Adoption challenges for wearable devices by the Indian healthcare providers

A case study on healthcare providers using wearables in India
Abstract

Background:
The rapid advancements in technology to measure different bodily functions have enabled a normal person to measure various biological values of a body such as a heartbeat, calories, blood pressure, and more. These measurements can help healthcare providers provide better disease assessment, but what are the challenges that make it difficult for healthcare providers to adopt such devices?

Purpose:
This thesis investigates the challenges that healthcare providers face in adopting wearable devices.

Method:
To achieve the thesis' purpose, the authors choose to conduct a quantitative study through a survey and a qualitative study through semi structured interviews. The data was acquired through an online survey of Indian healthcare providers and the public, which was distributed using the messaging app WhatsApp. To ensure that enough responses were collected, the authors adopted a non-probability snowball sampling approach. The interviews were conducted in India in person. The questionnaire was divided into five sections based on the Theory of Planned Behaviour (TPB) and the Technology Acceptance Model (TAM), two well-known theories for predicting human behaviour on technology adoption.

Finding:
The findings reveal that individuals' attitudes towards using wearables and their purchase intentions serve as strong predictors of its adoption intention. The study also highlights that the primary challenges hindering the adoption of wearable technologies in the healthcare sector are the ease of use and device affordability. These findings contribute to a better understanding of the factors influencing the adoption of wearables, offering valuable insights for healthcare professionals and stakeholders in promoting their effective implementation.

Keywords:
Healthcare Providers, Wearables, Adoption, TAM, TPB
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Sincerely,

Sourabh Jaiswal
Raghwendra Singh
List of abbreviations

OECD Organization for Economic Cooperation and Development
GDP gross domestic product
IoT Internet of things
IT Information Technology
CVD cardiovascular disease
ECG Electrocardiogram
OS Operating System
TAM Technology Acceptance Model
TPB Theory of Planned Behaviour
PU Perceived Usefulness
PEU Perceived Ease of Use
PE Perceived Enjoyment
VA Visual attractiveness
SN Subjective Norm
PBC Perceived Behavioural Control
JMP Jump
SPSS Statistical Package For The Social Sciences
SD standard deviations
ATU Attitude towards Using
PI Purchase Intention
TRA Theory of Reasoned Action
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1. Introduction

Chapter one presents an introduction to the main area of concern; the purpose and significance of the study; the research question; the scope and delimitations; finally, the thesis organization.

1.1. Background and Research problem:

A human body functions like an orchestra of millions of interdependent functions. Humans have been studying our bodily functions for millennia and still we continue to find unanswered questions every day. The endeavours towards the understanding have required various physiological measurements starting from listening to the beat of a heart to the sound of blood moving in our veins (Wu and Luo, 2019). These measurements helped us to understand and fix various functions which may have gone wrong. In modern times with advancements in chip manufacturing and low energy-intensive communications, these measurements can be taken very precisely and continuously. Today researchers can incorporate many biosensors within small devices. This has given rise to an increasing number of wearable sensors that can measure biological data from our bodies (Sun et al., 2007). These wearable sensors are referred to wearables within this thesis. Wearables can measure a range of values from a human body. The most important ones are heartbeat, temperature, and blood oxygen level. Appendix 1 lists the various measurements which relate to healthcare measured by wearable sensors.

In today's modern society, individuals are confronted with the demanding challenges of fast-paced learning, work responsibilities, and the complexities of daily life. Moreover, the prevalence of chronic illnesses, such as heart disease, is on the rise, posing additional obstacles to overall well-being. Concurrently, healthcare providers are facing a multitude of pressing issues within the contemporary healthcare landscape. These include coping with an aging population, managing the escalating burden of chronic diseases, addressing the soaring costs associated with hospitalization, and mitigating the risks of medical errors (Baig et al., 2017).

Within the healthcare sector, a healthcare provider refers to both individual professionals and health facility organizations that offer crucial healthcare diagnosis and treatment services encompassing medication, surgery, and advanced medical technologies (Legal Information Institute, 2022). Chronic conditions like heart disease, stroke, cancer, diabetes, and arthritis exemplify medical conditions that can be managed but not cured (Eaton, Roberts and Turner, 2015). The increasing number of individuals living with chronic illnesses is placing a considerable strain on healthcare providers, further amplifying the urgency for effective solutions (Honglun Meimei and Minghui, 2013).

Accurate diagnosis based on reliable data is a paramount requirement for effectively addressing and treating these medical conditions. However, medical diagnosis is a multifaceted task that demands precision, efficiency, and comprehensive expertise. The automation of the diagnostic process holds immense potential for yielding significant advantages. It is unfortunate that not all doctors possess expertise in every subspecialty, and in certain regions, there is a scarcity of
qualified professionals. Consequently, an automatic medical diagnosis system would prove exceedingly beneficial by synergistically bringing together diverse medical expertise and resources (Soni et al., 2011). In this context, wearable devices can play a vital role as a sophisticated medical diagnosis system. These wearable devices are capable of capturing and measuring various physiological changes within the human body. By harnessing these measurements, accurate diagnosis and precise medication dosage calculation can be achieved, thereby optimizing patient care and outcomes.

Wearable devices are hardware devices that can be worn or attached to the human skin, allowing continuous monitoring of an individual’s actions without hindering their movements (Haghi Thurow and Stoll, 2017; Steele et al., 2009). These devices track and measure various physiological and biomechanical parameters, including sleep quality, pulse, ECG, blood glucose levels, cardiac fitness, brain activities, blood pressure, blood oxygen levels, body temperature, pulmonary readings, and blood alcohol content (Vermesan et al., 2011). By collecting and transforming healthcare data in real-time, wearable devices enable a continuous and personalized approach to monitoring. Moreover, the incorporation of unseen scanning and sensory features, in wearable technologies has the potential to enhance healthcare-seeking behaviours and improve doctor-patient communication (Maisto, 2013). Wearable devices come in various forms such as finger rings, hand belts, clothing, spectacles, and lenses (Haghi Thurow and Stoll, 2017).

In the realm of medical diagnosis, two main categories of wearables can be distinguished. Fitness wearable devices, primarily assist users in monitoring and tracking their daily fitness parameters, including steps, distance, calories burned, sleep, and diet. On the other hand, medical wearable devices, are specifically designed to address the needs of the elderly and individuals with illnesses, targeting the treatment and management of specific conditions like diabetes and cancer (Gao, Li and Luo, 2015).

According to (Vijayaraghavan et al., 2017) Medical wearable devices used for continuous monitoring of chronic diseases have a unique value proposition because their sensors are capable of monitoring multiple biomarkers, including those associated with diabetes, hypertension, and certain lung conditions such as breast health, skin health, cardiovascular health, asthma monitoring, nicotine levels, blood glucose levels, bedsore and ulcer prevention due to inactivity during hospitalization. Another area being investigated is the therapy and management of neurological problems to modify behaviour and treat anxiety and depression, as well as monitor and prevent seizures, stroke, and other neurological disorders. These IT-based technology gadgets acquire real-time data from biosensors in real-time. Despite their enormous potential, some medical wearable in healthcare applications is more popular. These stand out due to their unique requirements, broader impacts, and fewer costs and risks, among other advantages.

A fitness wearables device can typically track activity (e.g., step count) as well as other physiological data (e.g., heartbeat rate). The data is uploaded and stored on a server, and it is visualized in ways that allow users to track their progress and provide feedback in real time. The data can also be shared with other social media platform users. The goal is typically twofold: the data visualization will increase awareness so that users are aware of their most
recent activities, and the social sharing platform will provide additional support to motivate
individuals to maintain personal activities (Consolvo et al., 2006; Toscos et al., 2006; Maitland
et al., 2006; Ali-Hasan et al., 2006; Lin et al., 2006). So, all physical activity tracker platforms
include some form of goal setting and feedback mechanism, notification features, and social
sharing, which allows users to share tracked data with groups and/or other individuals.

Wearables have been successfully used in the healthcare industry for a variety of applications
and for a long time. Wearable devices can be used as assistive technologies to enhance human
senses (Lee & Song, 2012; Tanuwidjaja et al., 2014) as prosthetics to replace or support human
organs or limbs (Oliver et al., 2009), or as medical devices to track specific medical conditions
(Grönvall & Verdezoto, 2013). In recent years, there has been an increasing demand for a
sustainable health system that can manage not only acute care (in hospital wards or emergency
departments) but also outpatient care, particularly for those with chronic illnesses. The expense
of hospitalization, as well as the cost of rehabilitation following a major illness or surgery, is
steadily rising. Permanent placement in a care facility is a costly method of providing care for
individuals, who would like to remain in their own homes to save on cost. Hospitals are
considering sending patients home to recover as earlier as possible. Several physiological
markers must be monitored continuously during this recovery phase. As a result, remote patient
monitoring at home is becoming increasingly crucial. IoT-enabled wearable devices, that record
crucial patient information and aid in remote monitoring, are proving to be an excellent tool for
chronic disease prevention, early detection, and management (Baig et al., 2017; Woo et al.,
2018).

The acceptance and adoption behaviours of people and organizations are critical to the success
of a technology-based innovation such as IoT-based wearables for healthcare applications
(Sivathanu, 2018). When using new technologies to aid in medical treatments, medical
professionals are always concerned about the risk and uncertainty. As a result, medical
professionals typically adopt new technologies later, until they have become more mature and
safer in their application. To effectively promote the spread of such devices in hospitals, a study
of how medical professionals adopt wearables is desperately needed. Furthermore, many
researchers have generally argued that hospital characteristics other than IT-related attributes,
such as hospital size/type and user/provider type, may influence the acceptance of emerging
technology in hospitals (Wu and Luo, 2011).

The spread of wearable technologies has been considerably faster in developed countries, and
it has just lately begun in developing countries like India. In a country like India, where the
patient-to-doctor ratio is excessively high, doctors have a huge opportunity to integrate data
from patients wearing wearable biosensors and using an integrated mobile app to improve
patient care and clinical outcomes (Nanda, 2017). However, in India, there are considerable
barriers to its implementation in health care. The medical innovation industry and respective
marketers face a problem in lowering innovation costs and raising customer awareness in the
midst of transforming research by collecting huge data on pre-symptomatic patients to better
understand disease etymology and generate earlier inventions (Nanda, 2017). This study
provides a more comprehensive understanding of consumer and healthcare professional
acceptance of healthcare wearable devices, especially fitness wearables.
For this thesis, the wearable sensors that are externally worn are being considered, with a primary focus on the Indian market for such device adoption. More specifically smartwatch type of sensor measuring Oxygen saturation, heart sounds and body movements. These sensors are used to aid the diagnostics of various diseases.

### 1.2. Purpose Statement and Research Questions

This thesis focuses on challenges with the use of wearable sensors as an aid to healthcare monitoring. The goal is to investigate the various reasons that prevent healthcare providers from using wearable devices to aid in patient health monitoring.

**RQ:** What are the barriers to the adoption of wearable technology by today's healthcare providers in India?

Our study on wearable adoption in healthcare could help researchers and practitioners understand and compare sub-sequential transformations of the healthcare industry embedded with wearable biosensors for continuous health monitoring of inpatients and outpatients. Aside from that, our contribution to Wearables could be used by healthcare providers in developing countries to create long-term competitive advantages through the adoption of technological advancements in the industry setting.

### 1.3. Topic Justification

Currently, there has been a sale of about 444.7 million wearable devices in the year 2020 according to IDC Corporation USA (IDC: The premier global market intelligence company, March 2021). These devices record data about a person’s heartbeat, breathing rate, activities like steps, workouts, and even blood oxygen levels during the time they are being used by the person. Most of them are built such that they can be worn throughout the day and night to even measure sleep patterns. These different data can and have proven to be valuable while diagnosing various diseases and their severity. For example, a very recent outbreak of Coronavirus resulted in Covid 19 disease. The severity of this disease could be measured by the oxygen level in the blood as this disease affects the lungs of a person. A lower oxygen level indicated a life-threatening situation and fatality could be prevented by giving a higher amount of oxygen to the patient. If it is observed that the patient is exhibiting signs of hypoxia, then an Oxygen therapy is prescribed. (Pascarella G et al., 2020). At present this data can be extracted by the patient taking the device to the hospital and connecting it to either a computer or noting it down on a piece of paper. If there was a way that healthcare organizations could seamlessly connect to the device and extract data directly to its system and configure alerts on any anomaly, a lot of complications as well as lives could be saved.

