



The role of implementing Internet of Things (IoT) applications in enhancing health care service delivery

Iyyanar P¹, Prince Tehseen Ganai², Ayan Das Gupta^{3,*}, Gopal Ramchandra Kulkarni⁴, Dipak Nath⁵

¹Department of Information Technology, Sona College of Technology, Salem, India.

²Research Scholar Department of Computer Science & Engineering, JagdishprasadJhabarmalTibrewala University, Rajasthan

³WBES, Assistant Professor, Postgraduate Department of Geography, Chandernagore Government College, Hooghly, West Bengal, Chandernagore Government College affiliated to the University of Burdwan.

⁴Principal, Merchant Engineering College, Basna Gujarat, India.

⁵Assistant Professor, Department of Physics, Sao Chang College, Tuensang, Nagaland

*Email : dasguptaayan11111@gmail.com

ABSTRACT

Medical science in the modern period has witnessed a high demand for using IoT applications and benefits to make more suitable healthcare decisions. Physicians and scientists have experienced a broad use of the Internet of Things for offering better patient-monitoring services. Previously, physicians have experienced a lot of issues while tracking proper medical equipment and managing better patient monitoring services over the decades. With the advent of proper IoT devices in medical sectors nowadays, all the potential clinical challenges have been solved by providing accurate data analytics as well as smart healthcare delivery services. Researchers have performed a primary data gathering approach through processing quantitative methods. However, by offering 70 participants three relevant survey questions, researchers have conducted a probability method of data sampling. After analysing all the survey results, from the research findings, researchers can identify that around 58% of the participants have strongly agreed with the utilization of IoT in enhancing more patient-care progress in the future. Apart from this, around 52% of the participants have supported the implementations of IoT approaches in more effective clinical tracking and patient-monitoring services. On the other hand, around 48% of the participants' responses stated a shift in their opinions towards error reduction rate in clinical decision-making by the use of IoT devices. For this reason, researchers show genuine interest in explaining the importance of using IoT advantages for healthcare delivery services in the future.

Keywords: *The Internet of Things (IoT), patient-care services, survey, researchers, healthcare practices, participants, and monitoring.*

Received 13.02.2022

Revised 22.03.2022

Accepted 21.04.2022

INTRODUCTION

In the current era, proper detection of critical diseases and undertaking accurate treatment procedures have become easier than in the past few years due to the implementation of IoT in healthcare [1]. After conducting relevant surveys and interviews, researchers have come to a point that IoT proactively allows medical professionals to become more careful about undertaking accurate diagnosis services [2]. On the other hand, IoT applications also enable physicians to be highly connected with the past clinical history of the patients. It has been also observed that all the IoT devices linked with disease-detecting sensors can be vastly used for tracking different locations of real-time clinical equipment [3]. Global physicians and scientists have also experienced numerous effective benefits of using IoT services in nebulizers, wheelchairs, oxygen pumps, defibrillators, and other clinical equipment used in patient monitoring [4]. Researchers have conducted various surveys among healthcare professionals for understanding the impact of IoT applications in enhancing future healthcare services. Researchers and scientists have identified the AI-based utilization of IoT has enhanced the overall efficiency of the healthcare industry by **86.57%** and is expected to reach around **93%-95%** within 2026 [5]. However, researchers reflected an excessive interest in investigating the impact of applying Internet of Things applications in the research paper towards improving patient-care service delivery in a better way.

LITERATURE REVIEW

Nowadays, the application of various AI-based machine learning approaches and IoT implementation has become a trendy topic across the healthcare industry in the UK. The regulation of interconnected neural networks from a remote place has become easier than before while processing effective healthcare services with the help of ML algorithms [6]. Physicians and scientists in previous times had no clue how to deal with the challenges faced in both disease detection and prediction fields regarding applying proper medical treatments [7].

