

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

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Abstract

The quality-of-service delivery in any organization needs to be at its best, otherwise, there would be losses in that organization. The health industry, particularly hospitals and specifically emergency departments in hospitals are not excluded. If anything, they play such vital roles that its evaluation needs to be carried out as regularly as possible. Several methods have been deployed in order to evaluate service quality. Two of these methods; the Taguchi approach and the SERVAQUAL approach have been utilized and compared in this research. The Taguchi approach, through the application of mini-tab software, showed that the role of the Nurses in the emergency department appeared to be the most vital. The SERVAQUAL approach revealed that patients perceived empathy from the workers as the highest quality displayed by staff in the department. It can be concluded that these two approaches gave similar results, as Nurses are trained particularly to have a great deal of empathy.

Keywords: Emergency department, Health, Patients, Service Quality, Taguchi

1 | Introduction

The degree to which a service rendered meets the expectations of the customer is defined as service quality [1][2]. For every organization, there is the need to ensure that service delivery stands out as utmost priority [3]. Health care institutions are not left out in this regard. Every patient admitted into 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 on the service received from the health care provider [5]. While some researchers have identified service quality as difference between customers' expectations with respect to their perception of the service received, others also viewed quality as the total utilities and characteristics which enable a product to satisfy every stated or implied needs [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]. In attaining the health-related millennium development goals (MDGS), strengthening of service delivery is of paramount importance [9]. The evaluation of service quality plays an important role in the measurement of 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. Definition of health has varied across many sectors with diverse implications for making policies, defining methods for practice and ultimately, determining policies which govern the structures put in place to ensure its sustainability. It is worthy of note that the World Health Organization (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 'complete' state of well-being [12]. In her latest definition of Health, WHO in 2021 has 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 of all organisations, institutions and resources that produce actions whose primary purpose is to improve health' [14][15]. 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 organisations, health financing organisations, pharmaceutical companies all play vital roles in achieving this goal [16]. Health care systems in Nigeria refer to all the organisations, institutions and elements, working together in Nigeria to ensure safe and efficient health care. There are three broad divisions of health care systems in Nigeria; The primary health care, secondary health care and tertiary health care. The primary health care is taken care of by the local government; the secondary health care is taken care of by the state government while the tertiary health care is taken care of by the federal government. The essential components of resources are doctors, nurses, midwives and community health workers [17]. The secondary and tertiary health care institutions are commonly referred to as Hospitals. A hospital is a typical complex dynamic system which normally attracts a large number of people seeking the services of highly skilled medical practitioners [18]. Such system is usually faced with the challenge of limited resources and high demands. For efficiency in delivery of services, hospitals are made up of different sections. These sections provide specialized functions in order to maintain standard quality delivery of health services to the patients brought in for treatment [19][20]. These sections include; medical records department, out-patient 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, in order for the patient to be stabilized, and emergency surgery carried out where necessary. Oxygen provided for, and any other emergency related service in order to try to save the life of the patient and to ensure the patient is stabilized before the patient may be transferred to another care unit till full recovery [21]. Patients requiring emergency services keep increasing, whereas, capacities of this department in most hospitals remain same, making it difficult for the department to maintain efficient services [22]. With occurrence(s) involving mass casualty, the after-effect varies with victims, and so, different levels of medical attention would be required by those involved, making triaging very essential [23]. Four triage tags: black, red, yellow and green are universally employed for indicating the severity of a patient's condition [24]. To enhance multiple improvements on production quality, as well as its cost, Taguchi, as far back as the 1950s, developed a method for combining engineering tools with statistical techniques [25]. This method usually finds application during early stages of product design and development for the improvement of production process and products variance. The Taguchi statistical method makes use of a loss function as a measurement of the quality characteristic of the unit under consideration. Solving health challenges require that the hospital maintains a certain standard, with each department having the necessary personnel and equipment to save lives [19]. 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 major role(s) to play in the preservation of the lives of patients who are brought in with critical health challenges [26]. Seeing the role the emergency department plays in any health institution, its state of the operation should always be considered regularly, as deterioration in the capacity can have adverse consequences on its ability to save lives. Furthermore, sustenance and improvement in the capacity of the department leads to favorable conditions for both the patients and the health care institution [27]. The need for patient satisfaction is paramount in the running of any health institution. The perception of the patients gives an indication of 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 [28]. They have been carefully considered over time as critical means to checking what needs to be improved upon in any unit being considered [29]. Comparative studies on methods and corresponding outcome in the evaluation of the emergency department have been carried out over time [30]. Metrics to consider in the evaluation of quality standards may vary according patient's perspective, but the standard evaluation method used for ease of interpretation is the SERVAQUAL method [10]. The use of statistical tools in the evaluation of service quality in health care systems has increased in recent times because while their importance has been widely acknowledged, and their relevance have also been established [31][32]. The application of Taguchi to health care systems has gained ground, and its use has shown reliable outcomes as regards the evaluation of quality [28]. Towards the end of the last millennium, 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 [33]. Not quite long