Furthermore, Cardiac arrhythmia, defined as abnormal heart rhythms, is a very common type of cardiovascular disease (CVD) and is thought to be responsible for most of the sudden cardiac deaths that occur every year. The most common test for cardiac arrhythmia is an Electrocardiogram (ECG). The ECG measures the electrical impulses of the heart via electrodes on the skin’s surface. Myocardial infarction, cardiomyopathy, and myocarditis are various
cardiovascular diseases which can be detected by using a Long-term ECG (Li P. et al., 2017). However, it is difficult to diagnose many arrhythmias with a standard resting ECG, because it can only provide a snapshot of the patient’s cardiovascular activity in time. An intermittent arrhythmia can go unnoticed, and physicians must rely on self-monitoring and symptoms reported by patients to support their final diagnosis. In some cases, ambulatory recording of ECG data, collected over extended periods, may be taken in an attempt to acquire data during an occurrence of an intermittent arrhythmia. However, existing solutions for this type of recording are limited. Although they can lead to a diagnosis and therapy that may greatly improve the quality of life for the patient, they can be inconvenient for both the patient and the physician (Oresko et al., 2010).

This thesis will discuss the challenges and barriers that prevent a user and a healthcare professional from making substantial use of wearables to control chronic sickness. For instance, diabetes and cardiovascular diseases are better detected and controlled with continuous monitoring.

1.4. Scope and delimitations

The suggested study attempts to determine the important elements that influence an individual's intention to use wearable equipment for healthcare. To propose the research model, the extended technology acceptance model with numerous external variables was used. Online surveys and individuals interview with various stakeholders such as doctors, nurses, patients, people of various ages, and wearable developers was conducted to understand everyone’s perspective on the adoption, challenges, and uses of wearables in healthcare. It will display a genuine list of impediments to the integration of wearables in healthcare. With this empirical data, we will use a model which consists of TAM and TPB to complete our thesis.

However, this study has some delimitations, such as the fact that we can only reach a limited number of healthcare professionals to obtain feedback on the adoption of wearables within the healthcare domain, and how beneficial it would be to obtain data from user devices rather than physically meeting and conducting several tests. Furthermore, the respondents have been chosen using snowball approach which limited them to be confined to friends and relatives. This increases the risk of community bias. Similarly, the author is a Google partner employee who works on Android Wear OS. The author contacted a limited amount of his colleagues to obtain their opinion. However, he fails to meet or understand the perceptions of other brands such as Samsung, Apple, and Xiaomi regarding the development motivation and adoption opportunity of wearable technologies from their context. As a result, it may influence our conclusion.

1.5. Thesis organization

This thesis presents the findings of the research in six chapters. The first chapter provided an overview of the principal area of concern, the objective and significance of the study, the research question, and the scope and constraints. The second chapter is a review of the literature, which starts with search criteria, and a review of published material of general importance to
this topic. And further it goes with a definition of wearable devices, then moves on to the topic of wearable inclusion in healthcare and furthers the Theories of Technology Acceptance. Lastly, the research hypotheses.

Thereafter, chapter three presents the methodology of this research paper. It starts with the research philosophy, approach, and purpose. Then comes research strategy and design. Further data collection, interview, and survey design, sampling, and then data analysis. Finally, the limitations of the methodology and certain reliability and validity metrics, as well as some ethical considerations, are mentioned. Chapter four presents the empirical findings from the data collection. It begins with demographic sample details, and then moves on to detailed descriptive analysis of acquired data. Finally, it concludes with Hypotheses Testing.

The findings are explored further in Chapter 5, where the respondents are separated into two categories: attitude toward adoption and purchasing intention. The variables used to study the adoption barrier via TAM and TPB were discussed. The final chapter is chapter six, which wraps up the entire research work. It offers a summary of the important findings as well as some recommendations for further research.
2. Literature Review

This chapter provides an overview of wearable technology as well as a more in-depth look at the use of wearable in healthcare. Following that, an in-depth theoretical foundation is provided, including the establishment of a theory-based research framework and the formulation of hypotheses.

2.1. Search Strategy

The significance of establishing what is already known in the body of knowledge before undertaking any research study cannot be overstated (Hart, 1998). A literature review is a summary of what has been published on a particular topic by recognised scholars and researchers (Taylor et al., 2008). This convinces the reader that your work was well thought out. A literature study was done for this thesis, and the author conducted it in a systematic manner to help in enhancing the intellectual standards and value on the chosen topic. The research plan was developed using Creswell & Creswell’s technique (2017). According to this, a search for certain terms and keywords was undertaken in selected databases of scientific journals, periodicals, and online libraries in order to first investigate the relevant literature. A second round of selection was conducted using filters such as publication year, language, and degree of relevance to determine which items should be kept and which should be removed. To improve the literature review and identify more important scientific papers, a search using searching platforms and academic journals was followed by a backwords search. Backwords searching entails searching the reference list of the searched works for further related material (Creswell & Creswell, 2017).

To identify relevant academic literature, several scholarly databases were used. An initial keyword search was conducted using the Linnaeus University OneSearch search engine to identify open relevant literature, such as books, articles, and scientific journals. Google Scholars and Linnaeus university library databases (IEEExplore and Scopus) were chosen to ensure broad coverage of articles and conference papers relevant to Warbles and Technology use in education. A second search in the 'Basket of eight' journals was added to the literature review. The basket of eight, refer to the top journals in the field of Information System (IS) which includes – the European Journal of Information Systems, Information Systems Journal, Information Systems Research, Journal of AIS, Journal of Information Technology, Journal of MIS, Journal of Strategic Information Systems, and MIS Quarterly.

A list of keywords was identified in order to search for topic-related literature. After the keywords were determined, the Boolean operators "AND" and "OR" were used to connect them, and different keyword combinations were tried for the initial search. We were able to obtain 50+ related documents as a result of the search procedure, allowing us to begin our research. The inclusion and exclusion criteria were then established to ensure that the research papers were both relevant and of high quality. The papers that were chosen had to be in English, published between 2000 and 2022 (recently released content because of the ongoing progression of this topic), and should freely be available in full text. After applying all the previously mentioned filters, we found the appropriate, relevant, highest citations, and
reference-worthy material. We further filtered the documents by scanning the abstracts, important headers, and conclusions, resulting in 30 odd documents. Furthermore, it revealed a gap in the field's research.

During the search, the following keywords and their combinations were used:

- Wearables
- Wearables AND Healthcare
- Wearables AND Healthcare professional AND Adoptions
- Wearables AND healthcare applications AND adoption
- Adoption AND Challenges AND wearable AND healthcare professionals
- Adoption AND Challenges AND Technology OR Wearables

We have narrowed down the topics based on the review, as indicated below.

2.2. Classification of Wearables

Wearable devices are an important application of the Internet of Things (IoT), which has grown dramatically in recent years (Felea et al., 2021). A wearable device is any computer device that refers to smart technological items that are embedded in a variety of accessories that can be worn on the body (Wright and Keith, 2014). Just a few examples include smartwatches, smart strips, smart eyewear, and even smart jewellery. A vast number of the gadgets/devices included various sorts of sensors that collect data and information to improve the devices and the consumer experience. As a result, these technologies are focused on offering direct services to consumers, such consume low energy and provide continuous monitoring, as well as secure communications and data protection. According to Borowski-Beszta & Polasik (2020), these devices have various common properties, including:

- Hands-free operation allows users to perform multiple things simultaneously.
- The user always has complete control over it.
- The devices are outfitted with a variety of sensors and operating modes.
- Keeping the user's attention through alerts, reminders, or messages.
- They can communicate with one another via an IoT wireless network.
- The user can operate the device independently; the device does not require his attention.

There are various sorts of wearables on the market; table 1 shows a categorization done by Tarabasz and Poddar (2019)

<table>
<thead>
<tr>
<th>Sector</th>
<th>Type</th>
<th>Body Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumers: Health</td>
<td>Smartwatch</td>
<td>Head</td>
</tr>
<tr>
<td>Sport and fitness</td>
<td>Fitness tape</td>
<td>Ear</td>
</tr>
<tr>
<td></td>
<td>Virtual glasses</td>
<td>Eye</td>
</tr>
</tbody>
</table>
2.3. Application of Wearable in healthcare

For millions of years, humans have struggled with health issues. Diseases can bring a lot of stress and discomfort. Patients must visit the hospital every time they seek medical care because traditional healthcare services require well-trained professionals and heavy-duty testing equipment (Wang et al., 2017). This makes real-time and long-term health monitoring more inconvenient, especially for chronically ill patients and those recovering from surgery. Traditional diagnostic procedures will be changed, and medical equipment will be revolutionized, thanks to wearable flexible electronic technology that provides timely, remote, wearable, and portable functionalities (Lou et al., 2020). Wearable healthcare technology devices can increase the accuracy of health information while also encouraging healthier behaviour in individuals, resulting in significant improvements in their health and lower healthcare expenditures. When applied to a sporting setting, athletes can improve their sports performance by checking physiological data such as heart rate, running pace, and core temperature, as well as other kinematic factors such as joint angles or temporal parameters (Cheung et al., 2019).

Wearable gadgets will play a bigger role in health care and become more embedded into people's daily lives as personalized health concepts become more widespread. According to Lu et al. (2020), these devices are mostly engaged in the monitoring of health and safety, chronic disease management, and disease diagnosis & treatment.

2.3.1. Monitoring of Health and Safety

Wearable gadgets' health and safety monitoring functions are mostly used for elderly persons, children, pregnant women, and patient groups. The gait, walking speed, posture, respiration rate, blood oxygen, heart rate, blood pressure, energy expenditure, position, and other associated characteristics of the user are all monitored in real-time to inform nursing needs (Takei et al., 2015). For the elderly, Wearable gadgets are used to measure gait and fall risk detections (Godfrey, 2017). For children, in addition to detecting routine vital signs for health management, Wearable devices equipped with GPS positioning technology can be used to track the child's location and amount of exercise in real time (Wen et al., 2017). It can also be used to track mood in children and adolescents in order to predict depressive symptoms (Sequeira et al., 2020). Pregnant women's health monitoring can be split into two categories. These applications can be used to track physiological status, mental state, sleep, and other data before and after conceiving, while wearables can also be used to provide quick feedback on specific problems that arise during the child-rearing process (Prioreschi et al., 2018). According to Takei
et al. (2015), wearable devices can be used to track symptom changes throughout therapy for patient groups, which can be useful for disease monitoring and efficacy evaluations, as well as contributing to the personalization of treatment plans.

2.3.2. Management of Chronic Diseases

Changes in passive disease therapy to active health monitoring are part of chronic disease management. According to National Cancer Institute (NCI) dictionary, Chronic disease can be defined as - A disease or sickness that lasts at least three months and may worsen over time. Chronic diseases are growing more common among people of all ages, and they can usually be treated but not cured. Cancer, heart disease, stroke, respiratory disease, diabetes, and arthritis are the most common chronic diseases. Wearable devices make data collecting and monitoring easier throughout the day, as well as offer dynamic, intelligent, and complete analysis of numerous indicators to allow clinicians to treat chronically ill patients. Through cloud services, this technology also allows for remote illness monitoring, revision of remote treatment plans, lifestyle management, and other tasks, all of which are critical in disease management (Sun et al. 2016).

Cardiovascular diseases, one of the most frequent chronic diseases, are often overlooked. It's critical to improve everyday monitoring in order to detect and control the cardiac disease. According to a study done by Kaspar et al (2018), the use of a wearable cardioverter-defibrillator protected patients from sudden cardiac arrest in nonhospital settings until the reimplantation of an implantable cardioverter-defibrillator. Thanks to the advent of low-cost wearable devices, People can now continually monitor their heart rate, pulse, oxygen saturation, and physical activity, as well as audio to detect cough, breath sounds, and other attributes. These signals can be employed in predictive analysis to detect early signs of lung function impairment. The feasibility of utilizing a smartwatch for centralized monitoring of COPD (chronic obstructive pulmonary disease) patients was proven in a prospective cohort study conducted at the University of Toronto (Colantonio et al., 2015). Diabetes, one another chronic diseases, is a category of metabolic illnesses defined by glucose-induced by insulin secretion abnormalities or biological actions that are disrupted. Damage, dysfunction, and failure of many organ tissues, particularly the eyes, kidneys, nerves, heart, and blood vessels, can result from long-term poor glycemic control (Flannick et al., 2016). Improving the ability of diabetic patients to self-monitor and self-manage their blood glucose levels has helped to reduce diabetes-related morbidity and death. As a result of the advancement of mobile and sensor technology, wearable dynamic blood glucose level monitoring products have arisen. Spectrometry, blood substitution (urine, tears, and tissue fluid), counter-ion electroosmosis, and microwave technology are the most used and painless procedures compared to traditionally measured blood glucose levels by extracting a venous blood sample or taking a finger-prick blood sample which were inconvenient and painful.

