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Pragya Thapa

IoT in Healthcare in Nepal: A SWOT Analysis

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Technology has been rapidly changing and influencing everything around us. The Internet has made life easier, and it has been used widely in almost every aspect of life. The healthcare system is also affected from the wide usage of the internet and as such the Internet of Things (IoT) has proven to be such a blessing. This thesis aims to provide information on the status of IoT in healthcare system in developing countries such as Nepal as well as the impact along with strengths, weaknesses, and threats.

As this is a research-based thesis, an informal interview with different patients, doctors and IT technicians who were involved in the healthcare system in Nepal was carried out. A questionnaire survey was also conducted with a sample size of 100 respondents through different media. To make the data collection process smooth, the questionnaire was tested with a pilot study. The main objective of the research was to find out the current situation of IoT in healthcare in Nepal.

The results indicate that Nepal is still far behind in terms of optimizing IoT in healthcare and for its smooth implementation, the government of Nepal should come up with proper strategies that will make IoT in healthcare cost effective.

Keywords- IoT, Nepal, pilot study, technology, healthcare, COVID-19, SWOT Analysis

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List of abbreviations

BS	Bikram Sambat
F	Female
HIT	Health Information Technology
IGS	Image-Guided Surgery
IoT	Internet of Things
M	Male
RPM	Remote Patient Monitoring
SWOT	Strengths, Weaknesses, Opportunities and Threats

1 Introduction

The Internet of Things (IoT) describes physical objects (or groups of such objects) with sensors, processing ability, software, and other technologies that connect and exchange data with other devices and systems over the Internet or other communications networks (Yasar & Gillis 2024). IoT allows the integration of sensors and devices with objects that are connected to the Internet through fixed and wireless networks. Nowadays, with the advancement of technology, healthcare is impacted by the usage of IoT. Health care in developing countries such as Nepal has not been advancing as in the other developed countries. There have been obstacles in acquiring technology and applying it. Several factors make it hard to acquire the latest technology, especially with the lack of sufficient funds and manpower. The poor economy of the nation is quite often the first hurdle to advancement.

Human resources, particularly healthcare workers, are not available in the required quantity. In addition, they need further training to effectively integrate and utilize the Internet of Things (IoT) technologies in healthcare. Most healthcare workers are still in the initial stages of learning to use IoT, so its adoption is currently slow and challenging. On the one hand, weak economy, poor human resources and weak affordability of patients offer challenges in the adoption of IoT, while on the other hand, such a backward situation calls for a more severe need of IoT to overcome the disparity in the services between urban and rural areas. Despite having limited resources, healthcare workers also have the pressure to save time and provide diligent care at the same time.

In a developing country like Nepal, the network of communications has a more significant role in the field of medicine. With the use of the Internet of Things, hospitals can mobilize technology and human resources to provide more effective services. They can automate their service by making the long and complex process of healthcare short, simple, and affordable. Hospitals have been trying to invest a notable amount that is almost greater than their affordability in health information technology (HIT) to upskill and update their service.

However, the amount of present investment in IoT is too low to bring about some noticeable change or to support health professionals to simplify their complex process of treatment. So, healthcare service is seen as poorly supported by IoT and laggard in the initial phases where the main system of healthcare consists of manual activities. Divergent phases and different sectors of healthcare require the backing of the Internet. Right from transportation either in an ambulance or in another vehicle the patient can be cared for, information can be shared in real-time with the help of the Internet of Things. Ambulances in Nepal do not use the internet and there is no location tracking of the patient nor is there anything to monitor the condition of the patient that is taken to the hospital.

At least the educational institutions of healthcare studies can use the Internet of Things for teaching. The institutions prepare healthcare workers for the future where IoT will be an integral part of healthcare and every sector in future. A patient from one part of the country can be diagnosed in another part and they can be operated on in another hospital, and then the patient can receive post-operation care in the next hospital. As IoT in healthcare needs several factors for its smooth operation and implementation, it cannot move ahead as a single entity. It needs the advancement of healthcare institutions and professionals in IoT for sharing ideas, expertise and resources which mutually benefit each other eventually.

1.1 Background of the Study

Policymakers have been increasingly aware that the current models of healthcare cannot sustain the increasing demand of the population and their modern healthcare problems. There is a desperate effort to make the healthcare facility accessible to common people. The changing world of medicine cannot function to address the modern treatment system in the absence of information, communication, and technology. The volume of requirement of IoT in healthcare is far greater than that operating in the field in Nepal. Health professionals are still using their mobile phones for sharing images, reports, and suggestions. There is an immense possibility of using internet-operated devices to make

healthcare cheaper, easier, and safer. Yet, the achievement in the use of IoT is still too low. Surely, there are several challenges in inculcating the internet operated devices in the healthcare sector. There are also some threats traceable to the untrained hospital staff, and the patient's inability to afford the high rates.

The problem lies in the government's inability to make the services cheaper using IoT. Research on how the different aspects of healthcare can be made simpler with the use of IoT is much needed. Such research should explore how the challenges can be overcome, how the threats can be reduced, and how the opportunities can be utilized using IoT in healthcare. Healthcare sectors can surely see tremendous improvement by identifying the opportunities that can be created by IoT devices. There is little research into investigating the challenges of IoT as well. Without the identification of challenges, IoT in healthcare cannot work flawlessly in its full fledge. Much vital research on the strengths, weaknesses, opportunities, and threats of IoT is an urgent need of the present time before IoT is fully utilized in the field of healthcare.

1.2 Objective of the Study and Research Questions

The advancement in the field of healthcare has made significant progress in improving the quality of its service. The use of Internet of Things in healthcare is still in its initial stage in Nepal. Professionals and specialists are suggesting more widespread use of IoT in healthcare. However, more research is required to fully explain the opportunities, challenges, and threats of using IoT in healthcare in Nepal.

This study endeavours to find out the real situation of the use of IoT in healthcare in the hospitals of Nepal. Then further exploration will show how the concerned people, such as health professionals, patients and their relatives, can save their time and money. At the same time, the findings of the study will guide the use of IoT in making healthcare more patient-centred rather than the doctor-centred. Furthermore, the research report will enhance healthcare by exploring ways of making it more pleasant and humane rather than mechanical. The exploration of

opportunities, challenges, and threats of using IoT offers the field of healthcare with the idea of making it a soothing, effective, and affordable process for common people.