afterwards, findings evaluating the length of stay in the emergency departments with the aid of computer-simulated interventions were conducted [34]. Similarly, it was specified that the SERVAQUAL approach has become a widely accepted, standardized, assessment method for the evaluation of service quality [35]. It entails the use of questionnaires in addressing five crucial points which include: Reliability, Tangibles, Assurance, Responsiveness and Empathy [36]. To a rather sad note, existence of differences in the timing of new arrivals, and servicing of registered patients make it difficult for most emergency departments to accommodate all patients that are being brought [18]. Owing to the unsteady nature of inter-arrival times, severity of illness, emergency cases, and departments concerned, analysis of patients' flow become complex [37]. It is imperative to conduct triaging on every new emergency patient to assess severity of injuries and chances of survival [38]. However, ascertaining the provision of health care services that do not fall below predefined standard(s) is the main duty of a health system [39]. 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 [20]. This paper covers the evaluation of the emergency department of a government hospital in South-Western Nigeria using SERVAQUAL approach and Taguchi method.

2 | Methodology

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

2.1 | Investigating the Current Practice

Available health care professionals on days of observations in the emergency department granted interviews on questions about the practices of the hospital. Questions asked covered: duration of services s; units in the department and means of admitting patients.

2.2 | Data Collection

Using the 5-Likert Scale, with standard twenty-two(22) SERVAQUAL questions tailored to extract necessary information from patients, questionnaires, based on the SERVAQUAL model were prepared to address the five tools of evaluation, with each having five options[40]. These were thereafter administered to patients on transfer to other wards from the emergency department. The patients filled the questionnaires according to their perception of the quality of service received, without any external influence.

Data was collected for a period of six (6) months, and data collected covered daily admissions of patients, number of servers (Doctors and Nurses) and the number of beds available at the emergency department of the hospital in question. Average response time of the servers was also observed.

2.3 | Data Analysis

Data collected were collated and tabulated according to the five divisions for the evaluation of 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 for individual questions were analyzed. Each of these factors was evaluated to obtain the SERVAQUAL score, showing the perception of customers in relation to 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 quality control approach was adopted, using the mini-tab software [31]. 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 of the levels 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 response of patients in the emergency department. The effect of the factors on the patients was determined through the S/N ratio calculation.

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

Where;

n= number of responses in factor level combination

y= responses for the given factor level combination

2.3.3 | Response table

To select the best levels for each factor, the response table was deployed. To identify the factors with the largest impact on the response feature, the “Delta” and “Rank” values are utilized. Thereafter, 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 levels of a factor 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 of the design parameters and errors.

3 | Results and Discussion

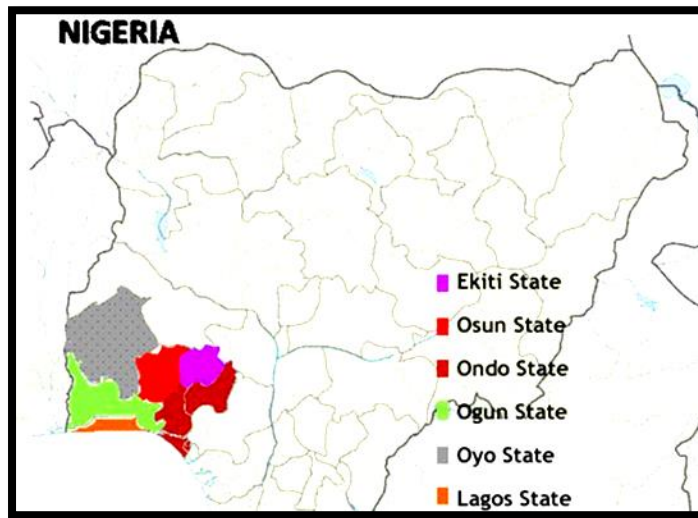


Fig. 1. Map of Nigeria showing the states in the south-western Nigeria [41]