2.3.3. Disease Diagnosis and Treatment

For timely diagnoses and treatments, a thorough understanding of changes in physiological and pathological indices during the early stages of disease is essential. Wearable devices are extremely useful in the diagnosis and treatment of a variety of diseases because they can track
changes in vital signs in real time (Sun et al., 2016). According to recent studies, wearable gadgets have proved to have significant application possibilities in the early identification of neurological illnesses such as Alzheimer's disease. In studies it has found that, the user's gait metrics can be gathered using a wearable device for early identification of Alzheimer's disease. Similarly, Wearable nocturnal breathing monitoring technology can increase the accuracy of early identification in individuals with Obstructive Sleep Apnea Hypopnea Syndrome (OSAHS) and can be used at home (Crupi et al., 2015). Apnea, which is defined as a pause in breathing lasting more than 10 seconds and Hypopnea is defined as a 50% reduction in ventilation that leads in a 4% or more fall in arterial saturation due to partial airway blockage (NHLBI, 2010). In the utility of wearable in the process of diagnosis and treatment, A wearable defibrillator have found to assist monitor arrhythmias in patients who are at risk of cardiac arrest. When cardiac arrest or ventricular fibrillation is diagnosed, emergency defibrillation can be used to restore normal rhythm (Odeneg et al., 2019).

2.4. Challenges in acceptance of wearables in healthcare

Despite the potential benefits, broad adoption and use of wearable technologies faces substantial obstacles. These devices' ability to track, retain, and transmit patients' health data raises concerns about data security and privacy (Amyx, 2017). Wearables' design, accuracy, and reliability have also been key sources of worry (Chuah et al., 2016). Wearables may not track heart rates accurately in people of colour has also been highlighted as one barrier (Hailu, 2019). Another key barrier is the acceptance of innovative wearable technologies by the technology community. According to market research, these devices are being used less frequently and are being abandoned after a few months of purchase. Finally, the country's culture, as well as digital and health literacy, are seen as important concerns in the uninformed adoption of wearables in developed and developing nations. We go over a few of them in detail and then compare our findings with these in our discussion section.

2.4.1. Healthcare service challenges

The healthcare system's structure and care delivery methods, as well as the immaturity of wearable solution present today, are the major challenges to putting wearable technologies in daily use in healthcare systems. The existing healthcare system is fragmented, and the care delivery model makes it difficult to share information and care. Wearable technology implementation will require a shift in such delivery model, as well as responsibility and data sharing between doctors, other care professionals, and even informal caregivers like families. The type of data, the patient's general and health literacy, and the specific goals for recording the data all have an impact on the data's reliability. Using heterogeneous data from a range of sources, such as patients and informal caregivers, is considered "not approved/validated" by the healthcare system, and thus "non-reliable data." Working with this data could result in issues with liability and responsibility, as well as worries about data security and privacy. Another barrier in adoption, is that This requires additional time, education and training for healthcare provider to work with the system, which increases the workload and cost for organisations. Furthermore, we cannot overlook the massive amount of data it generates, which increases the burden on healthcare providers to treat it while adhering to all security and privacy constraints. To implement these solutions, communication infrastructure is required, which currently does not exist, and it is unclear who will pay for it. The technology's cost is also an impediment, as healthcare organizations cannot afford it. This is why it is only given to select groups of people with special needs (Lewy, 2014).
2.4.2. Digital and Health literacy

Despite the fact that the digital health industry is rapidly growing and has the potential to improve health results, it is failing to reach and meet the needs of a larger population. Wearables have the potential to help achieve widespread adoption and successful application of digital health technologies. However, a lack of digital literacy inhibits both the adoption and effective usage of digital health devices once they've been adopted (Gualtieri et al., 2018). Because of the fast-increasing availability of information via the Internet or wearables, the ability to improve the 4Ps (predictive, precise, preventative, and personalized) of medicine has improved (Alonso et al., 2019). As a result, patients will expect their healthcare providers to possess a high level of medical knowledge as well as digital literacy, as well as the ability to meaningfully interpret these growing data streams for the benefit of patients and, where necessary, translate this information into appropriate action (Kooman et al., 2020). For consumers to make educated decisions, wearable devices require knowledge of technological capability (such as data collection, transmission, storage, and future use). Many of us acknowledge that we are unclear about the scope of data collected from us in the background by these devices, as well as how that data is used. According to the study, 91 percentage of American adults says, "Consumers no longer have choice over how companies collect and use their personal data". Most technology consumers have a limited understanding of technology and data flows (Hagen, 2017).

As wearables become more mainstream around the world, is it bridging the digital divide by making health monitoring more accessible to everybody, or is it widening it? Only younger, healthier, wealthier, more educated, and technoliterate adults use wearables, leaving other groups behind. As the most consumers are young (between the ages of 25 and 34), the benefit to these younger consumers—who are presumably in good health—is likely to be negligible. Individuals over 55, on the other hand, account for the smallest proportion of users (TLD Health, 2020).

2.4.3. National Culture's Social influence

A country's cultural values influence technology acceptance (Alshare et al., 2011). Risk appetite is more valued in high uncertainty avoidance cultures than in low uncertainty avoidance cultures. Adoption of new technologies will introduce new risks, such as concerns about privacy and ineffective technology. As a result, people in high uncertainty avoidance cultures may be hesitant to adopt new technologies. Similarly, people in an indulgence culture believe that having fun and being entertained are basic human needs that should be met (Hofstede et al., 2010). People who live in a restraint culture believe that social norms and prohibitions should limit human behaviour and that engaging in leisure activities, overconsumption, and other indulgence behaviours are wrong. As a result, people in a high-indulgence culture are more likely to purchase wearable health care devices for nonpractical functions such as gamification and innovation rather than practical functions (Minkov, 2007). Finally, the degree to which people prefer to care for themselves and their families is reflected in individualism versus collectivism. Individuals in an individualistic culture place greater emphasis on themselves, whereas people in a collectivist culture place greater emphasis on their families. Individualistic cultures are more familiar to using emerging technologies in their daily lives, such as email, online banking, and e-commerce. People in collectivist countries value spending time with
family and friends over spending time on the internet. As a result, people in individualistic cultures may be more likely to use wearable health care devices (Minkov, 2012).

2.5. Theories on Technology Acceptance:

Understanding the consumer behaviour and preferences of the user is crucial for effectively deploying an information system or technology. In health care, new technologies are constantly being implemented (Blackwell & Blackwell, 2008). Modern information and communication technology (ICT) has been shown to improve service quality in the health care sector in general, as well as in clinical medicine and hospitals, by increasing patient safety, staff efficiency and effectiveness, and lowering overall costs (Scott, 2007). Thanks to the emergence of wearable technology, the phenomenon of "anywhere, anytime" communication is now predominant. It has also demonstrated a promising role in healthcare. Despite the widespread use of wearable, there are few research that look at the aspects that influence healthcare adoption of these devices in general (Kim & Shin, 2015). To explain the adoption of various technologies, several theoretical models have been developed, such as TPB, TAM, Theory of Reasoned Action (TRA), Social Cognitive Theory (SCT), Motivational Model (MM), and Innovation Diffusion Theory (IDT).

One of the most popular psychological theories for explaining how people naturally respond to various technology is the theory of planned behaviour (TPB). This model hypothesises that intentions are influenced by three factors: attitudes toward the behaviour, subjective norms, and perceived behavioural control (PBC) (Irawan et al., 2022). According to Garrison et al., (2018), the determinants of TPB, mentioned previously, have a direct relationship with technology adoption. For example, in a study on cycle commuting adoptions in the Spanish city of Victoria-Gasteiz, the authors discovered that a positive attitude and the presence of subjective norms influenced cycling adoption (Lois et al., 2015). However, because the TPB model only takes into account the effects of user-related or internal factors on technology use intention, some studies on technology adoptions used the TAM instead. And it was identified by its robustness, parsimony, and predictive power in explaining technology acceptance across a wide range of technological settings, and it was able to explain as much as 50% of IT acceptance behaviours (Holden and Karsh, 2010). According to this model, perceived usefulness, perceived ease of use, and attitudes towards use, all have a major impact on a person's intention.

2.6. Theoretical Background & Research Model

This thesis adopts a research framework that incorporates two widely discussed models in the field of technology adoption: the Theory of Planned Behaviour (TPB) and the Technology Acceptance Model (TAM). Through an extensive review of existing studies on technology adoption, specifically focused on wearables, it has been observed that TPB and TAM are the most commonly employed models in this context. The literature indicates that behavioural intention is influenced by factors such as attitude, subjective norms, and perceived behavioural control with intention serving as a determinant of actual behaviour. The TAM model, in particular, highlights the significance of perceived usefulness and perceived ease of use in shaping attitude. Building upon this foundation, our analysis explores the interrelationships between perceived usefulness, perceived ease of use, and perceived behavioural control. By focusing on these theoretical constructs, we aim to address the existing gap in understanding
and provide valuable insights into the factors influencing technology adoption within the context of wearables.

The definitions of each of the variables used in this study are provided in the following table 2. This research, it is expected, will provide a new layer to our understanding of the impact of psychological factors (through TPB) and TAM's basic beliefs (perceived ease of use and usefulness) on wearable adoption in Indian healthcare. India was chosen for this study since it is one of the top ten countries in terms of personal wearables usage. Wearables are used by almost 41% of Statista respondents in India, which is greater than any other country.

Table 2: Determinants used in adopted research framework

<table>
<thead>
<tr>
<th>Determinants</th>
<th>Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived Usefulness</td>
<td>The extent to which an individual believes that employing technology will help him or her perform better on the job.</td>
</tr>
<tr>
<td>Perceived Ease of Use</td>
<td>The extent to which someone believes that using technology would be comfortable (Davis, 1989)</td>
</tr>
<tr>
<td>Attitude towards Using</td>
<td>How much someone likes or dislikes a particular behaviour, and takes into account the results that come from doing that behaviour.</td>
</tr>
<tr>
<td>Subjective Norm</td>
<td>The extent to which an individual believes that the majority of individuals who matter to him believe he should or should not use the system (Fishbein et al., 1975; Venkatesh &amp; Davis, 2000)</td>
</tr>
<tr>
<td>Perceived Behavioural</td>
<td>The extent to which an individual believes he or she can perform a specific behaviour (Ajzen, 1991)</td>
</tr>
<tr>
<td>Control</td>
<td></td>
</tr>
</tbody>
</table>

**TAM** (Technology acceptance model) (Fig. 1) has long been regarded as one of the most effective models for forecasting people's behavioural intentions (Sprenger & Schwaninger, 2021). TAM has been used to investigate individual adoption behaviour over the years (Davis, 1989). This included a variety of technologies in a variety of circumstances with varying control elements (Lee et al., 2003). The Technology Acceptance Model has been widely used in a variety of research, adoption of online shopping (McCloskey, 2003); e-learning and mobile financial services adoption (Lee & Song, 2012); internet banking acceptance (Al-Ajam et al., 2013); and acceptance of blockchain technology for corporate governance through cryptography (Singh, 2019). According to Venkatesh & Davis (2000), perceived usefulness and perceived ease of use can predict customer behaviour and acceptance of technology. The reason why TAM was chosen as the foundational framework for this thesis is twofold. Firstly, it is widely recognized as one of the most employed theoretical models for studying people's adoption of information technology, thus making it highly pertinent in this context. Secondly, it is known to be highly dependable (King & He, 2006; Venkatesh & Davis, 2000).
Fig 1: Technology acceptance model (adapted from Davis and Fred, 1985)

The Technology Acceptance Model (TAM) proposes that people's decision to adopt a particular technology is influenced by their perception of its perceived usefulness (PU) and the perceived ease of use (PEU), which leads to their intention to use and actual use of the technology (Davis, 1989). Despite its simplicity, TAM has been shown to be a robust and relevant framework for technology acceptance research (King & He, 2006; Venkatesh & Davis, 2000). Therefore, TAM has been widely used in previous studies of various types of technologies, including wearable technologies (Choi & Kim, 2016; Chua et al, 2016; Kim & Shin, 2015; Rauschnabel & Ro, 2016).

