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Comparative Analysis of Service Quality of Health Care Systems: Case of the Emergency Department of a Government Hospital in Southwestern Nigeria

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Abstract

The health industry's role is vital in the preservation and elongation of the lives of many people. The emergency department in any hospital is designed to handle delicate health situations. An emergency department without adequate capacity to handle these situations would frequently record mortality. Service quality in any establishment is an important performance indicator. Therefore, this study aimed to evaluate the service quality in the emergency department of a chosen hospital. Using SERVAQUAL and Taguchi (mini-tab software and excel package) approaches, factors affecting the quality of service in the department were identified; perception data on the quality of service available to patients were collected through questionnaires under five sections; analyzed and compared. While identified factors include the number of health workers – doctors and nurses, number of bed spaces and retention period of patients, the five sections in the questionnaires covered Tangibles, Reliability, Assurance, Responsiveness and Empathy. Responses recorded totaled one hundred and two (102). Taguchi analysis (mini-tab software) revealed that the presence of nurses played the most vital role in the survival of patients brought into the department, as it ranked first (1st) among the other factors. Excel software showed Empathy as the factor with the highest perception data score of 364.4, while Tangibles had the lowest perception score of 340. From the SERVAQUAL analysis, the patient's perception of Empathy revealed the importance of emergency nursing care, aligning with results from the Taguchi analysis. The need for better infrastructure and equipment within the department was also identified as an area that would increase the quality of service since these had the lowest perception in the patients' minds (Tangibles). Evaluation of the quality of service provided in an emergency department of a government hospital using Taguchi and SERVAQUAL approaches gave similar results, with Empathy and Tangibles playing critical roles in patients' survival.

Keywords: Emergency department, Health, Patients, Service quality, Taguchi.

1 | Introduction

The degree to which a service meets the customer's expectations is defined as service quality [1], [2]. For every organization, there is a need to ensure that service delivery stands out as the utmost priority [3]. Healthcare

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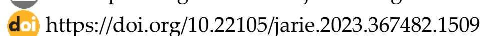

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institutions are not left out in this regard. Every patient admitted to the hospital wants to feel safe and should be able to trust the personnel and be satisfied with the environment [4]. Service quality in the hospital is the satisfaction of patients, revealed by the level of contentment with the service received from the health care provider [5]. While some researchers have identified service quality as the difference between customers' expectations concerning their perception of the service received, others also viewed quality as the total utilities and characteristics that enable a product to satisfy every stated or implied need [6], [7]. The priority of every organization is to ensure its delivery of services equals or exceeds expectations, such that the individuals involved become a testament to how well their service is [8]. Service delivery strengthening is paramount in attaining the health-related Millennium Development Goals (MDGs) [9].

The evaluation of service quality plays an important role in measuring work effectiveness and the attitude to work of the workers tasked with the responsibility of providing such service [10]. Set standards must be met, as any decline may have unwanted consequences. The definition of health has varied across many sectors with diverse implications for making policies, defining practice methods and ultimately, determining policies that govern the structures put in place to ensure its sustainability. It is worthy of note that the World Health Organisation (WHO) in 1948 defined health as a state of complete physical, mental and social well-being [11]. This definition has often been criticized over the years as many researchers argued that there may be no time when one can be said to have a 'complete' state of well-being [12]. In her latest definition of Health, WHO in 2021 modified the definition of health as a state of mental and social well-being and not merely the absence of disease and infirmity [13]. To ensure the health of many people, different structures have to be in place, working together to achieve the common goal. As defined by WHO, the health system comprises all organizations, institutions and resources that produce actions whose primary purpose is to improve health [14]. The main goal of this system is to ensure that the health of the individuals in the community in context is at its best. Patients, families, ministries of health, health service organizations, health financing organizations, and pharmaceutical companies all play vital roles in achieving this goal [15].

Health care systems in Nigeria refer to all the organizations, institutions and elements working together in Nigeria to ensure safe and efficient health care. Nigeria has three broad divisions of health care systems: Primary health care, secondary health care and tertiary health care. Primary health care is taken care of by the local government, secondary health care is taken care of by the state government, while tertiary health care is taken care of by the federal government. The essential components of resources are doctors, nurses, midwives and community health workers [16]. Secondary and tertiary healthcare institutions are commonly referred to as Hospitals. A hospital is a typical complex dynamic system that normally attracts a large number of people seeking the services of highly skilled medical practitioners [17]. Such a system is usually faced with limited resources and high demands. Hospitals are made up of different sections for efficiency in service delivery. These sections provide specialized functions to maintain standard quality delivery of health services to the patients brought in for treatment [18], [19].

These include the medical records department, outpatient unit, pharmacy, radiotherapy, renal unit, medical laboratory, Wards, Storage unit, Ophthalmology unit, and the emergency department. The relevance of the emergency department in any hospital cannot be overemphasized. When life-threatening issues are brought to the hospital, they are first referred to the emergency unit for the patient to be stabilized and emergency surgery carried out where necessary.

