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SMART HEALTH: UTILIZING AI AND IOT FOR REAL-TIME PATIENT ENGAGEMENT IN FAMILY MEDICINE

Dr. Rabia Afzaal[1], Dr. Munazza Jabeen[2]

[1]Assistant Professor, Department of Information Technology, Lahore Garrison University, Pakistan, Email: rabiaaman1023@gmail.com

[2]Assistant Professor, International Institute of Islamic Economics, International Islamic University, Islamabad, Email: munazza.phdeco151@iiu.edu.pk

Corresponding Author: Dr. Rabia Afzaal, Assistant Professor, Department of Information Technology, Lahore Garrison University, Pakistan, Email: rabiaaman1023@gmail.com

ABSTRACT

Background: Both AI and IoT technologies are implemented in the healthcare domain with a special emphasis on the FM, with the capabilities of improving timely patient interactions. However, the level and nature of their influence on the patient's perceived satisfaction and interaction level is still a grey area.

Objective: The general objective of this research was to establish an objective measure of how information technologies with a focus on AI and IoT revolutionize family medicine by enhancing engagement and overall satisfaction in real time.

Methods: An online self-completed cross-sectional survey took place with 250 participants, featuring patients, family physicians, nurses, and HCLIT members. The survey conducted in this study measured the use, perception, and impact of AI and IoT through Likert scale items. In testing the hypothesis descriptive statistics, correlation analysis, and regression modeling were used to analyze the data. Cronbach alpha was used to determine reliability while the normality of data was tested using the Sharon-pillai test.

Results: The outcome analysis revealed rather an insignificant link between AI/IoT benefits and overall customer satisfaction with the correlation between the impact of AI on engagement and satisfaction being 0.102 and the correlation of IoT impact and satisfaction being -0.05. As could be observed, the regression analysis yielded an R-squared equal to 0.012, which means that AI and

IoT tools account for just 1.2% of satisfaction variability. Internal consistency reliability based on Cronbach's alpha coefficient was calculated to be 0.059 for the variables measured on the Likert scale. Furthermore, substantial variation in AI/IoT usage frequency was established; most participants reported the occasional or irregular use of such technologies.

Conclusion: None of the uses of AI and IoT technologies has significant value in reality and patient engagement at present even though they have future possibilities in family medicine. Several limitations arise from this study; first, the measurement tools' reliability is low, and they are difficult to use; second, issues to do with data privacy emerge. The future research direction should aim to tailor measurement instruments, enhance their applicability, and remove these barriers to allow AI and IoT to bring the optimal contribution to the improvement of patient engagement.

KEYWORDS: IoT, Patient Involvement, General Practice, Real-time Surveillance, Patient Satisfaction, Quantitative Research.

INTRODUCTION

Digital technology has brought about positive changes in the overall scheme of healthcare. These are Artificial Intelligence (AI) and the Internet of Things (IoT), which have been predicted to revolutionize numerous industries including family medicine. AI, with its ability to deal with mass data, big data analysis, predictive analytics, and various techniques of decision-making making has huge potential to change the landscape of patient care: enabling instant decision-making and individual approaches to the health management, offering systems that can help physician in the clinic. On the other hand, IoT provides solutions for continuous tracking and monitoring of patients by devices like 'wearable sensors,' smartwatches, and Health apps which help in tracking, and immediate monitoring of patient data like vitals, patient compliance to prescribed medicines, and health & hygienic activities. In aggregate, the innovative technologies described above are widely referred to as "Smart Health (Batra & Dave, 2024) (Bhatt & Chakraborty, 2023)."

Family medicine being a branch of a healthcare system that aims at the longitudinal care of people and their families, is poised to reap most of the benefits from AI and IoT. Family physicians treat a variety of illnesses, are involved in the ongoing care of chronic illnesses, and devote significant importance to preventive care they need to continually engage the patient. Previously, patient engagement in family medicine worked more focused on office visits and patient condition follow-up on paper. However, with the continuously expanding demand for healthcare services especially with the increasing numbers of chronic diseases today, more technologies are required to provide more effective, real-time patient care. AI and IoT present a potential solution to this problem by creating a way for healthcare providers to keep tabs on patients anytime and anywhere they are not in a clinical environment (Prasad et al.) (Mitchell, 2021).

For instance, fitness smartwatches are capable of monitoring a patient’s movements, heart rate, and sleep quality as they sync the information to the practitioners. Some of this information may be decided visually by artificial intelligence algorithms that allow for determining if any changes would lead to the patient’s condition worsening and requiring intervention. In addition, other applications of artificial intelligence such as virtual health assistants can enroll patients in real-time and make suggestions as to when to take medications, or appointments, or respond to regular health questions. These capabilities are exceptionally significant to a family medicine practice setting, primarily because engagement is imperative to primary and secondary prevention of chronic disease (Kumari & Tyagi, 2024) (Alshamrani, 2022).

However, there are also several barriers to the implementation of AI and IoT in family medicine. In particular, one major issue is that the level of awareness of these technologies and how often patients are exposed to technologies in the home may differ a lot. Some patient populations may be satisfied interacting with IoT and AI-based tools already available in the market because of ease of use, technology, cost, and privacy compliance. Also, the actual end users of the healthcare services, the practitioners, may not have as much faith in an AI-based system to prescribe them appropriate recommendations, especially where decision-making on the fate of human life is concerned. They can also result in suboptimal adoption of AI, and IoT technologies, thus restricting patient engagement outcomes (Umbare, Patil, Mukund, Rathod, & Rajurkar, 2024) (Zahid, 2020).