2.6.1. Perceived Usefulness (PU)

Perceived Usefulness (PU) is derived from the TAM and is described as the degree to which a person believes that employing a specific technology will improve his/her job performance (Davis, 1989). PU is one of the key factors in predicting and explaining people’s willingness to accept information technology (Kalantari, 2017). Thus, the concept of PU argues that individuals accept modern technology because they believe it to be useful in achieving one of their current goals, and thus because it allows them to obtain the external reward (Chua et al., 2016). As a result, it is tied to a user's intrinsic drive and outcome expectations (Kim et al., 2007; Venkatesh, 1999). The concept of perceived usefulness enables us to comprehend the pragmatic obstacles that healthcare providers encounter when utilizing wearables.

2.6.2. Perceived Ease of Use (PEU)

Davis (1989) described Perceived Ease of Use (PEU) as the degree to which a person believes that utilizing a certain system is effortless. PEU is thus driven by an individual's efficacy, or self-assessment of his or her perceived competency in using technology (Venkatesh and Davis, 1996). Using TAM in a large sample, Park et al. (2016) discovered that how easy it is for consumers to use wearables influences their perceptions. As a result, the more customers perceive the fitness wearable as simple to use, the more likely they like to utilize it. The perceived ease of use of TAM is referred to as the effort expectations. A previous TAM study has discovered that PEU promotes attitudes toward using technology both directly and indirectly with PU. Those findings have been confirmed in several smartwatch adoption surveys. In this study, the application of the perceived ease of use construct aids in comprehending the level of ease associated with utilizing wearable technology by healthcare providers, thus revealing practical barriers to its adoption.
**TPB** is a TRA (Theory of Reasoned Action) (Fig. 2) extension that proposes that an individual's behavioural intention in the purchase or use of technology is determined by their attitude toward behaviours, their subjective norm (SN), and their perceived behavioural control (PBC) (Ajzen, 1985). This behavioural intention can be thought of as the motivating variable that influences action in the end (Ajzen, 1991). Among all, PBC refers to an individual's control beliefs, which are whether he or she feels that there are circumstances that help or hinder the execution of the behaviour (Ajzen, 2002). Hsu et al. (2006) used a long-term study to examine users' ongoing behaviour with regard to online shopping. They used TPB components (attitude, subject norms, and perceived behaviour control) as well as the theory of expectation disconfirmation to build their research model. The empirical findings indicate that the main variables influencing customers' continuing intention to shop online are subjective norms, attitude, and perceived behaviour control. The above-mentioned literatures' empirical study showed that TPB can be used to describe the behavioural processes of people who use or adopt information technology.

![Fig 2: The theory of planned behaviour (adapted from Ajzen, 1991)](image)

### 2.6.3. Attitude towards Using

The dimension of the research model where TAM and TPB coincide is the attitude toward usage. As a result, TAM's "attitude towards using" and TPB's "attitude towards behaving" represent the same dimension in the underlying thesis. The degree of people's positive or negative assessments of using technologies can be characterized as the attitude toward usage in the context of technological acceptance (Choi & Kim, 2016). Similarly, TPB believes that attitudes toward behaviour are formed by behavioural beliefs that people hold about the action as well as subjective evaluations of these beliefs (Ajzen, 1991).

Previous studies on wearable adoption, including those conducted by Choi and Kim (2016), Chua et al. (2016), Wu, Wu and Chang, (2016) consistently identified attitude as a significant predictor of intention to use or purchase these devices. These studies revealed a positive association between favourable attitudes towards wearables and the intention to adopt or purchase them.

### 2.6.4. Subjective Norm (SN)

Subjective norm relates to a person's sense of how important others in his or her social surroundings wish or expect him or her to behave in a certain way (Moan et al., 2006). It originates from a person's normative ideas or beliefs about whether relevant referent groups or individuals approve of particular conduct. As a result, according to Ajzen (1991), the intentions to conduct a given behaviour are influenced by the opinions of significant referent persons or
groups, such as family and friends. Previous research on wearables (Wu, Wu and Chang, 2016; Kranthi and Ahmed (2018) has shown the importance of SN in predicting the intention to adopt these technologies. Using SN we would be evaluating if there is a positive or negative impact on the individual’s purchasing intentions.

2.6.5. Perceived Behavioural Control (PBC)

It is described as a person's sense of how tough it is to carry out a behaviour (Ajzen, 1991). Perceived behavioural control is made up of a person's thoughts about his or her ability to manage and engage in a specific action; it indicates how easy or difficult it is to conduct the behaviour. Ajzen (2002) distinguished PBC from attitude by emphasizing that PBC refers to a subjective degree of control over the performance of behaviour, not the perceived likelihood that doing the activity would result in a specific outcome. None of the prior fitness wearable adoption studies has taken the PBC factor into account. Based on the description of that dimension, it is proposed that in the case of fitness wearables, people's PBC may be particularly influenced by the price and ability to purchase them. This assumption is consistent with Turhan (2013), who used a similar definition of the dimension when looking at the impact of PBC on the adoption of various wearable technologies, such as smart bras and smart t-shirts. In general, past research has found that PBC has a beneficial impact on the desire to acquire or purchase wearable technologies (Wu, Li and Fu., 2011). With the use of PBC we would examine if there is a positive or a negative impact on the intention of healthcare professionals and individuals to purchase wearables.

2.6.6. Behavioural / Purchase Intention

According to the TPB, Behavioural intention is a general indication of an individual's preparedness to do a certain activity, as well as the subjective likelihood of performing the behaviour (Ajzen, 1991; Ajzen & Fishbein, 1975). It's considered to be a powerful predictor of genuine behaviour (Mao et al., 2006). Unlike in TAM, it is argued here that people's intentions to embrace wearables are influenced not just by their views toward using and purchasing them, but also by the SN and the PBC. As a result, in this regard, we adhere to TPB and Ajzen's (1991) general rule, which states that the more favourable the attitude and SN, as well as the greater the PBC, the stronger the individual's intention to perform the behaviour of interest, which in this case is the adoption of wearables in healthcare.
3. Methodology

Chapter three presents the methodology of this research paper. It begins with the methodological tradition and approach. Then data collection and analysis methods were described in addition to mentioning how data will be reported and interpreted. Lastly, some reliability and validity measures are mentioned, as well as some ethical considerations.

This section of the paper will go through the research paper's methodology. Methodology procedures improve the research process and show how the research will be carried out. It aids in explaining the methodologies used in research and presenting the idea to the world in an elegant manner of how research hypotheses are proven. This section of the document explains the research method chosen and why it is the most suited research approach in the current situation. There are three main types of research methodology. They are as follows: (i) Qualitative research, (ii) Quantitative research, and (iii) Mixed method research. Methodologies with a qualitative focus on words, a quantitative focus on numbers, and mixed methods provide a flavour of both words and numbers (Creswell & Creswell, 2017). We used the mixed technique strategy for our current study. This chapter will go over the reasons and motivations for choosing this strategy for research.

The purpose of this study is to discover the challenges to wearable adoption by healthcare providers in their daily activities. As the quantitative component of the mixed method approach, a survey method incorporating an online questionnaire with closed ended questions was used to address the corresponding study topics. As part of the qualitative research, interviews with identical open-ended questions are structured. By doing so, credible and promising results can be obtained, contributing to the current field of study.

3.1. Research Philosophy

Important assumptions about how researchers evaluate their surroundings are contained in the research philosophy. Furthermore, these assumptions support the research plan as well as the methods used in that strategy. Positivism, realism, interpretivism, and pragmatism are four different research philosophies. Furthermore, the research is value-free, and the studies are neutral and unbiased, with an objective attitude to ensure that the outcomes are not influenced in any manner (axiology). Two current theoretical frameworks are merged and extended in this thesis in order to collect structured data in order to measure the assumptions (Saunders et al., 2009).

In order to achieve the research aims, those hypotheses were examined and either supported or disproved. The entire study is well-structured and comprises a large sample size inside a quantitative measurement, which is also a hallmark of positivist research.

3.2. Research Approach

In this thesis, two main research approaches are being used which are deduction and induction. Induction approach involves the search for patterns in observations and the development of explanations – theories – for those patterns via a set of hypotheses (Bernard, 2011). The inductive approach aims to generate meaning from the data set collected in order to identify patterns and relationships in order to construct a theory; however, the inductive approach does not prevent the researcher from formulating the research question to be investigated using
existing theory. Learning through experience is the foundation of inductive thinking. In order to draw conclusions, patterns, resemblances, and regularities in experience are observed (Saunders et al., 2009).

This thesis aims to explore the barriers faced by the healthcare providers in India towards adoption of wearable devices. In scientific inquiry, deduction is the most common method, in which well-developed hypotheses are employed to proceed from theory to empirical facts (Saunders et al., 2009). It is based on the objective gathering and analysis of facts and information. Following that, hypotheses are created, which will be examined using quantitative data collected by the researcher (Saunders et al., 2009). The authors of the underlying thesis scoured academic literature extensively before constructing a methodology to collect their own primary data. Another key part of deduction is discovering correlations between variables to explain causal relationships. As a result, the approach must be highly structured, and control must be used to assure the veracity of the data (Saunders et al., 2009). Furthermore, a deductive method necessitates large sample sizes in order to statistically generalise about human social behaviour (Saunders et al., 2009).

A framework that integrates the TAM and its extension with TPB was added to the current theory. In an empirical investigation, the authors looked for correlations to evaluate their hypothesis. Generalizable results were obtained thanks to a large sample size. The study's findings revealed whether the hypotheses were true for healthcare practitioners regardless of whether they used wearables.

### 3.3. Research Purpose

The goal of this thesis is to learn more about the problems that healthcare professionals face when it comes to using wearables. As a result, the authors intend to build correlations between certain variables, such as attitudes or subjective norms, and adoption intention in order to discover occurrences in a certain circumstance. As a result, this thesis is descriptive in nature. According to Saunders et al. (2009), there are three different research purposes: explanatory, exploratory and descriptive. Descriptive research depicts the characteristics of people, events, or circumstances (Robson, 2002).

### 3.4. Research Design and Research Strategy

As previously said, we used a mixed method approach for this study, which contains characteristics of both quantitative and qualitative research methodologies and adopting the best of both worlds would result in convincing and reliable results. Both quantitative and qualitative data are converged or combined during this procedure in order to mitigate the shortcomings of quantitative and qualitative data and produce convincing and comprehensive results (Creswell and Creswell, 2017). An investigation is being conducted in this case in order to determine all possible causes controlling the acceptance and denial of wearables by healthcare providers. And in doing so, we would not only find the selection criteria that a healthcare practitioner examines when selecting a new technology, but we would also receive a quick overview and updated evidence of the elements that healthcare providers consider when selecting a new technology.

An online survey, as a quantitative approach would limit the results to only a subset of factors, but our goal was to identify all of the factors that influenced healthcare practitioners' decisions to choose or not choose wearables. As a result, there was a need for more thorough and enlightening outcomes, and in order to achieve that, the qualitative approach's characteristics
had to be included as well (Creswell and Clark, 2007). As a result, a mixed method approach was the best way to achieve the thesis's goals and objectives.

In the current study, we used a literature analysis to identify the possible factors that influence new technology acceptance by healthcare practitioners. Based on this, survey questionnaires and a set of interview questions are developed and executed simultaneously. Finally, the outcomes of both qualitative and quantitative methods are compared and correlated to produce a comprehensive set of data.

Why online survey, not other quantitative methods - There is one primary reason to reach the greatest number of people in the shortest amount of time, but there are other reasons to avoid using other quantitative approaches, leaving online survey as the only and best option for our situation. A case study, for example, is typically used when we aim to thoroughly investigate a topic or issue. The goal here is to identify all possible causes. If we undertake a case study, we will only be able to evaluate a few or more practitioners in the allotted time limit, resulting in incomplete data. As a result, a case study is not preferred. Similarly, we abandoned others due to a lack of clarity regarding variables and their interdependence.

