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Smart Nanomaterials in Medicine: Integrating AI and IoT for Real-Time Health Monitoring and Therapeutics

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ABSTRACT

Background: The integration of smart nanomaterials with artificial intelligence (AI) and the Internet of Things (IoT) represents a transformative opportunity in healthcare, offering the potential to significantly enhance real-time health monitoring and therapeutic interventions. These emerging technologies promise more precise diagnostics, personalized treatment, and improved patient outcomes.

Objective: The purpose of this research is to explore the adoption of innovative nanomaterials, artificial intelligence(AI), and the Internet of Things in healthcare — perceptions, challenges, and possibilities. This paper looks at how these technologies help improve the efficiency of real-time health tracking and therapy and the possible hurdles that will prevent these instruments from working effectively.

Methods: A cross-sectional quantitative survey involved 250 participants including healthcare professionals, researchers, and technologists. A formalized questionnaire containing both the Likert scale and closed questions was used to gather the data on awareness of the technologies, perceived efficiency, and identified difficulties. Descriptive statistics, correlation analysis, and reliability tests were conducted in data analysis.

Results: According to the results obtained, there was a fair level of awareness of AI and IoT in healthcare, highlighting that data privacy was the most significant challenge (35%), followed by cost at 30%. The respondents are aware of the benefits in which the utilization of nanomaterials can be practical, specifically in monitoring health, since the results are not generally distributed according to the Shapiro-Wilk test. In addition, while finding a Cronbach's Alpha value of (0.13), it can be understood that there is poor internal consistency with the survey questions measured using the Likert scale format and poor survey design.

Conclusion: Intelligent materials, AI, and IoT have a wide range of applications in healthcare but have not been fully implemented because of privacy and cost issues. The only way to reduce this will be by gaining further awareness of the problems addressed here through education and improved data protection mechanisms. Therefore, there is a need to conduct more research and refine the methodologies that can successfully explain the attributes that characterize the adoption of the technologies into medical practice.

Keywords: *Intelligent Materials, Artificial Intelligence, Internet of Things, Medical Care, Monitoring In Real-Time, Quantitative Research.*

1. INTRODUCTION

The development of technology in healthcare is revolutionizing the strategies healthcare providers use to diagnose, treat, and manage patients. There are smart nanometer materials, artificial intelligence as well as the Internet of Things that represent some of the most promising innovations in healthcare. When combined, such technologies are capable of dramatically increasing the effectiveness of real-time healthcare monitoring, as well as treatment. Smart nanomaterials are characterized by abilities allowing their application in targeted drug delivery, early diagnostics, tissue engineering, and also wound healing. On the other hand, AI and IoT come in and help with aspects such as carrying out a process, analyzing information, and offering timely feedback that will enable a much more customized approach to healthcare delivery (Rani, 2024) (M. A. Mujawar et al., 2020).

Nevertheless, such technologies reveal several potentials, which have not been fully utilized in promoting healthcare. Lack of compliance with data privacy and security, high implementation costs, and lack of awareness among healthcare professionals are the challenges that should be dealt with. Considering that healthcare organizations are seeking to implement AI and IoT within their framework along with the use of nanotechnology, it is essential to explore the said perceptions and reveal what hampers the integrations (Chugh, Basu, Kaushik, Bhansali, & Basu, 2024) (Manickam et al., 2022).

In this research work, discoveries will be made on how smart nanomaterials can be incorporated with AI and IoT for health monitoring and treatment with an understanding of the opportunities, difficulties, and perspectives involved. More specifically, this quantitative study examines the level of awareness about the effectiveness of such technologies in the organization, its perceived benefits among the respondents, and challenges that have to be addressed to advance it through a survey involving healthcare workers, researchers, and technologists. Therefore, to fill this knowledge gap, this paper aims to contribute to the knowledge advancement in the field of healthcare technology in the future task of enhancing patient care (S. Kumar et al., 2024) (Pandurangan et al., 2023).

