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Qualitative Analysis of Nanotechnology Approaches in Healthcare Monitoring and Evaluation of Patients

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ABSTRACT

This paper focuses on building monitoring and Evaluation System using nanotechnology approaches in Healthcare sector by providing a comprehensive system used in healthcare to evaluate the total number of patients that have been treated using nanotechnology approach towards healthcare. Data for this study was obtained through questionnaires and previously existing documents and related works. Statistical Package for Social Science (SPSS) was used as an analytic tool for the quantitative analysis of the work. The work also made use of Google sheets as a technical tool. A series of analysis which includes survey analysis and descriptive analysis were employed to analyze the data. Object Oriented Analysis and Design Methodology (OOADM) was adopted as the methodology of the design and implementation of the system while, HTML, CSS, JavaScript were employed to build the nanotechnology health care monitoring and evaluation system as object oriented programming languages. Results gotten from this analysis showed that the new system is very much user friendly, 67.6% efficient in its use, and provides great satisfaction of 76.5% to its users.

1.0 INTRODUCTION

The word Nanotechnology, popularly referred to nanotech is "a science, engineering, and technology conducted at the nanoscale (1 to 100 nm), where unique phenomena enable novel applications in a wide range of fields, from chemistry, physics and biology, to medicine, engineering and electronics", [1]

Sequel to the definition, nanotechnology is a science which enables the reduction or breaking down of devices or materials into smaller components in order to ensure a more effective output. It has helped in different areas as well including fertility through artificial insemination and in-vitro fertilization, otherwise known as IVF. In the areas of medical imaging, it has helped through ultrasound, radiology, and even in the performance of certain surgeries such as gastric sleeve and gastric bypass surgeries, which enables minimal or non-invasive surgeries. In that study it was observed that some of these nanotechnology approaches in healthcare are toxic to the human body. Monitoring and evaluation systems help to improve the efficacy and safety of treatments through early detection because constant observation can identify early on any potential negative reactions or unintended effects of nano-medicines, allowing for timely management and preventing major complications. This therefore leads to continuous improvement as a result of the information acquired by M&E systems, which in turn enables the design, delivery, and treatment protocols of nano-medicines to be continuously improved, eventually resulting in increased efficacy and safety.

The design and implementation of a monitoring and evaluation system on nanotechnology for patient's health aims to address the concerns of the efficiency of nanotechnology approaches in healthcare, as well as enable researchers as well as healthcare workers and practitioners to evaluate the effectiveness of these nanotechnology approaches. This study is also essential because it helps to provide useful insights as well as prioritize patient safety. It explores the integration of nanotechnology approaches into healthcare systems.

1.1 Literature Review

The problem with nanotechnology in healthcare is that it is very new, yet very much advanced. Due to its complexity in nature, it may be difficult for healthcare practitioners to keep track records of the patients that are treated with the various approaches of nanotechnology in healthcare. There is need for a continuous monitoring and evaluation of nanotechnology's impact on patients' health in order to ensure the safety of the patients.

1.2 Evolution of Wearable Devices with Real-Time Disease Monitoring for Personalized Healthcare:

This study by [2] shows the use of wearable technology in biomedical monitoring systems and healthcare is growing because it makes it possible to measure biomarkers continuously for physical health monitoring and medical diagnoses. Acute and chronic illnesses become more significant as the ageing population rises, requiring real-time monitoring and point-of-care diagnostics. Implantable devices have been made possible by advancements in electronics, biocompatible materials, and nanotechnology, which have enhanced medical services [3]

1.3 Mobile Healthcare System

The study in [4] produced a mobile health system that measures uric acid concentration using blood samples and a biosensor for renal diseases, gout, and excess uric acid. For on-site determination and data management, the system makes use of a lateral flow pad, mesoporous Prussian blue nanoparticles, and auto-calculation software. It provides cloud computing, simplicity, and real-time primary care physician monitoring.

1.4 Recent Progress and Application of Gold Nanotechnology

The use of mathematical modelling and artificial intelligence (AI) in medical applications—specifically, gold nanotechnology—is reviewed. It looks at both theoretical and clinical evidence, with a particular emphasis on the Turkevich, Brust, and Schiffrins one-pot approach for the synthesis and production of gold nanoparticles. The results indicate that features of nanoparticles are influenced by their size, shape, and functionality; these elements also have an impact on cytotoxicity and cellular absorption [5].