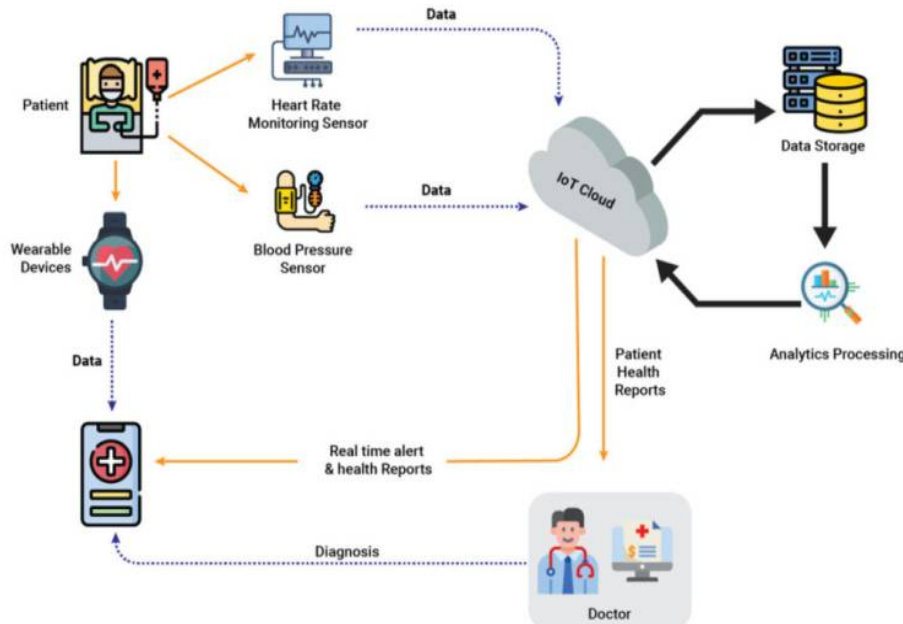


Figure 1: Contributions of IoT in enhancing healthcare services[7]

Scientists and physicians have examined that apart from disease detection and treatment predictions, IoT approaches also can be highly used in various other technical fields. IoT devices can be attached with sensors that are primarily utilized for tracking various real-time areas of medical tools and equipment. Scientists have identified that patients can acquire beneficial IoT applications while using wheelchairs and oxygen pumps [8]. In contrast to that, around **74%** of healthcare professionals prefer the tagging of IoT devices with defibrillators and various nebulizers for providing better patient-care services [9]. Physicians mainly collect relevant health data with the use of IoT sensors that at once help them to communicate efficiently and store data securely. On the contrary, the effective application of the Internet of Things can allow a smart patient-care service description to the data analytics [10]. Moreover, IoT applications can develop and improve the process of risk factor identification more accurately.

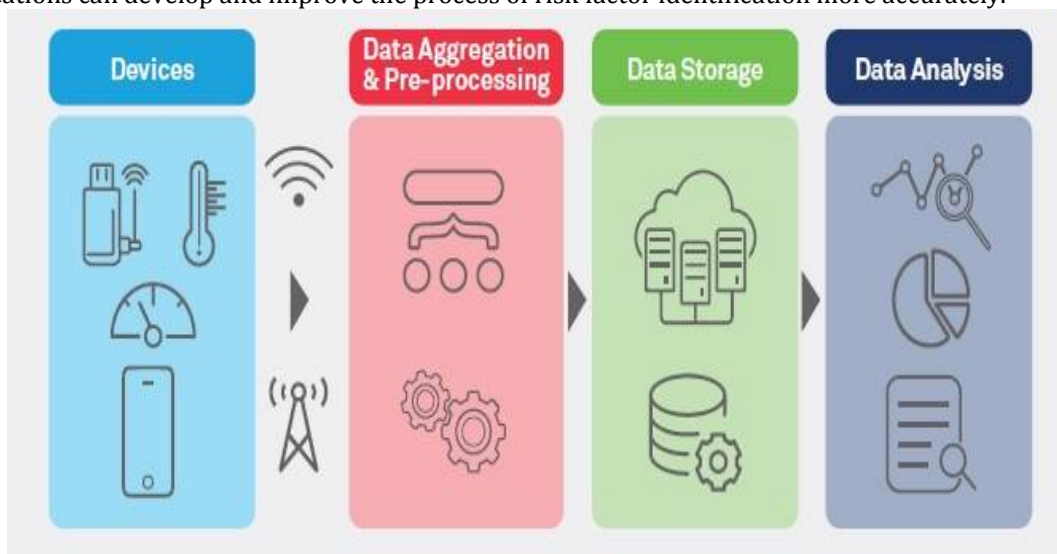


Figure 2: Various benefits of using IoT devices in patient-care services[10]

Today, the use of IoT in healthcare seems to be a relevant topic of discussion among global scientists and researchers. However, regarding various critical treatments as well as remote patient-monitoring services, IoT applications also provide physicians with a **63.25%** increased efficiency rate [11]. Researchers while conducting the research study have identified various reasons and impacts of using IoT devices in enhancing health care services for a sustainable future. **65%** of the IoT implications can be used for measuring flexible patient-care monitoring [12]. Besides, physicians use around **49%** of the modern IoT applications for making patient-care services smoother and more accessible than before [13]. However, scientists prefer almost **81%** utilization of IoT devices for tracking clinical resources more accurately [14].