The first of them is the utilization of IoT devices for constant health supervision whereby connected devices can collect health information from patients, simultaneously, AI applications will process the information in real mode to offer pertinent information. For example, some smart wearable devices empowered by AI and smart nanomaterials could not stop and continuously measure and analyze any degraded status of the human body and respond therapeutically without the direct supervision of healthcare personnel. These changes could transform the care of long-term conditions, healing, and the prevention of illness. Further, Nanomedicines in drug delivery techniques allow treatment to reach the exact area that requires it, hence minimizing side effects and enhancing the efficacy of therapies (Dhanalakshmi, Das, Iqbal, Mohanan, & Dave) (V. Verma & Thakur, 2023).

Nevertheless, while the use of these technologies is massive they come with their own set of problems. Of course, the most noted challenges are related to data protection and security. The problem with IoT devices is that they are constantly flowing personal health information and therefore it is of paramount importance to ensure that such information is protected from hackers and similar unauthorized individuals. Situations where there is an instance of data loss or breach make it possible for unauthorized individuals to access or misuse personal information which results in a loss of confidence in healthcare facilities may occur. Also, cost is a challenge which is a crucial factor in its implementation. The adoption of smart nanomaterials, along with AI and IoT technology and support involves significant costs in terms of investment of the healthcare organization to acquire the appropriate technology and in training of the healthcare professionals to effectively work with the technology (H. Kumar et al., 2024) (Banerjee, Chakraborty, Kumar, & Biswas, 2020).

The third and perhaps the biggest impediment to increased adoption rates is the relative newness of the technology and the general population's comparative unfamiliarity with it in the healthcare setting. Even though, the role of these technologies is being analyzed in academic and technological discourse as well as is being introduced into practice for a relatively short time in the context of healthcare. Regarding the application of smart nanomaterials, AI, and IoT, there is a lack of technical knowledge among many healthcare providers and that is why some of them are hesitating to use these sophisticated

technologies. For this reason, healthcare organizations may lag in adopting these innovations and hence the transformational impact of these technologies may be felt much later than expected (Ibrahim, 2024) (Sahi & Kaushik, 2022).

This research seeks to establish these challenges by analyzing the views of healthcare workers, researchers, and technologists concerning the application of smart nanomaterials, AI, and IoT in the health sector. The quantitative survey therefore forms the approach of the study aims at establishing the current state of awareness and usage of these technologies, their perceived suitability in enhancing patient care, and the factors that are likely to have reduced the utilization of the technologies. Through such findings, the study seeks to offer useful information that may be helpful in the formulation of future policies, educational activities, and other technological advances that will enable the enhancement of integration of such superior technologies in health care (Sidhu, Jamwal, Mehta, & Gautam, 2024b) (M. Mujawar et al., 2020).

Besides, the focus on the education and training aspect will also be highlighted since the level of familiarity with smart nanomaterials, AI, and IoT can have a great impact on the use of such technologies. HCPs trained in the use of such technologies coupled with advanced knowledge and practical experience in their application are more likely to appropriately apply these technologies, thus eliminating the first barrier associated with the lack of knowledge in the effective use of these technologies. Moreover, reconsideration of the issues linked with the cardinality of private information through enhanced security measures and intention towards cheap methods for implementation might enable using such technologies (Chen, Cui, Haick, & Tang, 2024) (Banerjee, Chakraborty, & Rathi Sr, 2020).

2. LITERATURE REVIEW

Recently, the incorporation of sophisticated technologies in the healthcare value chain has attracted much attention due to its possibility to reinvent medical treatment with smart nanomaterials, AI, and IoT. This literature review therefore seeks to review and identify the existing literature on these technologies and how they are being applied in the healthcare real-time health monitoring, therapeutic interventions, and the issues arising from these technologies. Through reviewing the current state of research in this field, this paper will explore the main potentialities and challenges that need to be addressed to allow for the proper incorporation of these technologies (Vo et al., 2024) (Pramanik et al., 2020).