Why interviews, not other qualitative methods - The reason for employing interviews as one of the study methodologies along with online surveys is that using online surveys would only allow us to evaluate current factors and determine if they are the reasons why practitioners are not opting for wearable. However, the study's goal is to identify all of the factors that prevent practitioners from adopting wearable technology. Thus, an interview with a few of healthcare practitioners would show factors other than the usual ones, if any. This would provide us with more trustworthy and concrete research outcomes. We used semi-structured interviews (interview types - structured interviews, unstructured interviews, and semi-structured interviews (Fox & Frakes, 1997) in this research study, which is a hybrid of structured and unstructured interviews. We chose this strategy because it allows us to have both detailed and open-ended discussion (Hove and Anda, 2005).

3.5. Data Collection Method

Data collection comprises collecting data as well as defining how the information will be documented (Creswell & Creswell, 2018). Rather than relying on a single data source, many sources of data are frequently collected in research, and in interpretative research, one kind of data collecting should work as a complement to the other (Vaat & Walsham, 2005). After analysing several data gathering methods, two methods were chosen as appropriate for this study. Interviews are used to obtain qualitative data, while surveys are used to collect quantitative data.

3.5.1. Phase one: Internet survey

The authors decided to create a self-administered questionnaire to collect data (Appendix 2). A self-administered questionnaire is one in which the responder is responsible for reading and answering the questions themselves (Babin & Zikmund, 2016). As a result of this data collection strategy, respondents answer questions independently, and the researcher is not present when the survey is done. The authors opted to conduct the survey online using the "Microsoft Forms" platform and distribute it using WhatsApp (for a more full explanation, see "3.7 Population Sampling").
In general, the decision to conduct an internet survey was made because it offers several advantages, the most important of which is speed and cost-effectiveness, as large samples from various parts of India can be reached in a short period of time, and administrative costs such as printing, and postage are eliminated when compared to a paper-based survey (Babin & Zikmund, 2016). Furthermore, internet-based surveys enable reliable real-time data capture by allowing respondents to quickly enter their responses into a data file, as well as the ability to prevent incorrect data entry (Babin & Zikmund, 2016). The authors found the additional feature to be particularly useful because it allowed them to save time compared to if they had to manually enter the data into the statistical software IBM SPSS 24 Statistics (SPSS - V28) that was used for data analysis. It also decreases the chance of data entry errors that might arise when data is entered manually. Furthermore, because the study's sample consisted of smartphone users in India - and thus people who were technologically and internet-literate - using an internet survey was thought to be a good fit. After all of the data was digitally collected using "Microsoft Forms," it was exported to SPSS and evaluated there.

3.5.2. Phase two: Interview

In order to gain a deeper understanding of the subject at hand, five in-depth semi-structured interviews were conducted with doctors, nurses, and lab analysts based in India. These interviews were particularly helpful in exploring the topic and aiding in decision-making. The semi-structured interview format was chosen for its flexibility in allowing for questions to be altered and rephrased during the interview. The reason for selecting semi-structured interviews with online surveys as one of the study methodologies is that online surveys would only allow us to validate current factors. However, the study's goal is to identify all of the factors that prohibit healthcare professionals from using wearables in their regular occupational practice. Thus, a semi-structured interview with a few of healthcare practitioners would show factors other than the usual ones, if any. This would provide us with more trustworthy and concrete outcomes for our research. One of the most difficult challenges was designing the questionnaire for the interview. The questionnaire selection included both specific and open-ended questions. It was made up of six specific technology acceptance models assumptions. The questions were comparable to the survey questions and were mostly concerned with the attitude towards the use of technology and its purchasing intention. Table 3, provides an overview of the participants who were chosen for their representation of the stakeholder group and knowledge of the subject area. The interview process was initiated by thanking each participant for their time and knowledge, introducing the interviewer and the research, and creating a calm and relaxed atmosphere for the conversation. The interviews were conducted in English as a default language, with the option of using Hindi if preferred by the participant. The conversations lasted an average of 30 minutes and were directed towards the research topic. Participants were chosen using a list of relevant stakeholder contact information that was established during the stakeholder analysis phase of the project. All participants fulfilled the basic criteria of being representative of the stakeholder group and knowledgeable in the subject area of gravel road maintenance. The full list of interview questions can be found in Appendix A.

<table>
<thead>
<tr>
<th>Interview #</th>
<th>Stakeholder Type</th>
<th>Interview Type</th>
<th>Years of experience</th>
<th>Interview Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant 1</td>
<td>Doctor</td>
<td>Face to face</td>
<td>10+</td>
<td>30:00 minutes</td>
</tr>
<tr>
<td>Participant 2</td>
<td>Nurse</td>
<td>Face to face</td>
<td>8+</td>
<td>25:00 minutes</td>
</tr>
<tr>
<td>Participant 3</td>
<td>Lab assistance</td>
<td>Face to face</td>
<td>11+</td>
<td>40:00 minutes</td>
</tr>
</tbody>
</table>
The interview process involved the following steps:
1. Preparation of interview questions relevant to the research questions.
2. Presentation of research details to the participants.
3. Scheduling of interview date and time.
4. Obtaining the consent of the interviewee.
5. Interview using online methods such as Zoom call or in person.
6. Transcription

3.6. Survey Design

To obtain data from the respondents, a self-administered quantitative internet survey was chosen. The goal of this research, notably that it is part of a master thesis at Linnaeus University, was explained to respondents while delivering the questionnaire in order to appeal to their obligation to fill out the survey truthfully and honestly. Furthermore, the authors strove to keep the questionnaire as brief as possible because it was understood that, due to the comprehensive research framework that needed to be examined, there was a possibility that the survey might end up with too many questions if special attention was not paid to this. A questionnaire that is excessively long may lower the quantity of usable responses since respondents may become bored while filling it out and hence abandon it. Furthermore, it may result in respondent mistake, which will have a significant impact on the meaning of the data, as people may simply select any answer without giving it much thought in order to complete the survey. To circumvent this, the authors chose to examine each dimension using only three to four closed-ended questions that had previously been verified in other studies. In general, employing previously verified questions ensured that the linguistic style of each question was appropriate, allowing the respondent to understand the question's meaning. Depending on the type of question, all closed-ended questions are accompanied by ordinal scales with 5 degrees of scoring ranging from “strongly disagree” to “strongly agree”. Because the data was not selected from a normal distribution and statistical methods could not be used to examine the data, the ordinal scale was chosen above alternative scales such as ratio or interval scale.

3.7. Population and Sampling

It is critical to specify the target audience before selecting the sample space from which the survey questionnaire will be conducted. A target population is the group or set of individuals to whom the survey is directed, or the group of people to whom the survey applies (Kitchenham & Pfleeger, 2002). A sample of possible respondents for the research is chosen from the target population. The sample is chosen in such a way that their responses will be extremely beneficial to the subject of study as well as the target population.

Since the goal of this study was to look at the adoption of wearables by healthcare practitioners, it made sense to only contact persons who work in the field. As a result, persons who fell within that category had to be sampled for this research's empirical investigation. The authors employed a non-probability snowball sampling strategy to do this and ensure that enough replies were gathered. This is a strategy in which the authors pick initial respondents using a non-probability sampling approach and then use those respondents to discover further respondents (Babin & Zikmund, 2016). In this scenario, the authors send the link to the questionnaire to their Indian family and friends via the messaging app WhatsApp, and then asked them to forward it to their Indian relatives and acquaintances who work in the healthcare
profession via the same medium (Babin & Zikmund, 2016). WhatsApp is by far the most popular chat app in India, with over 487.5 million users in 2021. WhatsApp is used by a majority of people in India (eMarketer, 2022). This means that sending a survey via WhatsApp might reach the majority of Indian people.

3.8. Analysis of Data

In this master's thesis, we were using mixed methods approach to collect data - an online survey and interviews. The survey was conducted first, and the data collected from it is being used as the foundation for the interviews.

3.8.1. Quantitative Data Analysis

According to Saunders et al. (2009), quantitative data in its raw form, that is, before it has been processed and analysed, has little meaning for most individuals. As a result, this data must be processed in order to be usable, or to be converted into information. Quantitative analysis techniques like graphs, charts, and statistics enable us to explore, display, describe, and analyse relationships and trends in the data. All the respondents' information was gathered through an online survey on the Microsoft Forms platform, which meant that everything was saved digitally and could be quickly exported to any statistical software, which could be used to analyse the data. So, because human mind is incapable of analysing vast amounts of data (such as those acquired through surveys), selecting the appropriate software to evaluate the collected data was a tedious task. Furthermore, there is a wide range of applications available to examine the data at hand. MINITAB, JMP, and SPSS can be used for it. Because SPSS is a well-known and free trial based statistical software tool that allows us to do data analyses, we used it to answer our research questions. Our decision to use the SPSS statistical program was based on its ease of use, user-friendliness, efficiency and ability to do both parametric and nonparametric comparative analysis (Ong and Puteh, 2017). By analysing the survey data using SPSS, we have created charts that show the results. These charts are helping us to understand the data better and to prepare for the interviews. Overall, the survey data is an important component of this thesis, and is playing a key role in our research.

3.8.2. Qualitative Data Analysis

To analyse the qualitative data gathered from the interviews, a data analysis guide adapted from Creswell (2014) was used in this master's thesis. Thematic analysis was found to be the most relevant method for this research as it allowed the extraction of themes. The researcher listened to and transcribed all three recorded interviews, and checked the quality of the transcriptions. Field-notes, interview transcripts, and available documents were analysed to find themes and patterns, followed by interpretation using a coding framework by Burnard, Gill, Stewart, Treasure, and Chadwick (2008). Initial coding was followed by final coding, which involved grouping relevant codes. To ensure reliability, the researcher continuously compared data with codes and reviewed the data to organize it into codes across all data sources. The process followed an iterative procedure outlined by Miles and Huberman (1994), which involved data collection, data display, data reduction, conclusion drawing, and data verification (see fig.3). The result was the presentation of themes and their interpretation, as per data analysis in qualitative research.
After the analysis of the data, the following mapping of the questions were created with the themes (table 4) which were derived from tools used as described above. The same themes would be continued to be studied during the empirical findings. How we derived these themes will be discussed in the Interview findings section.

**Table 4: Themes Identified during Qualitative Analysis and its correlation with the survey questions**

<table>
<thead>
<tr>
<th>Themes</th>
<th>RQ: What are the barriers to the adoption of wearable technology by today’s healthcare providers in India?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Availability of wearable technology</td>
<td>I am positive toward using wearables&lt;br&gt;I would like my patients to achieve fitness goals using wearables&lt;br&gt;I would like my patients to be heavy users of wearables. I intend to check notifications from wearables frequently</td>
</tr>
<tr>
<td>Integration and utilization of wearable by healthcare and individuals</td>
<td>Wearables would increase my productivity&lt;br&gt;Wearables would improve my overall health. Wearables are important to me as a healthcare professional&lt;br&gt;Monitoring health through wearables is a good idea</td>
</tr>
</tbody>
</table>
In this master's thesis, chapter four presents the analysis of the research findings, which will then be discussed and compared to the reviewed literature in a later chapter. The discussion will be viewed through the lens of the theoretical framework. This approach will help to provide a deeper understanding of the research findings and their relevance to existing theories in the field.

3.9. Limitations of Methodology

It's crucial to note that there are some drawbacks to employing quantitative methodologies. This research methodology, on the other hand, has a number of flaws. Most importantly, unlike qualitative studies, quantitative studies do not account for people's emotional responses to the survey's questions. These reactions, on the other hand, may reveal important information about people's genuine inner meanings and sentiments about a topic (Babin & Zikmund, 2016). As a result, failing to evaluate them and instead relying solely on the responses provided in the survey could limit the study's usefulness. Furthermore, because respondents cannot ask an interviewer detail of a question if they do not fully understand it, quantitative studies that use self-administered questionnaires, such as the one used in this thesis, may be more prone to response errors caused by unconscious misrepresentation (Babin & Zikmund, 2016). When performing quantitative research, it's critical to keep such constraints in mind. Furthermore, a unique weakness of the underlying study is that by utilising snowball sampling, there may be a risk of bias because the initial respondents may select respondents who are similar to themselves (Babin & Zikmund, 2016). Furthermore, despite the fact that WhatsApp has a very high market penetration in India, there are still a few smartphone users who do not utilise this messaging programme. They were not included in this study due to the questionnaire distribution delimitation.

