ASSESSING PERCEPTION AND ADOPTION OF ROBOTICS AMONG HEALTHCARE PROFESSIONALS IN KERALA : A QUANTITATIVE STUDY ON ACCEPTANCE OF ROBOTICS WITHIN HEALTHCARE SECTOR.

A dissertation submitted in partial fulfilment of the requirements for the MSc. Digital Transformation

Innopharma labs and faculty of science

Griffith College Dublin

Dissertation Supervisor: Rebecca Power

CHRISTEENA MATHEW

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CANDIDATE DECLARATION

I hereby declare that the dissertation entitled “ASSESSING PERCEPTION AND ADOPTION OF ROBOTICS AMONG HEALTHCARE PROFESSIONALS IN KERALA : A QUANTITATIVE STUDY ON ACCEPTANCE OF ROBOTICS WITHIN HEALTHCARE SECTOR” submitted in the partial fulfilment of MSc. Digital Transformation is the result of my own work and due acknowledgement given, where reference is made to others work.

Candidate name: Christeena Mathew

Candidate signature:

Date: 26/08/2024

Supervisor name: Rebecca Power

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LIST OF ABBREVIATIONS

FDA - Food and Drug Administration

AESOP - Automated Endoscopic System for Optimal Positioning

UV - Ultraviolet

NRI-3.0 - National Robotics Initiative 3.0

OECD AI Policy Observatory - Organisation for Economic Co-operation and Development Artificial Intelligence Policy Observatory

SARs - Social Assistance Robots

UTAUT - Unified Theory of Acceptance and Use of Technology

IT - Information Technology

TAM - Technology Acceptance Model

PU - Perceived Usefulness

PEOU - Perceived Ease of Use

BI - Behavioral Intention

ABSTRACT

Robotics, initially developed for automation and precision tasks across various industries, have now established a vital role in healthcare by alleviating burdens for both patients and medical professionals. This study primarily seeks to investigate how healthcare professionals in Kerala perceive robotics and to assess the extent of their adoption of these technologies. It aims to understand the acceptance of robotics in the healthcare sector, providing insights into potential barriers and facilitators for integrating robotics into medical practice in Kerala. Utilizing the Technology Acceptance Model (TAM) and employing structured surveys and statistical analysis, the study delivers robust insights into the current state of robotics integration in healthcare by assessing the perceptions of professionals employed in hospitals, clinics, and other healthcare facilities across Kerala. Surveying 70 healthcare professionals, the research unveils significant enthusiasm, particularly among younger professionals aged 24-34. Overall, 67% of the respondents recognize the benefits of robotics in automating routine tasks, enhancing surgical precision, and improving operational efficiency through error reduction. The study highlights key challenges: 49% of respondents report a lack of comprehensive training as a major barrier to training, while 38% cite financial constraints as major challenge to broader adoption. Despite these challenges, 53% of professionals express strong support for integrating robotics, showcasing their readiness to leverage technology for enhanced patient care and surgical outcomes.Additionally, the study identifies a positive relationship between increased awareness of robotics and greater comfort in using this technology, suggesting that enhancing knowledge could significantly improve comfort levels and adoption rates among healthcare professionals. These findings underscore a generational shift towards embracing advanced technologies and emphasize the need for targeted training programs and strategic policy development to facilitate the adoption of robotics, aiming to make healthcare services in Kerala more precise, efficient, and cost-effective.

Keywords : Robotics, Healthcare Professionals, Kerala, Technology Acceptance Model (TAM), Medical Practice, Surgical Precision, Operational Efficiency, Financial Constraints, Comprehensive training, Generational Shift, Integration of Robotics, Policy Development

CHAPTER 1

1.0 INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Robots, originally developed for automation and precision tasks across various industries have now found a significant role in healthcare. Here, they serve a vital role by alleviating both patients and medical professionals from the burdens of routine and delicate tasks requiring utmost care and precision(Kar, 2019). In spite of their current presence in healthcare applications, robotic technology has to achieve mainstream adoption, which signals a future where its widespread integration still remains as a goal yet to be achieved.

In the past few years there has been a lot of research and innovations within robotic healthcare solutions which is driven by global demographics that shows an aging and increasingly ailing population, leading to escalating demands on healthcare providers. The potential of robotics in this sector is immense, promising elevated levels of patient care, enhanced clinical productivity, and safety for all involved(Silvera-Tawil, 2024).