Oxygen is provided for, and any other emergency-related service to try to save the patient's life and to ensure the patient is stabilized before the patient may be transferred to another care unit till full recovery [20]. Patients requiring emergency services keep increasing, whereas this department's capacities in most hospitals remain the same, making it difficult for the department to maintain efficient services [21]. With occurrence(s) involving mass casualty, the after-effect varies with victims, so different levels of medical attention would be required by those involved, making triaging essential [22].

Four triage tags: black, red, yellow and green are universally employed for indicating the severity of a patient's condition [23]. To enhance multiple improvements in production quality and its cost, Taguchi, as far back as

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the 1950s, developed a method for combining engineering tools with statistical techniques [24]. This method usually finds application during the early stages of product design and development to improve the production process and product variance. The Taguchi statistical method uses a loss function to measure the quality characteristic of the unit under consideration. Solving health challenges requires that the hospital maintains a certain standard, with each department having the necessary personnel and equipment to save lives [18]. This is the primary reason for quality evaluation, ensuring that these standards are in order and continually maintained by each department in the hospital [8].

The Emergency department is one of the choice departments in any hospital, as this department usually has a major role(s) to play in preserving the lives of patients with critical health challenges [25]. Seeing the role the emergency department plays in any health institution, its state of operation should always be considered regularly, as deterioration in the capacity can adversely affect its ability to save lives. Furthermore, sustaining and improving the department's capacity creates favorable conditions for patients and healthcare institutions [26]. The need for patient satisfaction is paramount in the running of any health institution. The perception of the patients indicates the service quality delivery [4].

Findings have shown that the use of statistical methods to determine the individual effects of various factors, their interactions and how they affect the overall performance of the sector has become a welcome development in recent times [27]. They have been carefully considered over time as critical means of checking what needs improvement in any unit being considered [28]. Comparative studies on methods and corresponding outcomes in evaluating the emergency department have been carried out over time [29]. Metrics to consider in evaluating quality standards may vary according to the patient's perspective, but the standard evaluation method used for ease of interpretation is the SERVAQUAL method [10]. The use of statistical tools in evaluating service quality in healthcare systems has recently increased because their importance has been widely acknowledged, and their relevance has also been established [30].

The application of Taguchi to healthcare systems has gained ground, and its use has shown reliable outcomes regarding quality evaluation [27]. Towards the end of the last millennium, a series of experiments were carried out using Taguchi's quality evaluation method for service delivery improvement in the emergency department of a hospital in Western Washington [31]. Not long afterward, findings evaluating the length of stay in the emergency departments with computer-simulated interventions were conducted [32]. Similarly, it was specified that the SERVAQUAL approach has become a widely accepted, standardized assessment method for evaluating service quality [33]. It entails using questionnaires to address five crucial points: 1) reliability, 2) tangibles, 3) assurance, 4) responsiveness, and 5) empathy [34]. On a rather sad note, differences in the timing of new arrivals and servicing of registered patients make it difficult for most emergency departments to accommodate all patients being brought [17]. Owing to the unsteady nature of inter-arrival times, severity of illness, emergency cases, and departments concerned, analysis of patients' flow becomes complex [35]. It is imperative to conduct triaging on every new emergency patient to assess the severity of injuries and chances of survival [36]. However, ascertaining the provision of health care services that do not fall below predefined standard(s) is the main duty of a health system [37]. Here in Nigeria, a number of researchers had in the past considered emergency nursing care in two hospitals in Oyo State, Nigeria, and found this to be unsatisfactory according to feedback from patients, even though their study focused only on one factor [19].

This paper covered the evaluation of the emergency department of a government hospital in Southwestern Nigeria using the SERVAQUAL approach and Taguchi method. Therefore, the objectives include 1) evaluating the current practices of the emergency department, 2) collecting relevant data, and 3) evaluating data collected and drawing inferences.

2 | Methodology

In this research, an evaluation of the emergency department of a government hospital in Southwestern Nigeria was carried out using the SERVAQUAL approach and the Taguchi Method.

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2.1 | Investigating the Current Practice

On days of observations in the emergency department, available healthcare professionals granted interviews on questions about the hospital's practices. Questions asked covered the duration of services, units in the department, and means of admitting patients.

2.2 | Data Collection

Using the 5-Likert Scale, with standard twenty-two SERVAQUAL questions tailored to extract necessary information from patients, questionnaires based on the SERVAQUAL model were prepared to address the five evaluation tools, each having five options [38]. These were administered to patients transferred to other wards from the emergency department. The patients filled out the questionnaires according to their perception of the quality of service received, without any external influence.

Data was collected for six months, covering daily admissions of patients, the number of servers (Doctors and Nurses) and the number of beds available at the emergency department of the hospital in question. The average response time of the servers was also observed.

