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MHEALTH IN INDIA: UTILISING BIG-DATA TO DETERMINE HEALTHCARE NEEDS OF COMMUNITIES

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ABSTRACT

This report is determining the healthcare needs of the Indian community by analysing the data generated from mHealth devices. First, the status of Indian healthcare needs to be researched and analysed in detail to extract precise information. The background is basically the rural areas of India where healthcare is not available.

Healthcare can be improved by coordinating the mHealth system and big-data analytics: examining and determining the sources of mHealth data, mainly the mHealth devices distributed over the rural area and collecting the data into a central hub or storage. This collected data should be analysed using special big-data tools. This research explains the easy and user-friendly analytic method called Hadoop and shows the exact steps to determine the healthcare needs in a region using mHealth Big-data.

Finally, the research paper also gives a brief idea and concepts that can be implemented in rural Indian healthcare to avoid the current flaws in that sector by using mHealth and big-data systems. The report could be helpful for future research workers who need an idea of the mHealth system and Big-data and how it should be helpful to healthcare. The research paper points out several proposals for the authorities that could be used for improving the healthcare needs in India.

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Thank you to all those who helped me in this research project, especially my supervisor, friends and the family.

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1. INTRODUCTION

All the revolutionary advancements in technology and new innovations should be applied in the healthcare sector before all other fields because healthcare is the first priority. But when it comes to reality, technological advancements can be delayed in reaching healthcare. Even the digitalization of medical records became popular in the medical field only recently. Now big-data and its analysis is the new trend in technology because of its vast advantages and applications (Groves, 2013)

Big-data is known for its enormous amount and if this much volume of data is put into analytics, the results can be promising. As healthcare does have dealings with huge volumes of data from different types of equipment, related to different patients, Big-data can influence and transform the current circumstance into a better future. Considering the healthcare sector in India, the application of mHealth might be a gift-like procedure, especially for rural area communities. There are lots to do in the Indian healthcare sector as the technologies are not running fast enough, that is where the significance of mHealth lies in Indian society.

Some rural areas are really backwards in case of healthcare and they suffer a lot to get even a basic facility of healthcare. For such regions and communities, the mobile health technology can be applied and facilitate them their basic needs. That is how the portable technology and the anaysis of the data from such devices can be very useful for determining healthcare needs.

1.1. Research Objectives

The primary aim of this research paper is to investigate and analyse how Big-data can be used to determine the healthcare needs of a community, focusing on mHealth technology and its significance in India. The main objectives of this research paper are as follows:

1. Investigate and analyse the status of mHealth system of India.
2. Critically examine and evaluate the mHealth Big-data generated to determine the healthcare needs according to regions and individuals.
3. Provide recomendations for the efficient use of analysed Big-data for improved healthcare policies by various authorities.

1.2. Significance of the Research

The research will critically investigate the current implementations of the mHealth system and its drawbacks. Even mHealth and Big-data is becoming common in most industries and areas. However, in analysing the conditions of developing or under developed countries it is very clear that these upcoming technologies are not accepted widely. Considering the healthcare system in India, mHealth devices and analysing Big-data from those devices can be utilised for a good cause and thereby increase the healthcare facilities.

This research helps to throw light on the field of healthcare and the improvements that can be brought to meet the needs of rural communities. The analysis of Big-data can even be helpful in monitoring the needs or the health conditions of an individual or a region. This research can be a reference to help governments and health organisations to make some practical solutions to meet such requirements.

1.3. Scope of the Research

The research objectives can be achieved only through investigating the healthcare needs among the communities of India. Some articles and published journals need to be thoroughly read and data collected in order to analyse the needs and provide the recommendations according to the requirements of individuals or regions. A critical investigation into the methods of mHealth and Big-data analysis is required to get the desired result.

1.4. Limitations of the Research

The investigation into mHealth in the Indian community is not an easy task as it is difficult for the Indian rural community to accept a new feature, especially in the medical field. The healthcare sector in India is a vast spread and it is not under a single umbrella. Time is another important factor, time is short to completely gather the details. Also, to filter and combine the gathered information should be done within a very short time.

1.5. Research Outline

The research helps to understand the different methods and strategies to analyse the Big-data; thereby increasing the chances for the government and the healthcare organisations to improve

healthcare facilities according to the analysis made by monitoring the mHealth Big-data from the Indian community across individuals to regions. In this research the objectives are to be achieved step-by-step and gradually.

Firstly, the current situation and status of mHealth should be researched and analysed which will provide us the recommendations and new ideas for Big-data to merge with mHealth and how the healthcare needs can be met. The next step is to critically examine some implemented case studies across the Indian community and explain the reach of such projects among people. In that way, the procedure to integrate the Big-data into mHealth can be studied and proper recommendations can be given.

1.6. Summary

The project deals with the critical analysis of Indian healthcare by explaining the current infrastructure facilities used in rural India and by researching the technologies that can be implemented to improve healthcare. The project deals with a detailed analysis of the applications of the mHealth Big-data in healthcare and the necessary setup and tools required to determine the needs of the community. In addition, some proposals and steps for improvisations of the current healthcare need to be discussed.

CHAPTER 2

2. LITERATURE REVIEW

2.1. Introduction

Health challenges present in the current era are the most significant barriers to sustainable global development. According to a survey conducted by the Times of India, the Indian healthcare system is falling far behind many other under developed countries and the healthcare points are very low. Even though the healthcare growth rate was high from the beginning of 1990s till 2000, 16 years after, it is considered as a dark chapter in Indian healthcare as the healthcare growth rate has fallen behind. The main reason for the lack of healthcare facilities in the undeveloped or rural areas of inner India is that technology is not reaching those areas, always staying in the urban areas, where the facilities are easily accessible.

In addition to that, the government did not help in funding the expansion and increasing the reach of more technologies to such areas, which is the most prevailing reason why the rural areas cannot meet even their basic needs. This research takes a closer look at the healthcare problems faced by the Indian community to understand the exact issues and analyse and determine the solution to these problems using mHealth Big-data.
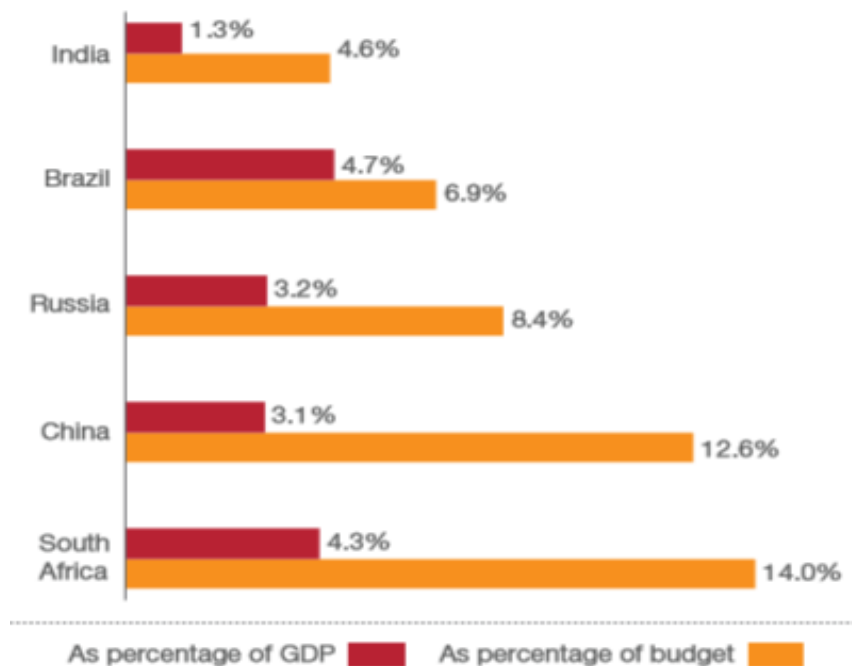

Figure 1: Comparison of Indian government healthcare expenditure (Pwc, 2018)

Figure 1 shows the percentage of budget and percentage of GDP allocated to healthcare by different countries. From the comparison among five countries, India, Brazil, Russia, China and South Africa, India has the lowest percentage of budget allocation for healthcare activities and facilities, only about 4.6% whereas for South Africa it is 14%. In the case of GDP percentage India is far behind compared to other countries having only 1.3% where as Brazil has got 4.7%. Hence the studies show that some improvements are needed all over India with some new innovations and better budget allocations. However, although budget allocation is completely the government's responsibility, new ideas and innovations to improve healthcare can be given through this research (Pwc, 2018).