The key objective of the study is to assess the impact of use of IoT. It is also to find out the situation of IoT in healthcare in Nepal. With the help of research methodology, the one used in this case being a questionnaire by performing a simple survey, this thesis will provide information on the usage and the problems faced by patients while using IoT. The specific research questions are as follows:

- What is the present situation of IoT in healthcare in Nepal?

  As IoT is still in the very beginning phase in case of Nepal, the current situation needs to be analyzed. Only by analyzing the present situation can we come to an understanding of how effective it is.

- What are the opportunities, challenges, and threats of using IoT in healthcare?

  Along with the advancement of technology, there are many strengths, weaknesses, and threats. All these need to be studied to analyze the impact of IoT on healthcare. As IoT is still in a very primitive stage of development in Nepal, the impact needs to be studied more carefully.

- What are the ways to utilize opportunity, cope with challenges and reduce threats?

  After analyzing the pros and cons of IoT, it is important to carefully utilize the opportunities while minimizing the threats and dealing with the challenges it comes with.

- Are there any recommendations for the appropriate use of IoT in healthcare?

Since IoT use in healthcare is not full-fledged in Nepal, it is very important to make sure that citizens aware about what it is and what the safety measures of using it are.

1.3 Structure of the work

This thesis is divided into 7 chapters including introduction of the thesis, healthcare system in Nepal, literature review, research methodology, analysis of research methodology, challenges and opportunities/threats of IoT in Nepal and conclusion. Chapter 1 deals with the general introduction of IoT. Chapter 1 is subdivided into background of the study along with the research objectives and questions. Chapter 2 gives a glimpse into the healthcare system of Nepal whereas Chapter 3 is the literature review part and discusses about the brief history of IoT along with the applications of IoT. Chapter 4 deals with research methodology. Chapter 5 contains the analysis of the research methodology with the findings and limitations from the research and survey. Chapter 6 delves into the strengths, weaknesses, opportunities and threats of IoT in healthcare in Nepal and chapter 7 is the conclusion of the thesis.

2 Healthcare System in Nepal

2.1 Overview

Nepal is a developing country with most health problems arising from communicable diseases. The healthcare system in Nepal has been divided into public and private (Figure 1.). Public hospitals and healthcare centers are managed by the government. Public hospitals are large in number, since there are several rural areas that need access to such healthcare. The public facilities are funded by taxes and government funds, and they consist of various levels of healthcare facilities which can range from primary healthcare centers to tertiary hospitals.

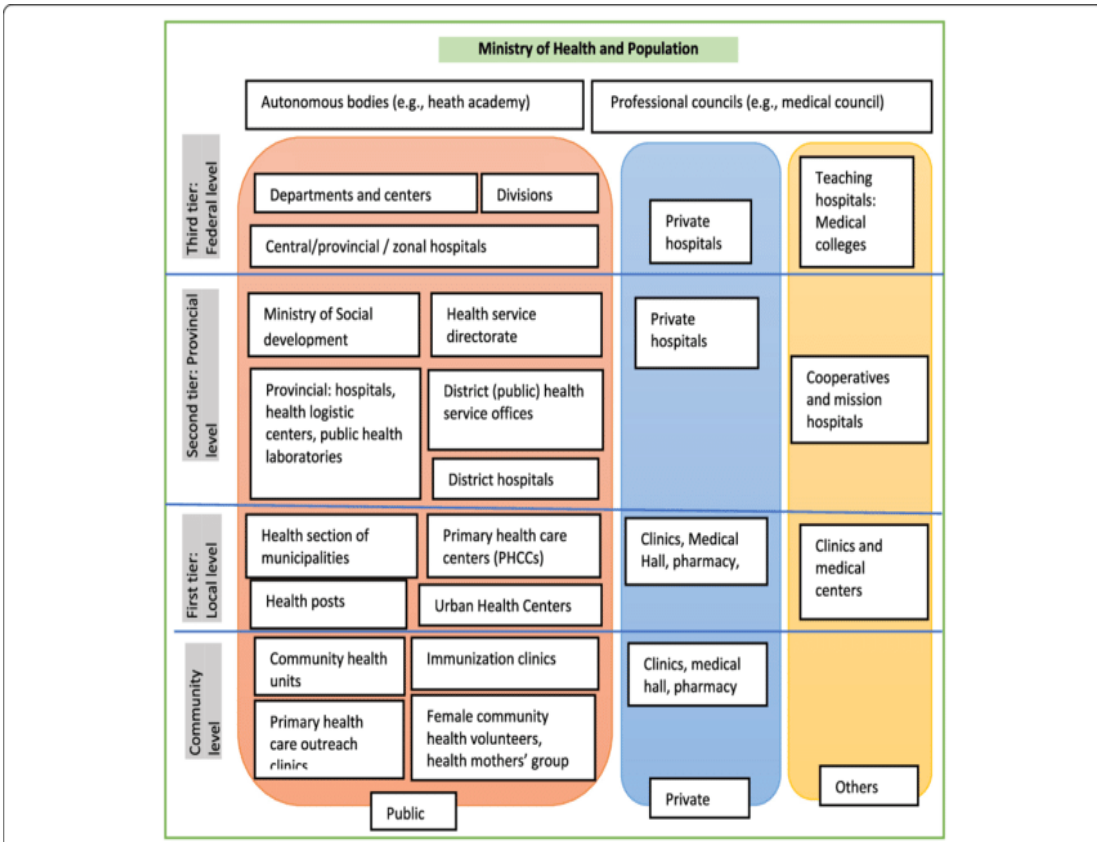

Figure 1. Healthcare System in Nepal (Nepal Department of Health Sciences n.d.).

2.2 Present situation

Nepal's healthcare system operates on a three-tier system consisting of primary, secondary and tertiary levels. The primary level consists of health posts and community health centers that provide essential services like basic emergencies, and some other essential services. The secondary level consists of district hospitals which provide better services and finally the tertiary level are advanced teaching hospitals which provide both medical care and training. Due to the geographical infrastructure, there is always a huge difference in the services provided between urban and rural areas. This kind of disparity is still prevalent because of the inadequacy of fundings which is further worsened by the problems like shortage of skilled medical professionals and limited medical supplies. The government has been trying to make healthcare accessible to everyone, but this will take a lot of time as there are no proper means.