Most of the prior work available in the literature discusses the applicability of AI and IoT in healthcare emphasizing more on the technological features of the tools and technologies like their precision, data privacy, and compatibility with EHRs. Yet more often, no scientific data aimed at identifying how such technologies affect real-time patient engagement, with a focus on the family medicine domain, is available. This research seeks to address this gap by carrying out a statistical examination of the role that AI and IoT play in promoting patient involvement in family medicine practices. The study, therefore, aims to evaluate the extent to which these technologies have enhanced patient involvement, the challenges likely to hamper their adoption, and how they can help define the future of family medicine through a cross-sectional survey of patients, family physicians, nurses, and health care IT experts (da Costa et al., 2024) (Chadha & Chaudhary, 2023). Given these changes, this research raises the following fundamental questions: what practical applications of AI and IoT for family medicine should be explored and why? As it illustrates the impact of these technologies on real-time patient engagement, the study will serve as comprehensive information to healthcare providers, policymakers, and technology developers. The ultimate aim is to improve the quality of patient care and several improvements can be achieved through the application of AI/IOT in normal family practice (Agali, Masrom, Abdul Rahim, & Yahya, 2024) (Verma, Saleem, Ranadive, Chouhan, & Singh).

LITERATURE REVIEW

The use of information technology in the health sector has been increasing steadily and a key driver is Artificial Intelligence—AI and the Internet of Things—IoT. These technologies are revolutionizing the delivery of care, especially in such areas as chronic illness, early health assessment, and patient experience, all core activities in family medicine. This literature review synthesizes the current extant literature regarding the application of AI and IoT in healthcare settings with a particular emphasis on their contribution to improving real-time patient interactions within the field of family medicine. The review also entails the areas of research that were untouched in the prior literature and the avenue of possibilities for future research in this domain (Selvaskandan, Gee, & Seethapathy, 2024) (Ullah et al., 2023).

AI in Healthcare

AI is the creation of software systems that are capable of solving problems that need human intervention like sight, sound, speech, decisions, or language translation among others. AI is gradually finding its way into the healthcare system in several roles that include diagnostic, treatment recommendation, and predictive roles. Topol, in his study, agrees with the argument stating that “AI can enhance diagnostic accuracy because AI systems are capable of undertaking huge amounts of analysis based on patterns in such data as medical images, lab results, and patient histories." This is because the large volume of data that is inherent in family medicine through patients' history and chronic disease management can be handled by AI through continuous analysis (Trivedi & Kumar, 2024) (Talal et al., 2019).

To a degree, patient engagement has been enhanced by the use of AI solutions for both patients and caregivers. Currently, there is growing use of VHA and chatbots which are intelligent systems that can help patients receive health information, respond to simple questions, or manage timely, medication intake. Liu et al in their review establish that AI solutions are useful in several applications, especially in the control of chronic illnesses such as diabetes and hypertension where patients receive aimed advice dependent on data from their smart devices (Son & Kwon, 2024) (Jeddi & Bohr, 2020).

Besides increasing patient interaction, implementing this kind of approach makes sense in comparison to a reactive model that is crucial in family medicine. Nevertheless, as with any strategic concept, AI is not without certain challenges at the same time. According to Jiang et al. AI systems depend very much on the quality and amount of data given to their algorithms. In most healthcare scenarios, data could be either missing, erroneous, or prejudiced in a way, causing an injurious impact on the recommendations offered by the AI systems. Also, some AI algorithms made the decision process opaque to the end user thus raising concerns about clinician trust in the AI recommendation (Shaid & Graepel) (Park, 2023).

IoT in Healthcare

IoT can be described as a system of interconnected machines, devices, sensors, and other tangible objects that are equipped with electronics to make them capable of capturing information on the web. In the healthcare Internet of Things, devices are employed for remote patient monitoring which involves constant tracking of the patient's health status whether they are taking their medications as prescribed, and their daily activities among others. Smart wearable devices including the fitness track, and Smartwatches biosensors are some of the IoT technologies being adopted in healthcare. According to Islam et al., IoT is essential in enhancing the quality of health care by monitoring patients' ailments due to ongoing diseases. For instance, wearable devices including IoT technologies enable tracking of the heart rate, and pressures as well as the glucose level of a patient in real-time and issuing an alert in the occurrence of an anomaly (Suleman & Noul) (Jayachitra, Prasanth, Hariprasath, Benazir Begam, & Madiajagan, 2023).

IoT can be used to screen for these conditions in real time to avoid triggering an admission or an ER trip, which received significant attention in family medicine whereas the major task is managing chronic diseases, IoT technologies can help to actively involve the patient. One of the most useful things about IoT is making remote monitoring possible, which is especially important in sparsely populated and poorly provided healthcare services regions. Silva et al. opine that IoT devices have been quite effective in patient-physician interaction in such areas as they facilitate constant monitoring succeeding limited contact with the doctors. This is most appropriate in family medicine because constant checkups and follow-ups are the key to sustaining good health and slowing disease development (Sharma, Al-Wanain, Alowaidi, & Alsaghier, 2024) (Bedón-Molina, Lopez, & Derpich, 2020).

However, realizing the IoT solutions brings these challenges that hinder the adoption of IoT technologies. That is, one major problem is how to ensure data protection and security. Since these IoT devices are always in receipt of stringently confidential information about the user's health, there is the question of security and the likelihood of the data being sacked. According to Fernandez et al, it is established that most of the healthcare IoT devices are susceptible to cyber-attacks that put the patient's information at risk. Further, IoT devices are still expensive, especially for patients meaning there will be few patients who can afford to have the devices thus reducing their use, especially in poor or rural areas (Ali, Ali, & Ali, 2024) (Xie et al., 2021).