On the other hand, proper use of the Internet of Things can at once improve the administration of medication by around **87.23%** across the healthcare sector [15]. Due to the advent of the global COVID-19 pandemic, scientists and physicians seek the help of proper IoT applications because it can optimize **75%** of the delivery of relevant vaccines to save more lives [16]. It has been observed that after the high use of AI-based ML algorithms in IoT devices become successful in mitigating the high mortality rates, around **36%** lower than the past few decades [17]. Apart from those medical usages, the accurate use of IoT devices also leads physicians to ensure more hospital sanitation processes to avoid dangerous contact of coronavirus during the period of the global pandemic.

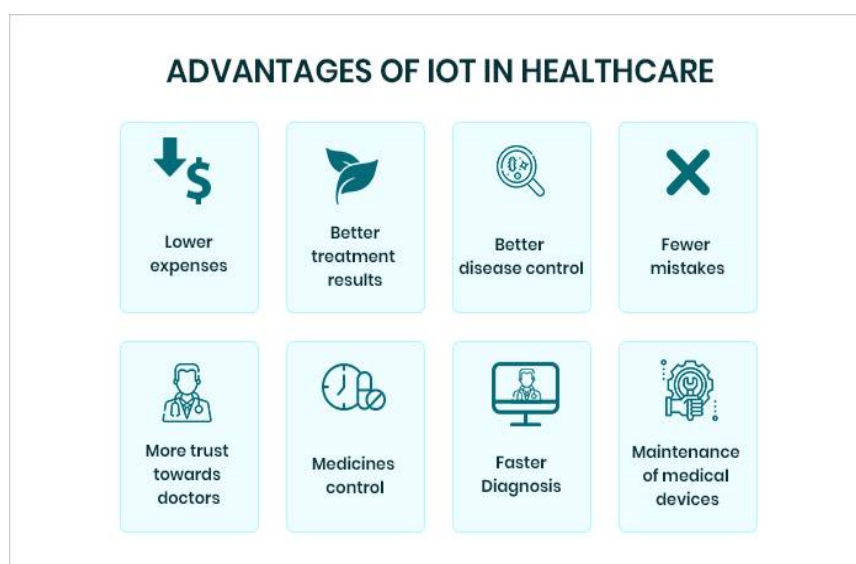


Figure 3: Numerous identified advantages of implementing IoT towards a better healthcare-services[17]

However, after conducting relevant research upon the proper use of IoT in healthcare, researchers have identified that around **97%** of the drug efficiency measurement can be effectively done with the proper use of IoT approaches [18]. Scientists have determined the use of IoT in saving more lives through the collection of clinical devices and neural network applications. With the use of machine learning algorithms, IoT devices can connect all the AI-oriented regulatory bodies in healthcare systems through [19]. Besides, hospital supervisors and doctors in recent times, broadly use virtual computer networks for accessing proper patients' records and medical history with the use of IoT approaches [20]. Moreover, in the research paper, it is thus important to investigate more on the use of healthcare IoT for conducting a better patient-care service in the future.

MATERIAL AND METHODS

The proper applications of IoT systems can at once maintain a better patient-physician relationship for the escalation of overall industrial revenue by around **61.49%** in the sustainable future [21]. Researchers have used proper research methodology to investigate this study with a high focus. However, Researchers tend to collect and interpret all the collected medical resources from various **primary sources**. While conducting the investigation, researchers have performed a quantitative data gathering method from relevant sources.

Researchers have conducted relevant quantitative research methods by collecting and evaluating proper medical data and records for measuring the use of IoT in healthcare. However, they have outlined necessary survey questionnaires in this research paper by using a positivism philosophy. While collecting

authentic medical records, researchers have focused much on applying a deductive approach for carrying out the particular research study. Researchers have incorporated a descriptive research design in the study to gather desirable patient-care data for investigating the particular research topic. On the other hand, the engagement of the primary data collection approach would be effective for the researchers in mitigating potential challenges associated with the entire research study.