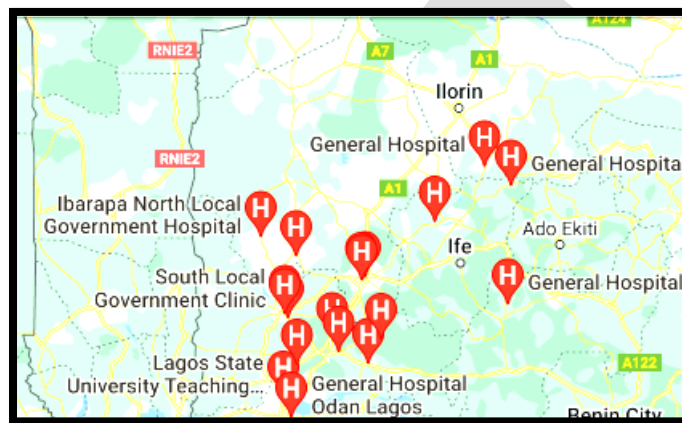


Fig. 2. Map of south-western Nigeria showing government-owned hospitals [42]

As shown in Fig. 1, the South-West of Nigeria is made up of 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[41]. 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 mass of forest reserves with forest area of about 842,499 hectares [42]. 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 emergency department of the hospital under consideration runs twenty-four (24) hours on daily basis round the year and is divided into six units of records, resuscitation, intensive care, laboratory, theatre and pharmacy. Patients either walk into the department by themselves, and are subsequently attended to by health care professional on hand 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 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

SD- Strongly Disagree, D- Disagree N- Neutral A- Agree, SA- Strongly Agree

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

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 (5) tools of evaluation (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.

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 and the total average under the classification ‘Tangibles’.

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 and the average score under the classification ‘Reliability’

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 and the average score under the classification 'Responsiveness'.

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 and the average score under the classification 'Assurance'.

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 and the average score under the classification 'Empathy'.

Information gathered on factors affecting service quality is as 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

As shown in Table 8, 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 Table 3 – Table 7 into the Microsoft excel sheet (SERVAQUAL technique), the results, as shown in Fig. 3 – Fig. 7 were obtained.

