 %	21 %	8 %	16 %
Third	23 %	25 %	20 %	21 %	11 %
Fourth	8 %	26 %	20 %	34 %	11 %
Fifth	2 %	15 %	23 %	18 %	43 %
Final Rank	1st	3rd	2nd	4th	5th

Source: Survey Research, 2021

The percentage contribution of all responses received was computed as shown above. The dimensions were then ranked by allocating to each dimension the position for which it received the highest votes. From the accumulated results, the respondents have ranked the quality dimensions as follows:

- Reliability dimension – 1st (Most important)
- Tangibility dimension – 2nd
- Assurance dimension – 3rd
- Empathy dimension – 4th
- Responsiveness dimension – 5th (Least important)

There are some notable similarities between both sets of results (Tables 4, 5) as the Empathy and Responsiveness dimensions still retain the lowest ranks (4th and 5th respectively). However, hospital performance for the Reliability dimension which is considered to be the most important to respondents from Table 6 is ranked 3rd in Table 5.

Performance Gap

The performance gap was used to evaluate the level of customer satisfaction across the quality dimensions being evaluated. This is estimated by subtracting the values obtained for customers' perception of hospital's actual performance (P) from their service expectations (E) that is:

$$\text{Gap (g)} = E - P$$

Table 7. Performance Gap

Dimensions	Description	Expected Service Level	Hospital's Service Performance	Performance Gap
Reliability	Provision of accurate medical reports	7.37	6.26	1.11
	Provision of required treatment	7.47	7.28	0.19

Tangibility	Hospital environment is clean and organized	7.85	7.15	0.70
	Availability of standard equipment	7.32	6.20	1.13
Assurance	Hospital is trustworthy	7.45	6.71	0.75
	Expert medical staff	7.46	6.60	0.86
Empathy	Warm and caring attitude of staff	7.47	6.11	1.37
	Affordable service charge	7.44	5.70	1.74
Responsiveness	Prompt service	7.38	5.56	1.81
	Willingness of staff to attend to patients' queries	7.45	5.77	1.68

Source: Survey Research, 2021

Analysis According to Research Objectives

As stated earlier, the major objective of this study is to assess the effectiveness of the multi-objective optimization on the basis of ratio analysis (MOORA) method for evaluating the service delivery priorities of patients in Lagos state. This was done using the steps below:

Create a Decision Matrix

A 5 by 3 decision matrix was generated by collating the average score for each quality dimension (alternatives A_1 to A_5) across the criteria (C_1 to C_3) as illustrated in Table 8 below:

Table 8. Decision Matrix

Criteria	Desired Service Level (C_1)	Expected Service Level (C_2)	Hospital's Service Performance (C_3)
Reliability (A_1)	8.74	7.42	6.16
Assurance (A_2)	8.57	7.46	6.65
Tangibility (A_3)	8.69	7.59	6.67
Empathy (A_4)	8.29	7.46	5.90
Responsiveness (A_5)	8.85	7.41	5.62

Source: Survey Research, 2021

$$X = \begin{bmatrix} 8.74 & 7.42 & 6.16 \\ 8.57 & 7.46 & 6.65 \\ 8.69 & 7.59 & 6.67 \\ 8.29 & 7.46 & 5.90 \\ 8.85 & 7.41 & 5.62 \end{bmatrix}$$

Normalize the Decision Matrix

$$C_1 = \sqrt{(8.74^2 + 8.57^2 + 8.69^2 + 8.29^2 + 8.85^2)} = 19.30$$

$$A_1C_1 = 8.74/19.30 = 0.45$$

$$A_2C_1 = 8.57/19.30 = 0.44$$

$$A_3C_1 = 8.69/19.30 = 0.45$$

$$A_4C_1 = 8.29/19.30 = 0.43$$

$$A_5C_1 = 8.85/19.30 = 0.46$$

$$C_2 = \sqrt{(7.42^2 + 7.46^2 + 7.59^2 + 7.46^2 + 7.41^2)} = 16.69$$

$$A_1C_2 = 7.42/16.69 = 0.44$$

$$A_2C_2 = 7.46/16.69 = 0.45$$

$$A_3C_2 = 7.59/16.69 = 0.45$$

$$A_4C_2 = 7.46/16.69 = 0.45$$

$$A_5C_2 = 7.41/16.69 = 0.44$$

$$C_3 = \sqrt{(6.77^2 + 6.65^2 + 6.67^2 + 5.90^2 + 5.67^2)} = 13.89$$

$$A_1C_3 = 6.77/13.89 = 0.44$$

$$A_2C_3 = 6.65/13.89 = 0.48$$

$$A_3C_3 = 6.67/13.89 = 0.48$$

$$A_4C_3 = 5.90/13.89 = 0.42$$

$$A_5C_3 = 5.67/13.89 = 0.40$$

The normalized matrix becomes: $X = \begin{bmatrix} & 0.45 & 0.44 & 0.44 \\ 0.44 & 0.45 & 0.48 & \\ 0.45 & 0.45 & 0.48 & \\ 0.43 & 0.45 & 0.42 & \\ 0.46 & 0.44 & 0.40 & \end{bmatrix}$