Smart Nanomaterials in Healthcare

The concept of nanotechnology has been investigated for more than two decades, and the use of nanotechnology in medicine appears to be promising. Smart nanomaterials are thus designed at the nanometer range offering properties that make them appropriate for drug delivery, diagnostics, and tissue engineering. They have a small size as well as a high surface area and can also be functionalized with different molecules so that can selectively interact with biological systems. These properties have therefore placed smart nanomaterials as a topic of concern when it comes to the formulation of treatments that can directly attack cancer cells, mitigating inflammation or providing required aid in the healing of tissues (Dhanalakshmi et al.) (Yadav, Verma, Kumar, Kumar, & Solanki, 2021).

The application of nanomaterials in drug delivery is one of the most promising areas that enjoys the highest attention. That is why scientists have created systems where drugs are embraced in nanoparticles that allow delivering these medications to the target area without harming other cells, tissues, or organs. For instance, liposomes which are spherical structures formed by lipid bilayers have been employed to transport anticancer drugs in cancer therapy and this lessens the effects of chemotherapy on wholesome tissues. Similarly, other Nano carriers including dendrimers and carbon nanotubes have been examined with the same argument on cellular membranes and drug delivery (H. Kumar et al., 2024) (Hassan et al., 2023).

Apart from the targeted delivery of drugs, smart nanomaterials are employed in the diagnostics in areas like Biosensors and Imaging agents. Some of the materials that have been used in modality are Quantum dots, Gold nanoparticles, and magnetic nanoparticles, and the use of these materials has enabled imaging to detect diseases at the initial stage. These improved Nano diagnostics as stated suggest that the conventional methods of medical diagnoses are bound to be compared and possibly replaced with more accurate noninvasive solutions to help doctors make better decisions for their clients (Ibrahim, 2024) (Haick & Tang, 2021).

Artificial Intelligence in Healthcare

To begin with, the growth in AI use in healthcare has been very instrumental. Machine learning and deep learning-based AI systems are well capable of processing large data sets and making diagnostic and predictive analyses. In the healthcare industry, AI is used in medical imaging, drug discovery, prediction modeling, and the prescript**ive model**. Certainly, one of the most common and successful domains is diagnostic imaging; algorithms that analyze large sets of pictures have been proven to achieve performance comparable to or better than the specialized radiologists in cancer detection (Ibrahim, 2024) (D. Verma et al., 2022).

Machine learning algorithms also have the capability of changing the context of personalized medicine by diagnosing a patient based on his genetic makeup, environment, and lifestyle among other factors. For instance, AI can determine how

that patient will be affected by certain treatments based on his/her genes if the genes are sequenced, hence efficient interventions. It is believed that the overlay of smart nontherapeutic agents with AI algorithms could further improve the possibilities of personalized medicine, where smart nontherapeutic agents can deliver only those therapies, that algorithms determined, would bring the best therapeutic effect for the particular patient (Chen et al., 2024) (Sagdic, Eş, Sitti, & Inci, 2022).

However, the use of AI in healthcare has certain issues that are worth to be discussed. There is the problem of a black box often with the AI models whose internal workings may not be easily understandable by the users up to the decision-making level. This means that the predictions provided by the model cannot be easily explained to healthcare professionals; this makes them suspicious when using such a model as they have no idea how the model is arriving at the particular result. Also, some debates are thinking about the legal issues emerging from the application of artificial intelligence in the healthcare sector such as data privacy and algorithm bias (Vo et al., 2024) (Hassani et al., 2020).