1.1.1 HISTORY OF ROBOTICS IN HEALTHCARE

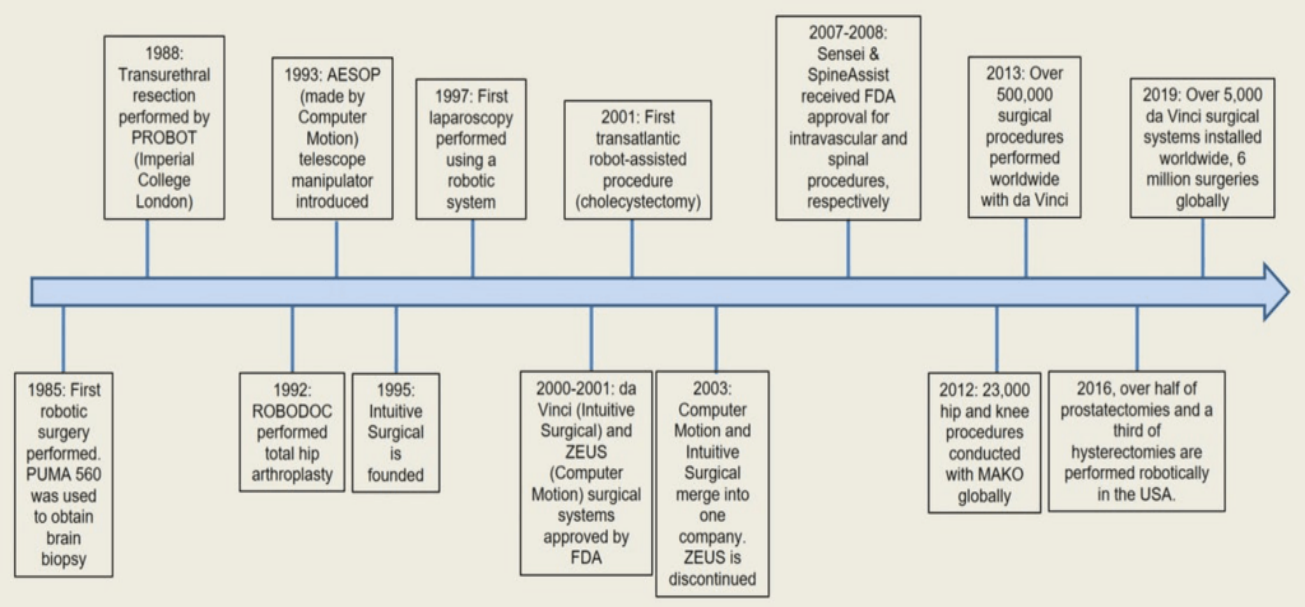

Figure 1:History of robotic surgery (Anon, 2020)

The history of robotics in healthcare has seen remarkable advancements since 1980s and 1990s, especially in surgical applications. Industrial robotic technology made its surgical debut in 1985, adopting a robotic arm to perform a stereotactic brain biopsy, paving the way for systems like Neuromate and Robodoc in neurosurgery and orthopedics surgery (Hockstein *et al.*, 2007).

Simultaneously, telepresence technology, initially developed by NASA, was recognized for surgical use by Scott Fisher, Ph.D., and Joe Rosen, M.D., leading to FDA-approved systems such as AESOP and Hermes by 1994, which automated endoscopic camera control (Hockstein *et al.*, 2007). In 1995, Intuitive Surgical introduced the da Vinci surgical system, transforming laparoscopic surgery with its debut in 1997. With over 5000 systems globally, da Vinci has expanded surgical capabilities, gaining FDA approval for various procedures and enhancing patient outcomes. The evolution of robotics has profoundly impacted healthcare, promising ongoing advancements in surgical precision and patient care.

1.1.2 POSITIVE IMPACTS AND CHALLENGES OF HEALTHCARE ROBOTICS

Medical robots offer significant advantages in healthcare settings, enhancing surgical precision to reduce complications and improve success rates. They streamline tasks like cleaning, disinfection, and medication delivery, optimizing healthcare professional's time for direct patient care and improving overall efficiency (Ohwoekevwo *et al.*, 2024). In infectious disease wards, robots minimize human contact, lowering the risk of pathogen transmission (Di Lallo *et al.*, 2021). Robotic surgeries are less invasive, resulting in reduced blood loss, shorter hospital stays, and faster recovery times (Kaiser *et al.*, 2021). Continuous monitoring and care provided by robots benefit elderly and disabled patients, enhancing outcomes and quality of life.