1.5 Patient Health Monitoring System Using IoT:

The study in [9] shows that in recent years, healthcare monitoring systems have grown in significance; yet, premature death from various ailments and inadequate medical care is a cause for concern. A smartphone application and GSM are used in a suggested real-time health monitoring system based on the Internet of Things to enable continuous wireless patient monitoring. The system uses sensors to monitor important metrics, WiFi is used to transfer data to the cloud, and real-time online patient condition information is provided. The timely goal of this IoT-based solution is lifesaving.

1.6 Revolution in Flexible Wearable Electronics for Temperature and Pressure Monitoring

The Study in [6] shows that our lifestyles and well-being have been greatly touched by technological progress, with wearable sensing instruments developing as an important industry. These attached to users, externally utilized instruments evaluate physiological attributes. This review examines the latest advancements in temperature and pressure sensing applications, with an emphasis on medical professionals, healthy persons, and patients with long-term problems. Different mechanisms make up the categories of flexile sensing devices, which are being refined to better fit a range of applications.

1.7 New Approach in SARZ-Cov-2 Surveillance Using Biosensor Technology: A Review:

The study in [7] discovered in their research that since biosensors are sensitive to viral antigens, they are analytical tools capable of early detection of SARS-CoV-2. They may be quick, sensitive, and on-site, which makes them perfect for people monitoring in crowded areas. Biosensors are essential for monitoring human health, including optical, electrochemical, piezoelectric, microfluidic, paper-based, immuno sensors, and nano-biosensors. It's also critical to develop calorimetric strips and smartphone biosensors that target antigens or antibodies.

1.8 Heath Care and Decision Support Systems

According to [8], decision support systems are clinical support that enhances health care delivery to patients and health care personnel by keeping track of the patients' medical records. The idea behind construction and building of medical support system should not be overemphasized as it is geared towards providing a comprehensive framework and technology that aids health care providers in the diagnosis, treatment and management of patient care. The study in [9] provided an approach towards minimizing disease diagnostic errors using weighted input variables and Fuzzy Logic rules with multiphase diagnostic engine as a support system with diseases having different weighted symptoms using fuzzy logic. This is to ensure that recommendations for disease confirmation based on symptoms return good percentage of true positive and true negatives. Also, [10] provided neutrosophic based MDSS that utilized multilayer perceptron neural network to classify liver diseases using an Indian liver patient dataset (ILPD)".

1.9 Materials and Methods

This study employed object oriented analysis design methodology using the unified modelling language (UML) to analyze the system. After building the nanotechnology monitoring and evaluation system, the system was deployed and tested in the hospitals. Statistical analysis tool of SPSS was used to analyze the responses from the participants.

2.0 METHOD OF DATA COLLECTION

The following are the methods that were used to gather data for the purpose of this research:

1. Primary method of data collection: The interview was done based on the need to ascertain the level of treatment of patients using nano-technological tools in the hospitals.
2. Secondary method of data collection: Existing Databases from the internet such as electronic health

care records were consulted pertaining to nano-medicine, patient demographics where relevant information were extracted.

2.1 Sample Size/Population

The formula adopted for the sample size/population for this study is Slovin's formula which is given as $S= N/(1+Ne^2)$. This formula was developed by Slovin in 1968 since it is not specific about the population behavior in the study, then it is employed to determine the sample size. Here, S represents the sample size, N represents the population size, e represents the marginal error and 1 is a constant. Let's take population size to be 296 and a marginal error of 5%.

Going by Slovin's formula, we have:

$S= N/ (1+Ne^2)$

$S= 296/ [1+(296*5\%*5\%)]$

$S= 296/ [1+(296* 0.0025)]$

$S= 296/ [1+(0.74)]$

$S= 296/ [1.74]$

$S= 170.11$

$S= 170.$

Table 1: The population Size

	Population size	Sample size
Participants	296	170

2.2 Sampling Techniques

The sampling technique used in this research is simple random sampling technique. This is to ensure that every individual in the population has a chance of being picked.