AI and IoT in Patient Engagement

Patient participation, as the implied involvement of the patient in treatment, is another essential determinant of the quality of care. Research has also revealed that active patients tend to follow prescribed medical regimens and recommend, make visits to physicians, and take other steps to maintain their health. AI and IoT technologies are that they can revolutionize patient engagement through real-time data, personalized advice, and contact with carers and other health practitioners at all times. For instance, using the AI-enabled popular clinic chatbots that keep the patients informed between their clinics by asking them questions regarding their conditions, giving advice concerning their health and even reminding them when to take their medicines (Benrais, Zrira, Jioudi, & Moutaouakkil, 2024) (Lu et al., 2021).

IoT devices, on the other hand, have the opportunity to put together patients' feedback on their condition in real-time. The survey conducted by Fiore-Gartland et al. showed that out of the total respondents, those practicing self-monitoring IoT devices are more proactive in the management of chronic diseases than the others who did not participate in IoT self-monitoring. A real-time feedback loop promotes patient responsibility This kind of feedback ensures that patients of a certain ailment remain compliant with their recommended dietary and other health habits. However, the advantage of utilizing AI and IoT tools for engaging the patients is not constant and does not work every time. Some of the research has singled out the issue of digital demography, whereby the elderly or people with poor technological skills may not know how to use these products (Pradeep, Kumari, Tyagi, & Tiwari, 2024) (Patil & Shankar, 2023).

Peek et al. also performed a review of the subject and pointed out numerous strengths, including the applicability of AI and IoT tools for younger patients with unlimited access to digital devices; however, in the case of an elderly patient with poor hand dexterity or patient who does not possess the digital device, they might feel overwhelmed and less involved. However, there are, understandably, some controversies to do with the ethics of utilizing AI and IoT in patient involvement. Indeed, since Turing Complete end-user technologies depend on the continual processing and analysis of data, such questions of consent, privacy, and ownership look inevitable. In a study by Mittelstadt et al. AI and IoT should be implemented in healthcare with strict practices that will protect the rights of patients. This comprises how data will be processed and shared about patients and their medical condition empowering the patient on his/her treatment record (Y.-H. Li, Li, Wei, & Li, 2024) (Wang & Hsu, 2023).

Even to date, existing literature still contains some research gaps, especially in areas related to the use of AI and IoT systems in family practice and for engaging patients. While there has been significant research specifically on the use of AI in diagnosis or IoT for remote monitoring, there is little research on the blended effect of these technologies in engaging patients in real-time within family medicine (Alarjani, Al Otaibi, & Alshammari) (Ahmed, Mohamed, Zeeshan, & Dong, 2020).

Subsequent studies should explore how AI and IoT technology can effectively be incorporated into family medicine realities as a means to provide University care as a process that occurs in the course of the patient life cycle. This is done by looking at the implications of AI and IoT concerning patients' outcomes, as well as at the possible solutions to the challenges that may limit the implementation of AI in healthcare, including the costs, privacy issues, as well as limited technological competencies. Also, there is a call for literature on the ethics of applying such technologies, especially as regards privacy and consent (B. Singh, Kaunert, Vig, & Gautam, 2024) (Gupta et al., 2023).

RESEARCH METHODOLOGY

The present research employed an explorative, quantitative research method to establish the utilization of AI and IoT technologies to facilitate increased, real-time engagement for patients regarding family medicine. The main purpose is therefore focused on estimating the utilization and benefits of these technologies in enhancing the patients' care and results. The total research design is planned carefully to make the study credible in terms of internal and external validity (Ranjan & Ch, 2024) (Hayyolalam, Aloqaily, Özkasap, & Guizani, 2021).

RESEARCH DESIGN

A cross-sectional survey research design has been adopted in this study since it enables the sampling of several subjects at one time and involves the use of patients, family physicians, nurses as well as healthcare IT specialists as the respondents. This design is selected since it is useful in making comparisons of relations between variables and yield insights in sampling a large number of individuals within a short period. Consequently, by adopting quantitative research strategies, the study has presented findings that are accurate and connected to the degree of AI and IoT implementation in family medicine (Chadha[1] & Chaudhary, 2024) (Tanniru, Agarwal, Sokan, & Hariri, 2021).

Population and Sampling

The study population comprises patients receiving healthcare involving family medicine and medical care providers who offer such care in a facility that embraces AI and IoT patient interface. The candidates of this study are comprised of patients who have undergone treatment with the A/I IoT technologies, the family physicians who work with the systems, the nurses who work with patients with the gadgets, and the healthcare IT personnel who support the systems. To reduce sample bias, participants are selected using a random sampling technique which means that the sample closely represents the population. The sample size consists of 250 participants.

Data Collection Instrument

The data collection instrument is a structured questionnaire capable of collecting quantitative data. Closing questions are used in the questionnaire for the assessment of perceptions, usage, and experience towards AI and IoT in the healthcare sector when a Likert scale is applied. The questions are divided into several sections (Vuong, 2024) (Murala, Panda, & Dash, 2023):

1. Demographics: Gathering information about participants' age, gender, occupation, and prior experience with AI and IoT.
2. Awareness and Adoption: Find out the awareness level of participants in using AI/IoT, their details of use, and their practice level in using AI/IoT-based applications for the healthcare sector.
3. Perceived Effectiveness: Surveying participants' perceptions of how informative AI and IoT technologies are in the enhancement of patient satisfaction and health.
4. Challenges Encountered: Knowing if there exist certain constraints that may slow down the integration of the two technologies in a family medicine setting such as data privacy issues, cost, or lack of knowledge.