3 Literature Review

3.1 Evolution of IoT in Healthcare

IoT has been in use for many years now. Due to the advancement of technology, most of the things around us are making use of IoT. The terminology was already in use in 1999. Nowadays, everything around us is affected by the advancement of technology. From farming fields to the high industrial production of equipment, the impact of IoT cannot be discarded. Likewise, IoT has shown a huge transformation in the field of healthcare over the past few years. The concept that started with just the help of internet has now spread its wings over a massive scale of healthcare services which might not have been possible in its absence. There were just some devices used in collection of data in the beginning of IoT enabled healthcare system. Slowly with the introduction of wearable devices such as smartwatches and fitness trackers, IoT could witness a major development in its usage. During the Covid-19 pandemic, IoT saw a huge surge in its popularity as IoT-enabled telemedicine services became a great choice among patients and healthcare providers. The hospitals have now become smart hospitals where IoT is optimized for providing best quality care to the patients in real-time. With the advancement of technology, the IoT in healthcare is only bound to have an even greater future as there are talks of new innovations in healthcare technology.

3.2 Applications of IoT in Healthcare

Implantable Glucose Monitoring Systems

Nowadays diabetes is one of the major diseases in developing countries. IoT has made it easier for patients who suffer from diabetes as they can have devices with sensors implanted in them, just below their skin. The sensors in the devices will send information to a patient's mobile phone when his or her glucose levels get too low and will record their treatment history for them too. This way, patients can tell when they are most likely to be at risk for low glucose levels.

Activity Trackers During Cancer Treatment

IoT has made treatment easier for cancer patients too. Since there are many factors affecting the right treatment of cancer patients that go beyond their weight and age, the lifestyles and fitness levels can be easily tracked and as such the proper treatment plan for them can be followed. Activity trackers track a patient's movements, fatigue levels, appetite, etc.

Heart Monitors

IoT has made it easier to track and monitor heart rates for heart patients too. Patients as such can find out if they have high blood pressure. These types of wearable devices alert healthcare professionals when patients are having symptoms of heart attacks.

Ingestible Sensors

These types of IoT devices can be swallowed by the patients and these look-like pills. These sensors once ingested can relay information to the patient's phones which will alert them in taking medications on time. Sometimes such sensors can also be used to diagnose patients with even colon cancer.

Trackable Inhalers

Patients can get alerted in case of asthma attacks while using the trackable inhalers. These type of IoT devices transmit information to patients' smartphones or tablets. Patients can also be reminded to take medications on time.

Mood monitoring devices for Depression

Some smartphones are equipped with apps that help track the mood of people going through depression. Patients can now track their mood using such devices and get proper treatment in time.

Connected Contact Lenses

Connected contact lenses can be used for reading the glucose levels of diabetes patients. They have been improving it with an aim to restore the focus of the patient's eyes, which as a result might also improve vision in such patients.

Location Services

IoT devices can be used in tracking the items like wheelchairs, defibrillators which can be time saving as some times physical equipment can be misplaced.

Remote Patient Monitoring

Healthcare professionals can monitor the condition of their patients who just underwent surgery with the help of IoT devices. RPM can be used in monitoring the overall condition of such patients, which in turn can be helpful in managing acute and chronic conditions.

Currently, with IoT, Internet communities in healthcare are growing even more. People can share their motivations and experiences; the support to these people is as personalized as if they were face to face with the doctor, but offers unique aspects of comfort, anonymity and interaction without prejudice.

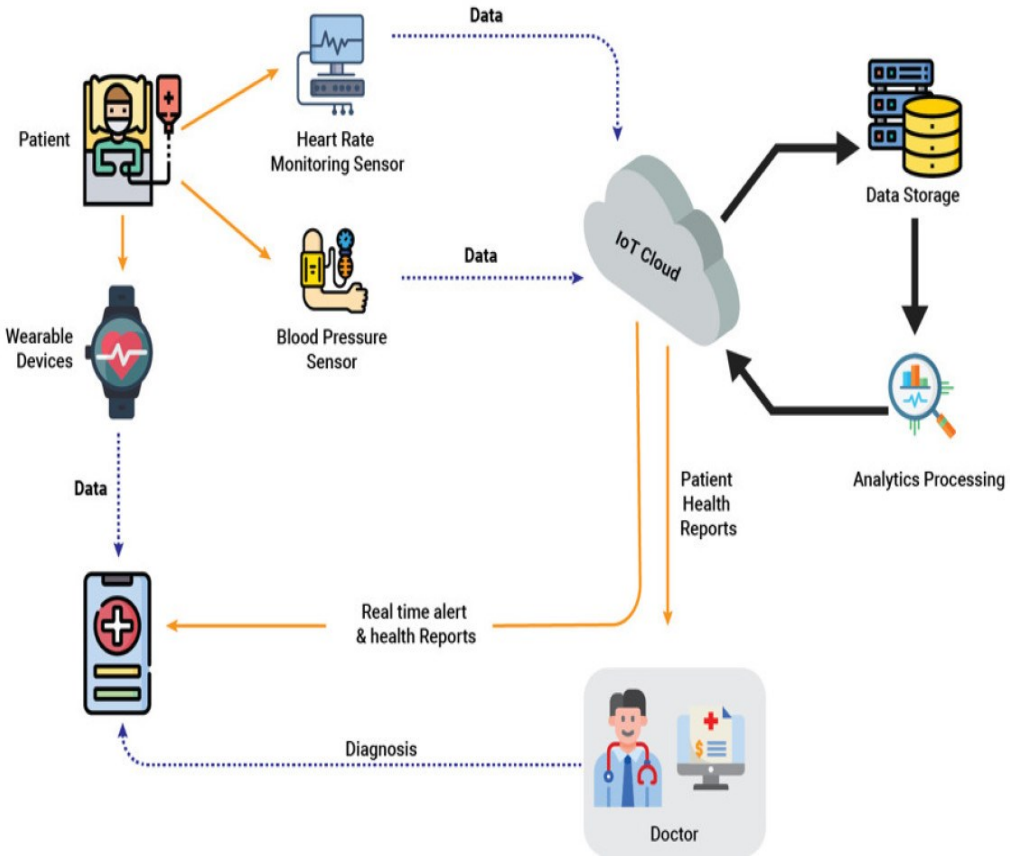

Figure 2. Applications of IoT in Healthcare (Embedded Computing n.d.).