2.2. Healthcare and mHealth

The revolution in mobile technologies and the advent of more and more features in smart phones have led to a significant change in healthcare in a good way. In the old days healthcare was not good enough and not available for all the people, but now in this century healthcare has become more available and accessible. The number of healthcare facilities in an area has gradually increased and the utilisation of simple and modern technologies make healthcare affordable too. The healthcare data in a clinic or the data regarding a patient and the patient's health monitoring was one of the most difficult tasks to maintain, but with the help of the newest technologies information management has improved a lot ensuring the right information at the right time. mHealth is one of the major factors in these new technologies (Akter, 2010).

As the name suggests, mHealth is the practice of using mobile phones or Personal Digital Assistant (PDA) in health services. mHealth devices should have the ability to create, store, retrieve and transmit data to provide right time assistance for patients. mHealth can be useful in monitoring the health conditions of a person, and thereby providing safety to the patient and the required quality of care. mHealth devices are nowadays becoming more popular in the section of smart devices as they have the capability of remote assistance and remote data collection that provides advantages in personal health care. Unlike an individual healthcare service, mHealth can also be applied among a community to understand common trends and thus improve the standards of healthcare (Akter, 2010).

2.2.1. Technologies in mHealth

Any feature on a device or an application that can collect information about health can be an mHealth device (Lupton, 2013). Technology has created different types of devices for an easier life for human beings. Smart Phones are just a small leap into that, and there are a number of other devices available in the current market, the use of them is limitless. In this age, the number of applications available for a smart phone shows the market for such features. Besides these software apps there are devices available which vary in type according to their application and the area of usage. Some of these devices that can be used in accordance with the mHealth are (Pwc, 2018):

a. Wearables

Wearable devices can be any device that can be worn as an accessory. The smart watch is one of the most popular models most people are using today. Compared to the normal smartwatch, mHealth wearable devices will have a slight difference because they include biosensors for monitoring blood pressure, heart rhythm, respiratory rate, blood oxygen saturation, temperature, eye pressure, glucose level, brain waves, sleep metrics, etc. These can be used for remotely monitoring patients after they are discharged from hospitals or under home care (Lupton, 2013).

Figure 2: Wearable Device – Smart Watch (Sumra, 2017)

b. Implants

Implants come under the most modern technologies on medical treatment, which can be an ingestible sensor placed inside of the body. The position of the sensor depends on the function it carries, and it can be placed temporarily or permanently. Some common uses of such sensors are tumour detection, tracking genomic signals and even diabetes control (Pwc, 2018)

Some implants are available nowadays which are capable of treating the patient automatically. Implants for diabetes control is one of them, these implant pumps infuse insulin into the patient's body throughout the day. The dosages which the implant infuses should be controlled by the patient themself through upcoming meals or activities (Ravikumar, 2015)

Figure 3: Implants (Watson, 2014)

However, these implant sensors are highly expensive compared to other mHealth devices and that is why they are used for such critical situations and patients. This implant cannot be implemented on a large scale as all people may not agree with placing an electronic device inside their body.

c. Location-based trackers

These are very tiny sensors that detect the proximity, position and movement of the carrier. Location-based trackers cannot be carried independently, instead this device is assembled with any smart devices or any accessories. It can be a watch or even a walking stick. These trackers include sensors or RFID tags used for tracking patient movement. The data is used to improve operational efficiency, track critical equipment and identify whether a patient has fallen and not recovered, etc

d. Sensors for legacy devices

Legacy devices are outdated devices that do not have the latest technology features or the capability the newest versions have; however, those devices are not necessarily replaced due to their long life and performance schema. Rather than replacing them, the devices are modified by reassembling with some other parts and including more features (Park, 2011).

Sensors are such an attachment that enables biomedical legacy devices to transmit data captured, thereby offering connectivity to analyse and monitor results (Pwc, 2018). These

devices however, are expensive to get reprogrammed and attached to a person to function as per the need. The sensors are available in different varieties as each variety senses totally different stuff.

e. Smart ambulance

Previously, ambulances were just for the transportation of patients to the hospital. It did not have any on board doctors or specialists who could give critical care to patients or even make a preliminary action before reaching the hospital. Then, in recent years this has changed a lot bringing more facilities to ambulances which have on board doctors or a specialist or a nurse who can check the patient's condition and make a preliminary report and decide which doctor to call or which department is needed for admission.
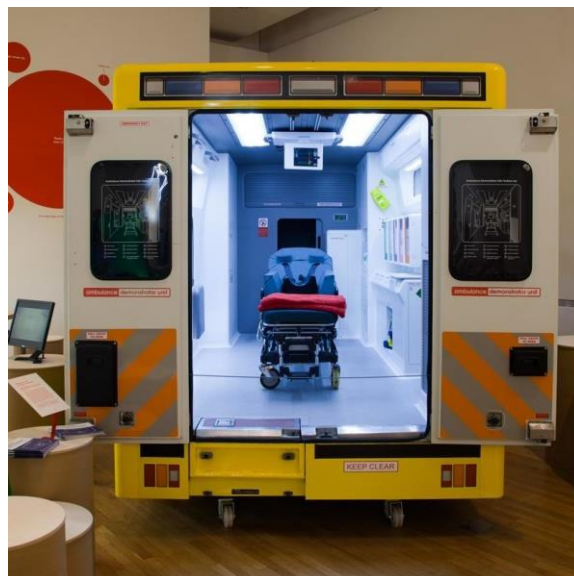
Figure 4: Smart Ambulance

These procedures still have some limitations as time is a very important factor when it comes to the life of an individual. So, the idea of a smart ambulance came to significance, these ambulances are equipped with modern technologies such a sensors, equipment and other devices that can check and analyse the patient's condition and transfer the results to doctors in the hospital in real time. In such a way, the doctors can make the necessary arrangements at the hospital before the patient arrives (Pwc, 2018).

2.2.2. Global impact of mHealth

In many countries the use of mobile phones exceeds access to clean water or bank accounts. The use of mobile technologies and their impact is likely to be increased in the coming years. Surveys in different countries estimate that mobile technologies and devices will hold about 78% of the overall market within a few years. That is the main reason for the significance of the mHealth globally, as low-cost smart phones have the required features and capabilities to cope with the health-related applications and the necessary connectivity features (Hall, 2014).