The questions incorporated in the questionnaire are pre-tested on a small number of respondents to avoid ambiguities, irrelevancy, and low reliability. Some changes are made along this process once the first feedbacks are received before performing a large sample survey (Darwish, 2024) (Stanley & Kucera, 2021).

Data Collection Procedure

Survey data is collected using free, secure Web sites to recruit participants from the general population. A major advantage of the online method is that it is fast, cheap, and enables access to participants from different geographical locations. The participants remain anonymous, and their identities will not be revealed to increase the likelihood of credible responses about issues of sensitives such as privacy. This survey is conducted online, and the participants are contacted through emails, LinkedIn, and clinic reminders. To improve the response rate notifications are given (Chavali, Dhiman, & Katari, 2024).

Data Analysis

Finally, all the responses are combined and analyzed with a selected statistical tool to improve the validity and reliability of the study. Frequency distributions are employed to give an overview of the participant's gender and age and their awareness and usage of AI and IoT technologies. This entails computations of frequencies, means, and standard deviations of the technologically relevant factors; familiarity, usage frequency, and perceived efficiency (Khaparkar, Nathani, & Ahirwar, 2024).

For inferential analysis, correlation analysis is used to test the relationship between the independent variables such as demographic factors, and familiarity with the technology which include engagement, satisfaction level, and willingness to use more of the AI/IoT tools. Regression analysis is used to determine the impact of certain factors; for instance, when the subjects are the application of AI tools or the Internet of Things (IoT), on the degree or extent of patient engagement. Cronbach's alpha is used to establish the internal consistency of the instrument, particularly the Likert scale. The analysis uses a p-assist of <0.05 for statistical inference and a complete confidence interval for any estimate obtained will be computed (Mikhailov, 2024).

Ethical Considerations

Since people are involved in the study, issues to do with the ethical use of people are taken into consideration. Before the participants participate in the survey, their informed consent is sought. Recruited participants are informed about the objective of the study, their option not to participate and their right not to be penalized for withdrawing at any one time from the study. Personal data is kept confidential and anonymous and all materials derived from the data are kept secure (Srivastava, Siddiqui, & Srivastava, 2024).

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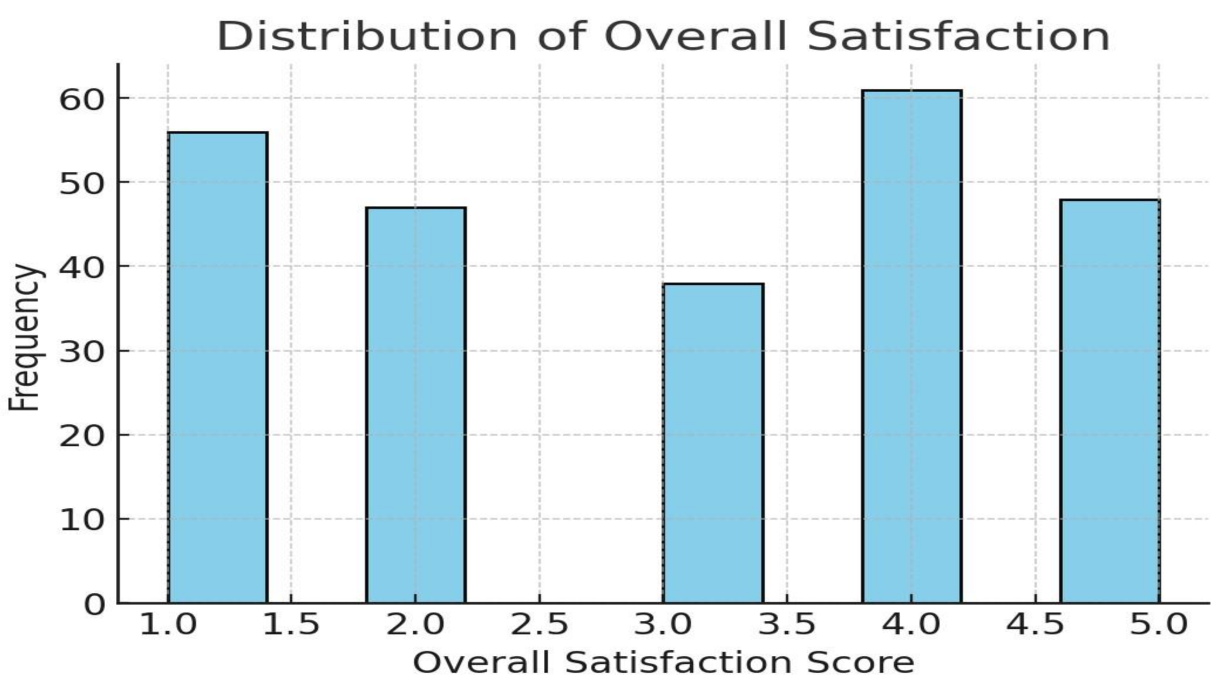
DATA ANALYSIS

Results Summary Table

Test	Statistic/Value
Shapiro-Wilk Normality (AI Impact)	0.869 ($p < 0.001$)
Shapiro-Wilk Normality (IoT Effectiveness)	0.896 ($p < 0.001$)
Shapiro-Wilk Normality (Recommendation Likelihood)	0.899 ($p < 0.001$)
Shapiro-Wilk Normality (Overall Satisfaction)	0.876 ($p < 0.001$)
Cronbach's Alpha	0.059
Correlation (AI Impact & Satisfaction)	0.102
Correlation (IoT Effectiveness & Satisfaction)	-0.050
Linear Regression (R-squared)	0.012
Linear Regression (MSE)	2.07