4 Research Methodology

This chapter deals with the research problems which helps to explore the strengths, weaknesses, opportunities and threats that comes along with the use of IoT in healthcare in Nepal. The study probes around the questions of present status of IoT in health care, what facilities it has enhanced, what weaknesses it has come with, what prospects it has created and what threats it may invite. So, the research requires a multi-aspect study of hospitals. The service, equipment, human resources, patients and expenses are to be analyzed to get the answer to these research questions. Therefore, the research is designed to collect most of the primary data from the field visits. For this purpose, two hospitals were selected as sample hospitals as sources of data. And this study has collected information through interview with hospital staff and observation of the hospital activities. Then the relevant data have been carefully selected. A research design was developed in an effective way to serve the purpose of the objective. Moreover, secondary sources of printed materials were used as required support to confirm and make the collected data more reliable.

Then, to study the role of Internet of Things in healthcare, the devices were observed, and their operators were consulted as the devices are not so automatized. The operators shared their experience, and important information was collected from the patients as well. At the same time their behavior and attitudes towards IoT were observed minutely.

4.1 Research Design

The required information was gathered through data collection from the selected hospitals and respondents through interviews and surveys. Most of the data was collected by visiting the sites, observing the treatment and by the survey questionnaires handed to people of different age groups. For this study both qualitative and quantitative research designs were adopted, and information was

collected from the people concerned with healthcare and other survey respondents.

4.2 Survey

Although almost every hospital in Kathmandu uses the internet, the IoT is still rarely in use. Only a few devices operate automatically with the internet. Out of the few hospitals using internet-enabled devices, Tribhuvan University Teaching Hospital and Manmohan Cooperative Hospital are selected as sample hospitals for our research purpose. IT staff, medical staff, and patients are the sample population selected as sources of information.

Many of the respondents provided qualitative information but they were converted into quantitative data. The opinions and information received from the target respondents were noted down and were further written down systematically. The respondents were given enough time to be prepared, and they were approached in their convenient time. The research has tried to maintain the diversity in respondents to some extent. The respondents have been selected from diverse cases.

4.3 Sampling

Research has been conducted in the hospitals and the collection of primary data has been done. Hospital ledger, bulletins and photos were used as sources of data. Also, the various records in the office of hospitals were consulted. The population and its size were selected purposely because they were the ones who were found expressive during the preliminary discussion. The data and information collected from interviews, observation, and dialogues as primary sources of data have been recorded. The research uses the data and information collected from hospital records, municipality documents and bulletins as secondary sources of data.

The following research tools were used to collect the required data:

4.3.1 Interview Guidelines

Interview guidelines were prepared and administered personally. Also, the questionnaires were administered personally in the groups of individuals that were advantageous for the research. Activities like these can establish rapport with the respondents, and they can easily serve the purpose of the study. Open-ended and close-ended questionnaires were used in the research process to collect information from the health workers, patients, and their attendants.

In the process of study, interviews were carried out with the defined purpose of obtaining certain information that can serve to find the answer to the research questions. An interview is the most pervasive method of obtaining information from people. We cannot read feelings, thoughts, and intentions without physically observing them. An interview is the instrument used to find out this type of key information from the respondents. This information can be of great value in interpreting results.

4.3.2 Observation Checklist

Observation is the most primitive yet most refined of modern research techniques. For a systematic and deliberate study, a checklist was prepared to receive their spontaneous responses. Through the checklist the researcher collected significant data.

As the study is based on quantitative research, it mostly consists of field research work and survey. For this purpose, a form was devised and filled with information required to accomplish the objectives of the study.

4.3.3 Data Collection Procedures

Most of the data was obtained during the data collection phase through interviews and survey questionnaires. After the preparation of data collection instruments, an interaction program was held with a study population, i.e., doctors, nurses, IT

staff, and patients. At the beginning of the interaction program, the study population was introduced to the purpose of the interaction. This interaction session helped to identify articulating respondents. For the interview, the sample respondents attended, and they were facilitated.

Before the real interaction for information, the purpose of the interview was explained to create a comfortable environment in which they could openly express their opinions so that real and complete information could be obtained. In this quantitative research, in-depth open-ended interviews, direct observations, and written documents were included. The data gained from observations consists of detailed descriptions of internet devices, their functions and impact on patients and health workers.

After collecting the raw data from the respondents, they were compiled and grouped according to the nature of the information. The information collected through different tools and procedures was compiled differently. Then, the nature of information such as medical and physical comfort were compiled separately. The analysis of the data was carried out in different steps. In the first part, the data was refined by noting down during the work in the field. Then, the collected information was further summarized and arranged sequentially. Finally, in the summarizing process, key information was simplified, classified, and summarized. In the second part, the display of the data in various forms such as tables and narration of the opinion of the respondents have been done. In the third part, the conclusion from the findings has been drawn. As such, the conclusion and findings were verified.

To maintain reliability or to make the research findings trustworthy, every feature from the research questions to conclusions have been carefully handled. Reliability is maintained with a clear and contextual set of questionnaires that explore the reality about the use of the Internet of Things in health care. In addition, authentic people and documents have been consulted to maintain validity. The hospital officers were consulted several times while composing the questionnaire.

5 Compilation and Analysis

The role of IoT in healthcare has been increasing day by day to improve access, enhance the quality of care and to lower the cost of care. Moreover, it has given much space to an individual's unique biological and cultural features of wellbeing. As it is possible to individualize health care with the support of IoT, everyone can be treated with the basic healthcare principle.

5.1 Analysis of the Survey

While exploring information about the impact of the Internet of Things in healthcare in Nepal, various aspects of IoT were consulted and the concerning data were collected. The information collected from the healthcare institutions in a developing country like Nepal depict the strength, weakness, opportunities, and threats. Apparently, internet-enabled devices cannot function properly where there is weak network. Nepal has been suffering from the fate of weak internet or no internet coverage in some areas. On the other hand, the Internet of Things poses various threats when it is operated by inefficient hands. The Internet of Things has a multifaceted impact on healthcare.