After gathering valid responses from doctors, healthcare practitioners, medical professionals, staff, and nurses of hospitals, researchers went to a great extent to understand the impacts of applying IoT for obtaining more accurate clinical outcomes. However, after evaluating three valid questionnaires related to the survey, researchers show genuine interest in analyzing all the opinions and responses of the participants in the research study. Researchers have collected relevant survey opinions from around **70 participants** regarding the beneficial impacts of IoT for enhancing better patient-care services in the future development scopes through online mediums.

Researchers have formed three relevant survey questions while performing a detailed analysis regarding all the collected online binary options from almost **70 participants**. Besides, the survey investigation regarding the relevance and accuracy of the use of IoT approaches in medical fields has been incorporated in the research paper. Researchers mainly focused on the evaluation of a **probability technique for sampling** while collecting all their perspectives regarding the survey questions through a random technique of sampling. After gathering all the opinions from directly tagged participants, important results of the three questions of the survey have been analyzed minutely by the researchers. The survey outcomes show that healthcare participants do not have proper knowledge as well as comprehension about the benefits of using IoT in future healthcare facilities.

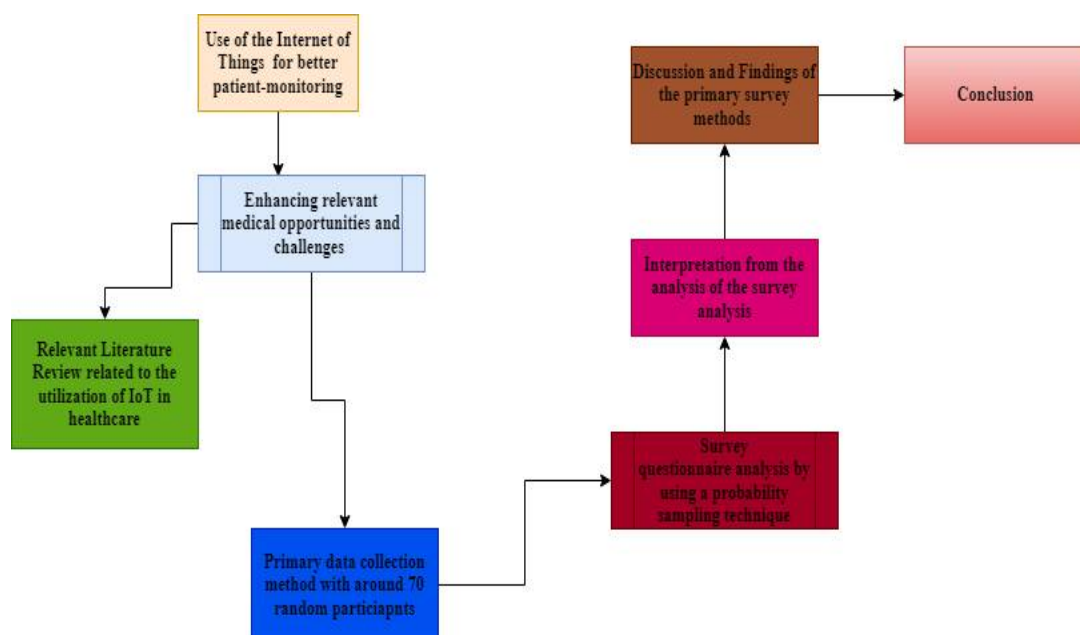


Figure 4: Research Flowchart

RESULTS

A set of important **survey analyses** have been undertaken by the researchers to comprehend the role of IoT in healthcare more clearly. Various surveys and medical reports collected from different UK-based healthcare sectors prove that the smooth conduction of IoT can enhance the process of disease diagnosis by **57%** [22]. Researchers must perform **probability techniques** for the sampling of more relevant data that will help in understanding the importance of collected responses from the medical practitioners more accurately. Besides the survey, they have also outlined two relevant **research questions** for better survey analysis. The questions are-

- How can IoT applications increase the accuracy rate while processing better patient-care services in the sustainable future?
- What are the opportunities and benefits of implementing IoT in enhancing better healthcare service delivery in the future scopes?

Important questions related to the survey analysis-

Q1. Do you think that proper IoT applications can be used in increasing the overall efficiency rate for future service delivery improvement?