2.3 Analysis of the Nanotechnology Monitoring and Evaluation System in HealthCare.

This system as shown in Figure 1, improves and enhances the functional capabilities of the contemporary M&E systems that are currently used today. It provides multilingual support which bridges language barrier and makes the system more accessible to people of different languages, ethnics, race and continents. It generally improves user visibility, usability and learnability which are key factors for a good monitoring and evaluation system. It is also much user friendly. It allows online appointment scheduling which allows the patients to book appointments with the hospital from the comfort of their own homes and it would be sent to the official mail of the hospital. This therefore reduces the crowds and level of congestion in the hospitals, and increases the level of professionalism. This system aims at providing maximum security and privacy for the patients. It grants access only to the doctors and system administrator at their respective levels. The system uses true random number generation to generate doctor number which serves as the doctor's username and as such reduces or possibly eliminate impersonation.

The system is able to display the total number of patients, employees and patients that have been treated with specific nanotechnology approaches in healthcare, in the hospital.

The system basically has three sections: module for patient management handled by administrator and the medical personnel and has an interface for patients to register and schedule for appointments in the hospitals of their choice, the clinical information system that comprises of the assessment of the patient, investigation of the symptoms diseases followed by the analysis and planning for treatment and finally the electronic medical record (EMR) repository section that stores the entire health record information from the hospitals. The doctor has the access to register new patients to the system, manage the records of the patients, and view the total number of patients that are contained on the database.

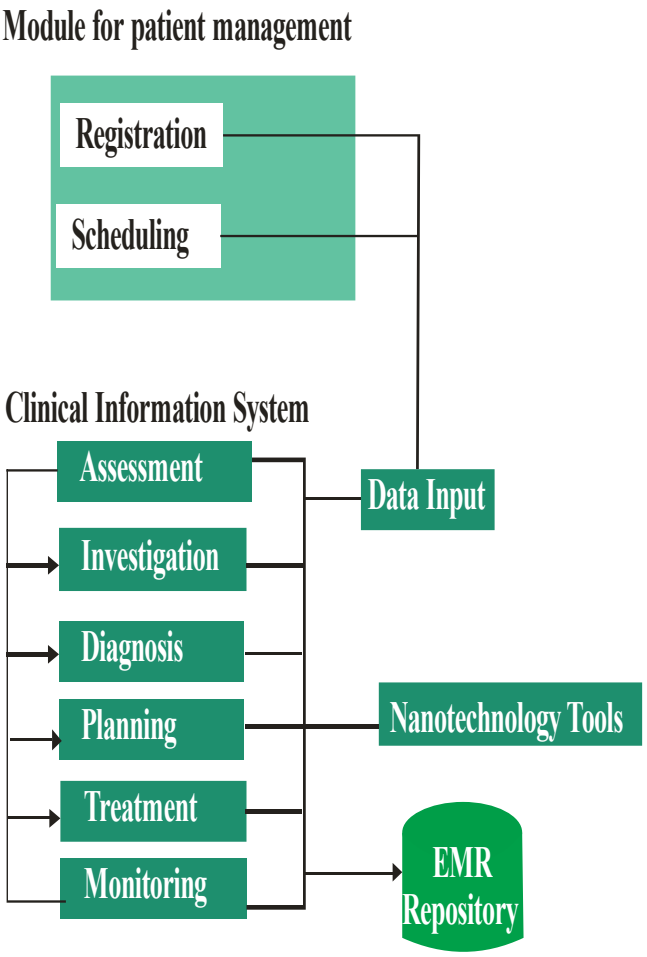

Figure.1: System Architecture

2.4 Algorithm of the Nanotechnology Monitoring and Evaluation.

Step 1: Identify the problems and solution for target audience.

Step 2: Get the required data from already existing data.

Step 3: Design the UI/UX designs as well as the activity/use case diagrams for the system.

Step 5: Implement and execute the new system.

Step 6: Test for errors

2.5 Use Case Diagram of the New System

The Use case diagram shown in Figure 2 depicts the

interaction of the authors in the system which includes the doctor, patients and the administrator.