However, the use of medical robots also pose certain challenges. High costs for initial investment and maintenance limit accessibility, primarily to developed countries and advanced hospitals (Alla and Pazos, n.d.). Despite their precision, robots may also experience mechanical failures or programming errors, posing risks to patient safety (Deo and Anjankar, n.d.). Extensive training for healthcare providers adds complexity and operational costs.There are also concerns about potential job displacement among healthcare personnel, emphasizing a need for effective management of workforce transitions to ensure beneficial integration into healthcare systems for both patients and workers.

1.2 SIGNIFICANCE OF THE STUDY

Robotics revolutionizes healthcare with enhanced precision, efficiency, and outcomes in medical procedures. Surgeons utilize advanced technologies for minimally invasive surgeries, reducing recovery times, infection risks, as well as the postoperative pain. Robotics helps healthcare professionals to be very precise when they diagnose and treat patients as well as automates routine tasks, and manages data effectively. This integration improves decision-making, supports personalized treatment, and allows healthcare professionals to prioritize critical aspects of patient care.

1.2.1 SCOPE AND RELEVANCE OF THE STUDY

This study focuses on Kerala, India, known for its advanced healthcare system and high literacy rates (Muraleedharan Ph.D and Chandak, 2021). Kerala's medical infrastructure and openness to new technologies among healthcare professionals make it an ideal setting for this research (Ummer *et al.*, 2021). The study aims to assess perceptions and adoption of robotics within this context, providing region-specific insights.

Kerala's healthcare system is renowned for quality and innovation, with professionals crucial in maintaining this standard (Muraleedharan Ph.D and Chandak, 2021). As robotics becomes integral to medical practice, understanding its perception and adoption in Kerala is essential. This region's strong foundation in medical education and proactive approach to new technologies make the study particularly relevant. By assessing how healthcare professionals in Kerala perceive and are willing to adopt robotics, the research can reveal the state's readiness to embrace technological advancements and enhance patient care outcomes.

1.2.2 CHALLENGES IN HEALTHCARE AND THE NEED FOR ROBOTIC INTEGRATION

The healthcare sector, both globally and in Kerala, faces many challenges, such as the increasing demand for high-quality care, a shortage of skilled professionals, and the need for more efficient medical procedures. Traditional methods can be slow and prone to human error, affecting patient care and overall healthcare delivery. Additionally, more complex medical cases need innovative solutions to help healthcare providers meet these demands effectively

To address these challenges, there is a pressing need for the adoption of robotics in healthcare. Robotics can provide the necessary support to healthcare professionals by enhancing surgical precision, automating repetitive tasks, and improving overall operational efficiency. However, successful integration depends on healthcare professionals acceptance and readiness. Thus, assessing their perceptions and willingness is crucial to identify potential barriers and facilitators

This study aims to bridge this gap by providing a comprehensive understanding of the perception and adoption of robotics among healthcare professionals in Kerala. By doing so, it will contribute to the development of strategies that can promote the effective integration of robotics in the healthcare sector, ultimately leading to improved patient outcomes, enhanced efficiency, and better utilization of healthcare resources.

1.3 RESEARCH AIM AND OBJECTIVE

The primary aim of the research topic is to investigate how healthcare professionals in Kerala perceive robotics and assess the extent to which they are adopting robotic technologies. The study aims to understand public acceptance of robotics in the healthcare sector, providing insights into potential barriers and facilitators for integrating robotics into medical practice in Kerala.

The following are the research objectives:

- Evaluate healthcare professionals knowledge and comfort levels in utilizing robotics within healthcare settings.
- To investigate the benefits and limitations of integrating robotics in healthcare facilities in Kerala.
- Identify factors shaping public attitudes towards robotics in healthcare, including safety concerns and perceived benefits.
- To examine socioeconomic factors impacting public perceptions of robotics in healthcare setting.