3.10. Reliability, Validity and Ethical Considerations

3.10.1. Reliability

The internal consistency of a metric is determined by its reliability. If multiple attempts to measure a dimension yield the same result, the measurement is deemed dependable. The internal consistency of a metric is determined by its reliability. If multiple attempts to measure a dimension yield the same result, the measurement is deemed dependable. Three to four previously validated questions that essentially pose comparable questions were provided for each dimension in order to assess the dependability of each of the dimensions tested in the survey.

The proposed research employs a sequential use of mixed methods, qualitative, and quantitative approaches. Concerns about validity and reliability in a mixed method research design necessarily require thorough and careful explanations. The extent to which a measurement procedure yields the same answer regardless of how or when it is performed is referred to as
reliability. There are three types of "reliability" that can be used in mixed approach (Hussain, 2019):

a. Quixotic: This refers to situations in which a single method of observation consistently yields the same measurement.
b. Diachronic: This refers to an observation's stability over time.
c. Synchronic: This refers to the similarity of observations made during the same time period, which can be assessed by comparing the same data using different methods.

To compare the response over time, the author employs Synchronic reliability. As the first phase of the research is qualitative, data is collected from participants who have been identified based on research criteria using a semi-structured interview technique, which provides a rich source of text data that leads to the identification of codes, categories, and themes directed by the research question. Following the qualitative thematic data analysis, a close-ended scaled questionnaire-based survey will be conducted in which scale and constructs will be defined based on the identified codes and themes. Combining the two would complement and triangulate each other's results.

3.10.2. Validity

Validity is concerned with the precision of a measure or the degree to which the scores produced accurately represent a concept. As a result, validity refers to whether a measurement accurately measures what it claims to measure. Face validity is required for a measure to be legitimate. Face validity exists when professionals agree that the scale used to gauge the notion is accurate. The scales employed in the underlying research may be said to have face validity because they had all been used in earlier studies on similar themes and hence had already been verified (Babin & Zikmund, 2016).

Semi-structured interviews and surveys with various types of healthcare professionals were conducted. The process's goal was to connect with people who had a good balance of technology and healthcare services in order to achieve the desired outcome. We made an effort to maintain the validity of our research in this way. Validity is unquestionably more challenging to obtain than reliability because, while we can use reliable resources to gather data, it can be challenging to ensure that the data will be useful in evaluating the claims we were focusing on.

3.10.3. Ethical Considerations

Research ethics encompass rules and guidelines that regulate the conduct of research, including safeguarding the dignity of research subjects and ensuring that research findings are presented in a responsible manner (Fouka and Mantzorou 2011, p. 3). It is essential to address ethical issues in various stages of research, from the beginning of the study to the data collection, analysis, storage, and presentation (Creswell and Creswell 2017).

Throughout this study, all participants, including interviewees and survey participants, were informed of our status, research questions, and purpose. The participants were also informed of their right to confidentiality and voluntary participation (Silverman, 2013). Interviewees were made aware that they could receive a copy of the interview transcript on request. All participants were informed that the information collected would be used solely for academic purposes, and their anonymity would be maintained.
Survey participants were informed about the study's purpose and assured that no personal data, such as their name, email address, or IP address, would be collected without their consent. Consent was obtained through the same survey form, which included a checkbox for participants to indicate whether they agreed or disagreed to share their personal information. During the interviews, participants were informed orally about the interview's format, agenda, or activities, and no personal information would be shared without their consent. Furthermore, all participants and interviewees were made aware that their participation was entirely voluntary, and they could withdraw from the study at any time.
4. Empirical Findings

The purpose of this chapter is to present the empirical findings of the study. First, the demographic sample is described. Second, descriptive statistics are presented, followed by the reliability testing and a factor analysis. After that, all the hypotheses are tested using correlation analysis and linear regression.

This section includes the presentation of an empirical study, which utilized both semi-structured interviews as a qualitative research method and online survey research as a quantitative research method. The online survey enabled us to conduct a quantitative analysis, while the semi-structured interviews provided valuable qualitative insights. The identification of themes in the thesis's data analysis phase was supported by evidence derived from the interviews.

4.1. Empirical Findings of Qualitative Data - Interview

Based on the participants—a medical professional and students—the data that had been collected was analysed. The important factors were how the researcher identified the participants and the key questions the researcher had posed to the participants to evaluate their interests in the integration of wearable technology and the difficulties associated with its adoption in the delivery of routine healthcare services. A thematic analysis will be performed using the compiled common themes and the picture they can depict based on the data that has been collected. Following are the themes that were identified after the data was analysed:

Theme 1: Availability of wearable technology
Theme 2: Integration and utilization of wearable by healthcare and individuals
Theme 3: Challenges in adoption of technology in practice

4.1.1. Availability of wearable technology

This first theme was developed in light of wearable technology's accessibility in the healthcare industry. The availability of technology is the most crucial topic that must be covered when exploring the ideas and facets of the integration of technology. A majority of participants made it clear that they were familiar with the medical wearable devices used in hospital settings and knew how to use it to gather information. However, they are unsure of the different kinds of fitness wearables that are on the market and how it can help them with their daily activities. They are well aware of the classy wearable watches, but they haven't fully examined what these devices' actual, fundamental functions are.

"Indeed, wearable devices exhibit considerable potential as a multifaceted tool within the healthcare landscape. However, I must acknowledge that my understanding of its full capabilities remains incomplete. Presently, I utilize it for routine health monitoring, extracting valuable data to establish personalized targets for my well-being. Nevertheless, envisioning a scenario wherein I recommend such devices to patients and subsequently obtain insightful health data, enabling the monitoring of pre-existing conditions and proactively alerting them to potential future complications through peer comparison or analogous means, would be an exceptional advancement."

The majority of respondents use fitness trackers for personal fitness monitoring, and some were
influenced by others to use them. Few of them didn’t use these devices, as it seems to be an extra burden for them to interact with modern technology.

4.1.2. Integration and utilization of wearable by healthcare providers

The theme is focused on how healthcare professionals are integrating and using wearable technology. Fitness wearables are used very differently than traditional medical wearables. The majority of respondents stated that they have positive experiences interacting with and using new technology for various purposes in their daily activities. To address the issues with paper prescriptions being lost or torn, a small number of them have recently adopted digital prescription solutions. A small number of respondents also argued that they had used wearables for their own fitness monitoring and for sharing visual report on their social media, but that they were unaware of the option to export the same information in another format so that it could be shared privately with someone. Some of them concurred that having a history of a person's personal health information will aid in quick and simple diagnosis as well as in alerting and preparing ahead of time if something seriously wrong appears with the person. One of the individuals in the interview session expressed the following sentiment:

“The integration and utilization of wearable devices by healthcare providers holds tremendous promise. As a healthcare professional, leveraging these devices in our practice allows for enhanced patient monitoring, precise data collection, and informed decision-making. By seamlessly integrating wearable technology into our workflow, we can gather real-time health metrics, identify trends, and deliver personalized care plans tailored to individual needs. This integration empowers us to optimize patient outcomes, promote preventive measures, and revolutionize the delivery of healthcare services.”

Smart wearables, which formerly served only as wristwatches and step counters, are now clinically useful healthcare instruments. Example of an Apple app that tracks users’ heartbeats and notifies them when they experience irregular heartbeat. Some of the respondents have drawn attention to their awareness of recent promises made by wearable manufacturers, such as blood oxygen saturation monitors, in-built sleep tracking features, faster FDA-approved electrocardiogram (ECG) sensors, and fall detection, which are beneficial in terms of workload distribution. Out of the high number of respondents, a few Gynaecologists recommended the use of wearables for women to monitor their fertility, pregnancies, and general health, and similarly a number of Paediatricians highlighted the tools to monitor neonatal indicators such as sleep patterns and oxygen saturation levels in new born babies.

4.1.3. Challenges in adoption of technology in practise

Respondents argue that although wearable technology has great potential to make the life of a healthcare professional much simpler, there are several other factors that are preventing its widespread adoption by healthcare professionals. Regarding the interview’s findings, I’m going to talk about the three biggest obstacles that the respondent says stand in the way of acceptance. The most important factor is user acceptance, all age group user acceptance. The simple truth is that older people are more vulnerable than people of any other age group, but due to their lack of awareness and digital literacy, they are completely out of the line. Patient confidentiality and data security. One of the participants said:

"Adopting technology in healthcare practice presents challenges, including ethical
concerns, early-stage development, and financial implications. Additionally, incorporating new technological advancements into our workflow presents hurdles such as resistance to change, and the need for training and skill development.”

Further he adds “Overcoming these obstacles requires a proactive approach, fostering a culture of innovation, providing comprehensive training programs, and ensuring robust safeguards for patient information. By navigating these challenges, we can harness the potential of technology to enhance patient care, streamline processes, and drive positive healthcare outcomes.”

Few of respondent were pleased to have access to the patient data through patients’ permission, but they also had concerns about privacy and the security of their personal information. As this technology is still in its early life, there is a possibility of data manipulation and system hacking. Ethical Issues, technology is being used more and more to track people's emotions, thoughts, and behaviours in real time. Wearable technology with global positioning system (GPS) capabilities to collect precise data on where participants spend their time. Wearable technology to passively collect objective measures of participants' movement, physical activity, sleep, and physiological response. It is very simple now to manipulate mood, companionship, and health-risk behaviour with so much information available.

4.2. Empirical Findings of Quantitative Data - Online survey

4.2.1. Demographic sample

The distribution of the online survey via the free Microsoft web form resulted in 343 replies in total. Despite this, only 290 of the 343 responders could be considered for further study. There were 17 people who didn't fit the sample. Aside from that, 21 of the participants had no idea what a wearable was, thus they were ruled out of the study. Another 10 people said they already had a wearable. Because their purchase had already occurred, these respondents did not match the sample standards (see chapter 3.7). 5 of the remaining 295 respondents had to be eliminated because their survey was not finished. The final details of the respondents are shown in table 5 below. According to Malhotra et al. (2012) the minimal size for problem-solving study is 200 people, the result of 290 people was acceptable for our study. Out of the 290 respondents, with a percentage of 50.8%, females represent the majority of participants. Males come in second with 47.1% of the participants, and only 2.03% of the remaining participants selected the "prefer not say" option. The age group "18-24," which accounts for 62.6% of the total, has the highest percentage of participants. The respondents classified as being between the ages of 25 and 40 make up the next older age group, with a percentage of 33.7%, while the remaining respondents are classified as being between the ages of 40 and 70, with a percentage of 3.6%. 31.8% (78 respondents) had a bachelor's degree or higher. The majority of respondents, 50%, had bachelor's degrees, and the second-most respondents, 31.7%, had master's degrees. The third-largest group of respondents are those with doctoral degrees, who make up 10.9% of the total. Individuals with an undergraduate degree make up the remaining 7.3% of the demography. The majority of respondents, 59.3%, were at work, and the remaining 43.08% were students.

Table 5: Characteristics of the respondents

<table>
<thead>
<tr>
<th>Variable</th>
<th>Characteristics</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Male</td>
<td>137</td>
</tr>
</tbody>
</table>
4.2.2. Scale of measurement

A psychometric (discipline of psychology concerned with the theory and application of measurement) scale known as a Likert scale is frequently used in studies that use questionnaires. It is the method for measuring responses that is most frequently used in survey research (Likert Scale; Wikipedia). The practitioners' perception and expectation from wearables and its adoption in day-to-day activity were measured using a five-point Likert scale. The options have two edges that range from "strongly disagree" to "strongly agree." The details are as follows:

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

The responses will be used as input for the SPSS software's and MS Excel for data analysis. Starting with the next topic, a thorough descriptive analysis of the input data is presented.

4.2.3. Descriptive Analysis

The distributed questionnaire is examined using the above-mentioned tools, excel and SPSS. The author has identified two outcomes based on the adopted framework, as mentioned earlier. Attitude toward wearing a wearable (ATU) and the purchase intention (PI). The responses have been compiled and are shown in the two tables below. The variable that determines how ATU will turn out is presented in the first table (table 6), and the variable's value for PI is presented in the second table (table 7).