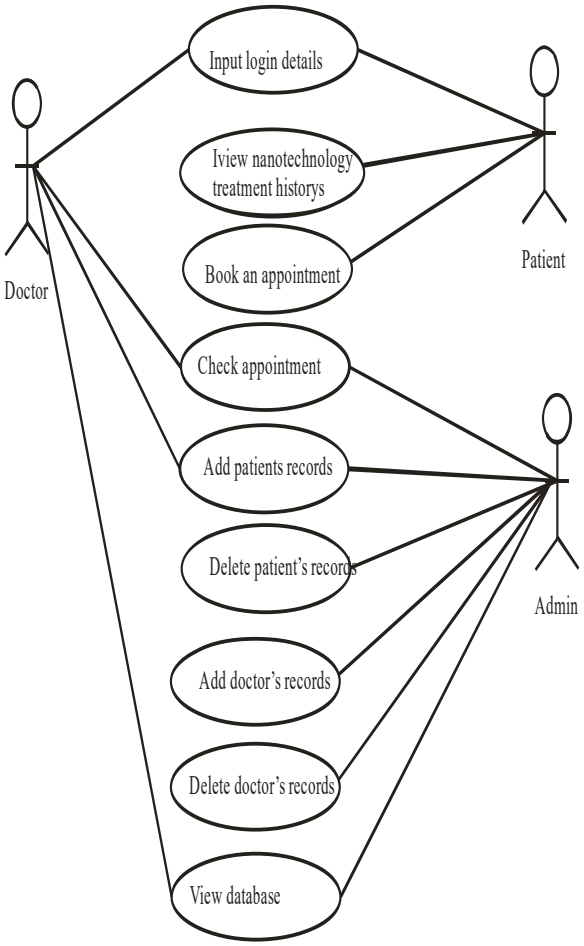

Figure 2: The USE Case Diagram

2.6 Development of Hypothesis

For the cause of the evaluation of the new system, the hypothesis serves as statements that are used to determine the efficiency of the new system. The hypotheses that would be applied to evaluate the performance of the new system are:

Hypothesis 1 – The developed monitoring and evaluation system grants utmost user satisfaction to users compared to manual method.

Hypothesis 2 – The system is very much user-friendly and has learnability features compared to previously existing system.

Hypothesis 3 –The system is efficient in quickly retrieving the records of patients that are stored in it compared to manual method.