TABLE I. INCREASED RATE OF HEALTHCARE EFFICIENCY CALCULATION BY THE USE OF THE INTERNET OF THINGS

Options offered to Participants	Overall Participants	Gathered Responses	Percentage
Strongly Agreed	70	23	32.85
Agreed	70	17	24.28
Remained Neutral	70	3	4.28
Disagreed	70	15	21.42
Strongly Disagreed	70	12	17.14

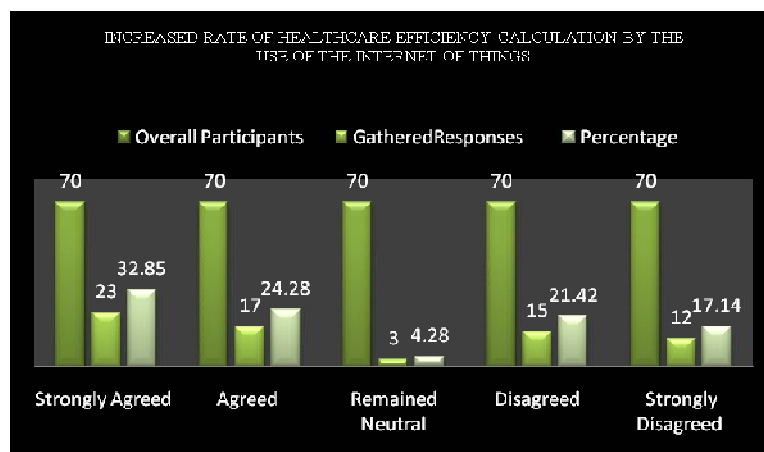


Figure 5: Enhanced rate measurements of efficient healthcare progress by utilizing IoT approaches

Researchers have conducted relevant primary surveys among **70 participants** to understand the role of IoT in more healthcare benefits. Among their responses, the above graph shows around **32.85%** of the participants strongly support the first survey question. In order to measure the increased efficiency rate in healthcare, researchers have focused on the options selected by almost **24.28%** of the people from a positive perspective. However, it has been traced that around **4.28%** of the participants remained neutral about their opinions over the first question. In contrast to that, around **21.42%** of the participants did not support the validity and relevance of the first survey question. On the other hand, researchers have spotted around **17.14%** of the people related to the survey who strongly disagreed with the particular topic-related question. Moreover, all the major differences and the key percentage gaps can be highly evaluated from the calculation table towards understanding the impacts of IoT in healthcare.

Q2. Will proper IoT applications help track medical equipment and enhance patient-monitoring services for more developed healthcare service delivery in the future?

TABLE II. CLINICAL TRACKING AND MONITORING EFFICIENCY RATE MEASUREMENT BY IMPLEMENTING IoT DEVICES

Participants' choice of options	Total Participants	Overall collected opinions	Percentage
Strongly Supported	70	13	18.57
Supported	70	23	32.85
Neutral	70	7	10
Did not support	70	16	22.85
Disagreed Strongly	70	11	15.71

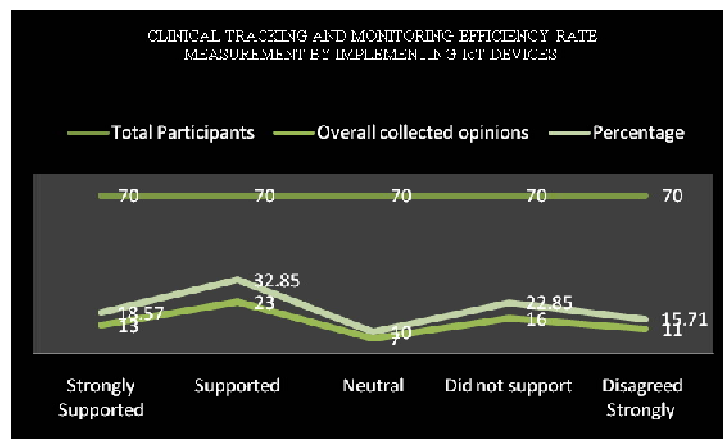


Figure 6: Increased rate measurements of clinical tracking and patient-monitoring by using IoT benefits

The second survey question mainly focused on gathering relevant opinions from **70 participants** regarding the use of IoT in better clinical tracking and patient-monitoring services. From the above graph and table, it has been observed that around **18.57%** of the people provided their strong perspective from a positive angle regarding the validity of the second question. In contrast to that, researchers have spotted almost **32.85%** of the participants who support the use of IoT in better tracking and monitoring services enhancement. However, only **10%** of the people neither provide positive nor negative answers related to the particular question. On the other hand, around **22.85%** of people can be traced from the graph who disagreed with the relevance of the question related to the topic. However, around **15.71%** of the participants have strongly disliked the validity of the question related to the research study.