1.4 RESEARCH QUESTIONS

Driven by the aims and objectives, the research is structured around the following research questions :

- What is the current level of knowledge among healthcare professionals in Kerala regarding the use of robotics in healthcare?
- How comfortable are healthcare professionals in Kerala with integrating robotics into their daily medical practices?
- What are the primary factors influencing public attitudes towards the use of robotics in healthcare in Kerala?
- What are perceived benefits and major challenges faced in integrating robotics in healthcare sector in Kerala according to healthcare professionals?
- Are there any significant differences in the perception of robotics in healthcare among different socioeconomic groups in Kerala?

1.5 RESEARCH HYPOTHESIS

The research hypothesis of this study are the following:

H1: Healthcare professionals in Kerala have a high level of knowledge and comfort in utilizing robotics within healthcare settings.

H2: Positive public attitudes towards robotics in healthcare are primarily shaped by perceived benefits rather than safety concerns.

H3: The integration of robotics in healthcare facilities is perceived to offer significant benefits such as improved efficiency and patient outcomes.

H4: Socioeconomic factors such as age and education level significantly impact public perceptions of robotics in healthcare.

1.6 OUTLINE OF THE STUDY

Robotics in healthcare has emerged as a transformative force, reshaping various aspects of medical practice, patient care, and operational efficiency. The potential benefits of robotics in healthcare are vast, promising to revolutionize the field by providing higher precision, reliability, and efficiency in medical procedures and patient care.As a healthcare professional, understanding these aspects is crucial for identifying areas needing additional training and support to ensure the successful and safe integration of technologies like robotics. It also facilitates correcting misunderstandings and educating stakeholders with valuable perspectives to optimize robotic use. Studying socioeconomic factors reveals disparities that influence public perception and acceptance. This research holds personal significance because it promises insights to enhance robotic utilization in Kerala's healthcare. Addressing healthcare professionals concerns and perceptions ensures responsible adoption of new technologies, thereby improving patient care and system efficiency.

While existing literature provides insights into robotics in healthcare, significant gaps remain. These include insufficient data on factors influencing individual adoption decisions and healthcare professionals attitude towards robots.Understanding how socioeconomic backgrounds shape attitudes towards healthcare robots is also under explored. This study aims to fill these gaps by evaluating professionals knowledge and comfort levels, identifying public attitudes, and exploring socioeconomic impacts. Data will be collected via surveys distributed through email and professional

networks, employing stratified random sampling across doctors, nurses, and pharmacists in both public and private hospitals. Analyzing this data with descriptive and inferential statistics will provide precise insights into healthcare decision-making, offering a comprehensive overview of attitudes towards robotics in Kerala's healthcare sector.

CHAPTER 2

2.0 LITERATURE REVIEW

2.1 INTRODUCTION

Robotics in healthcare is a groundbreaking advancement that is transforming medical practice and patient care. Initially emerging in the mid-20th century, healthcare robotics has evolved from rudimentary automated devices to sophisticated systems integral to modern medical procedures. The historical trajectory of healthcare robotics began with early laboratory automation in the 1950s and progressed to the advent of surgical robots in the 1980s and 1990s, such as the groundbreaking da Vinci Surgical System, which received FDA approval in 2000 (Hockstein *et al.*, 2007). These innovations have expanded to include various types of robots, including surgical, rehabilitation, assistive, diagnostic, telepresence, and service robots. Each category addresses specific needs within healthcare, enhancing precision, efficiency, and patient outcomes.

2.1.1 TYPES OF ROBOTS IN HEALTHCARE

Cleaning and Disinfecting Robots: These robots are designed to maintain hygiene in healthcare settings by autonomously cleaning and disinfecting surfaces, reducing the risk of infections and ensuring a sterile environment. They use technologies such as UV light and advanced sensors to effectively sanitize patient rooms, operating theaters, and other critical areas(Sanusi, 2023).

Safety and Monitoring Robots: Safety and monitoring robots are equipped with sensors and cameras to continuously monitor patient conditions and alert healthcare professionals to any changes. They enhance patient safety by providing real-time data and reducing the need for constant human supervision(Sanusi, 2023).

Surgical Robots: Surgical robots, like the Da Vinci system, assist surgeons in performing complex and precise procedures with minimal invasiveness. These robots translate a surgeon’s hand movements into finer actions, reducing the risk of complications and improving recovery times(Sanusi, 2023).