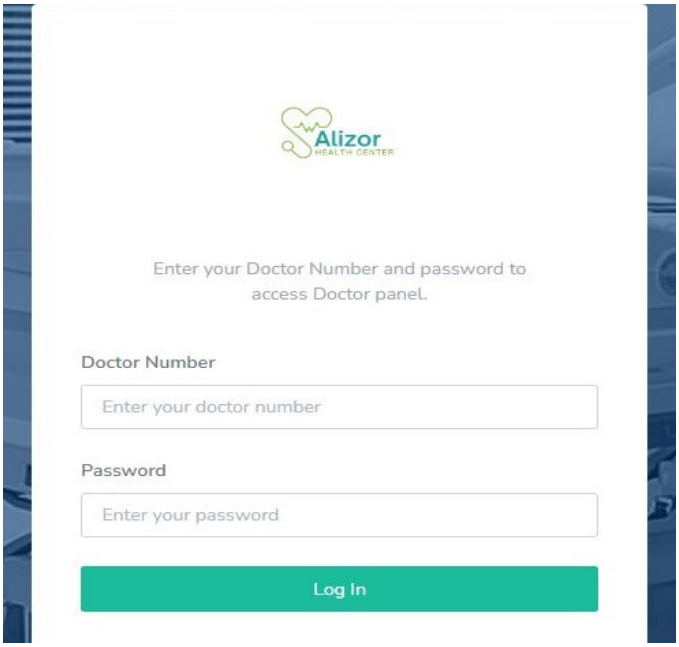

Figure 3: Login Page

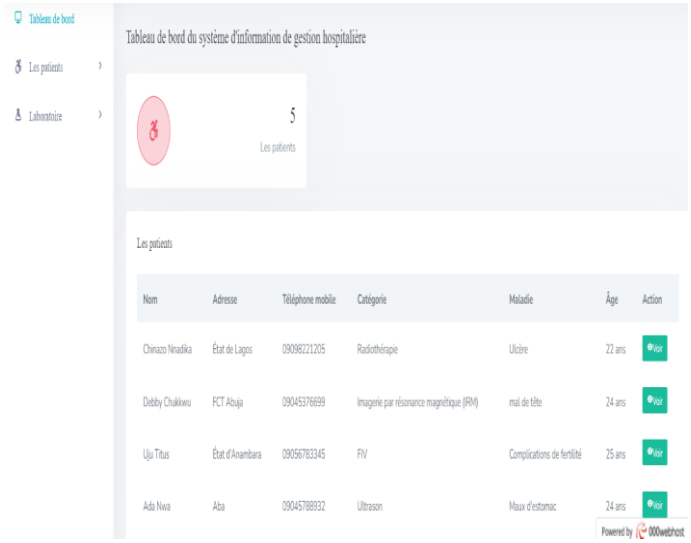

Figure 4: Doctor's Dashboard

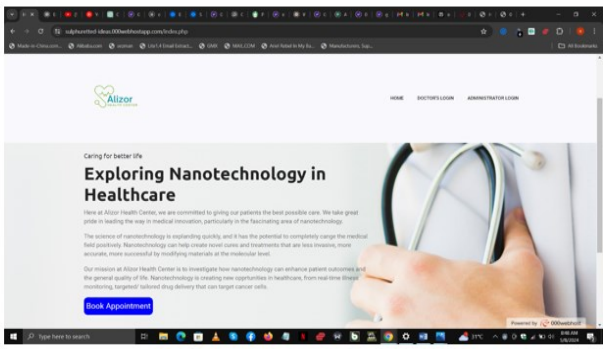

Figure 5: Admin /Patient's Login

Figures 3, 4 and 5 shows the monitoring and evaluation system to ascertain the level of usage of nanotechnology on patients. The report is ascertained by the medical doctors and the patients.
The system answers the basic fundamental hypothesis questions asked in section 3.7 and analyzed as follows;

A. How user-friendly is the web-based system for monitoring and evaluating nanotechnology applications in healthcare?

70 participants (41.2%) found it "Very user-friendly".
45 participants (26.5%) rated the system as "Moderately user-friendly"
30 participants (17.6%) were "Neutral".
15 participants (8.8%) considered it "Somewhat difficult to use".
10 participants (5.9%) found it "Very difficult to use".
Table 2: Cumulative Percentage Analysis of User friendly Web-based System

User-friendliness

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Moderately user-friendly	45	26.5	26.5	26.5
	Neutral	30	17.6	17.6	44.1
	Somewhat difficult	15	8.8	8.8	52.9
	Very difficult	10	5.9	5.9	58.8
	Very user-friendly	70	41.2	41.2	100.0
	Total	170	100.0	100.0	

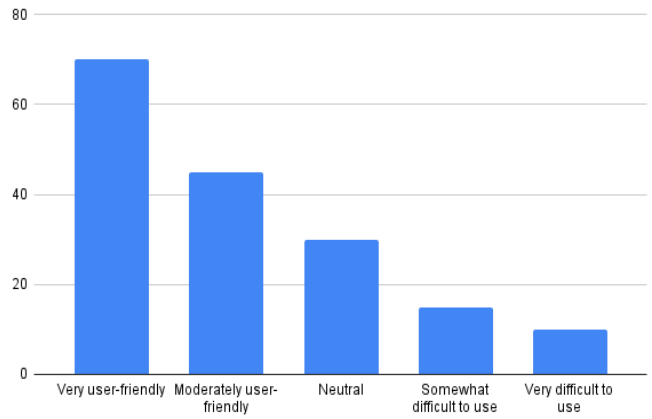

Figure 6 showing the user's perception towards nanotechnology in healthcare

In figure 6, the majority of participants rated the system as at least somewhat user-friendly, with a significant portion finding it very user-friendly. However, a minority experienced difficulties, highlighting areas for potential improvement in usability. The system is very much user-friendly and has learnability features.

From the analysis of the new system that was carried out, we can say that the system is actually very much user friendly because out of the 170 participants, 60 participants (35.3%) perceived the system as "Highly user friendly", while 55 participants (32.4%) considered it "Moderately friendly"

A. Security and Privacy:

How much does the system protect sensitive data pertaining to applications of nanotechnology in terms of data security and confidentiality?