Table 6: Interdimensional response of PU, PEU & PE to ATU

<table>
<thead>
<tr>
<th>Variable</th>
<th>Dimension</th>
<th>Attitude towards Using</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Strongly Agree</td>
</tr>
<tr>
<td>Perceived Usefulness</td>
<td>Wearables would increase my productivity</td>
<td>102</td>
</tr>
<tr>
<td></td>
<td>Wearables would improve my overall health.</td>
<td>93</td>
</tr>
<tr>
<td></td>
<td>Wearables are important to me as a healthcare professional</td>
<td>102</td>
</tr>
</tbody>
</table>
### Table 7: Interdimensional response of ATU, SN & PBC to PI

<table>
<thead>
<tr>
<th>Variable</th>
<th>Dimension</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Perceived Ease of Use</strong></td>
<td>I find using wearables easy to use</td>
<td>110</td>
<td>142</td>
<td>20</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Learning how to use wearables is easy for me</td>
<td>81</td>
<td>162</td>
<td>41</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>It is easy to become skillful at using wearables</td>
<td>93</td>
<td>131</td>
<td>73</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Perceived Enjoyment</strong></td>
<td>I am positive toward using wearables</td>
<td>122</td>
<td>93</td>
<td>73</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>I would like my patients to achieve fitness goals using wearables</td>
<td>110</td>
<td>131</td>
<td>32</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>I would like my patients to be heavy users of wearables</td>
<td>81</td>
<td>93</td>
<td>41</td>
<td>81</td>
<td>0</td>
</tr>
<tr>
<td><strong>Attitude towards Using</strong></td>
<td>Monitoring health through wearables is a good idea</td>
<td>102</td>
<td>102</td>
<td>52</td>
<td>32</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>I have no difficulty accessing basic information from patients’ wearables</td>
<td>61</td>
<td>142</td>
<td>52</td>
<td>41</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>I have no difficulty in using wearables</td>
<td>81</td>
<td>171</td>
<td>41</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>I intend to check notifications from wearables frequently</td>
<td>93</td>
<td>131</td>
<td>41</td>
<td>32</td>
<td>0</td>
</tr>
</tbody>
</table>

4.2.3.1. Results of Perceived Usefulness

The researcher has gathered responses to three questions they prepared for perceived usefulness (which is the degree to which a person believes using a particular system would improve his or her performance at work (Davis, 1989)). The results for this questionnaire response are shown in the bar graph (Fig. 4).
As previously mentioned, the researcher totalled 290 valid responses with a measurement scale ranging from strongly agree to strongly disagree. To symbolize and distinguish the responses, the author has chosen five different colors for better representation. According to the above-mentioned graph in figure 4, the most votes were cast for “agree”, followed by “strongly agree”, “neutral”, “disagree”, and “strongly disagree”, which received zero votes.

A total of five options were presented to the respondents. The majority of participants (more than 60%) chose the “agree” response combining all three questions, indicating that they believe wearable technology can enhance their performance. And no one chose "strongly disagree," indicating that no one believes it won't help them perform better. Above is a graphical representation of the three different questions and the answers provided by each respondent.

4.2.3.2. Results of Perceived Ease of Use

The following fig. 5, provides a brief summary of the respondents' perceptions with Perceived Ease of Use (how easy they thought it would be to use a particular system (Davis, 1989)). Similar to how researcher approached in Perceived usefulness, they followed the similar 3 set of questioners for this section.
The measurement scale and sample size used in this study were the same as those in Perceived Usefulness. The majority of votes were cast for "agree," which was followed by "strongly agree," "neutral," "disagree," and "strongly disagree," which received no votes.

In the survey, participants were given the same five options from which to select their responses. An average percentage of about 83% (of the three questions) participants, or the majority, selected "favourable" in response to all three questions, indicating that they thought wearable technology was simple to use. "Strongly agree" comes next, with a total count of 98 combined percentages, "Neutral" comes next, with a total count of 46, and "Disagree" comes second last, with a total count of 11. No one selected "strongly disagree," indicating that they don't think it will be tough to use wearable. The three questions and each respondent's responses are shown graphically in the section above.

### 4.2.3.3. Results of Perceived Enjoyment

This contains the results of the number of respondents on Perceived Enjoyment (which measures how much technology use is thought to be fun on its own, independent of any potential performance consequences (Davis, Bagozzi, & Warshaw, 1992). The result is depicted through the graph (fig. 6) below:
The same five options for recording responses were given to each participant. The two outputs "agree" and "strongly agree" received the most votes in this case, followed by "neutral," "disagree," and "strongly disagree."

Data have been gathered using the same measurement scale and sample size as above. Both answers "Strongly agree" and "agree" received the same number of votes from respondents—290 each. That indicates that, despite concerns about its performance, healthcare professionals found wearables to be a fun tool to use. "Neutral" came next, with a total of 140 votes, then "disagree," with 110 votes. Again, "Strongly disagree" did not receive any votes, indicating that no one thought that wearable technology was not a fun-loving element. In percent values there were about 72% users who gave a favourable response (Strongly Agree, Agree) towards the questions.

4.2.3.4. Results of Attitude towards Using

The attitude towards using wearables is the measure of how a user perceives the idea of using wearables in future. We combine the three responses and compute the combined response to get an overall response on attitudes towards use of wearables. The combined result exhibits the same agree, strongly agree, and neutral trends as the other individual’s respondents' results (PU, PEU, and PE). This shows that the majority of respondents are aware of the advantages of benefits of wearable and are eager to adopt one in order to achieve better results.
In addition to this, we have four sets of survey questions to ask in order to separate the purchase intention from the attitude toward using a wearable. Responses have been gathered the same way as mentioned in the previous sections (see fig. 7). Majority of the respondents agree and strongly with the notion of using the wearables in future and have no problems reading the notifications and using the wearables presently. This also indicates that the users are comfortable with using wearables and they are aware of how to access information from the wearables. There were about 15% of respondents who were neutral about it and about 10% who disagreed. This indicates that the majority of respondents are delighted with the use and want to purchase such a device to learn more.

### 4.2.3.5. Results of Subjective Norm

The following visualization indicate the influence of respondents from the society and people close to them. Whether the view of other people influence the decision making of the respondents. The data also talks about the feeling that the respondents get when they use the wearables. The response data is shown in graph (fig. 8) below and tabular (table 7) form above.
The responses were once again gathered using the same strategy as mentioned before. For the Subjective norm majority of the respondents either strongly agreed or agreed to being influenced by the views of society and people around them. Less than 15% people were neutral or disagree or strongly disagree combined.

4.2.3.6. Results of Perceived Behavioural Control

Perceived Behavioural Control is how the respondents believe in their own use of the wearables. If they have the necessary knowledge or resources that would be required to use the wearables. The response data is shown in graph (fig. 9) below and tabular (table 7) above mentioned.
The responses for perceived behavioural control are equally distributed among Strongly agree, agree and Neutral. This indicates that majority of the respondents have the knowledge and the resources of using wearables there were quite very few who lacked the resources for purchasing the wearables.

4.2.3.7. Results of Purchase Intention

The results of the number of respondents on SN and PCB are included for the purchase intention. According to Dehghani & Tumer (2015), buying intention is a variable that is influenced by a variety of external and internal factors such as price, perceived quality, perceived behaviour, and subjective norms. To determine the overall response on the intention to purchase wearables, we combine the two values and calculate a combined response.

The combined result follows the same trend as the other individuals PBC and SN, with the trend being agree, strongly agree, and Neutral. This indicates that the majority of respondents are aware of the availability of wearables and have the means to obtain them.

4.3. Summary of the empirical findings

The thesis incorporates an analysis of both interviews and surveys to provide a comprehensive understanding of the research topic. Firstly, the interviews and surveys employ similar sets of questions, allowing for a comparison of responses and insights across both data collection methods. Secondly, the themes derived from the interviews are correlated with the survey questions, enabling a deeper exploration of the research themes. The survey results, along with the interviewee's attitudes extracted from the interview transcripts, are meticulously analysed. The discussion section of the thesis is organized into two distinct sections: wearable's experiences and its adoption challenges. This approach facilitates a comprehensive examination and examination of the findings within these specific areas.
5. Discussion

The outcomes of the current research investigation are discussed in the next chapter. The findings are compared to those of earlier studies.

The subject of wearable technology in healthcare has attracted substantial interest from both companies and academics. This increased attention is due to its capacity to provide a new approach to continuous health monitoring outside of conventional clinical settings, as well as its potential for automated health event prediction, prevention, and intervention. Moreover, wearable technology promise as a tool for facilitating communication between patients and healthcare professionals (Mieronkoski et al., 2017). The objective of this study is to gather research findings on the factors that hinder the adoption of wearable technology among healthcare professionals in their professional practice. Furthermore, to recap the research question, it is restated as follows:

**RQ: What are the barriers to the adoption of wearable technology by today's healthcare providers in India?**

In accordance with section discussed above titled "Methods for Data Collection," the research employed an online survey to gather quantitative data. Additionally, semi-structured interviews were conducted for qualitative data collection. The empirical findings from both quantitative and qualitative approaches are then presented in the research's empirical findings section. As highlighted by Creswell (2014) in a mixed methods study, equal emphasis is placed on both quantitative and qualitative methods to comprehend the relationship between variables. Hence, in order to facilitate a deeper understanding of this research, the empirical findings derived from both quantitative and qualitative data collection methods are thoroughly discussed in this chapter. These findings are analysed in relation to the research questions, as well as the reviewed literature and theoretical framework.

5.1. Wearable Experience

Based on the research findings, the participants in the study reported varying experiences with the use of wearables in their daily work. Most participants reported positive effects when utilizing wearables for patient health monitoring and diagnosis. Healthcare professionals expressed that wearing wearable devices provided them with convenience and accessibility, particularly in terms of monitoring, receiving alerts, setting goals, and easily accessing results through their own devices or patient devices. This improved their daily activity and enabled them to track patient conditions more effectively. The survey responses also supported the notion that wearables were easy-to-use and found to be useful. Almost all participants acknowledged the value of integrating wearables as a preventive and monitoring aspect in healthcare.

As stated by Davis (1989), when a new technology is initially introduced, the primary technical factor that influences a user's attitude toward its adoption is perceived ease-of-use (PEU). Within the Technology Acceptance Model (TAM), PEU is considered an essential component. It is defined as the extent to which an individual believes that using a specific system would require minimal effort (Davis, 1989). During the interviews conducted with participants, it emerged that the accessibility of the technology plays a crucial role in its adoption. If a technology is too complex to operate, it becomes challenging for non-technical individuals to
adopt it. However, if the technology provides convenience and ease of accessibility, it has the potential to be accepted by a wider audience.

Perceived usefulness (PU) holds significant importance within the Technology Acceptance Model (TAM). It refers to the extent to which an individual believes that using a specific system would enhance their job performance (Davis, 1989). Numerous studies across various contexts, such as internet banking (Lee et al., 2016), smartphones (Agrebi and Jallais, 2015), virtual reality (Fagan et al., 2012), and wearable technology (Talukder et al., 2018), have demonstrated the crucial role of perceived usefulness in users' adoption of information technology. When healthcare applications, smartwatches, and sports-wearable technology products are perceived as useful in improving consumers' health status, this positive expectation significantly boosts the adoption intention of wearables (Kim and Shin, 2015; Dutot et al., 2019). During the analysis of study results, both qualitative and quantitative responses provided support for the usefulness of wearables. Nearly all respondents expressed a positive expectation regarding the usefulness of wearable technology in their lives.

In addition to healthcare professionals' recommendations, patients' subjective norms and perceived behavioural control emerged as significant motivating factors for purchasing wearables, aiding healthcare professionals in achieving their tasks with greater accuracy. In line with the studies conducted by Buenaflor and Kim (2013) as well as Yang et al. (2016), numerous researchers have examined the adoption of wearable technology by consumers, considering variables that encompass the social aspect of implementing new technologies. These studies have revealed significant effects for social influences. Subjective norms focus on individuals' interpretation of the opinions expressed by their social network regarding engagement in a particular behaviour. This highlights the importance of image enhancement and the social implications associated with the adoption of technology.

Furthermore, perceived behavioural control refers to an individual's confidence in their ability to perform a specific action. If a person believes they possess the necessary knowledge and resources to accomplish a task, they are more likely to engage in it. According to Da et al. (2020), perceived behavioural control stands out as one of the most influential predictors of consumer acceptance of health information technologies that are centered around consumers.