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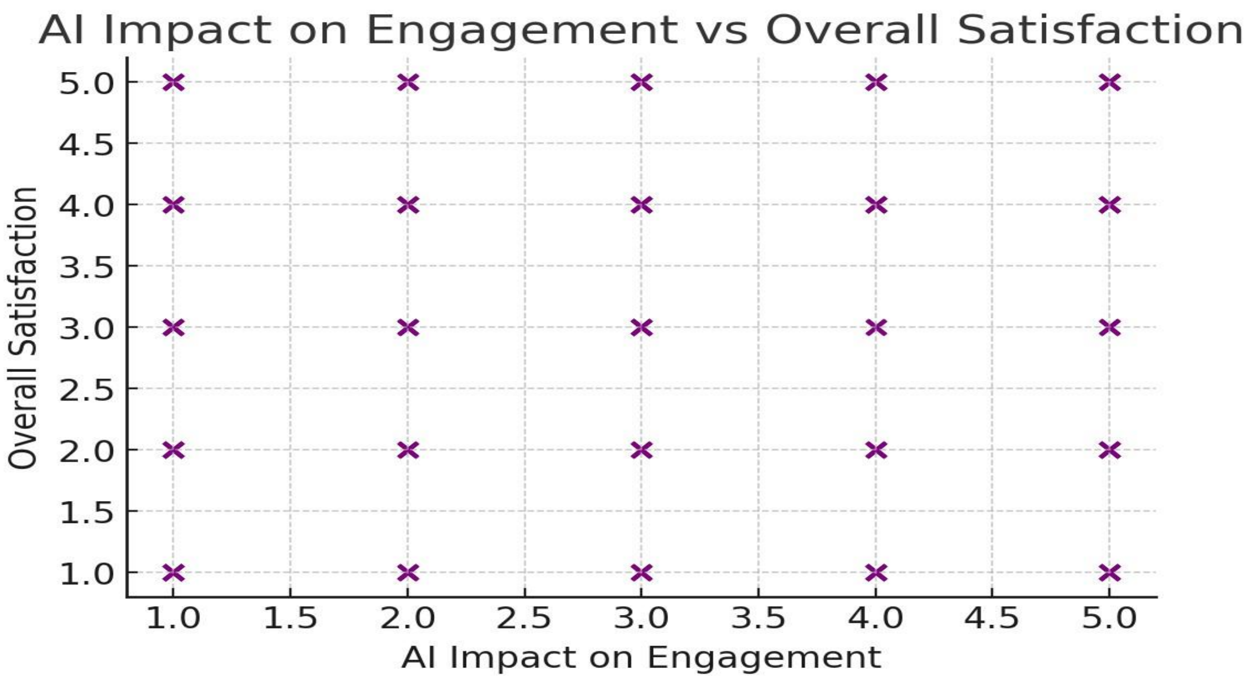