2.3 | Data Analysis

Data collected were collated and tabulated according to the five divisions to evaluate service quality. The values obtained from the data were analyzed using the un-weighted gap score SERVAQUAL evaluation method. Here, the total value of each evaluation parameter was recorded, and responses to individual questions were analyzed. Each of these factors was evaluated to obtain the SERVAQUAL score, showing the perception of customers concerning the quality of service rendered by the organization. Similarly, in the course of data analysis, in addition to the use of Microsoft Word and Excel packages, Taguchi's quality control approach was adopted using the mini-tab software [30]. The factors affecting the service quality of the department, as identified and reported, were evaluated. Each of these factors was assigned two levels (low and high). By varying each level against one other, their interactions and effects on the system were observed and recorded.

2.3.1 | Conducting Taguchi methods on mini-tab software

Step 1. The Mini-Tab software was opened.

Step 2. In generating a Taguchi design (orthogonal array), Stat > DOE > Taguchi > Create Taguchi Design was chosen. Each column in the orthogonal array represented a specific factor with two or more levels. Each row represented a run; the cell values identified the factor settings for the run.

Step 3. Custom Taguchi Design was defined in order to specify which columns are the factors and signal factors. Thereafter, the design was analyzed to generate plots.

Step 4. Stat > DOE > Display Design was chosen to change the units (coded or un-coded) in which Minitab expresses the factors in the worksheet.

Step 5. Stat > DOE > Modify Design was chosen to rename the factors, change the factor levels, add a signal factor to a static design, ignore an existing signal factor (treat the design as static) and add new levels to an existing signal factor.

Step 6. Stat > DOE > Taguchi > Analyze Taguchi Design was chosen to analyze the experimental data.

Step 7. At this stage, the experiment was allowed to run to display the results.

2.3.2 | Signal-to-noise ratio

The quality feature, larger-is-better, was used for the analysis. The signal-to-noise equation *Eq. (1)* was used to evaluate the levels of the factors that maximize the response of patients in the emergency department. The effect of the factors on the patients was determined through the S/N ratio calculation.

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$$\text{"Larger is better" } \frac{s}{n} = -\log\frac{1}{n}\left(\sum\frac{1}{y^2}\right), \quad (1)$$

where

n= number of responses in factor level combination.

y= responses for the given factor level combination.

2.3.3 | Response table

The response table was deployed to select the best levels for each factor. To identify the factors with the largest impact on the response feature, the Delta and Rank values are utilized. After that, the level of the factors conforming to the objectives was determined.

2.3.4 | Main effect plot

The main effect plot demonstrates how factors affect the response characteristics (standard deviations, S/N ratio, slopes, and means). A minimum effect exists when different factor levels affect the characteristic differently.

2.3.5 | Analysis of variance

The Analysis of Variance (ANOVA) was applied to examine the effect and interaction of selected combinations of factors on the response variable (emergency patients). The confidence level was 95%. The effect was measured by sorting the total variability of the S/N ratios, measured by the sum of deviations from the total mean S/N ratio, into percentage contributions by each design parameter and error.

3 | Results and Discussion

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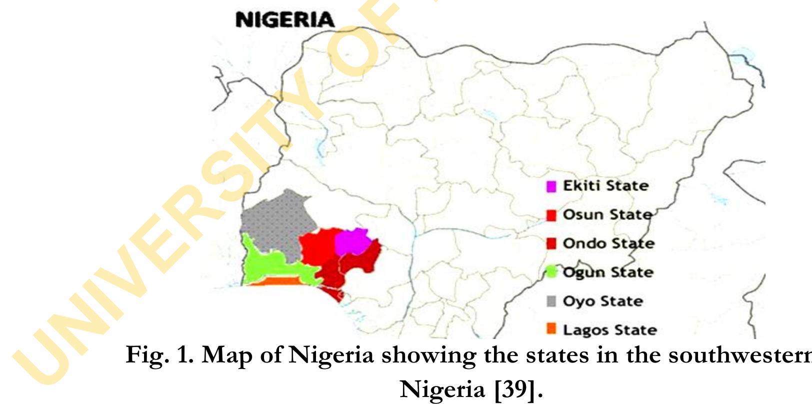

Fig. 1. Map of Nigeria showing the states in the southwestern Nigeria [39].

Fig. 2. Map of southwestern Nigeria showing government-owned hospitals [40].

As shown in *Fig. 1*, the South-West of Nigeria comprises six states: Ekiti, Osun, Ondo, Ogun, Oyo and Lagos States. These states constitute one of the six geopolitical zones in Nigeria, located on Longitude 30° and 7°E and Latitude 4° and 9°N [39]. The zone is bound eastward by Edo and Delta States, Northward by Kwara and Kogi States, westward by the Republic of Benin and southward by the Atlantic Ocean. It has large forest reserves with a forest area of about 842,499 hectares [40]. Shown in *Fig. 2* include the government hospitals situated within the south-west of Nigeria, one of which formed the setting for this study.