Robotics for Prosthetics: Prosthetic robots are advanced devices that replace missing limbs and restore mobility and function to amputees. These robotic prosthetics are often controlled by neural or muscle signals, providing a high degree of dexterity and responsiveness(Sanusi, 2023).

Rehabilitation Robots: Rehabilitation robots support patients in recovering physical functions lost due to injury or illness. They provide guided physical therapy and exercises, helping patients regain strength, coordination, and mobility(Sanusi, 2023).

Robots for Training Medical Personnel: These robots are used in medical education to simulate real-life scenarios, allowing healthcare professionals to practice and improve their skills. They provide hands-on experience in a controlled and safe environment, enhancing the training process(Anon, 2024).

Social and Telepresence Robots: Social and telepresence robots facilitate remote interactions between patients and healthcare providers. They enable virtual consultations, monitor patient well-being, and provide companionship, particularly for elderly or isolated patients(Sanusi, 2023).

Patient Transfer Robots: Patient transfer robots assist in safely moving patients from one place to another, such as from a bed to a wheelchair. They reduce the physical strain on healthcare workers and minimize the risk of injury to both patients and staff(Sanusi, 2023).

Healthcare Robots for Delivering Items: These robots autonomously transport medications, supplies, and equipment within healthcare facilities, ensuring timely and accurate delivery. They improve operational efficiency and allow staff to focus more on patient care(Sanusi, 2023).

Picking and Dispensing Robots: Picking and dispensing robots automate the process of selecting and distributing medications and medical supplies. They enhance accuracy in medication dispensing and reduce the risk of human error, ensuring patients receive the correct treatments(Sanusi, 2023).

2.1.2 GLOBAL TRENDS AND PERSPECTIVES

In India, as medical technology and engineering have progressed, robots in healthcare have advanced from handling administrative tasks to performing surgeries. Some of the significant robotic technologies in India, are micro- and nanorobots, surgical robots, image-guided surgical robots, and rehabilitation robots. Indian research also emphasizes advanced surgical robots like the da Vinci system, which assist in minimally invasive, image-guided surgeries. Additionally, robots help with dispensing medication, transporting medical supplies, and managing hospital operations, enabling healthcare professionals to focus more on patient care. Rehabilitation robots aid in post-surgical

recovery, showcasing the continuous improvements in India's medical robotics field (Lochan *et al.*, 2023).

The use of robotic surgery varies widely around the world due to differences in healthcare systems and economic disparity. Developed countries like the United States lead in robotic surgery because they have large healthcare budgets and supportive policies. European nations and some Asian countries like Japan and South Korea also use robotic surgery widely due to their advanced healthcare systems and focus on new technology. On the other hand, developing countries face challenges such as limited funds, fewer trained staff, and inadequate infrastructure, leading to slower adoption. However, countries like India, China, and Brazil are beginning to invest more in robotic technology (Mishra, n.d.) by recognizing the long-term advantages of robotic surgeries, including enhanced precision and better patient outcomes. Investments are made not only towards acquiring robotic systems but also towards training programs to equip healthcare professionals with the required skills. For example, multiple institutes in India provide robotic surgery training programs, guided by senior consultants from government institutions and private hospitals. The da Vinci Basic Surgical Skills Training Center has been set up in India to offer extra training opportunities (Bora *et al.*, 2020).

National programs in countries such as the U.S., China, Great Britain, Italy, Spain, and South Korea support the growth of robotic surgery through funding and research, leading to the successful adoption of these technologies (Collins, 2023). The National Robotics Initiative 3.0 (NRI-3.0) in the United States supports fundamental research to advance the integration of robotics for human benefit, including healthcare applications to enhance human safety and independence (Anon, n.d.). Studying and understanding how successful robotic programs operate in advanced countries can provide valuable lessons and strategies. By analyzing their approaches to funding, training, and implementation, other regions can adopt similar practices and adapt them to their own healthcare contexts. This knowledge can lead to better planning and execution of robotic programs, helping to overcome local challenges and improve outcomes on a global scale.