The effect of mHealth is not bounded by healthcare delivery and emergency response but instead it is spread over other fields too. Some applications monitor client education and behavioural changes, data collection and reporting, electronic health records and electronic decision support. mHealth is now extensively used in more and more fields and is getting increased day-by-day. A major evidence showing the increasing popularity of mHealth is the Google trends list.
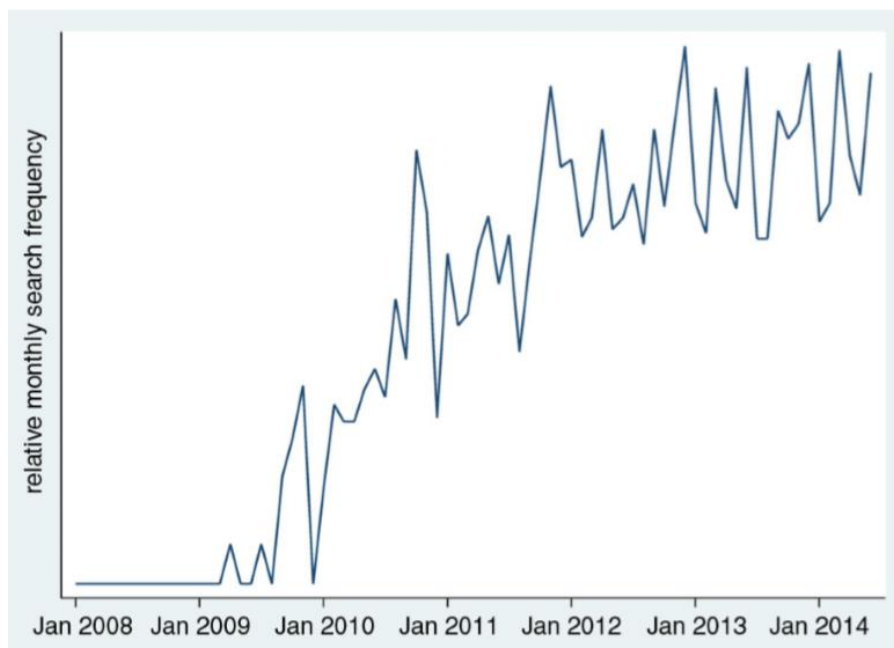

Figure 5: Google trends searches for 'mHealth' over time (Hall, 2014)

Figure 2 represents the Google trend results from 2009 to 2014. The search for mHealth began in 2009 and has gradually increased. The hits in Google have been to a high level within a very small time period and it was greatest at the end of 2012 and the beginning of 2013.

Since the popularity of mHealth became so high, countries are allotting more expenditure to this innovation helping society and communities to become more health conscious.
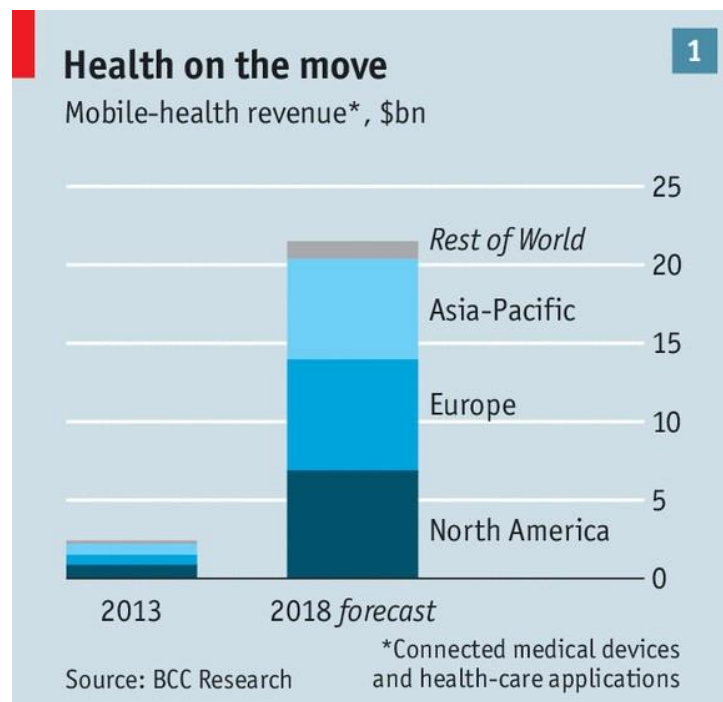
Figure 6: Impact of mHealth around the globe (The Economist, 2016)

Figure 3 shows the mHealth revenue allotted by countries in 2013 and in 2018. In 2013, the mHealth revenue was only 2.5 billion combining all the countries in North America, Europe, Asia Pacific and rest of the world. The amount multiplied several times within a few years, so in 2018 the revenue is about 22 billion for all the countries.

2.3.   The Indian Healthcare System

The Indian Healthcare system can be classified into two types according to the controlling authority: public sector and private sector. Despite other countries, India does not provide free healthcare or hospitality and that is considered to be the reason behind the establishment of more and more private hospitals. The private organisations mostly start a healthcare facility to make money rather than pledging to treat the people and exist for the welfare of the society. Meanwhile, the government is not providing enough healthcare support or sufficient facilities to treat and care for the community. Hence, the people go to private sector hospitals even though they are more expensive and far from their homes.
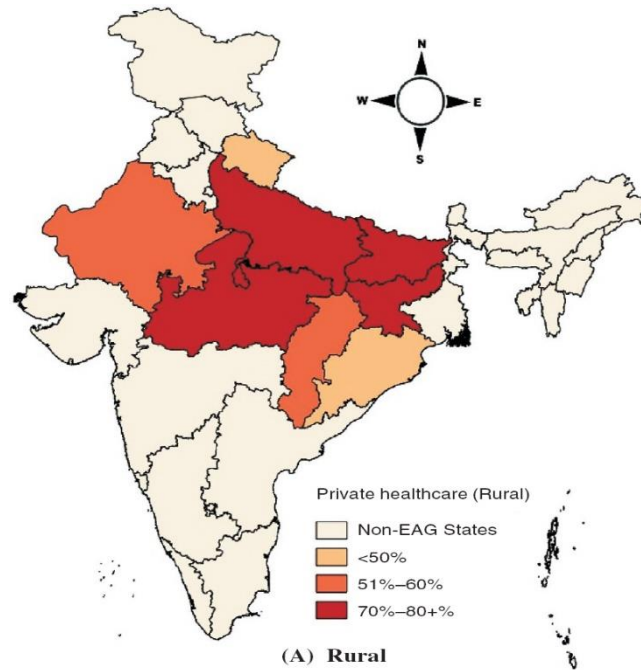
Figure 7: Usage of private healthcare in EAG states (Kumar, 2016)

Figure 4 shows the accessibility of private healthcare facilities by the people in EAG (Empowered Action Group) states. Most of the states are using private healthcare facilities and the only a couple of states use public healthcare centres.

2.3.1. Existing medical facilities in the Indian healthcare system

As discussed earlier, the Indian healthcare system consists of two variants: public healthcare sector and private healthcare sectors. In inner rural areas, the private sector is still not predominant and the people there access the public hospitals for their healthcare. The public/government hospitals follow a three-tier system in the establishment of hospitals and this system is known as the rural health system (Perinatol, 2016).

1. Sub-centres

A sub-centre (SC) is the first contact point of this rural health system and these centres only contain one or two doctors and several nurses for primary treatment. These centres are mostly established in an area with a population of 5,000 people or in a hilly or tribal area with a population of 3000 people.

2. Primary health centres

Primary health centres (PHC) are bigger establishments than the sub-centres. Rather than just providing primary treatment, such centres can be providing preventive healthcare and they conduct awareness programmes among the rural area people. These primary health centres are established in an area with a population of 30,000 people or in tribal areas with a population of 20,000 people.