The survey was done among a certain population with survey questionnaires and the interviews were done during the field visit with different questions for healthcare workers, IT staff and the patients. The survey questionnaires were handed to the respondents through different social media platforms. Out of 160 people, 100 people responded to the survey and thus the data from them have been collected for study purposes.

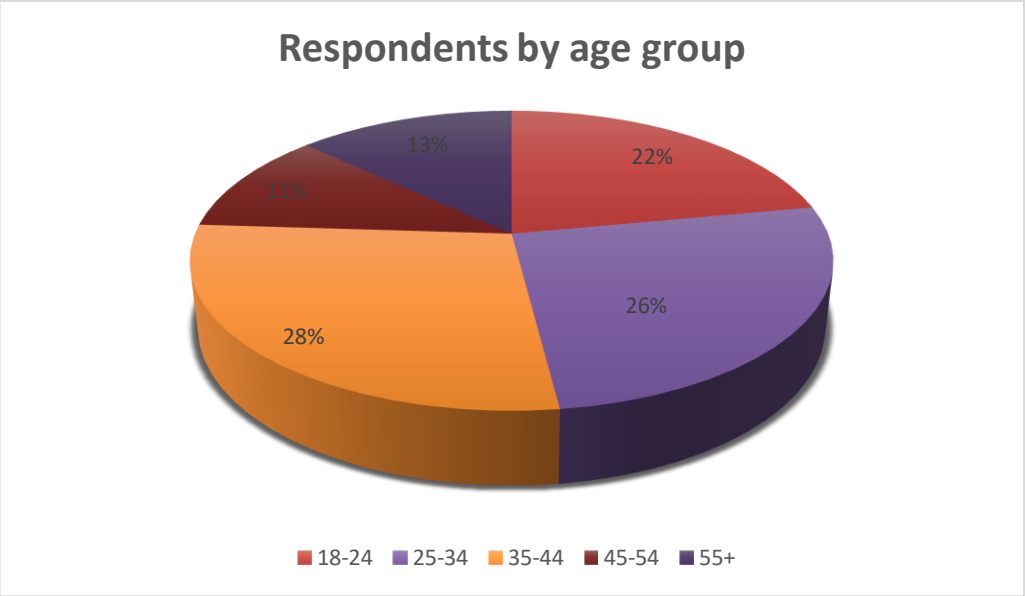

Figure 3. Survey Analysis by age group.

From the survey results (Figure 3.), it was found that most of the respondents were in the age group 35 to 44(28%) with the second majority age group being 25 to 34(26%). As mentioned before, the people using IoT for healthcare have been gradually increasing over the past few years. The number of women responding to the survey was comparatively higher than men. As IoT is still in the primitive phases in Nepal, the number of non-users surpassed the number of users. It was found from the survey that 37% used IoT in healthcare while 63% (Figure 4.) did not use it. Majority of the respondents used wearables such as smartwatches or sensors while some used glucose monitoring and mood monitoring devices. Many have already been using telemedicine. Many of the technologies used in IoT can be very expensive so not many people can afford it. There has been increasing concern among some people about the affordability since Nepal also has a weak economy and many people still live under poverty. While many were happy with the increasing demand of IoT, some were even worried about things like dependability on the devices or the fear of those technical equipment replacing human care.

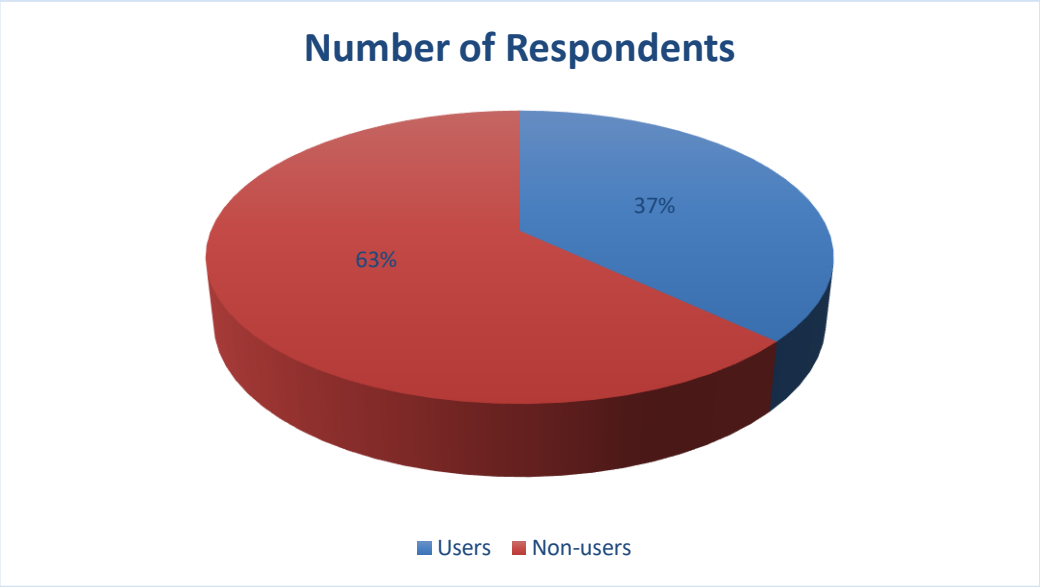

Figure 4. Number of Respondents by Population.

The use of IoT in healthcare in Nepal started rising after the COVID-19 pandemic. Before the pandemic, people were not that aware of IoT, but many people had mental and other health issues during and after the pandemic. Most of the respondents said they felt happy as technology can solve many of their health problems. IoT is still in its beginning stages in Nepal, but many people really felt grateful that technology is now solving their health problems. Most of the people are now using smartwatches, phones and sensors for tracking their health status. Since the number of respondents who do not use IoT in healthcare surpassed the ones who used it, it is high time that the Nepalese government should take proper measures to make IoT accessible to everyone regardless of their socio-economic status. The respondents also expressed similar views that they will use IoT in healthcare if they have more knowledge about it and they wanted IoT in healthcare to be more affordable.