3.1 | Investigating the Current Practice

The hospital's emergency department under consideration runs twenty-four hours daily around the year. It is divided into six records units: resuscitation, intensive care, laboratory, theatre and pharmacy. Patients either walk into the department by themselves and are subsequently attended to by a healthcare professional or are rushed into the hospital using ambulances and other available means. Regardless of the means of admission, triaging is carried out on each patient to assess the severity of illness and required treatment.

3.2 | Data Collection

Following the procedure earlier described for data collection, *Tables 1* and *2* were obtained.

Table 1. Questionnaire template for data collection.

S/N	Questions	SD	D	N	A	SA
1	Tangibles					
2	Assurance					
3	Empathy					
4	Responsiveness					
5	Reliability					

*SD: Strongly Disagree, D: Disagree, N: Neutral, A: Agree, SA: Strongly Agree

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Table 2. Template for perception of workers and facilities in the emergency department.

S/N	Factors	Not Good	Neutral	Good
1	Retention time (days)			
2	Nurses			
3	Comfort (bed space)			
4	Doctors			

As shown in *Table 1*, the five evaluation tools (sections) considered in the questionnaire are Tangibles, Assurance, Empathy, Responsiveness and Reliability. Also, the five options attached to each question in the questionnaire covered Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree. In *Table 2*, factors identified include retention time of admitted patients, number of doctors, number of nurses, and number of bed spaces available in the department. Altogether, a total number of 102 responses were received from the patients, meaning that the population size for the study was 102.

Table 3. Perception data for tangibles.

Question	Perception Score
1	322
2	296
3	398
4	344
Average score	340

Table 3 shows the perception score of each question (1-4) and the average score (340) under the classification Tangibles. Moreover, while question 3 recorded the highest perception score herein (398), question 2 recorded the lowest (296).

Table 4. Perception data for reliability.

Question	Perception Score
5	318
6	346
7	348
8	342
9	378
Average Score	346.4

Table 4 shows the perception score of each question (5-9) and the average score under the classification Reliability. Moreover, while question 9 recorded the highest perception score herein (346.4), question 5 recorded the lowest (318).

Table 5. Perception data for responsiveness.

Question	Perception Score
10	350
11	348
12	368
13	330
Average Score	349

Table 5 shows the perception score of each question (10-13) and the average score (349) under the classification Responsiveness. Moreover, while question 12 recorded the highest perception score herein (368), question 13 recorded the lowest (330).

Table 6. Perception data for assurance.

Question	Perception Score
14	328
15	358
16	320
17	410
Average Score	354

Table 6 shows the perception score of each question (14-17) and the average score (354) under the classification Assurance. Moreover, while question 17 recorded the highest perception score herein (410), question 16 recorded the lowest (320).

Table 7. Perception data on empathy.

Question	Perception Score
18	352
19	352
20	358
21	368
22	392
Average score	364.4

Table 7 shows the perception score of each question (18-22) and the average score (364.4) under the classification Empathy. Moreover, while question 22 recorded the highest perception score herein (392), questions 18 and 19 both recorded the lowest (352). Information gathered on factors affecting service quality is given in *Table 8*.

Table 8. Factors affecting service quality.

Factors	Level 1	Level 2
Retention time (days)	1	3
Bed spaces	5	11
Doctors	1	4
Nurses	2	5

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Table 8 shows identified factors, including retention time, bed spaces, doctors and nurses. While level 1 indicated the lower value on each factor, level 2 indicated the higher value on each factor.

3.3 | Data Analysis

On inputting the values obtained in *Tables 3-7* into the Microsoft Excel sheet (SERVAQUAL technique), the results, as shown in *Figs. 3-7*, were obtained.

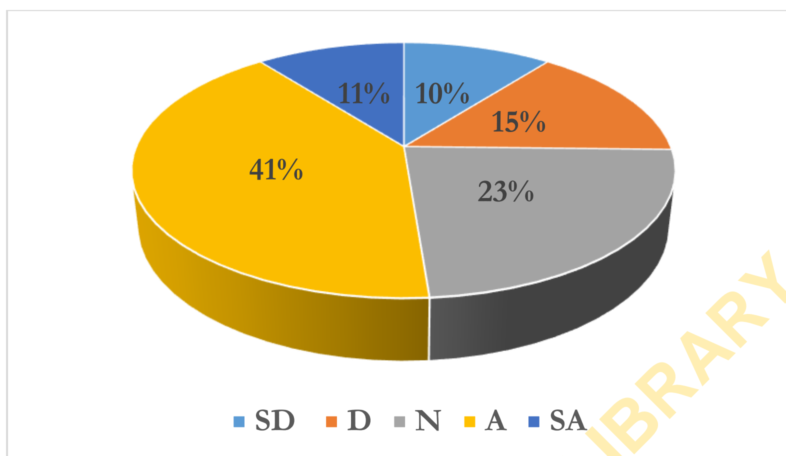

Fig. 3. Patients' perception of tangibles.