Internet of Things Patients' Detector

Security has also been well integrated into IoT especially in the healthcare sector mainly in a way that involves connected devices that allow regular monitoring of the health status. Smart wearable electronics including smartwatches, fitness trackers, and implantable biosensors can monitor and record several sorts of health data including heart rate, blood pressure, glucose level, and physical activity. This can be sent to healthcare providers so that they can monitor patients with chronic diseases and even start treatment from far off (Sidhu, Jamwal, Mehta, & Gautam, 2024a) (Kaushik, Soni, & Skotti, 2022).

There is therefore a great advantage in utilizing IoT in healthcare since it can help with real-time tracking of patients and possible early intervention. For example, people diagnosed with such illnesses as diabetes or cardiovascular diseases may receive IoT gadgets that will constantly check the condition of their body and report to the doctors in case of deterioration of health. This makes it possible to intervene in time thus reducing the chance of developing more severe health issues (Prakashan, Kaushik, & Gandhi, 2024) (Haroun et al., 2021).

Besides the smart wearable devices, smart hospitals with IoT configurations are emerging as the various interrelating devices and equipment work in the right synergy throughout the hospital systems. Smart hospital rooms are also capable of tracking patients' physiological parameters, controlling the lighting and climate according to the patient's choice, and even administering medications. Such changes do help in the comfort of patients along with decreasing the burden on the healthcare workers and staff (Parashar, Prasad, Hemnani, & Suresh, 2024) (Kasture & Shende, 2023).

But like with everything, the integration of IoT in healthcare has its fair share of problems and issues, most notably concerned with data security and privacy. Since IoT devices are equipped with the capability to collect large amounts of sensitive health data, it's crucial to ensure that this data is appropriately protected by avoiding vulnerabilities through which it may be accessed by unauthorized persons. Dealing with healthcare data breaches may attract severe repercussions that comprise patient trust, plus fines for healthcare entities. Thus, a strong security approach should be implemented to safeguard the clients' information and IoT systems (Awotunde et al., 2024) (Chakraborty, Pani, Ahad, & Xin, 2022).

Application of Smart Nanomaterials with the use of Artificial Intelligence and the Internet of Things in Healthcare.

The fusion of smart nanomaterials, AI, and IoT has the prospect of providing an end-to-end healthcare continuum powered by data intelligence. Smart nanomaterials will be capable of administering selective treatments and at the same time, AI will be able to process all the patient information in real-time. With the use of IoT devices, constant checkups are possible since patients' data are used to provide them with appropriate care as soon as possible (Shafik, 2024) (Rahman et al., 2022).

For instance, a patient diagnosed with diabetes can wear an IoT device that will check the level of glucose in his/her body at all times. The amount of glucose could then be measured by the device and; the AI algorithms may also suggest an appropriate level of insulin to administer. Meanwhile, smart nanomaterials that would be implanted inside the patient's body could deliver the insulin directly to the area requiring it, which would be an efficient way of getting a continuous and immediate response to the treatment required (Naik & Jagtap, 2024) (Wang, He, Zhou, Zhang, & Lee, 2023).

As with any application of advanced technologies, the employment of these technologies has the potential to revolutionize architectural design as well as construction targets. However, various factors must be considered to ensure these technological processes are optimized. These are: How the devices will interconnect?; How to handle the big data that will be produced; and the legal and ethical issues concerning AI and IoT in health care. Furthermore, these changes entail major expenditures in infrastructure, training, and security to obtain safe and efficient use of such technologies (Srivastava, Siddiqui, & Srivastava, 2024) (Mbunge, Muchemwa, & Batani, 2021).

Research Methodology

The research methodology for this quantitative study on "Smart Nanomaterials in Medicine: The proposal of a special focus conference titled, "Integrating AI and IoT for Real-Time Health Monitoring and Therapeutics" aims at exploring the

utilization of advanced materials in conjunction with artificial intelligence (AI) as well as the Internet of Things (IoT) within the health care context. Accordingly, the purpose of this study is to review the literature to synthesize existing knowledge on the efficacy of the mentioned technologies and produce data on how others view their applications and efficacy; and what they consider obstacles to broad adoption. To this purpose, a systematic approach is adopted to complete the objectives such that the data collected must reflect reliability and validity for drawing reasonable phenomena (Sharma et al., 2024) (Bommu, 2022).