Q3. Do you support that IoT implementation can mitigate error percentage rates while undertaking healthcare decision-making approaches regarding disease detection and treatment prediction in the future?

TABLE III. ERROR REDUCTION RATE MEASUREMENT IN MEDICAL DECISION-MAKINGS BY USING IoT TECHNIQUES

Participants' choice of options	Total Participants	Overall collected opinions	Percentage
Agreed Strongly	70	14	20
Agreed	70	19	27.14
Neutral	70	9	12.85
Disagreed	70	18	25.71
Strongly Disagreed	70	10	14.28

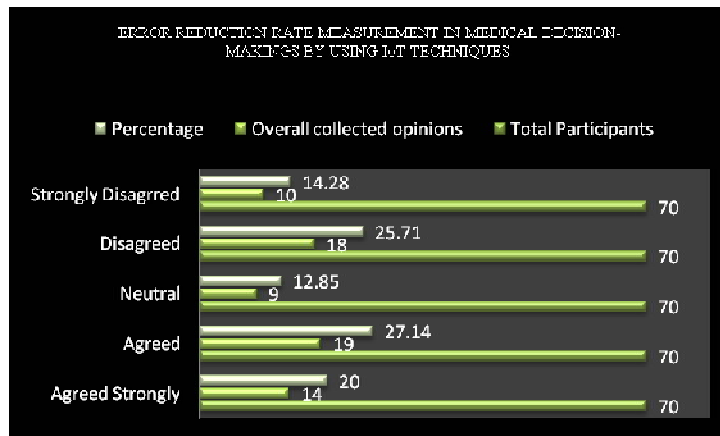


Figure 7: Error mitigation rate measurements in healthcare regarding the use of IoT approaches

In order to measure the error reduction rate, researchers have focused much on the analysis of the third relevant question related to the survey. However, from the resultant calculation table, it has been analyzed that around 20% of the participants have strongly supported the validity of the third survey question. On the contrary, almost 27.14% of the people can be traced from the table who agreed with the use of IoT in error mitigation aspects related to healthcare activities. Apart from this, only 12.85% of the people from overall 70 participants stayed neutral about their opinions on the particular question. On the other hand, researchers have also evaluated negative responses from almost 25.71% of the participants regarding the validity of the survey topic. In contrast to that, around 14.28% of the people can be spotted by the researchers who have strongly opposed the relevancy of the question regarding the research study. Moreover, with a proper analysis of the percentage calculation table, researchers can proactively examine all the gaps in the opinion values of the participants.

DISCUSSION

Researchers have efficiently identified and analyzed valid opinions from the large gathering of around **70 participants** directly related to various healthcare fields. After examining all the outcomes of the three potential surveys, researchers concluded that participants possess changing perspectives regarding the opportunities provided by IoT approaches in healthcare fields. The first survey question result shows that around **58%** of the people have supported the validity of the question from a positive perspective. Researchers have focused on analyzing the proper applications of IoT applications that can be highly used in enhancing the entire efficiency rate of the healthcare industry. However, around **94%** of the IoT implementations can be utilized by physicians and scientists in improving future patient-care service delivery facilities [23]. Scientists have also witnessed numerous effective applications of IoT in various AI-based surgeries and the treatment of cancer and other neural diseases. Researchers have also identified the fact that proper IoT applications can help in empowering physicians to properly manage all the necessary treatment procedures to improve healthcare services to a great extent.

On the other hand, from the analysis of the second survey question, it can be evaluated that around **52%** of the participants have placed their positive responses regarding the validity of the question. Researchers have efficiently identified that the proper utilization of IoT methods can be highly helpful for physicians in tracking various medical equipment. On the other hand, around **76.28%** of the IoT applications can be used by medical practitioners while enhancing better patient-monitoring services for the sustainable future [24]. Researchers have also identified that regarding data safety, IoT devices also help medical professionals to maintain and analyze big clinical data sets. After detecting the symptoms of diseases, IoT applications help physicians to be more accurate in applying proper treatment methods to mitigate the life threats of patients.