2.2 KEY THEMES

2.2.1 KNOWLEDGE AND COMFORT LEVELS OF HEALTHCARE PROFESSIONAL.

The focus on the knowledge and comfort levels of healthcare professionals regarding robotics has gained significant attention. González Aguña et al. (2023) examined how the COVID-19 pandemic accelerated the adoption of robotics, revealing that healthcare professionals found robots particularly helpful during the crisis, with many perceiving them as beneficial to patient care. Similarly, Georgadarellis et al. (2024) found that nurses and nursing student’s interest in healthcare robots

increased after educational exposure, indicating that familiarity with technology enhances job satisfaction and care effectiveness, though the study's limited sample size and lack of randomization may affect the validity of these findings. The OECD AI Policy Observatory (2021) emphasizes the importance of digital literacy and skill training, a view supported by Papadopoulos et al. (2023), who highlight the need for culturally sensitive training programs for social assistance robots (SARs) in healthcare, addressing the influence of cultural factors on technology acceptance. Puliatti et al. (2020) stress the necessity of comprehensive training programs for robotic-assisted surgery, noting the current gaps in clinical and simulation-based training. Rusch et al. (n.d.) describe the development of a European curriculum for robot-assisted gynecological surgery, underscoring the need for structured, competency-based training despite the challenges posed by limited literature and expert panel size. MIR et al. (2023) discuss the integration of robotic surgery and AI into medical education, acknowledging the precision of robotic techniques but also highlighting issues such as high costs and training requirements. Poulsen et al. (2022) analyzed factors impacting workflow and non-technical skills in robot-assisted surgery, identifying communication and coordination as key areas affecting efficiency. Together, these studies highlight the critical role of education, training, and cultural considerations in shaping healthcare professionals knowledge and comfort with robotics, essential for improving adoption and effectiveness in medical settings.

Vichitkraivin and Naenna (2021) found that medical staff's willingness to adopt healthcare robots is influenced by several factors, including safety concerns and technical knowledge. Their study revealed that younger medical practitioners were generally more open to using new technology. Since they have more technical knowledge compared to other population groups Similarly, BenMessaoud et al. (2011) examined the factors influencing robotic surgery adoption, noting that physicians attitudes towards technology and their perceived ease of use were significant. This study emphasized the need for hands-on practice to increase comfort and knowledge. Sierra Marín et al. (2021) showed that while healthcare professionals in Colombia had positive attitudes towards robotics, their knowledge was limited. They stressed the importance of enhancing education to build trust and improve integration. Łukasik et al. (2020) highlighted that future healthcare professionals showed varying levels of acceptance based on their training, with nursing students generally more accepting of assistive robots compared to medical students who prioritized privacy concerns. These findings suggest a need for better integration of robotics education into medical training to improve comfort and understanding.

Vichitkraivin and Naenna (2021) highlight that staff intentions and support are crucial for adopting robotics in healthcare. However, they also note that a lack of technical knowledge among medical staff is a significant barrier. This lack of familiarity can hinder the effective use of robotics and contribute to resistance against new technologies. Similarly, Vijayakumar and B (2022) emphasize

that while robotics and AI enhance efficiency and patient care by assisting with surgeries and managing supplies, challenges such as high costs and emotional detachment between patients and robots still persist. They stress that proper training and improved policies are essential for overcoming these obstacles and maximizing the benefits of robotics. Cresswell et al. (2018) further underscore the importance of addressing social and technical barriers for successful robotics implementation. Their research, which involved interviews with healthcare professionals, reveals that despite opportunities for improvement, significant obstacles remain, including issues related to knowledge and adaptation. This collectively points to the critical role of knowledge and comfort in the adoption of healthcare robotics and suggests that overcoming barriers through training and support is crucial for successful integration.

Osaka et al. (2023) found that healthcare professionals experiences with robots, whether through daily use or at work, significantly influenced their perceptions of the robot's usefulness and challenges. This study highlighted that those with more direct experience rated robots as more useful, suggesting that familiarity plays a crucial role in shaping attitudes towards robotics (Osaka et al., 2023). Similarly, Vichitkraivin and Naenna (2021) revealed that younger medical practitioners in Thai government hospitals were more receptive to robots, yet they also identified a lack of technical knowledge as a barrier to adoption, indicating that both age and familiarity with technology influence acceptance levels. Additionally, Soljacic et al. (2024) explored healthcare professionals expectations from robots, also highlighted that robots cannot fully replace human care. This study pointed out that understanding what healthcare professionals expect from robots can result in better integration strategies (Soljacic et al., 2024). These findings collectively highlight that both knowledge, comfort levels and familiarity with technology are pivotal in shaping how healthcare professionals perceive and adopt robotic technologies in their practice.