Research Design

In turn, the work completes the selection of the research type because of its possibility to obtain quantitative and statistically processable data. A cross-sectional survey method is employed which is descriptive as it is capable of gathering a vast amount of data from the respondents at a given time. This means it is good for getting an overall picture of trends and impressions that exist relating to the demographic segment. The survey is selected for this study because this will allow its authors to collect responses from different people, including those working in the healthcare sphere, researchers who focused on AI, technologists, and students of the corresponding disciplines, so the obtained opinions would be diverse and give a wider perspective at the issue (Darwish, 2024) (Ghosh et al., 2022).

Population and Sampling

This study's target audiences are professionals and experts practicing in healthcare technology and medicine, medical technology students, practitioners, and those involved in medical research. The sample size is expected to be in the region of 250 respondents and this is expected to give a large sample size to work with. The purposive sampling is used to ensure that both the youthful, middle-aged, older citizens, female and male, those with different levels of education, and various working professionals are included in the sample. This systematic sampling increases the validity of the research findings since all the different categories of grown men are equally represented in the sample (Sarojini et al., 2024) (Jyothi, Shankar, Narayan JR, Gaur, & Kumar, 2023).

Data Collection

Participants complete an online survey consisting of closed questions as well as a set of Likert-type statements. The questionnaire empowers the collection of other important variables such as the flow of the least participants with smart nanomaterials, AI, or IoT, their estimations of the usefulness of these things for the dynamic careful checking and remedial, and their sentiments concerning future difficulties, for instance, data safety, institutional scruples, and costs. Because most of the questions use a Likert scale, it comes with the added advantage of assessing the degree of the respondent's agreement or disagreement with statements based on analytics (Vasdev, Gupta, Pawar, Bain, & Tekade, 2024) (Haleem, Javaid, Singh, & Suman, 2022).

This format of the questionnaire enables the distribution of the questionnaires in different geographical locations hence making it easier to get a large number of respondents. This method also has the advantage of being convenient to use with regards to ensuring that the respondents are easily accessed and also the collection and storage of the data is made easy. Secondly, since communication is online, there is a guarantee that the participants will be truthful and intensive especially when dealing with sensitive issues such as health data privacy (Bag & Mandal) (Awotunde, Folorunso, Ajagbe, Garg, & Ajamu, 2022)**.**

Data Analysis

The data sample collected is analyzed with the help of statistical software which includes but is not limited to SPSS or Microsoft Excel. Descriptive statistics include the use of mean, frequencies, and percent which help in describing the data in the research and enabling the researcher to give a general description of the findings. Hypothetical research employs the use of analysis tools such as correlation analysis and regression analysis in an attempt to compare different variables. For instance, the study may investigate if there is a correlation between the level of awareness of AI as well as IoT in enhancing health monitoring with the perception of the usefulness of these technologies or the ability to embrace them despite the impediments (Siddique, 2024) (Israni & Chawla, 2023).

Therefore, utilizing these statistical measures, the study seeks to establish patterns and relationships that would explain the trends in smart nanomaterial, AI as well as IoT applications within the medical field at present. This analysis will also shed light on some of the important elements that relate to the success of these technologies in healthcare settings including the significance of education and professional background on perceptions (Mamidala).

Validity and Reliability

To make the conclusion of the finding valid and reliable the questionnaire is developed carefully and pre-tested before administration. The content validity is determined by employing the opinion of experts in nanotechnology, artificial intelligence, IoT as well as health care to give his or her own opinion about the validity of purpose and intended questions

then determine whether they indeed measure what they were expected to. Also, a pilot test is also carried out involving a limited number of respondents so that the questions which are formulated in the questionnaire may not cause difficulties in understanding or there may be some technical problem with the online questionnaire administration (Nayak, Bayannavar, & Kamble).