Fig. 3 shows the percentage representation of patients' choices in their perception of the Tangibles classification. 41% of the sampled population chose the option 'agree' making it the highest choice, while 10% chose 'strongly disagree', the lowest choice.

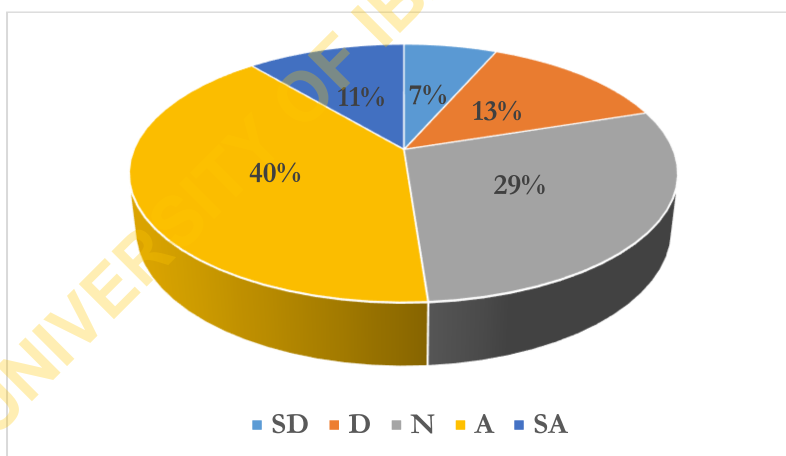

Fig. 4. Patients' perception of reliability.

Fig. 4 shows the percentage representation of patients' choices in their perception of the classification Reliability. 40% of the sampled population chose the option 'agree,' making it the highest choice, while 7% chose 'strongly disagree,' the lowest choice.

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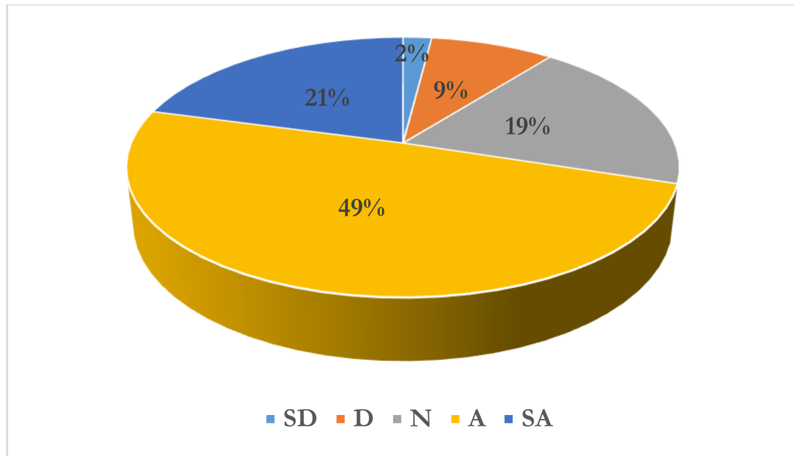

Fig. 5. Patients' perception of responsiveness.

Fig. 5 shows the percentage representation of patients' choices in their perception of the classification 'Responsiveness.' 49% of the sampled population chose the option 'agree,' making it the highest choice. In comparison, 2% chose 'strongly disagree,' making it the lowest choice.

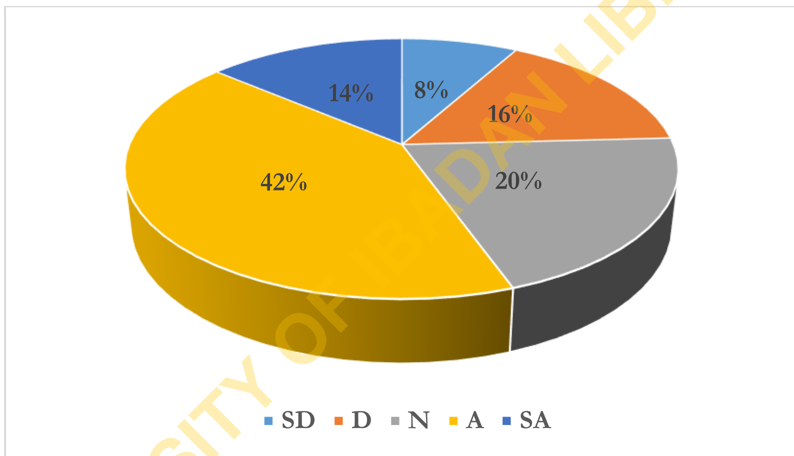

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Fig. 6. Patients' perception of assurance.