TABLE IV: SURVEY RESULTS ANALYSIS REGARDING THE USE OF IoT IN VARIOUS HEALTHCARE PRACTICES

<i>Discussion</i>	<i>Agreed</i>	<i>Neutral</i>	<i>Disagreed</i>
(a) IoT approaches are offering high scopes for enhanced healthcare delivery in the sustainable future.	58%	9%	33%
(b) Relevant IoT methods can improve clinical tracking and better patient-monitoring services in the future.	52%	13%	35%
(c) IoT devices can be highly used in the healthcare industry for mitigating errors in various patient-care services.	48%	2%	50%

In order to measure effective error reduction rates in healthcare decision-making with the advent of IoT, researchers have minutely investigated all the responses from those participants. The third survey outcome at once shows a shift in participants' opinions from positive to negative regarding the third survey question. From the analysis table, researchers have pointed out that only **48%** of the participants have supported the validity of the third question related to the particular topic. Most of the participants have a vague conception regarding the IoT implementation for reducing error percentages while performing numerous healthcare decision-making approaches. On the other hand, IoT can be also used in healthcare regarding disease detection and treatment prediction in future healthcare practices. However, with the applications of proper IoT devices, medical professionals can be more watchful while detecting critical diseases and recognizing essential medical images [25]. On the other hand, IoT applications can also strongly connect physicians with their proper diagnosis prediction while taking proactive care of the patients. Moreover, the overall survey evaluation reflects the importance of implementing IoT facilities in enhancing more sustainable healthcare delivery practices in the future.

CONCLUSION

Modern-day medical science has witnessed a progressive growth in patient-care services due to the huge applications of AI-based machine learning approaches and IoT benefits across the globe. Previously, detecting necessary symptoms of critical diseases and predicting proper diagnosis methods were problematic and physicians have experienced a lot of challenges in such clinical fields. With the advent of IoT and its beneficial approaches in the healthcare industry, all those medical operations got an air to flourish across the globe with more accurate results.

Researchers, for better understanding the impact of IoT in healthcare services, have evaluated all the gathered options provided by survey participants through *online mediums* due to the global pandemic. A primary data gathering research method has been undertaken by the researchers for investigating the contributions of IoT in enhancing the healthcare industry for a sustainable future. With the help of a *probability data sampling method*, researchers have collected survey options from *70 random participants*. All the survey questions related to the particular topic have been placed before them for analyzing their opinions from a positive perspective. Nowadays, healthcare services have taken a shift from the conventional way of treating towards a technological implementation of IoT to combat critical clinical issues. Researchers thus concentrated much on evaluating the proper IoT applications in the research paper towards developing a better healthcare delivery system in the sustainable future.

REFERENCES

1. A. Jain, A. K. Yadav & Y. Shrivastava (2019), "modelling and optimization of different quality characteristics in electric discharge drilling of titanium alloy sheet" material today proceedings, 21, 1680-1684
2. A. Jain, A. k. pandey, (2019), "modeling and optimizing of different quality characteristics in electrical discharge drilling of titanium alloy (grade-5) sheet" material today proceedings, 18, 182-191
3. A. Jain, A. k. Pandey, (2019), "multiple quality optimizations in electrical discharge drilling of mild steel sheet" material today proceedings, 8, 7252-7261
4. V. Panwar, D. K. Sharma, K.V.P.kumar, A. Jain & C. Thakar, (2021), "experimental investigations and optimization of surface roughness in turning of en 36 alloy steel using response surface methodology and genetic algorithm" materials today: proceedings, <https://doi.org/10.1016/j.matpr.2021.03.642>
5. Alraja, M.N., Farooque, M.M.J. and Khashab, B., (2019). The effect of security, privacy, familiarity, and trust on users' attitudes toward the use of the IoT-based healthcare: the mediation role of risk perception. IEEE Access, 7, pp.111341-111354.