5.2. Challenges

There were a few challenges that were noted about the adoption of wearables by the healthcare professionals. The biggest among them was identified as cost of these devices. As stated earlier “The technology's cost is also an impediment, as healthcare organizations cannot afford it. This is why it is only given to select groups of people with special needs” (Lewy, 2014). Since India is a developing country, the potential users of wearables may not want to invest a lot of money in buying such devices.

Another difficulty in the use of wearables was the knowledge of how to use a device by both the users and the healthcare professional. An interviewee stated, “You need to have time to learn it.” Every wearable comes with its own instructions on how to use. It was also stated during the interview that they needed someone to show how the wearables work. It could also mean that the individual would expect the healthcare provider to show him/her about the procedure and steps required to use a wearable. However, this was not a part of the study. Even though wearables come with instruction manual, users may be reluctant to study the manual to learn about the wearables.
The Ease of use data provides how easy it is to start using a wearable. Wearables may or may not have a user interface and some would be more complicated to use than others. As evident from the perceived ease of use data, users are confident on being able to use a wearable. However for certain users who are not familiar with technologies may find it difficult to use.
6. Conclusion

The conclusions concerning the research findings are presented in the following chapter. The research question has been addressed. The chapter concludes with suggestions for future research.

6.1. Conclusion

The aim of this study was to investigate the obstacles hindering the adoption of wearable devices among healthcare providers in India for the purpose of monitoring patients’ physical well-being. To achieve this objective, a research questions was formulated.

RQ: **What are the barriers to the adoption of wearable technology by today's healthcare providers in India?**

To answer the stated research question an explanatory sequential mixed methods approach was employed to gain a deeper understanding of healthcare providers’ experiences. Data collection involved the utilization of an online survey consisting of 20 questions administered through Microsoft Forms for quantitative analysis. Additionally, semi-structured interviews with open-ended questions were conducted both in-person and online to collect qualitative data. The survey and interview questions were developed based on insights from the existing literature. The results obtained from the quantitative analysis, employing descriptive statistics in Microsoft Forms, served as a foundation for the interview phase, which served as another data collection method. The qualitative data obtained were analysed following a data analysis guide by Creswell (2014) to identify recurring themes, leading to the identification of three themes that address the research questions.

Emerged data shows that there are numerous benefits to adopting wearables by healthcare practitioners, however despite all the positive aspects of wearables, there are numerous factors influencing their widespread adoption by healthcare professionals. Starting with ease of use where the wearables come with instructions but can be difficult to use unless demonstrated by someone. The data analysis indicated that people are generally confident of using a new wearable but those individuals who are not aware of technology may find it hard to incorporate in their lives. This in turn causes the issues with healthcare providers in making an effective use of wearables in diagnosis and treatment. Another factor determining the adoption rate is the cost of wearable devices. Even with advancements in the technology, the cost of the devices remains higher. When it comes to a developing country like India, the cost becomes a major factor why individuals and healthcare providers become reluctant to use technology.

6.2. Future Research

The current study's implementation opens various possibilities for further investigation. Future researchers could build on the study's limitations by doing a comparable study in different situations, such as developed or developing countries. This could lead to a cross-national comparison research, which could shed more light on whether geographical or economic disparities influence how wearables are used by healthcare professionals. Furthermore, the current framework might be expanded to include more dimensions, potentially producing more useful results. Alternatively, future studies could use the framework introduced in this thesis to conduct research on any specific type of wearable device.
7. References


8. Appendices

Appendix 1. Different types of Bio-signal measurements by sensors (Pantelopoulos et al., 2010)

<table>
<thead>
<tr>
<th>Type of Bio-signal</th>
<th>Type of Sensor</th>
<th>Description of measured data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrocardiogram (ECG)</td>
<td>Skin/Chest electrodes</td>
<td>Electrical activity of the heart (continuous waveform showing the contraction</td>
</tr>
<tr>
<td></td>
<td></td>
<td>and relaxation phases of the cardiac cycles)</td>
</tr>
<tr>
<td>Blood pressure (systolic &amp; diastolic)</td>
<td>Arm cuff-based monitor</td>
<td>Refers to the force exerted by circulating blood on the walls of blood vessels, especially the arteries</td>
</tr>
<tr>
<td>Body and/or skin temperature</td>
<td>Temperature probe or skin patch</td>
<td>A measure of the body’s ability to generate and get rid of heat</td>
</tr>
<tr>
<td>Respiration rate</td>
<td>Piezoelectric/piezoresistive sensor</td>
<td>Number of movements indicative of inspiration and expiration per unit time</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(breathing rate)</td>
</tr>
<tr>
<td>Oxygen saturation</td>
<td>Pulse Diimeter</td>
<td>Indicates the oxygenation or the amount of oxygen that is being “carried” in a patient’s blood</td>
</tr>
<tr>
<td>Heart rate</td>
<td>Pulse Diimeter/skin electrodes</td>
<td>Frequency of the cardiac cycle</td>
</tr>
<tr>
<td>Perspiration (sweating)</td>
<td>Galvanic Skin Response</td>
<td>Electrical conductance of the skin is associated with the activity of the sweat glands</td>
</tr>
<tr>
<td>Heart sounds</td>
<td>Phonocardiograph</td>
<td>A record of heart sounds, produced by a properly placed on the chest microphone (stethoscope)</td>
</tr>
<tr>
<td>Blood glucose</td>
<td>Strip-base glucose meters</td>
<td>Measurement of the amount of glucose (main type/source of sugar/energy) in blood</td>
</tr>
<tr>
<td>Electromyogram (EMG)</td>
<td>Skin electrodes</td>
<td>Electrical activity of the skeletal muscles (characterizes the neuromuscular system)</td>
</tr>
<tr>
<td>Electroencephalogram (EEG)</td>
<td>Scalp-placed electrodes</td>
<td>Measurement of electrical spontaneous brain activity and other brain potentials</td>
</tr>
<tr>
<td>Body Movements</td>
<td>Accelerometer</td>
<td>Measurement of acceleration forces in the 3D space</td>
</tr>
</tbody>
</table>

Appendix 2: Survey Questions

1. I find using wearables easy to use.
   - Strongly agree
   - Agree
   - Neutral
   - Disagree
   - strongly disagree

2. Learning how to use wearables is easy for me.
   - Strongly agree
   - Agree
   - Neutral
   - Disagree
   - Strongly disagree

3. It is easy to become skilful at using wearables.
   - Strongly agree
   - Agree
   - Neutral
4. Wearables would improve my overall health.
   - Strongly agree
   - Agree
   - Neutral
   - Disagree
   - Strongly disagree

5. Wearables would increase my productivity.
   - Strongly agree
   - Agree
   - Neutral
   - Disagree
   - Strongly disagree

6. Wearables could make it easier to monitor my health.
   - Strongly agree
   - Agree
   - Neutral
   - Disagree
   - Strongly disagree

7. Monitoring health through wearables is a good idea.
   - Strongly agree
   - Agree
   - Neutral
   - Disagree
   - Strongly disagree

8. Monitoring health through wearables is a wise idea.
9. I am positive toward using wearables.
   - Strongly agree
   - Agree
   - Neutral
   - Disagree
   - Strongly disagree

10. I intend to check notifications from wearables frequently.
    - Strongly agree
    - Agree
    - Neutral
    - Disagree
    - Strongly disagree

11. I would like my patients to be heavy users of wearables.
    - Strongly agree
    - Agree
    - Neutral
    - Disagree
    - Strongly disagree

12. I would like my patients to achieve fitness goals using wearables.
    - Strongly agree
    - Agree
    - Neutral
    - Disagree
    - Strongly disagree
13. I feel confident finding information in the wearables.
   - Strongly agree
   - Agree
   - Neutral
   - Disagree
   - Strongly disagree

14. I have the necessary skills for using an wearables.
   - Strongly agree
   - Agree
   - Neutral
   - Disagree
   - Strongly disagree

15. What wearables stands for is important for me as a healthcare provider.
   - Strongly agree
   - Agree
   - Neutral
   - Disagree
   - Strongly disagree

16. I enjoy wearing wearables since my beliefs and the ideals underpinning their use are similar.
   - Strongly agree
   - Agree
   - Neutral
   - Disagree
   - Strongly disagree

17. In order for me to prepare for future job, it is necessary to develop knowledge about wearables.
   - Strongly agree
   - Agree
18. I have no difficulty in using wearables.
   - Strongly agree
   - Agree
   - Neutral
   - Disagree
   - Strongly disagree

19. I have no difficulty accessing basic information from patients’ wearables.
   - Strongly agree
   - Agree
   - Neutral
   - Disagree
   - Strongly disagree

20. By entering my name, I allow the collection of my information.

21. By entering my email address, I allow the collection of my information.

Appendix 3: Interview Transcript

1. Do you find using wearables easy to use.
   Its quite easy for me to use. I don’t use a smartphones beyond making calls and using whatsapp but still I think it would be easy for me to use the wearables.

2. Do you think, Learning how to use wearables is easy for you?
   It would be easy for me to learn how to use wearables. I have not used smartwatch but I know its easy to use. If you know how to handle technology then it will be easy for you to use.

3. Do you think It is easy to become skilful at using wearables.
   No. You need to have time to learn it. I have time to learn but I need someone to show me how it works. Also, I am not that interested in learning about it. If I use it a lot then I would end up wasting my time looking at it and exploring it. I would rather learn something else.
4. Do you think Wearables would improve my overall health.
   No. You need to see a lot of information like when you sleep when you get up. This will let you know when to get up and sleep. If you take all this information and then use to improve your health then it will improve your health. But I don’t think I will use it in this way.

5. Do you think Wearables would increase my productivity.
   Yes. You will get to know how tired are you. This will show if you can work more or you should rest. I can manage my time when I should eat and when should I get up. What things I should eat to improve my health.

6. Do you think Wearables could make it easier to monitor my health.
   Yes. Your daily routine about when you sleep and when you eat largely affects your health. Smartwatch can help you manage it. And if you monitor your health using the timing of your activity, then wearables can help you monitor it.

7. Do you think Monitoring health through wearables is a good idea.
   Yes it is a good idea. Just like a doctor sees his patient, wearables helps you record the data for the doctors. When doctor receives that data will enable him to diagnose and treat a patient more efficiently and correctly.

8. Do you think Monitoring health through wearables is a wise idea.
   Yes because it is a store of knowledge. This will let you learn a lot of things about your own body. And if you can learn something then it is always a wise idea.

9. Do you think you are positive toward using wearables.
   I am positive towards using wearables. Because according to modern times it can tell me beforehand what is wrong with my body. Its like a computer who is watching my body.

10. Do you intend to check notifications from wearables frequently.
    Yes. This will show me what is going on. And information about my body in real time.

11. Would you like your patients to be heavy users of wearables.
    Yes, if he or she wears a wearable then it will be easier for the doctors to know about the patient. He can get an overall picture of this health and his activities.

12. Would you like your patients to achieve fitness goals using wearables.
    Yes. Wearables would enable him to change his lifestyle. He or she would be able to do the exercises and activities according to the time by the wearables.
13. Do you feel confident finding information in the wearables.
   Yes. Wearables will give me most of the data by itself. Rest I can find by using google. I am sure I would be able to get all the information that I need about any wearables from the internet.

14. Do you have the necessary skills for using an wearables.
   No.

15. What wearables stands for is important for you as a healthcare provider.
   It is important because it gives you notification about the events that take place in your body. You can know about your body not only from the wearables but using the data from wearables, you can google the stuff and know about your own self.

16. Do you enjoy wearing wearables since your beliefs and the ideals underpinning their use are similar.
   Yes, because I get to know about my body. And correct knowledge is something that I believe in and a wearable allows me to learn correct information which ends in a better knowledge about myself.

17. In order for you to prepare for future job, it is necessary to develop knowledge about wearables.
   Yes, if there are two persons interviewing for the same job and one has extra technological knowledge about wearables and more then it would be advantageous for the company to hire a doctor who know about it.

18. Do you have any difficulty in using wearables.
   No. If you have the knowledge then its never difficult. If you don’t know about it, then everything is difficult.

19. Do you have any difficulty accessing basic information from patients’ wearables.
   No. I have not taken the data from the patient’s wearables yet. But it would be interesting to read that data. Right now, I have no idea how to take that data.