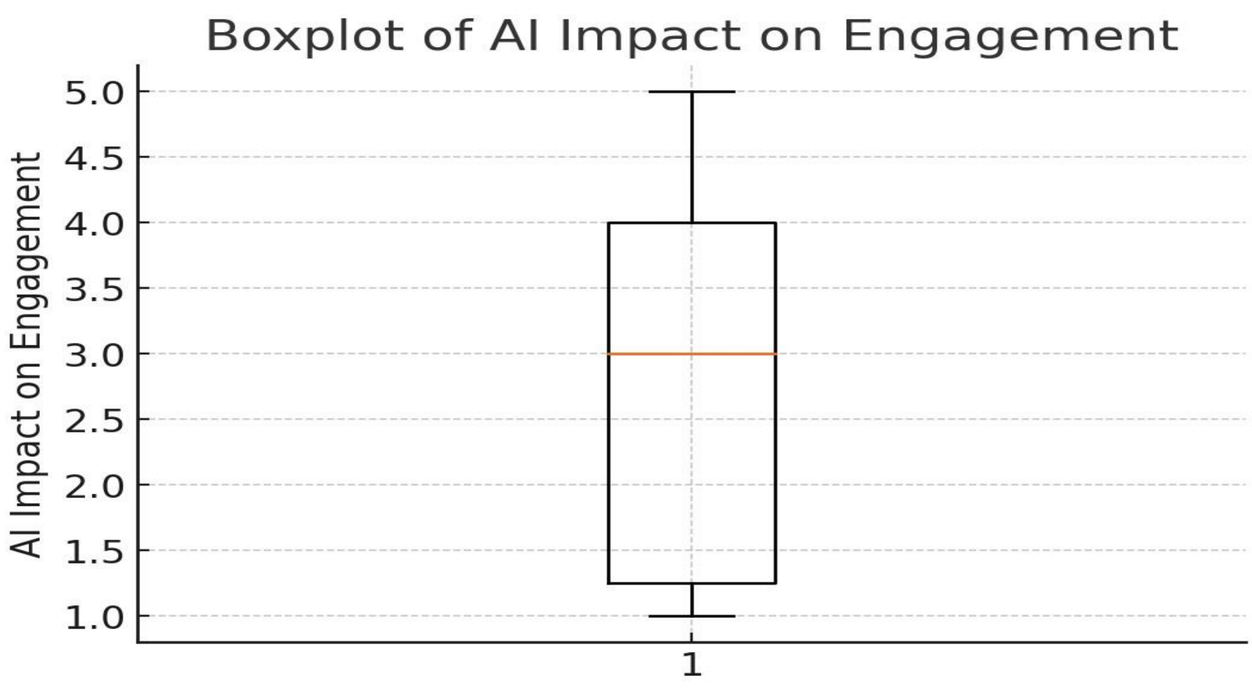

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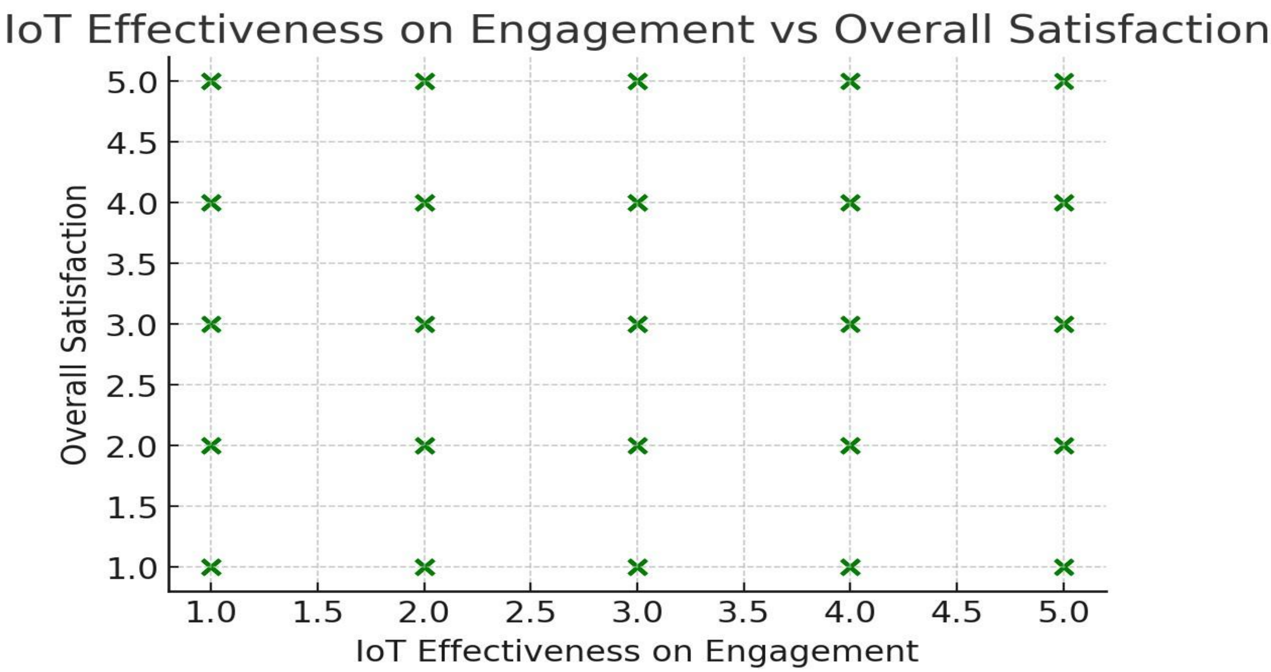