3. Community health centres

These are more advanced and larger building establishments under the direct control of the state government. Community Health Centres (CHC) serve as a referral centre of the primary health centre and are established mostly in an area with a population of 120,000 people or a difficult to reach area with a population of 80,000 people.

2.3.2. Lack of critical healthcare facilities in rural areas

India was the first country to give the citizens national health as a uniform right, but the current statistics show that Indian healthcare is going through some crucial circumstances. The government is successful in implementing good healthcare facilities in urban areas, but they fail to do so in rural areas. More than 86% of hospital visits are occurring in rural areas and the majority of the people need to travel more than 100 km to access such a hospital care. This travel and the healthcare expenses combinedly empty the pockets and thereby lead them to poverty (Singh, 2014).

Besides the above fact, the doctors, nurses and the health workers are very less compared to the high population of a specific region. Also, in rural India, certified practitioners are less so the people in such areas depend more on unqualified medical practitioners. As per the report of World Health Organisation (WHO), published on 2016, 31.4% of those who call themselves allopathic doctors are only qualified up to Class 12 and 57.3% of doctors did not have medical qualification (Sharma, 2017).
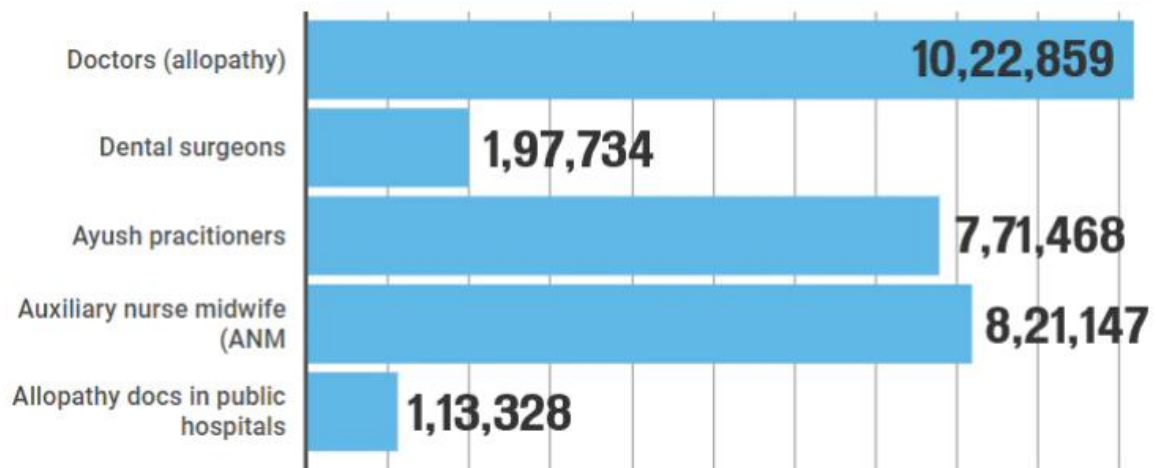
Figure 8: Number of specialists in India (Sharma, 2017)

The figure above shows the number of medical practitioners all over India. It can be seen that the India has got about 1 million doctors on modern medicine (Allopathy) for about 1.3 billion population. Of them, only 1.1 Lakh work in the public sector. About 900 million people in the rural region turn for treatment to this 1.1 lakh doctors.

2.4. mHealth in India

Considering the current healthcare situation in India, the country shows a good opportunity for mHealth to establish and it has already been started. The Indian community is apt for the mHealth to flourish because of several factors discussed in this research. The primary reason is lack of healthcare in rural areas, which creates the need for a new system to meet the requirements and healthcare needs. The second reason is the use of smart phones in India. About 69% of households in India have mobile phone connections with internet connectivity, which exceeds electricity connections or even food availability in India (Ramani, 2006).

India uses the mHealth system for several functions because of its vast application availability through smart phones. About 31000 health related applications are available online and it shows that more than 142 million downloads are done for the health-related apps only. Some of the basic features these mHealth applications provide are monitoring location and non-activity, doctor appointments and reminders, medication reminders and set thresholds/goals.
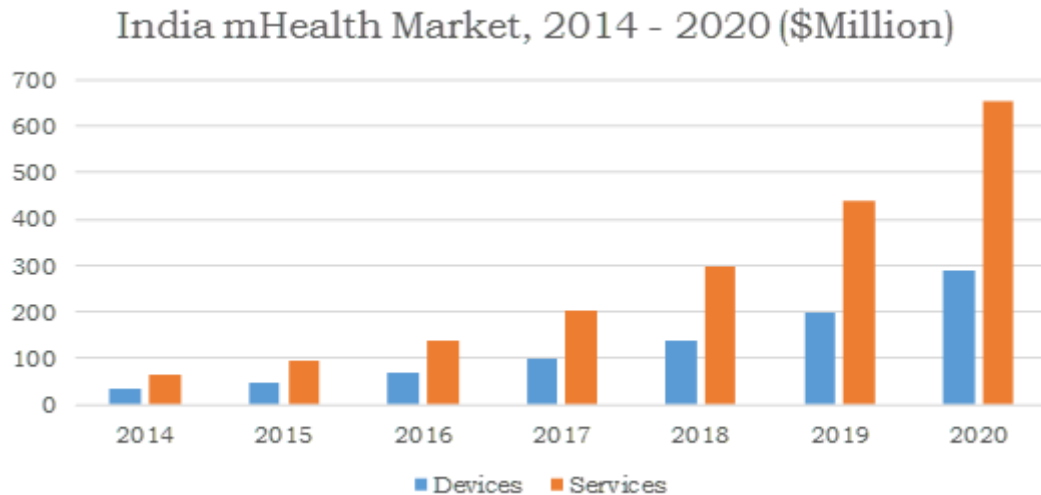
Figure 9: Indian mHealth market (Franco, 2015)

The bar graph shows the Indian mHealth market. It shows that in 2014 mHealth devices and services combinedly consumed 50 million of market price where through the next years it gradually increased and is expected to reach 650 million by 2020. It becomes clear that mHealth is taking its place in the healthcare sector with its outstanding applications and functionalities.

2.4.1. Integrating mHealth into Indian Healthcare Delivery System

mHealth is an innovation that has plenty applications in the healthcare sector for an individual or for a community. An mHealth device, for example, a smart watch connected to a smart phone can perform normal functionalities like detecting pulse rate, monitoring calories burned according to the activity by which the individual is doing, doctor appointment reminders and even alerts for non-activity. Besides these common functions, collecting this data to a centralised hub and monitoring from there, can be a revolution for the healthcare delivery system.

Monitoring such information can help the individual to give adequate instructions or even medical prescriptions for their condition. The authority can detect any emergency or critical situation and can avail the proper care at right time. Also, the authority can know about any spreading disease and help to take precautions and distribute the necessary vaccines.