Fig. 6 shows the percentage representation of patients' choices in their perception of the classification 'assurance.' 42% of the sampled population chose the option 'agree,' making it the highest choice, while 8% chose 'strongly disagree,' making it the lowest choice.

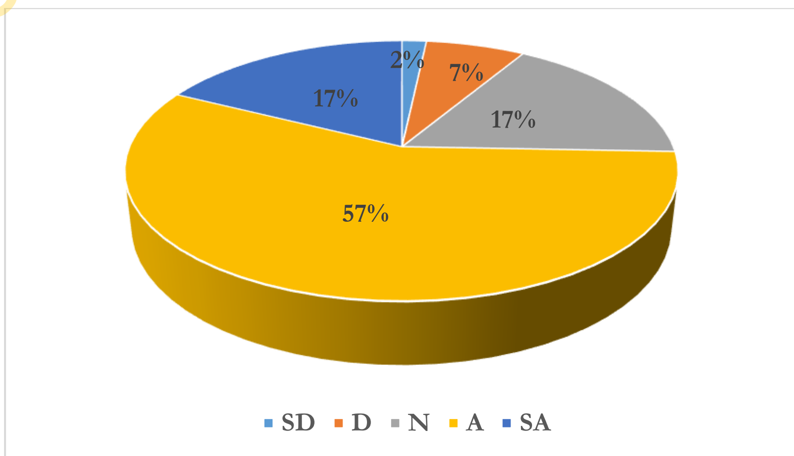

Fig. 7. Patients' perception of empathy.

Fig. 7 shows the percentage distribution of patients' responses to the classification 'Empathy.' Patients who chose the 'agree' option had the highest percentage with 57%, while those who chose the 'strongly disagree' option had the smallest percentage with 2%.

Table 9. Perception data gap and percentage deviation on each factor.

S/N	Factors	Score	Gap	Percentage Deviation in Quality Expectation (%)
1	Tangibles	340	180	34.6
2	Reliability	346.4	173.6	33.4
3	Responsiveness	349	171	32.9
4	Assurance	354	166	31.9
5	Empathy	364.4	155.6	29.9
Expectation score		520		

Table 9 shows the factors, their collective average scores and the gap in perception. The gap is the difference between the total available expectation score and the Perception score (responses of the patients). The percentage deviation from the expectation was also calculated.

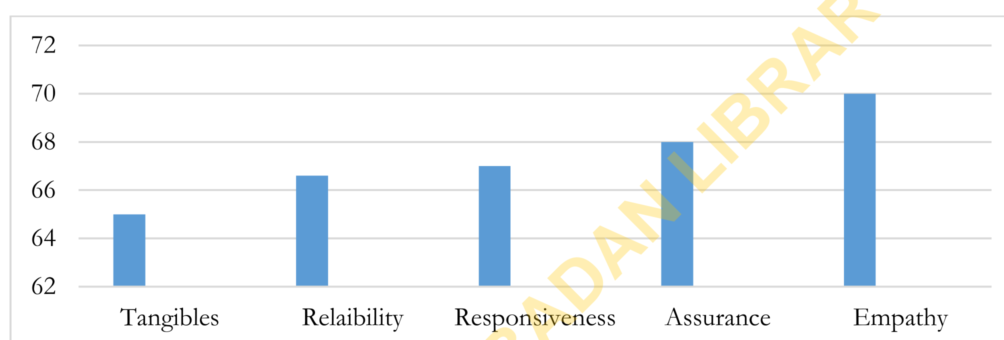

Fig. 8. Summary of perception data.

Fig. 8 shows empathy has the highest perception score, rating the workers' empathy highly. Tangibles had the lowest perception score with patients rating the infrastructure lowest. The other factors had perception scores falling between the two mentioned above, as shown in the figure above. Regarding ranking, while empathy ranked 1st, assurance, responsiveness, reliability and tangibles ranked 2nd, 3rd, 4th and 5th, respectively.

On inputting the values obtained in *Table 8* into the mini-tab software (Taguchi technique), an expanded table, as shown in *Table 10*, was obtained.

Table 10. Factors affecting service quality in orthogonal array L8 (2^7).

S/N	A	B	C	D
1	1	5	2	1
2	1	11	2	4
3	1	11	5	1
4	1	5	5	4
5	3	5	2	1
6	3	11	2	4
7	3	11	5	1
8	3	5	5	4

In *Table 10*, an L8 orthogonal array was followed, with both levels for each factor evenly distributed across the Table.

Table 11. Response table for signal-to-noise ratios.

Level	Retention Time	Bed Spaces	Nurses	Doctors
1	10.454	10.390	9.129	11.066
2	14.087	14.152	15.412	13.476
Delta	3.633	3.762	6.283	2.410
Rank	3	2	1	4

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Table 11 shows the signal-to-noise ratio response table. The ranks show the factors in order of importance. It can be seen that of all factors considered together, the presence of nurses in the emergency department ranks highest in importance.