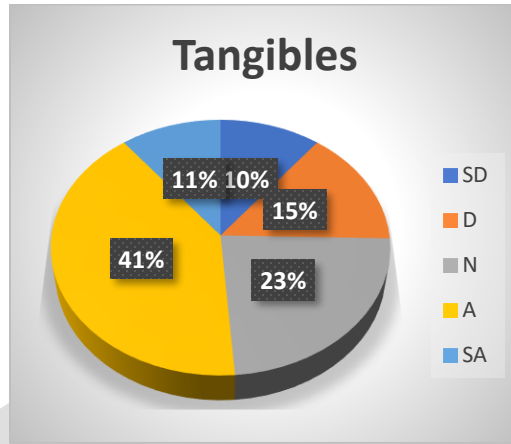


Fig.3. Patients' Perception on Tangibles

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

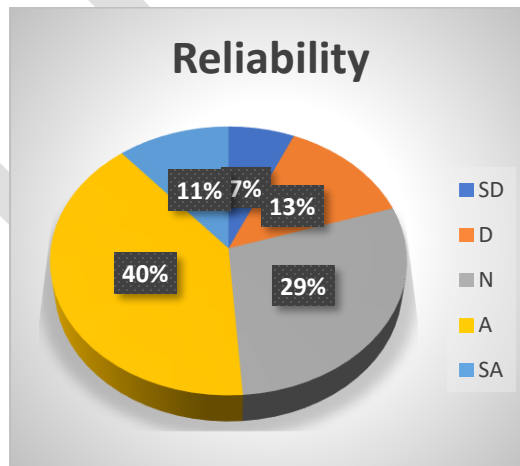


Fig. 4. Patients' Perception on Reliability

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

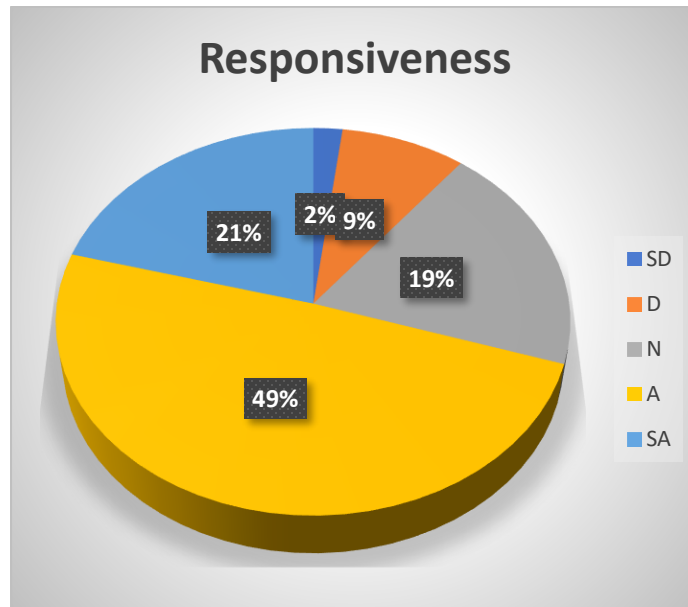


Fig. 5. Patients' Perception on Responsiveness

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

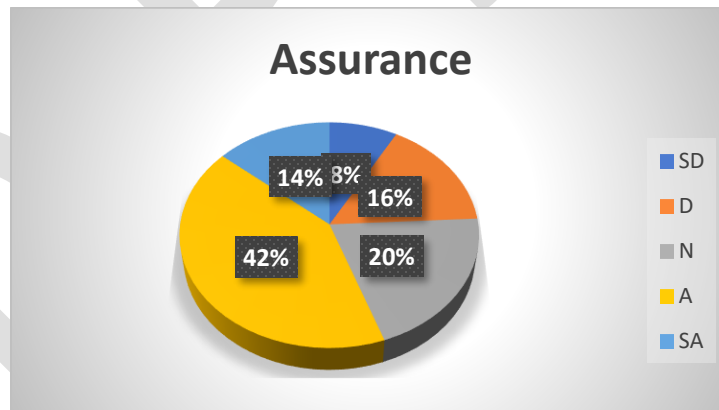


Fig. 6. Patients' Perception on Assurance

Fig. 6 shows the percentage representation of the choices of patients in their perception about 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.

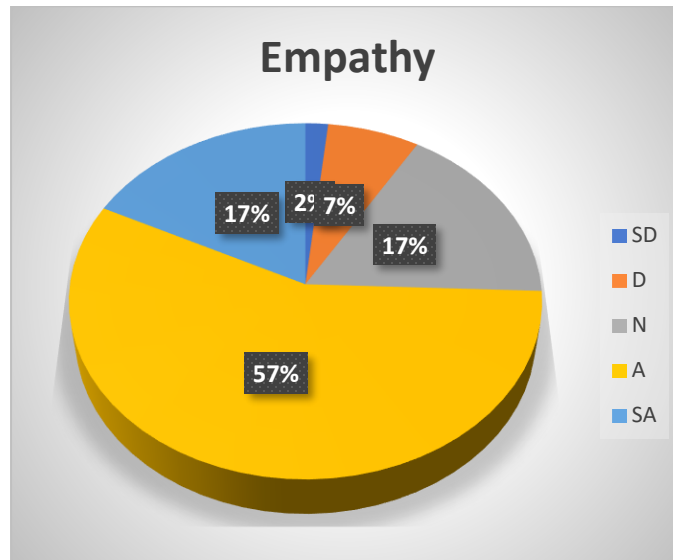


Fig. 7. Patients' Perception on Empathy

Fig. 7 shows the percentage distribution of the responses of patients to the classification 'Empathy'. Patients who chose the 'agree' option make up 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 and is shown above.