Compute the Weighted Decision Matrix

For the purpose of this study, the subjective weighting method was employed. This method relies on expert opinion such that to get the individual judgment of the experts, the analyst would typically compile and present a set of questions relating to the study to select professionals who must be trained experts or decision makers in the field under study. The decision-makers would then state their opinions on the relative importance of the alternatives being studied which can be expressed on an interval scale (Yin, 2020). Olson (2008) also stated that every model can be said to be flawed hence human decision-makers ought to be entrusted with making certain decisions and we must accept such judgment as the final authority.

For this study, five experts (medical doctors) were approached and asked to share their opinion on the importance of the SERVQUAL quality dimensions. They were then asked to rate the criteria (C_1 to C_3) from 1st (most important) to 3rd (least important). The results generated are displayed in Table 8 below:

Table 9. Experts Ranking of the Study Criteria

Rank	Desired Service Level (C_1)	Expected Service Level (C_1)	Hospital's Service Performance (C_3)
First	0 %	80 %	20 %
Second	0 %	20 %	80 %
Third	100 %	0 %	0 %
Final Rank	3rd	1st	2nd

Source: Survey Research, 2021

The criteria were then ranked by allocating to each dimension the position where it received the highest votes. The weights were allocated using the rank sum method which can be computed using the following formula:

$$\text{Weight } (r_k) = n - r_j + 1$$

Where n = total number of criteria and r_j = the straight rank

$$\text{Normalized weight} = (n - r_j + 1) / \sum (n - r_k + 1)$$

Where n = total number of criteria and r_k = weight

Table 10. Weight of the Study Criteria

	Straight Rank	Weight	Normalized Weight
Desired Service Level	3	1	0.167
Expected Service Level	1	3	0.500
Hospital's Service Performance	2	2	0.333
Total		6	1.000

Source: Survey Research, 2021

The weighted matrix was then computed by multiplying the rows of the normalized matrix by the normalized weight for each dimension to yield the weighted decision matrix below:

$$X = \begin{bmatrix} 0.08 & 0.22 & 0.15 \\ 0.07 & 0.22 & 0.16 \\ 0.08 & 0.23 & 0.16 \\ 0.07 & 0.22 & 0.14 \\ 0.08 & 0.22 & 0.13 \end{bmatrix}$$

Reduce the Maximum and Minimum Values for Each Alternative

The maximum value for each alternative was computed by summing up the three values for each alternative (figures across the row). The minimum value is set to zero as none of the criteria under study is being minimized. The results are displayed below:

Table 11. Reduced Values

	Maximum	Minimum	Y _i (Max - Min)
Reliability	0.445	0	0.445
Assurance	0.457	0	0.457
Tangibility	0.462	0	0.462
Empathy	0.437	0	0.437
Responsiveness	0.433	0	0.433

Source: Survey Research, 2021

Rank the Alternatives Based on Resulting Value

Table 12. Ranked Dimensions

Dimensions	Results	Rank
Reliability	0.445	3 rd
Assurance	0.457	2 nd
Tangibility	0.462	1 st
Empathy	0.437	4 th
Responsiveness	0.433	5 th

Source: Survey Research, 2021

Results obtained from MOORA analysis ranks the performance of hospitals in Lagos state across the five SERVQUAL quality dimensions in decreasing order of importance as follows:

Tangibility > Assurance > Reliability > Empathy > Responsiveness

A review of the data in [Table 13](#) reveals the disparity between patients' and experts' ranking of the SERVQUAL quality dimensions and MOORA ranking of the performance of hospitals in Lagos state. While both experts and respondents agree that the Reliability dimension is the most important quality dimension which is consistent with findings from other studies ([Oyatoye et al., 2016](#); [Islam et al., 2016](#)). However, hospitals' performance in the Reliability dimension is ranked a mere 3rd using MOORA which is indicative of the fact that these hospitals need to put in more effort to close the obvious gap. [Table 7](#) reveals that a performance gap exists across all the dimensions however, the largest gaps are seen in the Empathy and Responsiveness dimensions which is also implied in the results of MOORA rating where hospitals are assigned the lowest rates for both dimensions (4th and 5th respectively). While the respondents have also ranked these two dimensions as the least important, the experts have rated them as the next most important dimensions after the Reliability dimension indicating a disparity between patients' expectation and experts' perception. This divergence reveals an existing gap which if left unaddressed may further promote patient dissatisfaction with the hospital services because the experts do not recognize the customer's pain point but instead channel efforts to the improvement of the areas which they consider to be more important.