2.4.2. Application areas of mHealth in India

Healthcare is not the only application face where the mHealth can be implemented. Client education, supply chain management, vital events tracking, sensors and point of care diagnosis and Electronic Health Records are some of them. However, this research focuses only on the healthcare sector. The utilisation of mHealth in the healthcare field can again be classified into several variants such as monitoring patients, providing awareness and much more.
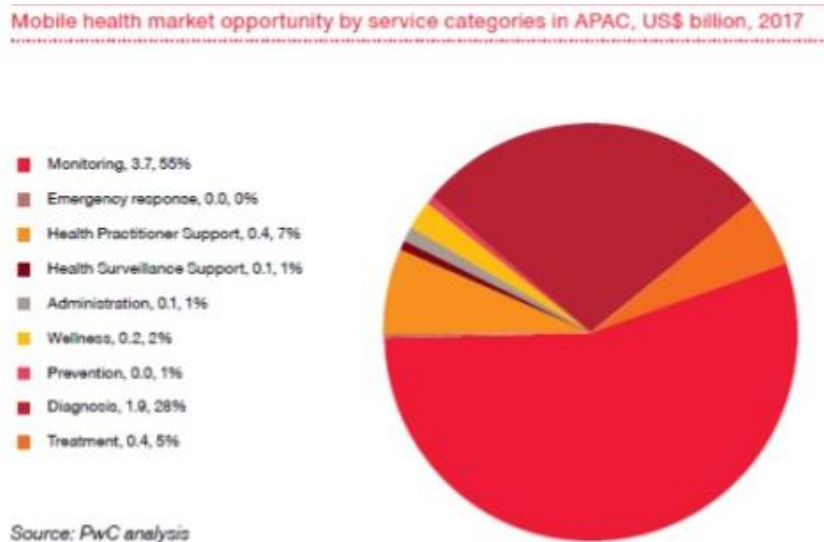
Figure 10: mHealth market opportunity in India (Bhandari, 2014)

In the above figure, the market opportunity of different mHealth applications is shown. 55% of the market opportunity lies in monitoring and administration of emergency response has the lowest market opportunity. The chart also shows the part of practitioner support, diagnosis, and prevention. The second largest market value in mHealth lies in diagnosis application and the third highest is for health practitioner support.

1. Emergency Response Service

One of the major applications of the mHealth programme is to deliver the care and medication at the right time. Emergency response services play a crucial role in handling such a situation by delivering healthcare. Basically, the emergency response service can work in two ways, by automatic or manual alert to the authority from an mHealth device. If the mHealth device which the individual is using has the facility to detect such an emergency, it will automatically alert

the response service by making a call or sending a message. Otherwise, the person should click on an emergency button that will trigger the alert (Labrique, 2013).

2. Healthcare Monitoring

Most mHealth devices are capable of detecting pulse rate and other normal health activities such as calories burned, distance walked, time of sleep etc. Along with this, some mHealth devices can detect the proximity of the individual and even medication timings (Ravikumar, 2015). Analysis and monitoring of such details from the whole community will reveal the common medicines that are used, and it helps in conducting different surveys and making conclusions directly from these statistics.

3. Understanding the healthcare needs

mHealth devices and mHealth services help understanding of healthcare needs of individuals or a community. The continuous monitoring of data from mHealth devices used in an area will provide us the knowledge of common diseases spreading and the diseases which most people are suffering from. By understanding such factors, the healthcare authority can implement a system or facility to treat the people, or else, the authority can provide awareness to the people regarding the spreading disease.

2.5. Big-data and mHealth in India

Big-data, as the name implies is an enormous amount of data, which is like normal data, but larger. Due to the volume of such data, it cannot be managed using traditional database management systems. The source of such data can be from the Web, Smart phones, any IOT devices, sensors or any mechanical equipment. In the old days, such a huge amount of data was no use to anyone because it was hard to manage and evaluate but due to the new Big-data technology such data can be analysed, and the data can be used for a good cause (Manyika, 2011). Big-data is basically defined by the 4 Vs: Volume, Variety, Velocity and Veracity (Qadir, 2016)

1. Volume – The huge quantity of data which Big-data is handling
2. Variety – The different types of data from different sources
3. Velocity – Big-data deals with fast processing data
4. Veracity – The quality of the data

In a third world and developing country like India, Big-data can be helpful in healthcare to improve the current situation and avoid the crisis which India is facing now. The major part of India's population is still outside of the healthcare policies and resources are limited, hence the utilisation of this technology combined with mHealth devices will enhance the healthcare systems to be more efficient and cheaper.

The data is collected from different sources like sensors or mHealth devices and the collected data gets transmitted to cloud-based platforms or servers to store. This data is then aggregated and analysed using Big-data analytics tools. The results will be generated according to the requirement or the query given. Continuously updating the patient's data and regular updates to physicians can reduce the risk of healthcare, improve safety and avoid unsuitable care. This method of treatment particularly helps for the diseases which need continuous monitoring such as hypertension, diabetes and asthma.

2.5.1. Big-data Generated in India's mHealth System

The mHealth devices used by everyone generate a continuous data stream which turns into Big-data eventually. The data generated from different sources combines to cause an explosion of data that cannot be maintained or reused with traditional methodologies. The main sources of Big-data can be defined as mHealth devices and mHealth applications. mHealth devices include wearable devices, smart phones, implants or any other personal health monitoring devices. mHealth applications include the health apps installed in the smart phones.
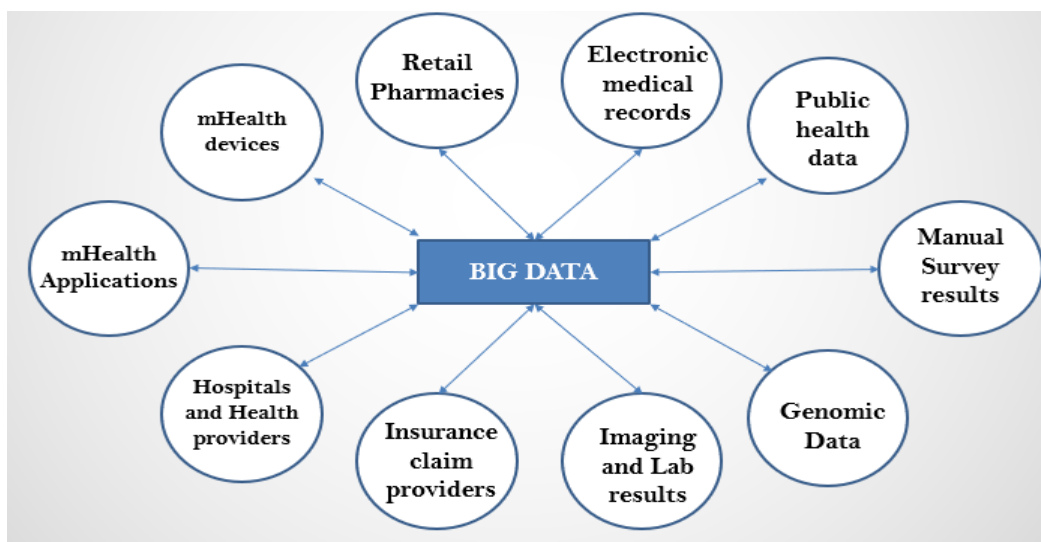

Figure 11: Big-data generated from India's mHealth system

Figure 6 shows the circle of Big-data sources in India, besides the mHealth devices and applications the data generated in healthcare is humongous. The majority of the data is from hospitals and healthcare facilities. The patient data and the health records alone cause an unmanageable amount. The data from insurance providers, labs and pharmacies are other sources.

2.5.2. Privacy and Security Issues of Big-data in the Healthcare System

Collecting patient data or personal health data from different sources and storing it in a data centre causes a high risk in security. A breach of such a data centre may affect many individuals. Introducing Big-data into healthcare increases the privacy and security concerns. Most of the healthcare data centres have HIPAA (Health Insurance Portability and Accountability Act) certification. However, this policy does not guarantee the safety of that data, as this policy is focused mainly on ensuring the security policy and procedures (Cohen, 2018).