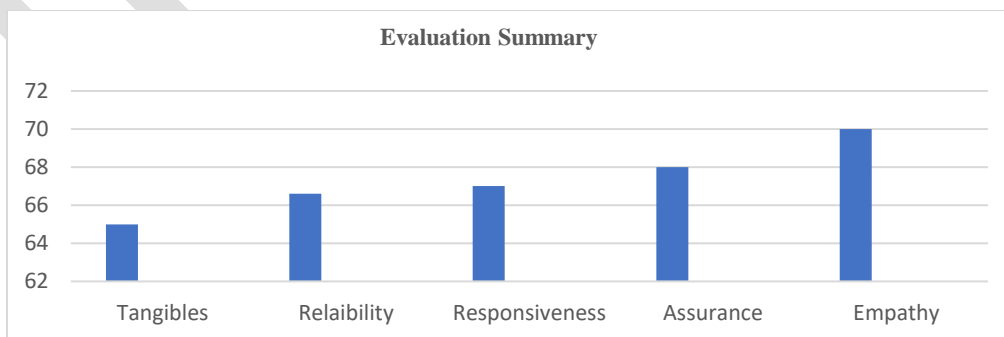


Fig. 8. Summary of Perception Data

Fig. 8 shows that empathy has the highest perception score, the population, rating the empathy of the workers highly. Tangibles had the lowest perception score with patients rating the infrastructure lowest. The other factors had perception scores falling in between the above two mentioned as shown in the figure above.

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 (2⁷)

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

Table 11 shows the signal to noise ratio response table. The ranks show the factor 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 terms of 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 response of means for each factor from the Taguchi Analysis. The ranks also indicate the factor with respect to 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 size of the impact by taking the difference between the average of the largest and lowest characteristics for a factor, “Rank” aided to distinguish which of the 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 is specified and ranked 2 and so on.

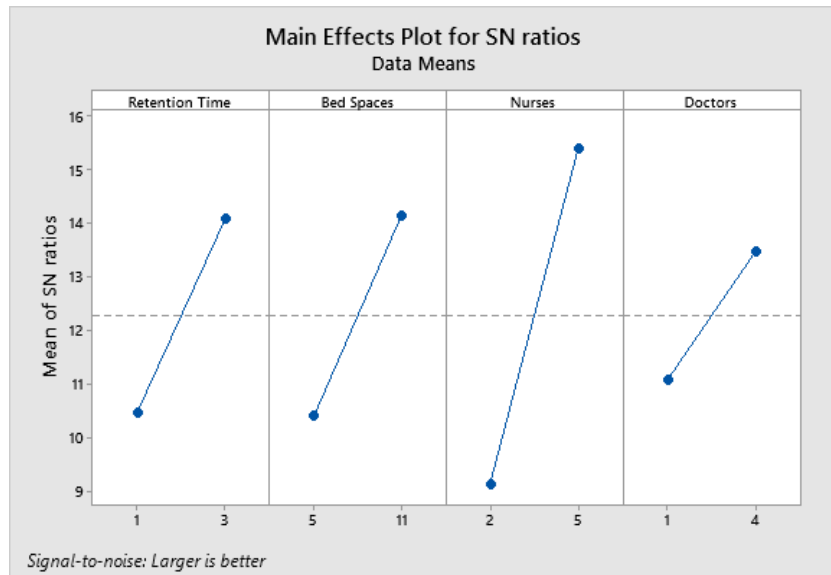


Fig.9. Main effect plot for S/N Ratio of the Emergency Department

When Fig. 9 was carefully considered, it could be noted that optimum condition was $A_2B_2C_2D_2$, indicating that even when all bed spaces were available (11), with four (4) doctors and five (5) nurses on shift, time available for patients to properly get well before transfer to other wards increased.

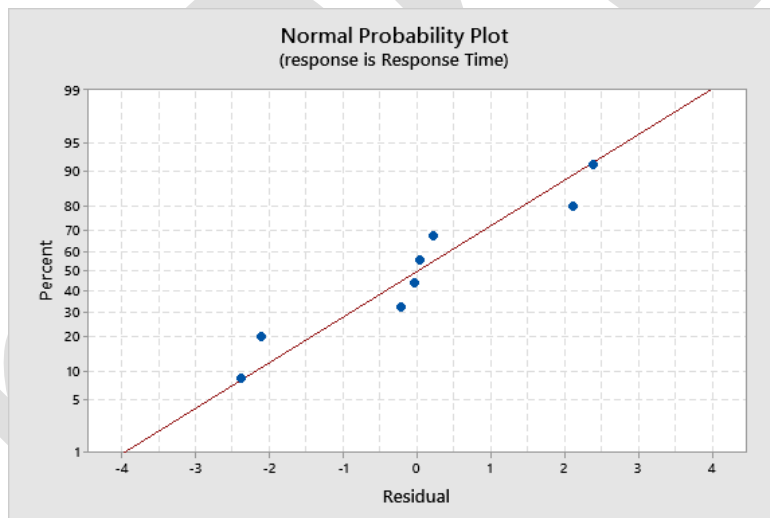


Fig.10. Normal Probability Plot for Response Time

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 analysed. 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.