2.2.2 FACTORS SHAPING PUBLIC ATTITUDES

Factors shaping attitudes towards robotic adoption in healthcare are multifaceted, encompassing both technological and socio-cultural dimensions. Alla and Pazos (2021) highlight the importance of understanding healthcare needs, collaboration among medical professionals, and adapting to evolving regulations as the key factors. Vichitkraivin and Naenna (2021) identify staff willingness, support facilitation, and safety concerns as critical predictors of robot use in Thai government hospitals. BenMessaoud et al. (2011) emphasize the perceived usefulness, ease of use, and external motivating factors as significant influences on the adoption of robotic-assisted surgery, suggesting enhancements to the Unified Theory Of Acceptance And Use Of Technology (UTAUT) model for better guidance. Sierra Marín et al. (2021) reveal positive attitudes towards robotics among Colombian healthcare professionals, stressing the need for enhanced education and trust-building. These studies collectively

underscore the multifaceted nature of robotic adoption, influenced by technological, social, and regulatory factors.

Studies by Cresswell et al. (2018) highlight the significant opportunities robotics offer in healthcare, while also identifying social and technical challenges that need to be addressed for successful implementation. These challenges include ensuring that healthcare professionals are comfortable with and knowledgeable about robotic systems, as well as addressing concerns about data privacy and the security of robotic systems. Stasevych and Zvarych (2023) emphasize the potential of robotics and AI to enhance healthcare delivery by increasing efficiency and reducing costs, but they also raise concerns about privacy and job security, which are crucial in shaping public attitudes. Furthermore, Vijayakumar and B (2022) discuss how robotics can alleviate the workload of healthcare professionals by automating surgeries, cleaning, and supply management, yet they also point out the emotional disconnect patients may feel and the high costs associated with robotic technology. These studies collectively underscore that while robotics hold great promise for improving healthcare, the attitudes towards their adoption are heavily influenced by the perceived benefits, potential risks, and the readiness of healthcare systems to integrate these technologies effectively.

Korn et al. (2021) explored cultural differences in the acceptance and design preferences of social robots among participants from Germany, Egypt, Jordan, and Saudi Arabia, finding that cultural factors significantly influence preferences for robot's roles, abilities, appearance, emotional awareness, and interactivity. Osaka et al. (2023) revealed that healthcare professional's experiences with robots impact their perceptions of usefulness and challenges, showing that daily life interactions enhance perceived usefulness while workplace usage highlights inconveniences. Laursen et al. (2022) emphasized the importance of education, IT experience, and performance expectations in accepting diagnostic robots, noting that younger, well-educated individuals are more likely to accept robotic diagnosis. Andtfolk et al. (2022) found that ethical concerns influence opinions on humanoid robots more than perceived usefulness, with positive attitudes predominantly among service workers, well-educated people, and older adults. Broadbent et al. (2010) identified mixed feelings about robots in healthcare among people over 40, who appreciated robots for simple tasks but had concerns about their reliability and safety. These studies collectively underscore that cultural context, personal experience, education, ethical considerations, and individual concerns are critical in shaping attitudes toward the adoption of robotics in healthcare .

González Aguña et al (2023) highlighted that the COVID-19 crisis accelerated the use of robotics, revealing that many healthcare professionals found these technologies helpful during the pandemic, suggesting a positive correlation between the perceived usefulness of robots and their acceptance. Similarly, Georgadarellis et al (2024) found that nurses' and nursing students' interest in healthcare robots increased after being exposed to educational materials, indicating that familiarity and

education can positively influence attitudes towards robotic adoption. Papadopoulos et al (2023) emphasized the importance of culturally sensitive training programs for social assistance robots (SARs), noting that cultural factors significantly impact technology acceptance and training needs.