Major security issues in Big-data are privacy preserving in Big-data analytics, and security issues in outsourced data storage. There are several methods that are still in the developing stage and some of them have been successfully implemented. The explicit authentication mechanisms in Big-data storage or from the source itself will avoid any security breaches into the private data. Another method implemented in the cloud environment with the same idea in mind is called Mycloud, which removes the virtual machine environment controlling the software in the host client. As the virtual machine is one of the major causes of privacy and security violations, removing it can avoid such issues. However, the analytics will be successful using Mycloud (Cuzzocrea, 2014). Other security policies that can be implemented in securing the Big-data are trust computing and the privacy-aware query authentication method.

2.5.3. Methodologies in Big-data Analysis in mHealth

The traditional analytics methods are not applicable in the case of Big-data due to its enormous quantity and the type of data which it is carrying. However, so many analytic tools are now available in the market for Big-data processing and analytics. The tools vary in their creation platform according to functionality and features. Some tools are very user friendly and have very interactive graphical user interfaces (Memon, 2017).

Tools	Pros	Cons
Excel	1. The most popular and powerful descriptive analytics tool available in the market. 2. Trained resources are easily available	1. Unsuitable for predictive modeling 2. Limitation of 1 million rows
R	1. Most powerful free analytics tool available right now 2. Excellent for almost any kind of analysis	1. Trained resources moderately difficult to find 2. Steep learning curve 3. Needs to be supported with other technologies when dealing with large amounts of data 4. No customer support
Revolution	1. All the advantages of R along with scalabiltiy and customer support	1. Trained resources moderately difficult to find 2. Steep learning curve
SAS/SPSS	1. Excellent tools for almost any kind of analysis 2. Easy to find trained resources	1. Very expensive. Sometimes license costs exceed cost of resources
WPS	1. Excellent tools for almost any kind of analysis 2. Easy to find trained resources as it uses the SAS language 3. Cheaper alternative to SAS	1. Visualization capabilities need to evolve more 2. Can do MOST of the things SAS can, but not ALL
Hadoop	1. Free 2. Combines well with R and other tools to deal with big data	1. Very hard to find trained resources
KXEN	1. Great for automating modeling or building large number of models 2. Easy to learn	1. Very expensive
Salford/Angoss	1. Very intuitive 2. Easy to learn	1. Expensive 2. Limited number of algorithms 3. Don't deal well with massive data sets
Statistica	1. Great tool for almost any kind of analysis 2. Moderately priced 3. Easy to learn	1. Doesn't deal well with massive data sets
Tableau/Microstrategy	1. Great tools for visualization and slicing and dicing of data 2. Easy to learn	1. Unsuitable for predictive modeling
SAS E-miner / IBM Modeler	1. Excellent tools for almost any kind of analysis 2. Easy to learn	1. Breathtakingly expensive!

Figure 12: Pros and Cons of different Big-data analytic tools (Loshin, 2013)

The above figure describes the merits and demerits of different tools and techniques used in Big-data analytics. Of them, Hadoop is the most commonly used technique and the main reason for that is this tool is free and created in java platform. The program code of Hadoop is open source, so anyone can modify it for their own use. Most of the other tools available are expensive and that is the reason they are not so popular. WPS is another tool which is as good as Hadoop and has less demerits.

2.5.4. The significance of mHealth Big-data in Healthcare

Healthcare is a very important sector that needs high accuracy and high speed in decision making. In a hospital, it is very hard to maintain and analyse a patient's records or even monitor them if they have any disabilities or diseases that need such care. The utilisation of the mHealth Big-data comes up on that as it makes it easier for a human being to study and monitor patient records. Prescribing medicines and predicting diseases become helpful for the doctors with the advent of mHealth Big-data. mHealth Big-data also helps to analyse common diseases in an area and helps to take necessary precautions at the right time before the disease spreads more.

The significance lies mainly in the rural areas of India, as in such places healthcare is not so prevailed as in urban areas or cities. They need healthcare in cheaper and faster ways, because the people in rural areas may have to travel more than several kilometres to get to a healthcare facility.

2.6. Summary

The literature review was all about the mHealth systems that are currently being used in India and the status of the healthcare facilities available in rural areas. In this chapter, the healthcare applications of mHealth devices have been discussed in detail. It also gave an overview and the specifications of the Big-data generated from mHealth devices. The background study has been clearly done in the literature review to emphasise the significance of mHealth Big-data. Further, as an introduction to the analysis, this chapter provided an overall view of topics like mHealth and Big-data.

CHAPTER 3

3. ADDRESSING INDIA'S HEALTHCARE NEEDS USING BIG-DATA IN MHEALTH

As India is a third world and developing country with the second largest population in the world, the healthcare facilities available are very few. Healthcare is advancing more and goes to heights only in cities where the people have enough money to spend. But the main thing is India's major part of the population lies in rural areas where the people struggle to get healthcare. The innovation of mHealth came as a relief for this situation but still the technology is slow to reach the inner areas. However, survey results in India show that almost 70% of Indian households have smart phone connectivity with the internet available. Even if it is strange, this fact will help in creating and providing mHealth devices to these people, thereby improving healthcare. As a next step towards a solution for this issue, Big-data analysis is made possible by technology. Combining mHealth with Big-data can be helpful to bring a solution to the healthcare problems in Indian communities.

The research shows how a solution for the problem can be made, by evaluating and analysing Big-data generated from mHealth devices.

3.1. mHealth Generated Big-data

mHealth devices used by an individual will be active 24/7 and it will be producing random data every second. This data becomes a large volume as it has different statistics of the individual, and this Big-data is basically called mHealth generated Big-data. The sources of mHealth Big-data are mostly the mHealth devices used by individuals, or any mHealth application that can provide health-related statistics.

mHealth devices can detect details of the human body such as position. The device will predict whether the person is in a standing position or sitting or sleeping by proximity sensors. These data help to analyse how many calories a person has burned in a day and how many hours the person has slept. The healthcare of a person is associated with all the above-mentioned details and it is necessary to monitor such parameters to deliver good care to society. Also, in more advanced mHealth devices the facility to monitor hypertension levels and diabetes levels are now available which helps the doctor or the emergency response team. If the individual is

taking medications on a daily basis, the mHealth device will remind them to take the medication at the right time. This data will also join in the Big-data cluster having the patient statistics.

However, these data cannot be read and analysed easily. The data from all the mHealth devices will be fed into a hub, mostly a server in a data centre and analysed and further monitored using advanced software and tools.

3.2. Assessing Required mHealth Big-data for Analysis

The data which the mHealth devices are generating continuously make the Big-data bulky. Storing this vast amount of data is very difficult. But this data contains valuable information which can be retrieved only by analysing and separating the statistics. Before going to the analysis stage, the stored data can be assessed for better and precise analysis.

Only the required data needs to be analysed. Some sources of data may be faulty or if an mHealth device used by an individual is reported as malfunctioning, the data generated from that device must be eliminated from the Big-data storage before it gets analysed. The more accurate the sources, more accurate the results will be. The reason behind the analysis to be done can be different, depending whether the result required is regarding an individual or a whole community. The data source can be removed before analysing the data.

In addition, Big-data stored in a cloud-based server can contain data from other sources as well, like pharmacy data, laboratory data or the hospital records as well. If it is possible to assess and exclude unneeded sources like lab results and pharmacy data, the analysis will run faster as the data quantity is reduced, thereby reducing the energy consumption as well.

3.3. Analysis of mHealth Big-data for India's Healthcare needs

The random and continuous data generated from mHealth devices or applications are the main sources of information for the analysis to be undertake. The data is continuous, and it varies in type as it is from different types of devices, the data becomes huge in volume that cannot be analysed with any normal or the traditional database management techniques. There is software available in the market that enable easy and precise analysis of data. Hadoop is the most commonly used software for Big-data analysis due to its ease of use and user interface.