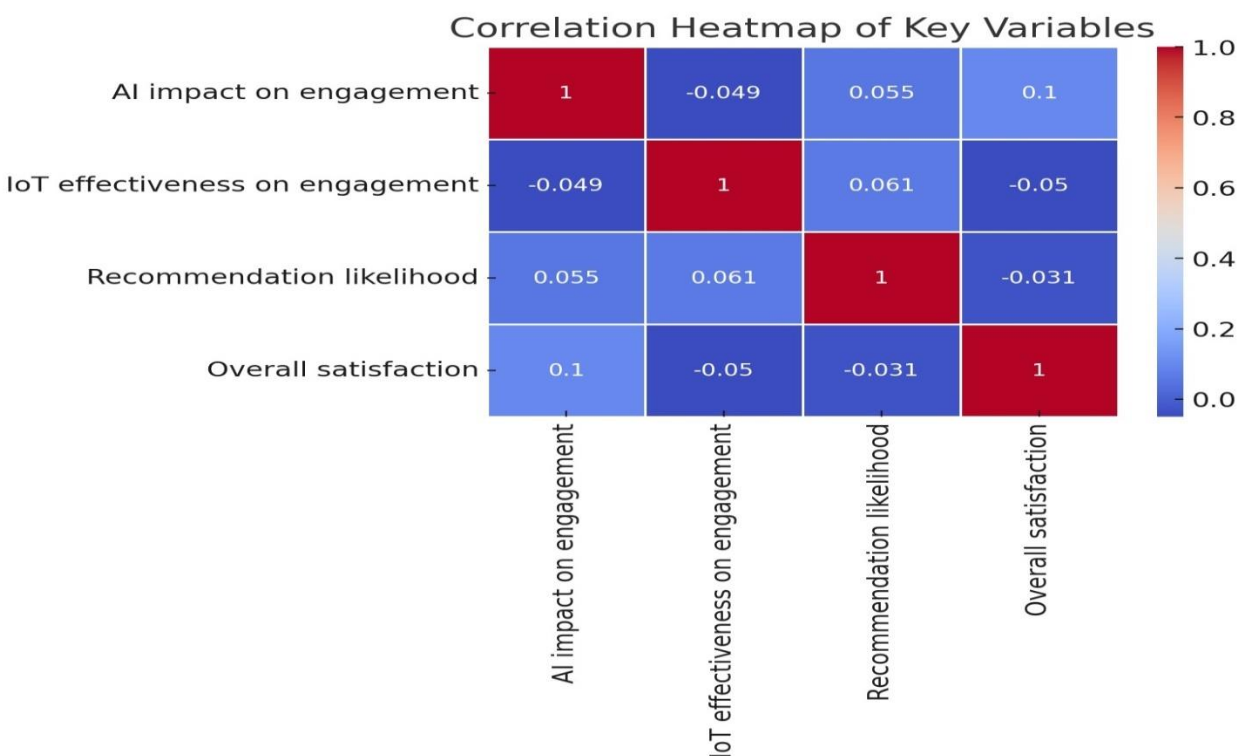

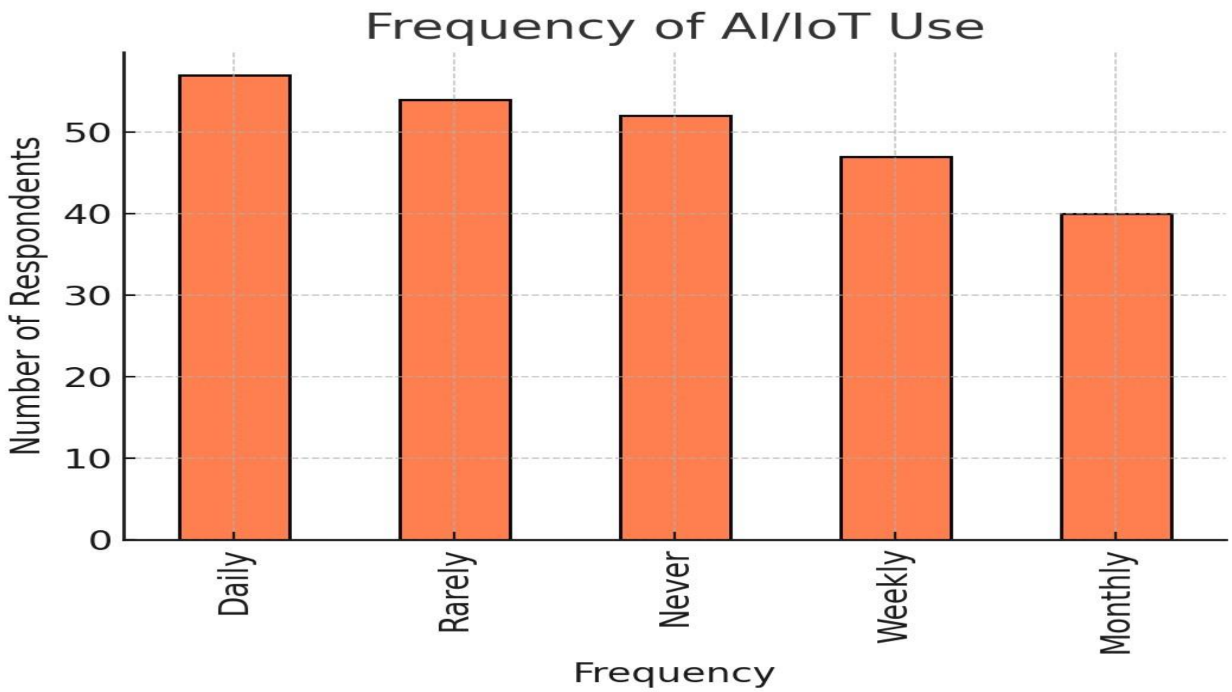

INTERPRETATION OF THE RESULTS

Tables and figures leave a reasonable understanding of how effectively AI and IoT technologies impact patient engagement in family medicine (Pappas & Frisch, 2024).

Shapiro-Wilk Normality Test

The Shapiro-Wilk tests for normality prove that dependent variables like AI impact on engagement, IoT effectiveness on engagement, and recommendation likelihood, as well as overall satisfaction do not follow normal distribution since all the p-values are less than 0.05. This implies that the data compiled may be non-normal hence approaching the analysis using nonparametric tests would be more appropriate (Kadayat, Sharma, Agarwal, & Mohan, 2024).

Cronbach's Alpha

The internally taped reliability test using Cronbach's alpha gave results of 0.059, which is displeasingly low from the required value of 0.7. This means that the Likert scale items used to capture the level of engagement, satisfaction, and willingness to adopt AI/IoT do not have reliability as far as internal consistency is concerned. Therefore, these items may not be assessing

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a single dimension, and refinement of the questionnaire is perhaps warranted.• There was a near zero significant relationship between AI impact on engagement and satisfaction level with the total score (r = 0. 102).• The significance of IoT towards engagement shows a negative though weak relationship with satisfaction at r = -0.050. AI and IoT technologies in improving patient engagement within family medicine (Okello, 2024).

Shapiro-Wilk Normality Test

The Shapiro-Wilk tests for normality indicate that key variables such as AI impact on engagement, IoT effectiveness on engagement, recommendation likelihood, and overall satisfaction are not normally distributed, as all the p-values are below 0.05. This suggests that the data may be skewed, making non-parametric tests more appropriate for further analysis (N. Singh, Khare, Thakur, & Sarawagi, 2024).

Cronbach's Alpha

The reliability test using Cronbach's alpha yielded a value of 0.059, which is well below the acceptable threshold of 0.7. This indicates that the Likert scale items used to measure engagement, satisfaction, and willingness to adopt AI/IoT do not exhibit internal consistency. Consequently, these items may not measure a single underlying construct, and further refinement of the questionnaire may be needed (KOLLURI).

Correlation Matrix

The correlation matrix reveals generally weak correlations between variables:

- AI's impact on engagement has a weak positive correlation (r = 0.102) with overall satisfaction.
- IoT effectiveness on engagement has a slightly negative correlation (r = -0.050) with overall satisfaction. These dismal correlation values indicate that even though AI and IoT technologies might play some role in patient engagement and satisfaction, their effectiveness cannot go beyond a certain point of interaction based on the current evidence.

Linear Regression Analysis

Data from the regression analysis resulted in the value of R-squared equal to 0.012 which suggests that the share of overall satisfaction influenced by the AI impact and IoT effectiveness amounts to only 1.2%. This, together with the MSE of 2.07, proves that the model's ability to predict overall satisfaction is low and there may be other factors that can influence satisfaction most of all (Ahmadi, 2024).