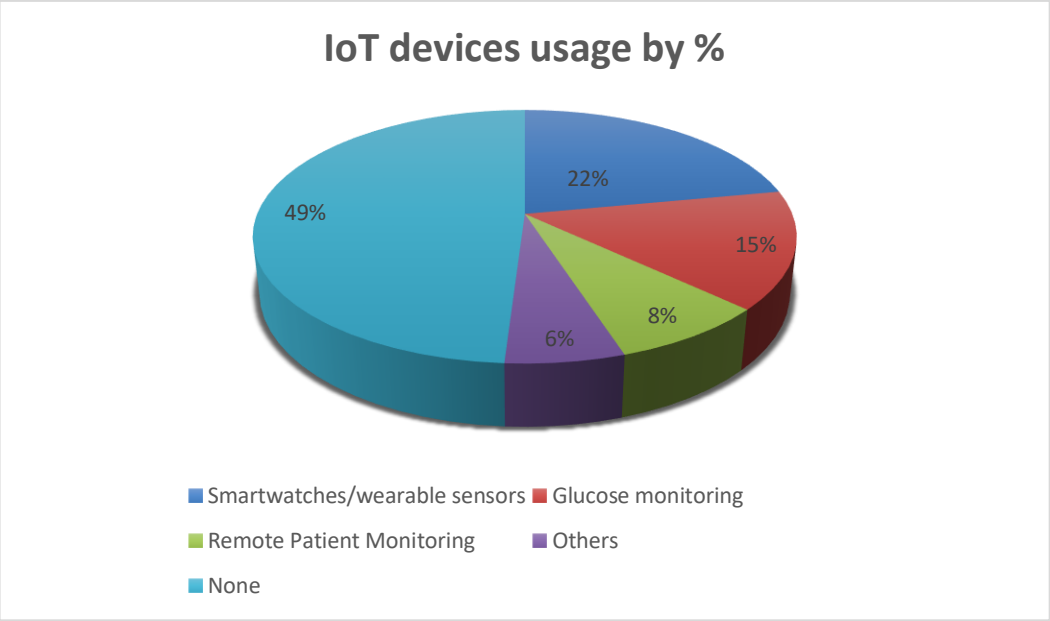

Figure 5. Types of IoT devices used.

From the survey results (Figure 5.), it could be seen that 23% of respondents used smartwatches or other wearable sensors to track their activities and health status. 16% of respondents used glucose monitoring to track their glucose levels. 8% of respondents used remote patient monitoring while 6% used some other IoT devices like the connected inhalers or mood monitoring devices. The sad thing about the survey analysis is that 47% of respondents did not use any IoT devices for their healthcare. If more people could afford and have access to these devices then it would be possible to detect illnesses earlier, thereby seeking medical help in time. There are still many people in Nepal who do not seek medical help unless they have medical emergencies so this kind of situation regarding the use of IoT devices in healthcare was expected.

Figure 6. Total number of interviewees.

During the research process, some healthcare professionals were also interviewed along with the patients, but it was not possible to get information from everyone. The data was collected from 31 interviewees, which included 5 doctors, 7 nurses, 3 IT staff and 16 patients (Figure 6.). Among the respondents, the doctors specialized in general medicine and psychiatry while the nurses specialized in public health and acute care. Most of the patients were above the age of 50. Among the patients, most of them had diabetes so they used glucose monitoring to track their glucose levels while some also had mental health issues. The patients had mixed reactions to the use of IoT in their treatment. Many were happy as it saved time while a lot had problems with its affordability.

One of the examples found during the research was about a patient who was admitted to the hospital and was preparing to be discharged. She was worried about her follow up visits as she had to travel almost 90-kilometer highway that usually gets stuck due to traffic. It was an orthopedic operation, and the patient had to consult about her wound with her surgeon to see if it was getting better or not. The daughter-in-law of the patient shared her problem with the doctor and the doctor soothed the attendant by giving her the option of using the internet to show the wound's progress and to share about her physical wellness. IoT used

during her treatment was able to save her from the extra time and trouble of travelling a long distance. She would otherwise have to arrange an ambulance or a comfortable vehicle from her village to the capital city Kathmandu that was 4 hours away. She was likely to worsen her wound by the movements which might have happened in the moving van due to the jolts. Moreover, she would not have wanted to go for a follow-up as the trip was very tiring. For every trouble and query, now she can just stay at home comfortably and consult her doctor. In this way, she can get quality care and timely response from the doctor.

Table 1 shows how IoT has been incorporated into the healthcare system of the patients who have been interviewed. Many patients said they benefitted from the usage of IoT.

Table 1. Usage of IoT among patients.

SN	Patient's age/gender	IoT Device
1	75/M	Connected Inhaler
2	80/F	Depression or mood monitoring
3	30/F	Remote patient monitoring
4	45/M	Heart-rate monitoring
5	49/F	Smart watch
6	55/M	Glucose monitoring
7.	60/F	Inhaler
8.	64/M	Telemedicine
9.	58/F	Smart watch

It was found during the research that most of the patients were using IoT devices for their treatment. The patients had mixed reactions to the use of IoT in their treatment. While patients in Tribhuvan University Teaching hospital were happy

to have IoT services for their healthcare, the same was not the true among the patients associated to IoT-operated devices in Mana Mahon Hospital, Kathmandu Nepal. They were found to have an unwillingness to use IoT. They preferred human care to machine monitoring. They found it dull and scary to lie on beds surrounded by technological structures. They felt that it would be far more comfortable and relaxing to be accompanied and treated by nurses and visited by doctors. Interestingly, patients were found dissatisfied even after they got free from disease and fully recovered because most often, they were not observed, and their condition was not accessed by the doctors. There were even such cases where patients were not able to fully trust the IoT devices they were using. They were scared about data inaccuracy too. For the interview, only those patients who used IoT were consulted for responses. Their responses displayed an increasing need for awareness regarding IoT usage in healthcare.

The healthcare workers such as doctors and nurses were also consulted for the interview to get a deeper understanding of how IoT has been used and what were some of the most common responses from their patients. Table 2 shows the doctors' and nurses' responses:

Table 2. Healthcare workers' response to IoT.

Experience and qualification	Department	Response
B. Sc Nurse/7 years	Acute care, mostly burn cases	Patients prefer the care of nurses
PCL Nurse/15 years	Pathology lab	Patients want to avoid such devices
MBBS Doctor/11 years	Physhiatry	Patients blame devices for extra expenses
MBBS Doctor/10 years	Outpatient	The Internet is not reliable so devices cannot work smoothly
MD Doctor/ 9 years	Radiology	It requires advanced ambiance which is not available in the hospital
Msc. Nurse	Acute and emergency care	A lot of knowledge is required for the proper implementation of IoT among patients
B.sc Nurse/ 5 years	Physhiatry	Patients are happy with the services

The response from healthcare professionals during the research was almost the same. They said that most of the patients preferred human care to the IoT devices. One of the main problems that raised concern about IoT usage was the

lack of proper internet access and the affordability of the IoT incorporated treatments.