MapReduce framework is the basis of the Hadoop application. It provides a highly scalable platform for high quantity data sets. MapReduce distributes its data into different nodes and evaluates the data in a parallel manner. The data will be transparent to users and since the evaluation goes through parallel nodes the analysis will complete really fast. Hadoop is an opensource implementation of the MapReduce framework, which gained its popularity through efficiency, fast analysing strategies, and data intensive application. The organisations that deal with Big-data, like Facebook, Yahoo and twitter are using Hadoop to analyse the data. Hence this analysis method is apt software for healthcare as well (Alam, 2016).

Hadoop mainly consists of two main core components, Distributed File System (HDFS) and Execution Engine (MapReduce), where the HDFS is used to store a variety of Big-data in a conventional fashion and MapReduce is used for the analysis of the data (Memon, 2017).
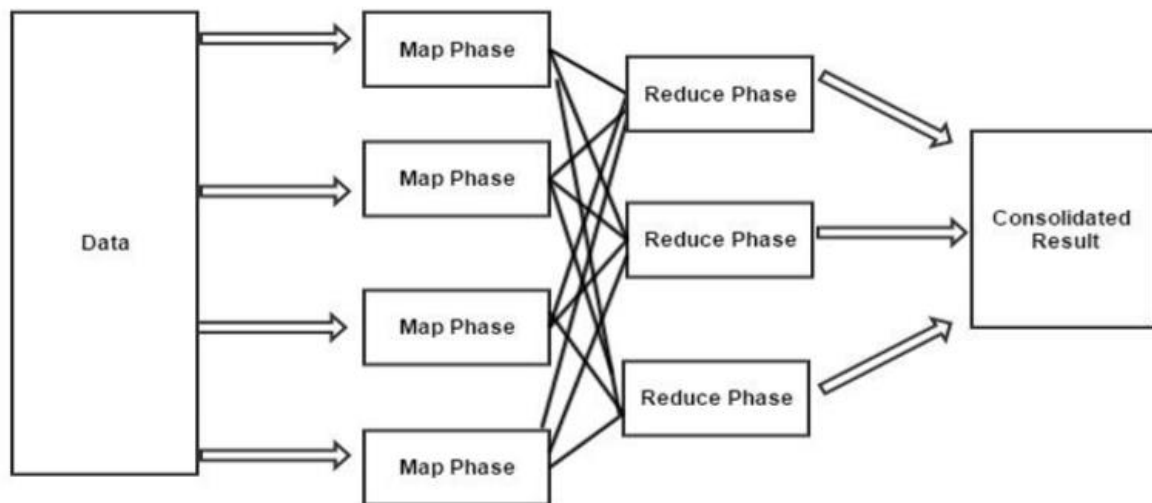
Figure 13: Hadoop framework model (Alam, 2016)

Figure 13 above illustrates the basic framework model of the Hadoop application. The data from different sources, which will be in different formats as well, are stored in the distributed file system known as the Data block. There are two phases in the MapReduce structure: the Mapper phase and the Reducer phase. The Big-data block is fed to different nodes according to the block size settings. Each node will get a small portion of the Big-data to process. The Mapper phase then analyses the data in each node and the results are combined using the Reducer phase. These combined results are then given as the consolidated output of the analysis.

3.4. Integrating mHealth Big-data Analysis in Addressing India's Healthcare Needs

All the data received from mHealth devices, which can be different in format, is stored in a single distributed file system in the Hadoop architecture. The data might be related to the health condition of an individual, or even just a pulse rate of that person. The aim is to differentiate specific information from this bulk amount of Big-data for understanding a scenario. Consider a disease is spreading over rural areas of India which needs to be detected and its spread rate examined. Big-data from mHealth devices can help in this situation, querying the disease name or the symptoms of the diseases into the Hadoop application where the Big-data from all the devices in the suspected locations are stored. The Hadoop framework will look for possible and exact matches of the symptoms from each and every node. After going through the mapper face, the output will contain the individuals who are affected by the mentioned symptoms and also show their location. This analytic method brings a high spike in the healthcare sector as it makes the work a lot easier than manual work of surveying. Furthermore, this method is said to be faster than many other traditional methods, and in Healthcare speed is an important factor.

By understanding the results of the analysis, an authority or the government can implement sufficient precautions to the community or even establish necessary facilities to avoid healthcare issues. The applications of such evaluated and analysed data is massive as the information brings out more and more knowledge about an area or a person.

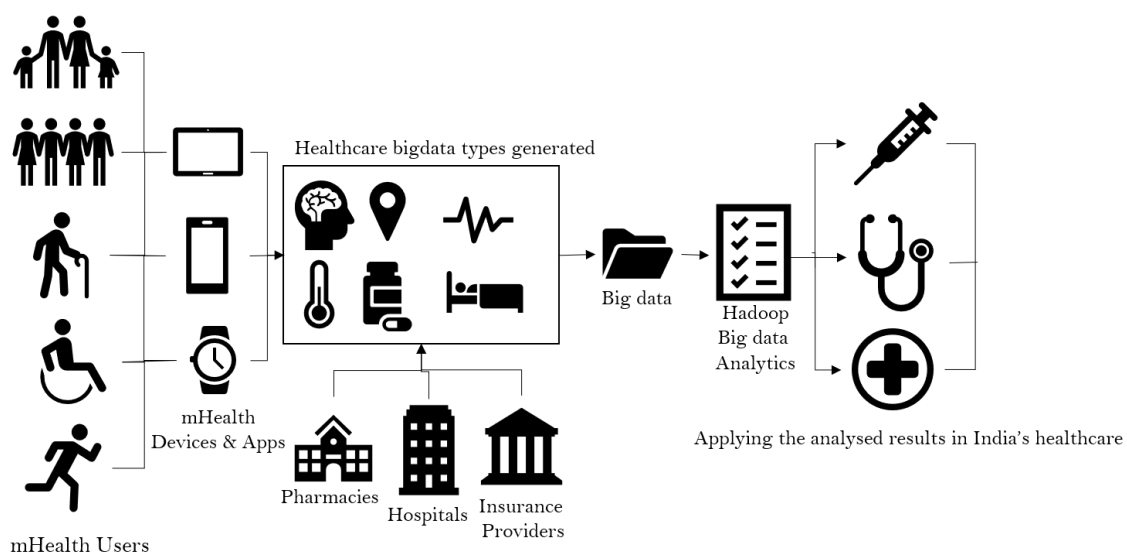1. Generated mHealth Big data types and applying results in India's healthcare

Figure 14:Generated mHealth Big-data and applying results in India's healthcare

The above figure briefly explains the complete procedure that can be used to improvise the situation in healthcare. From the mHealth users, using the mHealth devices and applications the types of healthcare data are collected. In addition, the data are collected from the hospitals, Pharmacies and the Insurance providers. Combinedly, results in a big data that is analysed using Hadoop software to determine different needs in India's healthcare.

3.5. Improving the Current System from Big-data Analytics

The current system is not so efficient as the utilisation of technology is not prominent even in this 21st century in India. Technological innovations bring vast changes, not only in the healthcare field but in every sector. Using Big-data analytics and mHealth devices can make a huge difference. The flaws of the current system can be met using this technology and thus a more efficient system of healthcare can be created.