Table 12. Response table for means.

Level	Retention Time	Bed Spaces	Nurses	Doctors
1	5.750	6.750	4.125	6.125
2	7.500	6.500	9.125	7.125
Delta	1.750	0.250	5.000	1.000
Rank	2	4	1	3

Table 12 shows the mean response for each factor from the Taguchi Analysis. The ranks also indicate the factor concerning their importance in increasing order. Again, the presence of Nurses in the emergency department ranks highest. As shown in *Tables 11* and *12*, while Delta measured the impact size by taking the difference between the average of the largest and lowest characteristics for a factor, Rank aided in distinguishing which factors have the largest effect. The factor with the largest delta value was specified and ranked 1, and the factor with the second largest delta was specified and ranked 2.

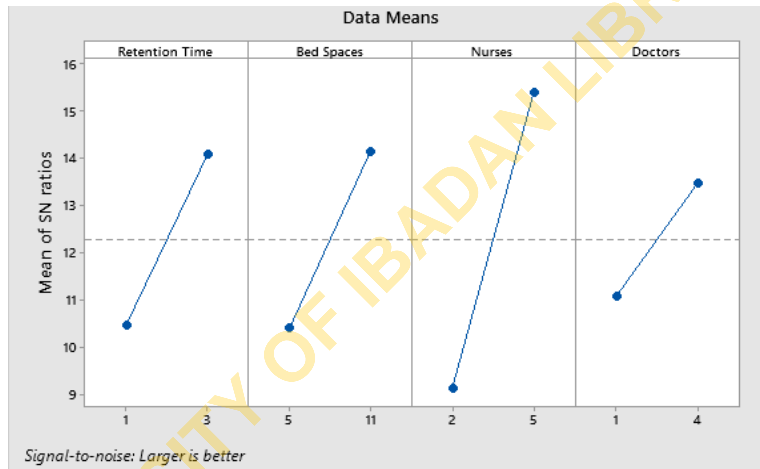

Fig. 9. Main effect plot for S/N ratio of the emergency department.

When *Fig. 9* was carefully considered, it could be noted that the optimum condition was $A_2B_2C_2D_2$, indicating that even when all bed spaces were available (11), with four doctors and five nurses on shift, time available for patients to get well before transfer to other wards increased properly.

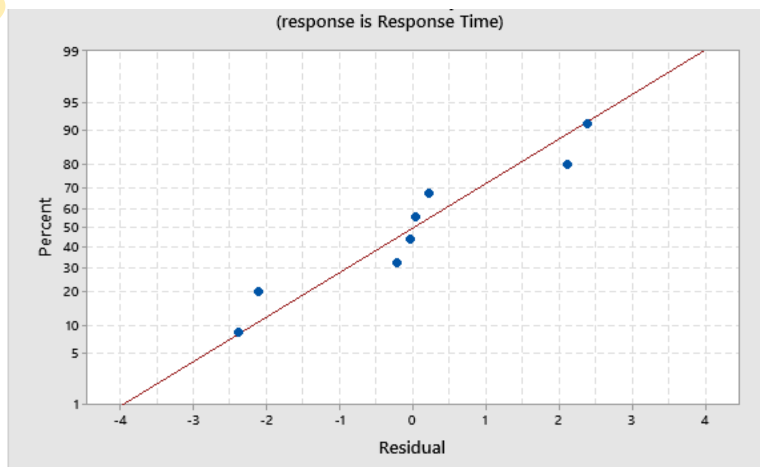

Fig. 10. Normal probability plot for response time.

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Fig. 10 shows the distribution of the data on the normal probability plot. The closeness of the data points to the straight line indicates the normal distribution of the data analyzed. This closeness of the data points to the line indicates that the data was normally distributed, and the results give a good representation of the system being considered.

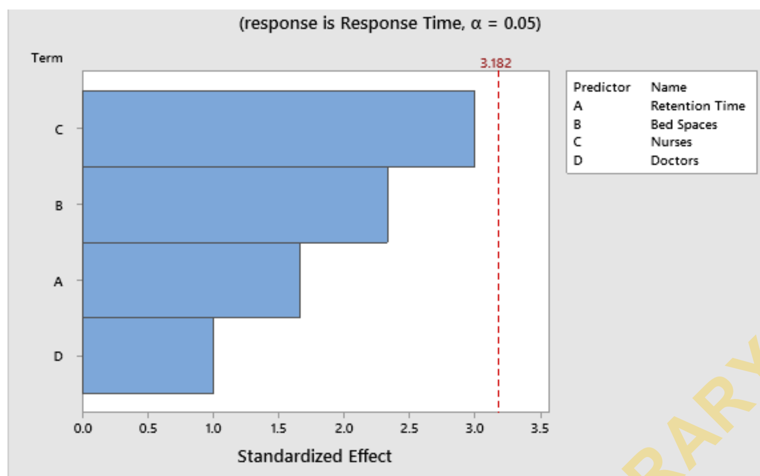

Fig. 11. The pareto chart of standardized effects.