60 participants (35.3%) perceived the system as "Highly secure and confidential".
55 participants (32.4%) considered it "Moderately secure and confidential".
25 participants (14.7%) were "Neutral".
20 participants (11.8%) found it "Somewhat insecure and lacking confidentiality".

Table 2: Cumulative Percentage Analysis of Security and Privacy Nanotechnology Health Care System

Security and Privacy

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Highly insecure	11	6.5	6.5	6.5
	Moderately secure	55	32.4	32.4	38.8
	Neutral	25	14.7	14.7	53.5
	Somewhat insecure	19	11.2	11.2	64.7
	Very secure	60	35.3	35.3	100.0
	Total	170	100.0	100.0	

10 participants (5.9%) regarded it as "Highly insecure and lacking confidentiality".

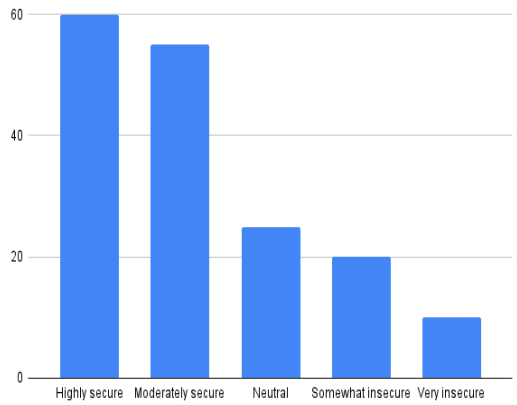

Fig 7 showing the User's Perception Towards Security and Privacy in Healthcare Nanotechnology Monitoring System. The majority of participants perceived the system to be at least moderately secure and confidential. However, there were concerns expressed by a minority regarding security and confidentiality, indicating areas for enhancement in data protection measures

A. System Efficiency:

How efficient is the ability of the system to quickly obtain the pertinent reports and data of the patients?

65 participants (38.2%) considered it "Very efficient".
50 participants (29.4%) found the system "Moderately efficient".
30 participants (17.6%) were "Neutral".
15 participants (8.8%) found it "Somewhat inefficient".
10 participants (5.9%) regarded it as "Very inefficient".

Table 3: Cumulative Percentage Analysis of Efficiency of the Web-based System

System Efficiency

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Moderately efficient	50	29.4	29.4	29.4
	Neutral	30	17.6	17.6	47.1
	Somewhat inefficient	15	8.8	8.8	55.9
	Very efficient	65	38.2	38.2	94.1
	Very inefficient	10	5.9	5.9	100.0
	Total	170	100.0	100.0	

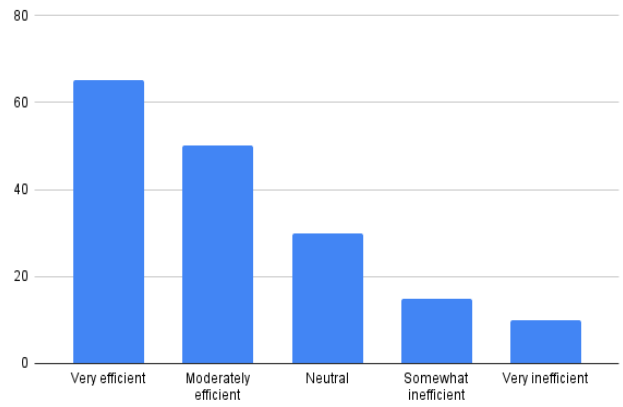

Figure 8 showing the user's perception towards efficiency in healthcare nanotechnology monitoring system

The majority of participants expressed satisfaction with the overall effectiveness and usefulness of the system. However, there were some who were either neutral or dissatisfied, indicating areas for improvement to enhance overall satisfaction. While, a significant portion of participants perceived the system to be at least very efficient in obtaining reports and data, there were some who experienced inefficiencies, suggesting potential areas for improvement in speed and responsiveness. The system is efficient in quickly retrieving the records of patients that are stored in it. From the analysis above, we can say that this is a true hypothesis because out of 170 participants, 65 participants (38.2%) considered it "Very efficient", and 50 participants (29.4%) found the system "Moderately efficient". This means that a total of 115 participants and a population of 67.6% agree with the hypothesis, thereby making this hypothesis true.