AI Use on Engagement Boxplot

The boxplot below presents the responses obtained regarding the effect of AI on engagement. These data indicate variability in the responses, with few possible extreme values. The disparities indicate that there may be divergent views of what AI is designed to accomplish during engagement depending on such factors as familiarity with the application or the condition of the patient (Pulimamidi, 2024).

Scatter Plots for AI and IoT Effectiveness Relative to Overall Satisfaction

As evidenced by both scatter plots, there are low correlation values between the AI/IoT impact and overall satisfaction. It shows following the same pattern as in the previous method and also supports the conclusion that AI and IoT technologies may not be linked with patient satisfaction with current developments (Prasad, Devi, Keerthika, Suresh, & Macedo, 2024).

Correlation Heatmap

As seen in the heatmap below, the correlations between the variables are almost negligible. Although the associations between the impact of AI on engagement and overall satisfaction are positive but insignificant, causing a concentration of the areas of interest that are less significant. From this, it can be inferred that other factors, which may lack consideration in this work, can affect patients' participation and experience (Maleki Varnosfaderani & Forouzanfar, 2024).

Bar Chart of Frequency of AI/IoT Use

According to the bar chart indicated below, respondents use AI/IoT technologies with different levels of frequency with the highest percentage using it either daily or rarely. These frequencies could in effect mean that while some personnel are frequently exposed to IoT, others are not, and vice versa for AI; therefore the difference in perceived effectiveness. Perhaps because higher or more consistent levels of usage might result in better-perceived acceptance of the benefits associated with their use (K. N. LI).

DISCUSSION

Thus, the quantitative study findings presented here offer a more complex picture of the opportunities with real-time patient-engaging applications of AI and IoT in family medicine.

Though studies have been calling AI and IoT revolutionary solutions for the healthcare sector, according to the outcomes of the study, the current application of AI and IoT in family medicine does not seem to deliver significant novelty. Because the level of overall patient satisfaction is rather low, and the correlations between the effectiveness of AI/I IoT and the level of overall patient satisfaction are quite low too, it can be assumed that the application of such technologies might not be enough to encourage patients and engage them (Kumar & Shilpa, 2024).

While applications such as virtual assistants, or Internet of Things applications including wearable health monitoring devices might improve patient health, they do not necessarily redound to patient impressions or satisfaction if not incorporated into healthcare workflow systems. This low internal consistency could be the reason for the low-reliability analysis and might be because unless there is adequate backing, encouragement, education, and awareness created in healthcare practitioners and patients, these technologies may not be integrated into daily use as much as they should be (Ng, Cramer, Lee, & Moher, 2024).

Additionally, the Shapiro-Wilk tests substantiated that the key variables were not normally distributed and the use of AI and IoT perceptions are diverse and possess an inclination that could be due to patient age, technological proficiency, and health status. The boxplot and the scatter plots depict this volatility in responses to the impact of AI and the effectiveness of IoT. Even as more healthcare organizations begin deploying AI and IoT, the low reliability (Cronbach's alpha of 0.059) raises questions if the questions used to measure satisfaction and engagement offer an accurate representation of patient interactions with these technologies (Badr & Khiami, 2024).

This means that future research should look for ways of making the metrics more accurate, perhaps, using qualitative data to explain why there is variation in satisfaction. Further, the regression analysis reveals an extremely low coefficient of determination (R2= 0.012,) which indicates that the extent of variation in patient satisfaction accounted for by the AI as well as IoT technologies is very low. This might be exacerbated by the fact that patient engagement and satisfaction are not just determinants of a technical nature but also depend on such factors as the doctor-patient relationship, general health system, and personal health status among others (Christopoulou, 2024).

Participants' usage frequency of AI/I IoT was also different; many of them utilized the technologies sporadically or infrequently. This could be because of factors such as cost, education on data privacy, or lack of comprehension of how the use of technology in their work could be done – issues raised by some of the respondents. These issues should be solved for AI and IoT can play a significant role in patient engagement. These challenges may be overcome by further developments in enhancing education and improving the incorporation of these technologies into clinical practice, as well as simplifying the interfaces of such systems (Bangare & Patil, 2024).

CONCLUSION

As a research proposal this study aimed at examining how the integration of AI and IoT technologies in the process can improve real-time patient engagement with family medicine. The conclusion reached is that, even though they are becoming popular, their contribution at the current stage to satisfying the patient and his or her engagement is not very significant. Due to the low interconnectivity between AI/IoT effectiveness with the global satisfaction and low reliability of the measurement tools AI/IoT technologies may not alone deliver superior results to enhance the quality of caring for patients. Secondly, the irregularity of the usage frequency and the perceived barriers of the participants including data privacy about the technology as well as the general difficulty of implementing the technology all reduce its potential drawback.

AI/ IoT driving real-time monitoring and personalized care are both good paths but the successful implementation of these technologies into FM will have to address the following Challenges. For these tools to become more effective, widely adopted, and their use to have better results, the following issues need to be addressed; Making these tools easier to use, better training of both patients and physicians, and lastly the issue of patient confidentiality and protection of their information. Furthermore, far more sophisticated tools are required for measuring the as-yet unquantified positive effects of AI & IoT on patients.

Overall, patient engagement in family medicine with the help of AI and IoT may become a revolution shortly, however, researchers ought to put more effort into the development and to make sure they are helpful for both patients and doctors. That is why the elimination of the current shortcomings might open possibilities for using such technologies in a more significant and valuable way in the future.

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