The current healthcare system is mostly working depending on humans rather than machines and precise and accurate statistics. Using these technological innovations or applications, we get the exact information instead of predicted results. Once the healthcare facilities are implemented with the analysis techniques, the people living in that region will get updated news and awareness of diseases and can provide required vaccines and preventive medicines before the disease spreads more. Another important improvement that Big-data analysis can make is to inform the government about the results before any situation gets serious. The government can thereby take the situation under control with the help of such technologies.

3.5.1. Proposals for New Healthcare Facilities

1. Mobile Healthcare Unit: A mobile healthcare unit is an automobile having ultra-modern machineries and equipment necessary to meet an emergency. The mobile unit can roam around the region each day providing the necessary regular health checkups, thus people get a facility to consult the doctors without any travel expense. This mobile health unit should contain a doctor and an assistant at least, the mHealth data should be monitored in real time and the results should be analysed and provide necessary healthcare according to the results.

2. Online doctor consultation: Using mHealth devices in the hands of each individual, they can book appointments with doctors and even talk to them in that consultation time and describe the health problems they are facing, and the doctor can provide necessary medication instructions.

3. Real time Health Forum: If any individual is having some queries regarding any disease or the health condition, he/she can just ask a question in a real time health forum where a doctor/specialist will always be available to answer them.

3.5.2. Opportunities and Challenges

Like any other technology, the mHealth system with Big-data has both opportunities and challenges. However, considering the extensive applications of Big-data analysis, the benefits of such an implementation are far beyond the challenges not only in case of the expenditure but also in helping the community and to build a healthy generation ahead.

The Indian community as discussed has got a major portion in rural areas where healthcare facilities are very few, and an emergency response system is unimaginable. By implementing mHealth programmes in the leadership of any authorities, the people in the area will get required healthcare which is the foremost opportunity this proposal can get.

As said above, most of the Indian community is in rural areas and the people living in more inner rural areas are uneducated and have no idea about these technologies. They are unaware of smart phone usage and other smart devices. It is a very hard challenge to educate the people in such areas and distribute these devices.

3.6. Case Studies of mHealth Applications

mHealth applications are coming into practical implementation one by one, understanding the explicit use of mHealth in the healthcare field in India. Private organisations are taking some important steps to bring forward this technology and help the communities. Three different organisations that have successfully implemented mHealth systems are explained below.

3.6.1. Case Study: BMJ Group

Over the past decade the growth of mobile technology is unimaginable, and this growth has brought new ideas and innovative thinking to the improvements in different sectors. mHealth is the result of such an idea that helps mostly for healthcare systems. Even though mHealth became more popular and has been started in high income developed countries, it is not so common in middle income or low-income countries. BMJ, a global organisation whose vision is to build a healthier world by sharing new and innovative knowledge, has partnered with the University College London Institute for Global Health and the Umea Centre for Global Health Research, Sweden. They together hosted a two-day symposium on mHealth where they

published the results of the successful implementation of mHealth programmes to determine the number of childbirth events in rural Madhya Pradesh, India.

The research was conducted over a population of 1.9 million in the entire district of Ujjain in India. They were able to collect information from 1800 village works through the use of mobiles. The information collected was verified directly as well to completely rely on the data collected. The procedure was by making a call center facility to inform the childbirth events by selected community members. The response rate was more than expected, about 68% revealing 20000 prescriptions (Diwan, 2017).

The researchers concluded that implementing mobile health systems in rural areas is highly beneficial in all means, which obviously improves the healthcare of the community.

3.6.2. Case Study: The George Institute

In the background of Indian mental health, only 25 out of 100 people receive proper mental healthcare because of the lack of mental healthcare facilities and practitioners. Besides, the shortage of doctors the Indian rural society has a totally different approach to mental diseases because of less awareness and social stigma. The George Institute India implemented an mHealth system across 42 villages, before proceeding to the study an anti-stigma campaign that has been conducted to create some awareness among the villagers and thereby increase the interest in participating in this programme.

As the mentally disordered person cannot use an mHealth device or smart phone, the selected health workers and volunteers are given a tablet with a specially designed mobile app. They conducted interviews using screening questionnaires on the study participants in those villages. The collected data were updated directly into the application instantly. The analysis of this data collected helped the authority to understand the condition of the patients. The screening was conducted on 5167 people in West Godavari district in India (The George Institute, 2015).

The Institute was able to find out that about 5% of the study participants needed urgent clinical checkups and almost no one had been diagnosed or treated for such mental health conditions before. The mental health consultation was increased 1500 times and mental health knowledge has been increased.

3.6.3. Case Study: Kilkari

This project was based on the maternal and child health service in India. One of the major issues in Indian rural areas is lack of good food which causes the overall ill health of the individual especially for a woman in her pregnancy period. The lack of good vitamins and health affects the birth of the child and even the health after the birth. Kilkari is a mobile health service created by the government under the design of BBC Media action. The project planned to help about 10 million new and expectant mothers.

The Kilkari project intends to create healthier lives for the woman before the birth of the child and even after birth. The project delivers free audio messages about pregnancy and child care. The project was first tested in the state of Bihar, India where the maternal mortality rate was 219. This project targeted pregnant women and mothers of children under two years of age. As this is a government project, the telecommunication companies participated in it to bring out the maximum in helping the people by giving necessary health information (GSMA, 2016).

The Kilkari project was a great success in India as it helped the people of rural areas where they struggled to get adequate suggestions from an expert. The knowledge they got from the mHealth system has eradicated the wrong procedures and bad habits.

3.7. Summary

In this research paper, Big-data analysis has been carried out in a step-by-step procedure. The collected Big-data from the different sources was analysed using the Hadoop architecture and the output result has been closely filtered to get the desired output. The healthcare needs of the community, or an individual can be monitored by these methods and several proposals are provided to the authorities to improve the current system.

CHAPTER 4

4. RECOMMENDATIONS AND CONCLUSION

4.1. Introduction

The study of mHealth devices and their application provided an understanding of the current healthcare facilities and difficulties. mHealth devices can be used to reduce or even completely wipe out flaws in the current healthcare system. Integrating mHealth with the latest technology Big-data helps to analyse each and every detail that can be collected. The research helped to show mHealth Big-data and its advantages in analysing without any human interaction. The research pointed out some recommendations and newly proposed ideas that can help to improve the current condition.

4.2. Recommendations

Understanding of the basics and studying the existing healthcare system has helped awareness of the flaws in the current strategies. The traditional way of healthcare centres and the lack of basic healthcare options in rural areas are a major problem which India is currently facing. But, the fact is that India can improve healthcare to a great extent as mobile users are very prolific. By utilising this fact, mHealth is the most apt choice that can be used in the Indian community.

Changing the traditional system of healthcare in a technological way, the combined application of Big-data and the mHealth system can make a huge difference. Providing proper awareness through mobile phones can prevent many diseases and these mobile applications and Big-data analysis will bring out more and more useful data from which the needs of a community can be determined and thereby increase the health of an entire region as well.

4.3. Conclusion

This research study has pointed out the steps that needed to be taken to improve the healthcare of a community by using the mHealth system. mHealth is a very simple and easy to use application where the only requirement is a mobile device and internet connectivity. Indian rural areas have got smart phone availability and internet connectivity where the healthcare is most needed. The study also explained the advantages of integrating Big-data analysis along with mHealth to examine and determine the healthcare needs of an individual or a community. Despite the mHealth system, Big-data is much more complicated technology. Different types

of data in different formats are collected together and analysed to get a desired result. The data from the mHealth devices distributed over a region is collected together and analysed using special tools and techniques. Thus, an overall healthcare view point on a region and even a health condition of an individual can be monitored.

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