However, during the time of COVID-19 epidemic period, the Internet of Things played a great role in its advancement in healthcare. When COVID-19 pandemic was officially announced and lockdown was imposed in Nepal on 24th March 2020 soon after the announcement of the second positive case, various online medical services emerged for the distanced treatment. In those days the fear of transmission of disease kept people far from each other. Naturally, even the patients and doctors had to remain away from each other. Such separation could be minimized by the Internet of Things, and it was done in large volume. Nepal still has a long way to go to incorporate IoT fully into the healthcare system. The IT technicians had similar responses too. They said that IoT is still not fully optimized for usage in the hospitals so most of the time they needed to operate it manually. They also highlighted the possibility of smart hospitals in the future if the government could make good investments in IoT devices. The IT technicians also wanted more Nepalese citizens to have knowledge about IoT in healthcare.

5.2 Limitations

There were some limitations in the survey and research process. The research was limited to two hospitals. Time and cost were the major challenges during the survey process. Although people of different backgrounds and regions could be met during the research, the survey and research were limited to the capital city areas. IoT is still in the very primitive state in a developing country like Nepal, so it was not possible to get the response from all the regions. Due to the poor infrastructure of a developing country like Nepal, it is not always possible to have proper electricity or internet for the proper functioning of IoT devices and methods.

6 Situation of IoT in Healthcare in Nepal

The use of the internet in the field of healthcare is one of the latest technologies in Nepal. Despite being in the beginning stages, it has already offered several insights into further strengths, weaknesses, opportunities and some threats. Being a new technology connected to the internet; it has fascinated most of its users. Of course, it has made healthcare easier, simpler and even cheaper at times, but there are some challenges to implementing it. There has been very little research in this field which explored the potential only while ignoring the threats. The main challenges of heavy investment and the need for well-trained staff have not been much highlighted. The country like Nepal has huge challenges in equipping the hospitals with IoT. Many hospitals, specialists and professionals need to be interconnected to the internet to share their expertise. The emerging digital world has energized the health sector with proliferation and impact of IoT-enabled devices. The devices are automatized in such a profound network that they do not need human hands to operate. Once the data is entered into the system, it is gathered in a concerned domain, analyzed, processed and sent to the department concerned. Now the expertise, discoveries and suggestions travel so fast to any part of healthcare that uses the Internet of Things.

The global healthcare sector has been overwhelmed with the discoveries of devices that operate with internet. The automatized machinery has saved the lives of many people. The expansion of the Internet of Things has enticed the people at health care services and the researchers of this field too. Nevertheless, it has created a disparity among rich and poor patients. The hospitals with inadequate resources have a tough time serving their patients as their services are not made easy with the automatized equipment and the health workers can show low efficiency sometimes. Therefore, the study of the impact of IoT in healthcare and a SWOT analysis is very important.

6.1 Strengths of IoT in Healthcare in Nepal

The Internet of Things has made healthcare accessible to people who otherwise would not get proper care from the efficient health workers. Nepalese people live sparsely in remote villages. Transportation of patients seems to be the most difficult part of treatment as the villages are not connected to the roadways or to the functioning roadways. Moreover, most of the villages suffer from the absence of an active population as they leave homes in search of a better opportunity. In such cases the patients or their relatives can at least have access to IoT through the internet. The strength of IoT in healthcare in Nepal can be contributed to its capacity to provide patient care, enhance operational efficiency and increase access to medical services, especially in remote areas. IoT devices can be used to keep track of the patients and as such detect the vital signs and symptoms in real-time without the need to visit the places. In a country like Nepal where the infrastructure has always been one of the major barriers, IoT can be a bliss.

IoT can also be used for data collection in a better way so that there is improved decision making. Nepalese people have already been using telemedicine and the use of IoT can help in improving the services more by integrating both services. If IoT can be used to its maximum, it may prove to be beneficial to a geographically hindered country like Nepal. IoT can prove to be a strong medium of healthcare to provide services to people all around the country as such.

6.2 Weaknesses of IoT in Healthcare in Nepal

IoT has certainly opened the doors to opportunities in the field of healthcare but at the same time, it has moved ahead with some disadvantages. While the idea of IoT seems fascinating, there are several difficulties to properly implement it in a geographically weak country like Nepal. One of the major issues is the lack of internet connectivity in rural areas. IoT needs internet to function properly but sadly some of the rural areas of Nepal are still deprived from proper availability

of internet. Moreover, the instability of the internet also might result in loss of data transmission in real-time and thereby making them less useful. The high cost of IoT technology is another drawback. The healthcare facilities in rural areas may not have the financial resources for using IoT technology. This might in turn impose a difference in treatment between the people living in rural and urban areas.

Also, in the process of using data efficiently, we have made them insecure and unreliable. IoT has not only played the role of a versatile supporter in healthcare, but also modified the way healthcare operates. Since there are connected devices, there is always a risk of data and other sensitive information being leaked. The healthcare system of Nepal still lacks tough regulations so there are not enough security measures to protect the data. In several cases it has powered the digital divide as Internet-operated devices and their services are apparently costlier than manual services.

6.3 Opportunities of IoT in healthcare in Nepal

As most people in Nepal live in villages, there have been concerns regarding the disparity in accessing healthcare services between the urban and rural areas. IoT can bridge the gap in those cases. Healthcare services can be significantly improved too with IoT. IoT has made it possible to get treatments by the transmission of data in real-time so Nepal can really benefit from it if IoT usage can be optimized. Many patients still go to other countries for their treatment but if the government can have a proper strategy and make a good investment for IoT in healthcare then it will be beneficial to everyone in the long run. The data collected from IoT devices can be used in identifying the health trends. Since there has been an increase in interest among the policy makers in new tech innovations, IoT can emerge as a game changer in Nepalese healthcare system if implemented properly. The integration of IoT in healthcare can make Nepal’s

economy foster and make healthcare accessible to everyone regardless of geographic location.