Fig. 11 shows the Pareto graph on the effects per factor. This graph shows the factors' effects in order of magnitude. Factor C has the highest, while factor D has the lowest.

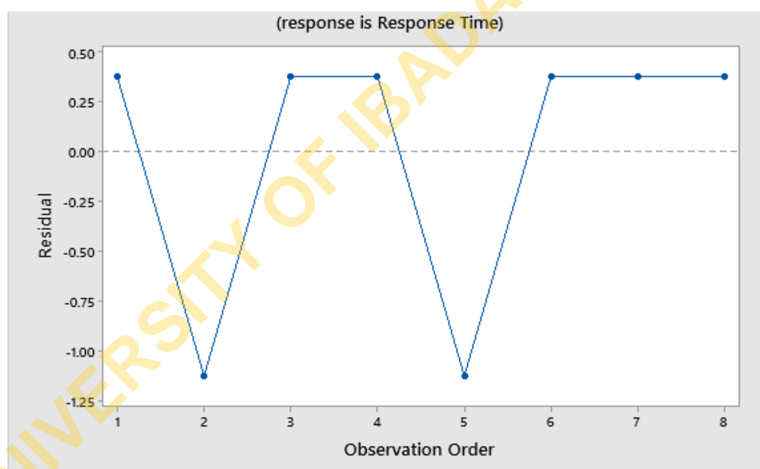

Fig. 12. The versus order graph for the response time.

Fig. 12 shows the versus order plot. This plot shows that the data bounces off the zero line, indicating that the data was random and there is no serial correlation between the data.

Table 13. Regression equation.

Response Time	=	-3.21 + 0.625 Retention Time + 0.292 Bed Spaces + 0.750 Nurses + 0.250 Doctors

Table 14. Model summary.

S	R-Sq	R-Sq (Adj)	R-Sq (Pred)
1.06066	85.86%	67.02%	0.00%

The R-sq value is 85.86% (*Table 14*). This indicates that of all the data utilized, 85.86% fits into the linear regression model (*Table 13*).

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Table 15. The ANOVA.

Source	DF	Seq SS	Seq MS	F-Value	P-Value
Regression	4	20.500	5.125	4.56	0.122
Retention time	1	3.125	3.125	2.78	0.194
Bed spaces	1	6.125	6.125	5.44	0.102
Nurses	1	10.125	10.125	9.00	0.058
Doctors	1	1.125	1.125	1.00	0.391
Error	3	3.375	1.125		
Total	7	23.875			

Table 15 shows the factors and their statistical significance to the regression model. Factor C (Nurses) has the lowest P-value, with the highest statistical significance in the study.

4 | Limitation of the Study

This study did not include other departments within the health care institution besides the emergency department.

5 | Conclusion

The service quality of the emergency department of a government hospital in Southwestern Nigeria was evaluated, and the following were drawn:

SERVAQUAL evaluation:

I. Tangibles had the highest deviation from the expectation. This implies that the outward attributes of the hospital, such as equipment and infrastructure, had the lowest perception in the patients' minds.

II. Empathy had the lowest deviation from the expectation. This shows that the patients felt that the strongest service attribute was the ability of the health care providers (Nurses and Doctors) to identify with their needs.

III. Overall, the average perception is above 67%. This indicates that there is room for a lot of improvement in the service quality delivery in the institution.

Taguchi Analysis:

I. The study revealed that the optimum retention time for a patient to be catered for should be three days to monitor recovery fully.

II. The need for bed spaces to always be available in the department was very important. The absence of this could lead to crowding and the patients who may not have fully recovered may be transferred before they should.

III. The research revealed that nurses played the most important role in the department as their presence makes available first aid treatment to the emergency victims, giving them a chance to survive.

IV. The effectiveness of doctors was identified to be best when other factors are in place.

In conclusion, the Taguchi method showed that the nurses had the highest rank in the factors at the emergency department, aligning with the empathy results from the SERVAQUAL method. The need for equipment and infrastructure improvement was identified in this work since Tangibles had the lowest perception score. The presence of modern equipment, well-trained personnel to run such equipment and other physical infrastructure should be prioritized to retain patients' trust in the department's capability.

6 | Recommendation

The system was observed to need increased infrastructure, modern equipment, and well-trained personnel to run such equipment, as the analysis has identified their paramount importance in providing the best form of

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service to patients. Therefore, it is recommended that the institution's management pay more attention to the availability of state-of-the-art facilities to meet the ever-increasing demands of the population relying on the institution to preserve their health in times of crisis.

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