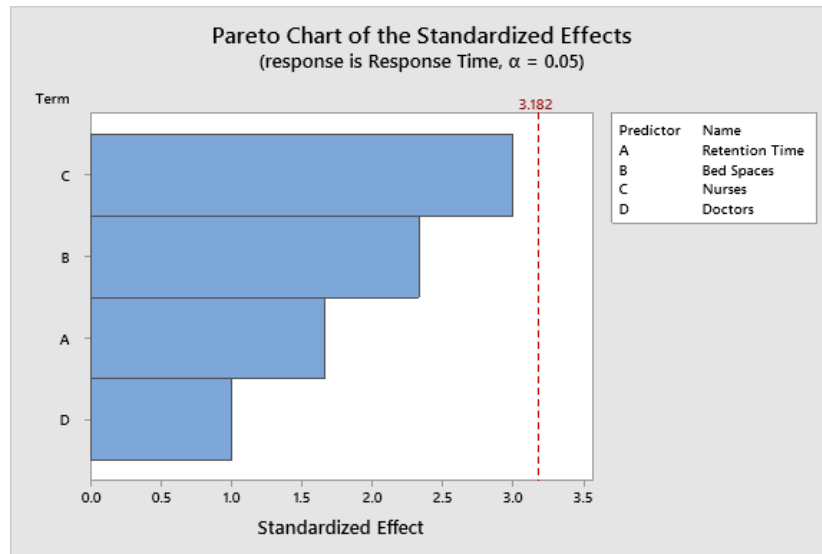


Fig.11. The Pareto chart of standardized effects

Fig.11 showing 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.

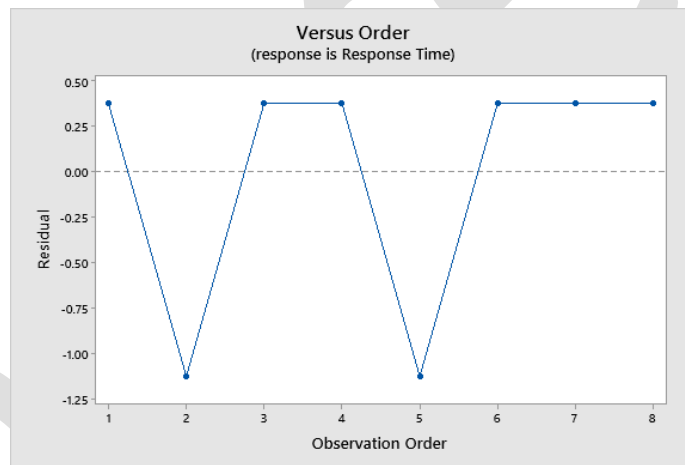


Fig.12. The Versus Order Graph for the Response Time

Fig. 12 shows the versus order plot. From this plot, it can be seen 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
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Table14. 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).

Table 15. The Analysis of Variance

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, meaning it holds the highest statistical significance in the study.

4|Limitation of the Study

Aside the emergency department, this study did not include other departments within the health care institution.

5|Conclusion

The service quality of the emergency department has been evaluated and the following can be drawn:

SERVAQUAL evaluation:

1. The Tangibles had the highest deviation from the expectation. This implies that the outward attributes of the hospital had the lowest perception in the minds of the patients.
2. Empathy had the lowest deviation from the expectation. This shows that the patients felt that strongest service attribute was the ability for the health care providers (Nurses and Doctors) to identify with the need of the patients.
3. 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:

1. The study revealed that the optimum retention time for a patient to be catered for should be three days in order to fully monitor recovery.
2. The need for bed spaces to always be available at 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.
3. 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.
4. 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 improvement in equipment and infrastructure was clearly identified in the course of this work. The Tangibles had the lowest perception score. The presence of modern equipment, well trained personnel to run such equipment should be made a priority in order to retain the trust of patients in the capability of the department.

6|Recommendation

The system was observed to have a need for an increase in the health care personnel as the analysis has identified their grave importance in providing the best form of service to patients. Therefore, it is recommended that the management of the institution pay more attention to the number of personnel available to meet the ever-increasing demands of the population relying on the institution for the preservation of their health in times of crisis.

7|Acknowledgements

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