A. System Performance:

How well can the system evaluate the numbers of patients treated with nanotechnology approached in healthcare?

55 participants (32.4%) believed the system evaluates patient numbers "Very well".
50 participants (29.4%) thought it does so "Moderately well".
25 participants (14.7%) were "Neutral".
20 participants (11.8%) found it "Somewhat poor".
20 participants (11.8%) regarded it as "Very poor".

Table 4: Cumulative Percentage Analysis of the System Performance of the Web-based System

System Performance

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Moderately good	50	29.4	29.4	29.4
	Neutral	25	14.7	14.7	44.1
	Somewhat difficult	20	11.8	11.8	55.9
	Very difficult	20	11.8	11.8	67.6
	Very good	55	32.4	32.4	100.0
	Total	170	100.0	100.0	

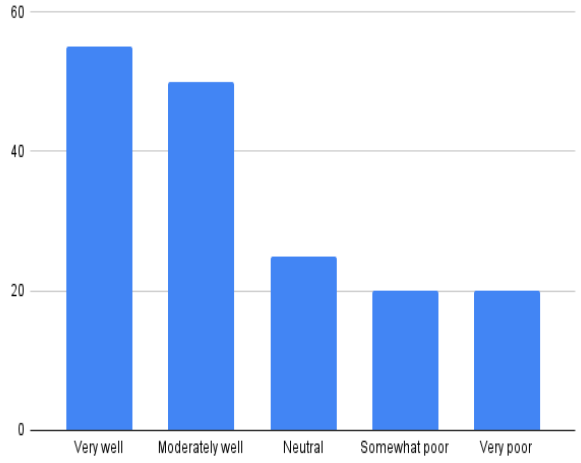

Figure 9 showing the user's perception towards system performance in healthcare nanotechnology monitoring system to the users.

Participants' perceptions of the system's ability to evaluate patient numbers varied, with a significant portion considering it to be at least moderately effective. However, there were concerns expressed by a notable minority regarding the system's effectiveness in this aspect.

A. System Satisfaction:

How satisfied are you with the web-based monitoring and assessment system's overall effectiveness and

usefulness?
70 participants (41.2%) were "Very Satisfied".
60 participants (35.3%) were "Satisfied".
20 participants (11.8%) were "Neutral".
15 participants (8.8%) were "Dissatisfied".
5 participants (2.9%) were "Very dissatisfied".

Table 3: Cumulative Percentage Analysis of Efficiency of the Web-based System

System Satisfaction

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Moderately satisfied	60	35.3	35.3	35.3
	Neutral	20	11.8	11.8	47.1
	Somewhat dissatisfied	15	8.8	8.8	55.9
	Very dissatisfied	5	2.9	2.9	58.8
	Very satisfied	70	41.2	41.2	100.0
	Total	170	100.0	100.0	

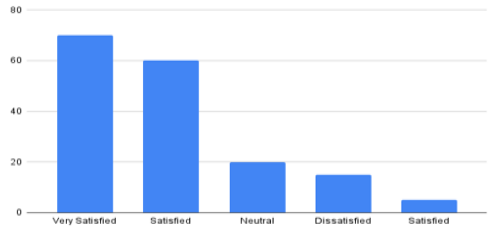

Figure 10 showing the user's perception towards system satisfaction in healthcare nanotechnology monitoring system by the users.

The system grants utmost user satisfaction to users. From the analysis of the new system, out of the 170 participants, 70 participants (41.2%) were "Very Satisfied" and 60 participants (35.3%) were "Satisfied" thereby making this analysis true.

3.0 CONCLUSION

In conclusion, the new monitoring and evaluation system on nanotechnology for patients' health is a very important tool for analyzing and managing the data of patients that have been treated with any nanotechnology approach in healthcare sectors. With this system, any adverse effect experienced by the patient while employing nanotechnology in the treatment of any ailment would be captured to avoid future occurrence. This gives room for improvement in areas where it is needed and recommendations made to the appropriate quarters.

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