Table 13. Summary of Findings

SERVQUAL Quality Dimension	Respondents' Ranking	Experts' Ranking	MOORA's Ranking of Hospital Performance
Reliability	1 st	1 st	3 rd
Assurance	3 rd	4 th	2 nd
Tangibility	2 nd	5 th	1 st
Empathy	4 th	2 nd	4 th
Responsiveness	5 th	3 rd	5 th

Source: Survey Research, 2021

Both parties (patients and experts) agree that the top three most important dimensions are the Reliability, Tangibility and the Assurance dimensions however, the hospitals were evaluated to have the best performance in the Tangibility dimension. The results generated using MOORA can be logically explained as thus – Hospital administrators believe a typical patient would not consider using their services unless the said hospital has a reputation for being trustworthy, is seen to have expert medical staff and appears to be in good condition (neat environment and staff, availability of standard equipment, etc.). Hence, they tend to lay more emphasis on activities that enhance the Tangibility and Assurance dimensions while paying less attention to other quality dimensions. The Microsoft Customer Service report (2017) suggests that there is a direct relationship between good customer service and brand loyalty, which implies that improved customer service is key to an organization's customer acquisition and retention strategy. In this case, patients would inevitably patronize whichever hospital is rated highly across the quality dimensions deemed to be more important to them based either on their personal opinions or on feedback from peers and associates. To improve customer satisfaction, hospitals would need to focus on enhancing their performance in these important dimensions as this would encourage customer retention in the long run.

4. Conclusion

This study utilized MOORA to evaluate patients' perception of services delivered by Lagos state hospitals using the SERVQUAL quality dimensions as key indicators. A structured questionnaire was deployed to collect feedback from respondents and the performance gap was evaluated. The results reveal that there is a huge gap across all quality dimensions between the patients' expectation and the quality of services rendered by their hospitals. The largest performance gap was recorded in the Responsiveness dimension implying that hospital administrators and healthcare decision makers need to implement processes aimed at improving the performance of hospitals in this dimension. Both experts and patients rated the Reliability dimension as the most important quality indicator however hospital performance for this dimension was ranked 3rd (average) using MOORA.

It is therefore recommended that hospital administrators sample customers' opinion regularly to determine their service delivery priorities and their perception of the quality of services provided by the hospital. Information generated can then be used to improve on internal processes to ensure maximum customer satisfaction. Where necessary, staff should also be trained/retrained on how to interact with patients and in so doing improve customer satisfaction thereby reducing the hospital's service performance gap across all quality dimensions.

5. Conflict of Interest

There is no conflict of interest for this study.

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УДК 33

Применение многоцелевой оптимизации на основе метода анализа отношений для оценки предоставления услуг в больницах штата Лагос

Сулаймон Оланреваджу Адебии ^{a, *}, Нкечи Эфенуре ^a

^a Университет Лагоса, Нигерия

Аннотация. Важность обслуживания клиентов невозможно переоценить, поскольку предоставление качественных услуг актуально во всех секторах бизнеса, включая сектор здравоохранения. Поэтому для обеспечения роста и непрерывности бизнеса жизненно важно определить факторы, влияющие на качество обслуживания в их организациях, и улучшить их. Это исследование направлено на выявление ключевых факторов, влияющих на восприятие клиентами качества услуг, получаемых в больницах в штате Лагос, и оценку работы этих больниц с использованием метода многоцелевой оптимизации. Структурированная анкета была распространена среди пациентов и медицинских экспертов в штате Лагос, а полученные данные были проанализированы с помощью MOORA. Результаты подчеркивают разрыв между ожиданиями клиентов и работой больницы. Однако обе стороны согласны с тем, что наиболее важным фактором была надежность. Полученные результаты вносят существенный вклад в разработку расширенных политик, направленных на сокращение существующего разрыва в производительности и повышение удовлетворенности клиентов.

Ключевые слова: здравоохранение, больница, качество обслуживания, MOORA.

* Корреспондирующий автор

Адреса электронной почты: soadebiyi@unilag.edu.ng (С. Оланреваджу Адебии), n.alumona@yahoo.com (Н. Эфенуре)