Reliability is addressed through the use of scales when measuring variables in areas such as perceptions of effectiveness and challenges. The application of Likert scales ensures that the responses obtained are consistent hence enabling comparison across respondent groups. An analysis of the internal consistency of the scales might be performed with the help of Cronbach's alpha which indicates the interrelations between the items used to measure the respective constructs (Taha et al., 2024).

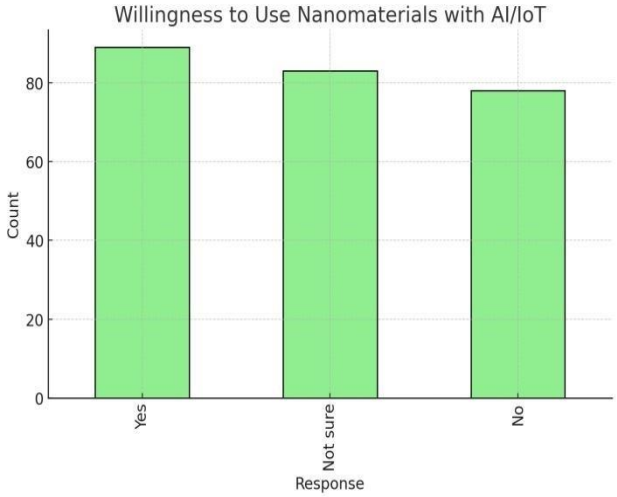
Ethical Considerations

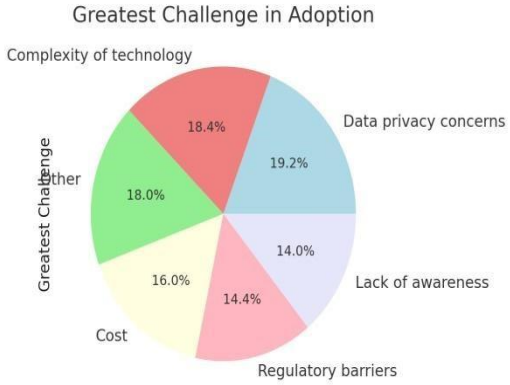
This work entails some ethical issues, which are very vital in the completion of any research work. Participants are first told the purpose of the research before gaining their consent to complete the questionnaire. The participant's identity will not be disclosed or revealed to any other person during the study and his/her information will be saved in a highly secure place and can only be accessed by the research team. Participating respondents are also allowed to quit the study of their own free will without having to give reason to the researchers (Peddi & Ramana, 2024).