6.4 Threats to IoT in Healthcare in Nepal

Although IoT has occupied a large space in the field of healthcare even in the developing countries, it has triggered a threat of complexities in human life. While it can serve hundreds of thousands of patients at the same time with a small effort, the fact that it invites the threats of cyberattacks cannot be left unseen. The data once collected from the patients is sent to the cloud that has universal reach, but the law of privacy varies in different countries. Since there are connections to several devices, there is always the risk of hacking and breaching of data and it might even expose the sensitive information of patients.

There is also a concern about the reliability of the devices themselves. There might be device malfunctions and inaccuracies which in turn can result in incorrect data transmission. These types of errors can be quite hazardous as they might impose a serious consequence for the safety of the patients. There is also a threat of people not being able to fully understand the mechanism of IoT which can lead to resistance among the patients in adopting the technology. Most often patients feel great comfort in expressing their pains and discomforts face to face with their healthcare providers. In this way anyone seeking healthcare service may have an anxiety using the IoT-enabled treatment. Such threats are very largely felt in a country like Nepal where people do not have enough knowledge about the proper usage of IoT. Although many people have appreciated the function of IoT devices they also expressed some threat regarding the use of the technology for treatment. There is a threat of obsession with devices which might in a way replace the human care provided through direct interactions. People also feared the situation where their family members might pay for some devices to watch them and leave them unattended for several days.

7 Conclusion

The Internet of Things has intensely encroached into the healthcare industry and has been an inevitable part of healthcare. It has occupied the space of resourceful hospitals and has been expanding into less resourceful ones too. Healthcare industries in developing countries have just started Internet-supported services with the active involvement of health workers. Yet, most of the tasks in Nepal are performed manually while IoT devices perform the part of communication and endorsement. With the availability of the internet throughout the country, the adoption of Internet Things (IoT) technologies is steadily increasing.

Most of the hospitals in Nepal find it challenging to integrate the Internet of Things in treatment, especially in remote areas. Right at the infancy stage of IoT, it has shown its strengths, weaknesses, opportunities and threats. In the field study, the narrative responses show that the health sector is so overwhelmed to see the capability of IoT devices that embodies some weakness as well. The Internet of Things enables patients to receive health care from any part of the country and from any expert, which might not be possible in its absence. Naturally, the human body and human relations are so delicate that they cannot be handled with the devices alone. The dominance of technology over human relations certainly damages the typically sweet moments of human care, human understanding and human cooperation (Preçi & Simms 2022). When human beings are not required by another human at the time of suffering, there is a risk of technology takeover. Surely devices will appear more valuable than humans in such situations.

The Internet of Things operates with hundreds of thousands of computers, advanced devices, health specialists and technology experts. As the foundation of IoT, some mobile apps have started online medical services and surveillance within Nepal. Growing gradually stronger, the Internet as a stable source now provides medical data for patient-doctor consultations. The Internet has entered the field of healthcare in Nepal through mobile apps before the arrival of heavy IoT devices. Although the initial set up of Internet of Things is too costly, it proves to be a boon to the country like Nepal where travelling is difficult due to the poor

geography and lack of specialists. The most prominent strength of the Internet of Things is that it connects people dispersed in the remote villages and provides them access to health care facilities and specialists. The system multiplies the capacity of experts as they can serve thousands of patients with a single effort.

Despite its immense capacity to serve patients in different regions at the same time, IoT suffers from its limitations. Healthcare requires the best qualities of human behavior: love, care, encouragement, belief, understanding and support. As IoT is a computerized technology, it cannot read human psychology. Unlike IoT devices, human caretakers can notice the sadness, happiness, fear and wishes of patients and can match their service or set up. Moreover, the IoT cannot function without electricity as the device needs charging. So, fully IoT-enabled healthcare is still a dream for Nepalese citizens. However, the IoT can play a significant role in reducing the complex cost of healthcare. With the help of IoT a patient can receive a timely service that sometimes proves to be a life-saving opportunity.

As the IoT serves numerous cases of healthcare, it also poses some threats to mankind. The Internet of Things cannot guarantee the security of data as it is connected to the vast cloud of information. The data can at any moment fall into the wrong hands and there is always a threat to personal security. Internet-operated devices are often designed with a focus on corporate goals, such as convenience and user satisfaction, rather than specifically addressing medical needs. These devices, in their aim to provide comfort and ease of use, can sometimes overstimulate the senses, potentially causing strain or harm to the body over time.

In a developing country like Nepal, there is even immense need of public awareness regarding the use of the IoT. Like all technologies, the IoT has its own advantages and disadvantages. To make sure the benefits outweigh the drawbacks, the government of Nepal should implement proper policies to make healthcare accessible to everyone to minimize the overwhelming disparity between urban and rural healthcare. If implemented correctly, the IoT has the potential to revolutionize healthcare in Nepal, significantly improving patient care,

medical efficiency, and overall health outcomes. However, more research into this field is an immediate need for investigating the future potential.

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Survey Questionnaire

1. What is your age group? Choose from below

18-24

25-34

35-44

45-54

Above 55

2. What is your gender?

Male

Female

3. Do you have access to the internet?

Yes

No

4. How often do you get medical checkups?

Every 3 months

Every 6 months

Yearly

Not at all unless there are medical emergencies

5. Are you aware of IoT in healthcare?

Yes

No

6. Do you use IoT for your healthcare?

Yes

No

7. What kind of IoT devices do you use for your healthcare?

Smartwatch/Wearable sensors

Glucose Monitoring

Remote Patient Monitoring

Others

None

8. Are you happy with the services? If not, what area is to be improved?

9. Do you think IoT is good in the case of healthcare?

Yes

No

10. Would you use IoT for health-related matters if you could get more information about it?

Interview Questions for healthcare workers

1. **What is your occupation?**
2. **Which department do you work in?**
3. **Are there a lot of patients using IoT?**
4. **What do you think of IoT in healthcare?**
5. **How are patients responding to IoT in healthcare?**

Interview Questions for the patients

1. **What is your age group?**
2. **What health problems do you have?**
3. **Do you live in the capital area, or did you travel from somewhere else?**
4. **Are you using IoT for your health?**
5. **How do you find IoT?**
6. **Do you have any concern regarding the usage of IoT?**