6. Marques, G. and Bhoi, A.K. eds., (2021). IoT in healthcare and ambient assisted living. Springer.
7. Chacko, A. and Hayajneh, T., (2018). Security and privacy issues with IoT in healthcare. *EAI Endorsed Transactions on Pervasive Health and Technology*, 4(14).
8. Mani, N., Singh, A. and Nimmagadda, S.L., (2020). An IoT guided healthcare monitoring system for managing real-time notifications by fog computing services. *Procedia Computer Science*, 167, pp.850-859.
9. Luo, E., Bhuiyan, M.Z.A., Wang, G., Rahman, M.A., Wu, J. and Atiquzzaman, M., (2018). Privacy protector: Privacy-protected patient data collection in IoT-based healthcare systems. *IEEE Communications Magazine*, 56(2), pp.163-168.
10. Aujla, G.S. and Jindal, A., (2020). A decoupled blockchain approach for edge-envisioned IoT-based healthcare monitoring. *IEEE Journal on Selected Areas in Communications*, 39(2), pp.491-499.
11. Li, J., Cai, J., Khan, F., Rehman, A.U., Balasubramaniam, V., Sun, J. and Venu, P., (2020). A secured framework for sdn-based edge computing in IOT-enabled healthcare system. *IEEE Access*, 8, pp.135479-135490.
12. Elhoseny, M., Ramírez-González, G., Abu-Elnasr, O.M., Shawkat, S.A., Arunkumar, N. and Farouk, A., (2018). Secure medical data transmission model for IoT-based healthcare systems. *IEEE Access*, 6, pp.20596-20608.
13. Mahmud, R., Koch, F.L. and Buyya, R., (2018). Cloud-fog interoperability in IoT-enabled healthcare solutions. In *Proceedings of the 19th international conference on distributed computing and networking* (pp. 1-10).
14. Huang, P., Guo, L., Li, M. and Fang, Y., (2019). Practical privacy-preserving ECG-based authentication for IoT-based healthcare. *IEEE Internet of Things Journal*, 6(5), pp.9200-9210.
15. Mavroggiorgou, A., Kiourtis, A., Perakis, K., Pitsios, S. and Kyriazis, D., (2019). IoT in healthcare: Achieving interoperability of high-quality data acquired by IoT medical devices. *Sensors*, 19(9), p.1978.
16. *ordr.net*, (2022): 10 IoT Healthcare Examples, available at: <https://ordr.net/article/iot-healthcare-examples/> [Accessed on 11th February 2022]
17. *i-scoop.eu*, (2022): Internet of Things in Healthcare, available at: <https://www.i-scoop.eu/internet-of-things-iot/internet-things-healthcare/> [Accessed on 12th February 2022]
18. *intellectsoft.net*, (2022): IoT Benefits in Healthcare, available at: <https://www.intellectsoft.net/blog/iot-in-healthcare/> [Accessed on 12th February 2022]
19. *jmir.org*, (2022): The Internet of Things: Impact and Implications for Health Care Deliver, available at: <https://www.jmir.org/2020/11/e20135/> [Accessed on 14th February 2022]
20. *nih.gov*, (2022): Internet of Things (IoT) enabled healthcare help, available at: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7897999/> [Accessed on 14th February 2022]
21. Pirbhulal, S., Pombo, N., Felizardo, V., Garcia, N., Sodhro, A.H. and Mukhopadhyay, S.C., 2019, December. Towards machine learning enabled security framework for IoT-based healthcare. In *2019 13th International Conference on Sensing Technology (ICST)* (pp. 1-6). IEEE.
22. Abie, H., (2019), May. Cognitive cybersecurity for CPS-IoT enabled healthcare ecosystems. In *2019 13th International Symposium on Medical Information and Communication Technology (ISMICT)* (pp. 1-6). IEEE.
23. Banka, S., Madan, I. and Saranya, S.S., (2018). Smart healthcare monitoring using IoT. *International Journal of Applied Engineering Research*, 13(15), pp.11984-11989.
24. Mishra, A., Kumari, A., Sajit, P. and Pandey, P., 2018. Remote web based ECG Monitoring using MQTT Protocol for IoT in Healthcare. *Development*, 5(04), pp.1096-1109.
25. Aktas, F., Ceken, C. and Erdemli, Y.E., (2018). IoT-based healthcare framework for biomedical applications. *Journal of Medical and Biological Engineering*, 38(6), pp.966-979.

CITATION OF THIS ARTICLE

Iyyanar P, P T Ganai, A D Gupta, G R Kulkarni, D Nath. The role of implementing Internet of Things (IoT) applications in enhancing health care service delivery. *Bull. Env.Pharmacol. Life Sci., Spl Issue [1] 2022 : 1120-1128*