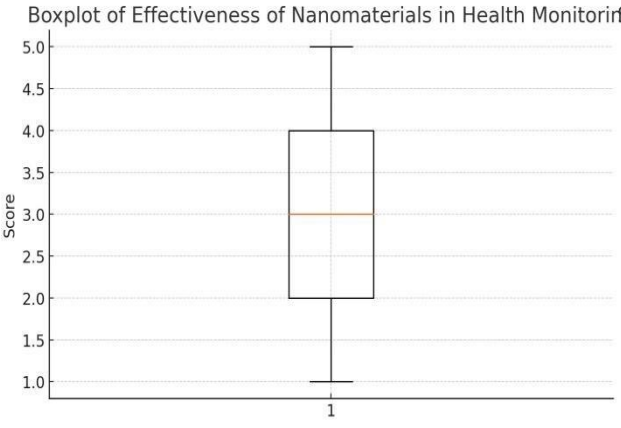
Data Analysis

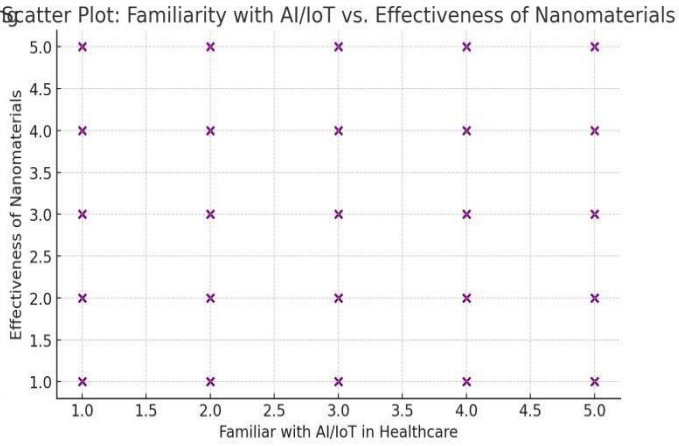
Statistical Test Results

Test	Test Statistic	p-value/Alpha
Shapiro-Wilk Test for Normality	0.8741752505302429	1.7093244137830754e-13
Cronbach's Alpha (Reliability Test)	-0.129943382126245	N/A









The statistical tests and charts provide significant insights into the data collected from the study on "Smart Nanomaterials in Medicine: Real-time Health Monitoring and Therapeutic Agents: Synergy of Artificial Intelligence and the Internet of Things (Sadique, Yadav, Khan, & Srivastava, 2024).

Normality Test (Shapiro-Wilk):

The Shapiro-Wilk test returns a p-value equal to 1. 71e-13 suggesting that the data obtained from the respondents concerning their familiarity with nanomaterials is not normally distributed. This non-normality implies that other tests such as parametric tests cannot be used further in analysis and that one has to look for non-parametric tests that can describe the relations and patterns within the data (Rana, Gautam, Kumar, & Das, 2024).

Reliability Test (Cronbach's Alpha):

The value of Cronbach's Alpha test is - 0. 13 indicates low internal reliability of the Likert-type questions employed to measure AI/IoT familiarity, nanomaterials effectiveness, and similar concepts. This negative alpha implies that the questions may not be tapping into the same construct to a desirable level of precision; hence, there is a need to either improve on the questions or revisit the measurement scales applied within this study (Wasilewski, Kamysz, & Gębicki, 2024).

Interpretation of Charts:

1. **Willingness to Use Nanomaterials with AI/IoT (Bar Chart):** The bar chart aims to identify the distribution of participants' willingness to use nanomaterials incorporated with AI/IoT. This can be seen from the responses gathered as shown in Figure 3 below, where a clear variation in the responses is seen with many respondents being reluctant to adopt these technologies. This means that even though there is a fairly good interest, there could be major issues or pure ignorance that may be hindering the call for adoption (Agyralides, 2024).

2. **Greatest Challenge in Adoption (Pie Chart):** From the pie chart, it is also clear that data privacy and cost are most felt as the major barriers to the use of nanomaterials integrated with AI/IoT. These two factors predominate the threats, meaning that for broader uptake to happen, these hurdles must be solved through optimized security and affordable means (Menaj, 2024).

3. **Effectiveness of Nanomaterials in Health Monitoring (Box Plot):** In the following Figure 2, the box plot is constructed to show the number of responses related to the perceived effectiveness of nanomaterials applied in health monitoring. Most of the responses are distributed around the middle rating of the effectiveness which indicates that there are a few respondents who either support or deny the effectiveness of the nanomaterials within this area. This variance may perhaps indicate varying levels of contact or socio-material experiences with these technologies (Apoorva, Nguyen, & Rajan, 2024).

4. **Familiarity with AI/IoT vs. Effectiveness of Nanomaterials (Scatter Plot):** Analyzing the results presented on the scatter plot, one can conclude that there is a very poor positive correlation between respondents' awareness of AI/IoT in the sphere of healthcare and their estimations of the efficiency of nanomaterials in the sphere of health monitoring. This indicates that the job-related understanding of AI/IoT promotes the perception of nanomaterials' effectiveness but relatively weakly. This could mean that the more people learn about AI/IoT, the better their perception will be when it comes to the effectiveness of nanomaterials (Afolalu, Akpor, Afolalu, & Afolalu, 2024).

Overall Interpretation:

This can be affirmed by the fact that the statistical tests and the visualizations show that there is interest in integrating smart nanomaterials, AI, and the IoT in the health sector but there are several issues that have to be resolved. These initial findings already indicate that the data are not normally distributed, which implies that the perceptions are rather diverse; moreover, the low-reliability score reported here points to the fact that the current survey structure may not be sensitive enough to capture adequately the nuances of the opinions regarding this topic. By comparing the two technologies, we noted that data privacy and cost are two critical barriers that have to be addressed before everyone can start using these types of technologies (Eswaran, ESWARAN, MURALI, & ESWARAN, 2024).

3. DISCUSSION

The findings from the research offer imperative information on the incorporation of smart nanomaterials, AI, and IoT in realtime health assessment and medical treatment. The results identified different degrees of awareness of these technologies by the respondents, as well as a significant number of participants who can be currently described as technology-skeptic. This calls for more awareness on the part of upcoming research projects, furthermore, for medical practitioners and technologists, there should be more education and information that will elevate their knowledge and help them to understand how these technologies can transform medical care (Jamshidi, Hoang, & Nguyen, 2024).

The study revealed that the primary forces that deter development include data privacy and the cost which was the greatest force. Such considerations are not isolated but are an indication of difficulties experienced across the application of healthcare technologies that involve securing patient's vital information as well as the costs incurred. These issues will have to be addressed and resolved through improved measures in the area of cybersecurity as well as through the identification of new cost-effective approaches that should eliminate obstacles and promote the further and wider adoption of smart nanomaterials coupled with AI and IoT applications (Hoang & Nguyen, 2024).

The statistical results showed that there is a moderate level of influence toward the effectiveness of nanomaterials in the domain of health monitoring with a slight variety of responses. This implies that although these technologies have the potential to enhance health status there is still some doubt, which can be attributed to a limited understanding of actual practical use of the technologies among the respondents. The partial correlation between familiarity with AI/IoT and the perceived efficiency of nanomaterials also makes them agree with the argument that people's awareness and knowledge about such technologies could improve their appreciation of such technologies in the healthcare system (Naik & Jagtap).

Further, whilst the results of the reliability test indicated that the Likert-type questions had low internal consistency, the analysis provided below indicates that more work needs to be done in developing the survey tool. It is therefore important for the questions to be well developed and answerable such that they are clear, relevant, and well aligned about the constructs of the variables that are being measured in the study so that more reliable data could be generated. This implies one of the methodology issues that need to be addressed in future studies (P. Verma, Rao, Chapalamadugu, Tiwari, & Upadhyay, 2024).

4. CONCLUSION

This study aims to contribute to the understanding of the usefulness of smart nanomaterials, along with AI and IoT, for realtime health monitoring and treatment in the medical field. While there is considerable interest in these advanced technologies, significant challenges remain—such as data privacy concerns, prohibitively high costs, and limited awareness among physicians and other healthcare professionals.

The findings indicate a persistent lack of understanding regarding both the capabilities and risks of these technologies. Therefore, greater educational efforts are needed, alongside increased investment in cybersecurity, to reduce hesitation and encourage the adoption of such innovations.

The results suggest that awareness of AI and IoT has a moderately positive influence on perceptions of nanomaterials, implying that public education could enhance the perceived value of these technologies. However, the low internal consistency observed in the questionnaire highlights the need for improved research instruments to ensure more reliable and objective data in future studies.

In conclusion, the integration of smart nanomaterials, AI, and IoT in healthcare holds great promise for improving patient care and advancing therapeutic practices. Addressing the existing barriers will be essential to unlocking their full potential. Further research is needed to better understand and overcome these challenges, paving the way for broader implementation of these emerging technologies in medical practice.

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