2.2.3 BENEFITS AND LIMITATIONS OF ROBOTICS INTEGRATION

The integration of robotics in healthcare presents numerous benefits and limitations, as explored in several studies. Stasevych and Zvarych (2023) highlight the positive impacts of robotics and AI in speeding up medical processes and reducing costs, but also emphasize concerns about privacy, data security, and potential job losses. Parre and Sujatha (2021) discuss the advantages of robotics in neurorehabilitation, noting that robotics can reduce human error and enhance patient support, but also point out for global standards and collaboration to address technical and financial challenges. Troccaz et al. (2019) review the evolution of medical robotics, recognizing improvements in surgical precision and patient-specific treatments while pointing out the need for more ergonomic designs and better clinical integration. According to Cresswell et al. (2018), robotics in healthcare offers significant opportunities to improve patient outcomes through advanced artificial intelligence, such as transitioning from open surgical approaches to minimally invasive keyhole techniques which results in less trauma and faster recovery for patients, though social and technical obstacles remain a challenge for optimal implementation. Lastly, Vijayakumar and B (2022) underscore how robotics can increase efficiency in healthcare settings, though they also highlight challenges such as the high cost, lack of emotional connection with patients, and potential job displacement for healthcare workers. These studies collectively underscore the transformative potential of robotics in healthcare while also acknowledging the critical challenges that must be addressed for successful integration.

According to Vänni and Salin (2019), service and social robots can boost productivity, reduce mental workload for healthcare workers, and enhance patient motor and cognitive skills. However, the field remains fragmented with limited intervention studies. Simshaw et al. (2016) emphasize the need for robust regulatory frameworks to maximize benefits while addressing safety, security, and privacy concerns. Sahoo and Choudhury (2023) highlight the growing use of mobile robots for patient monitoring and drug administration but point out the ethical issues, such as privacy and patient autonomy, that need more research. Additionally, Weerarathna et al. (n.d.) discuss how social robots can alleviate healthcare professional shortages and improve patient outcomes, eventhough they face challenges related to safety, acceptability, and ethical concerns. Overall, while robotic technology promises enhanced efficiency and patient care, it also presents challenges such as privacy concerns, safety and security that must be addressed through comprehensive research, regulation, and strategic implementation

González Aguña et al. (2023) demonstrated that healthcare professionals found robotics to be extremely helpful during the COVID-19 pandemic, enhancing the overall quality of care. This study highlights the potential for robotics to improve healthcare delivery, particularly in crisis situations. Similarly, Georgadarellis et al. (2024) showed that increased familiarity with healthcare robots can boost job satisfaction and effectiveness among nurses, suggesting that education and exposure to robotic technologies can positively influence their adoption. Despite these advantages, the study also notes limitations such as small sample sizes and non-random participant selection, which may impact the generalizability of the results. Papadopoulos et al. (2023) emphasized the need for comprehensive training programs that address cultural dimensions to ensure effective implementation of social assistance robots (SARs) in healthcare. For instance, participants from collectivists countries prioritized training on what to do if the robot malfunctions and on patient safety, whereas participants from individualistic countries placed more importance on knowing how to operate the robot, such as turning it on and off, indicating that cultural sensitivity is crucial for successful technology adoption. On the other hand, Puliatti et al. (2020) and Rusch et al. (n.d.) both pointed out the challenges in training healthcare professionals in robotic-assisted surgery. They highlighted the necessity of structured and validated training programs, including tele-mentoring and modular, competency-based curricula, to overcome the shortage of well-trained robotic surgeons. MIR et al. (2023) also acknowledged the precision and effectiveness of robotic surgery, particularly in delicate procedures, but noted significant challenges such as high costs, extensive training requirements, and the risk of mechanical failures. Despite these hurdles, the integration of robotics and AI into medical education is seen as essential for future advancements. These studies collectively underscore that while robotics integration in healthcare holds substantial promise for improving patient care and operational efficiency, it also requires addressing training needs, cultural factors, and cost-related challenges to fully realize its potential.

The research by Vichitkraivin and Naenna (2021) focuses on the factors influencing the adoption of robots in Thai government hospitals, revealing a lack of technical knowledge among staff as a significant barrier. Osaka et al. (2023) further explore healthcare professionals experiences with robots, noting that those using robots daily perceive them as highly useful, though they also highlight considerable inconveniences, indicating a need for intermediary support and enhancements. Laursen et al. (2022) examine the potential of diagnostic robots in Denmark, finding that acceptance is higher among younger, well-educated individuals with IT experience. However overall acceptance hinges on enhancing robot performance and addressing user expectations which could be achieved by tailoring educational prorams and providing clear communication about robots capabilities and benefits. Andtfolk et al. (2022) investigate attitudes toward humanoid robots, discovering a general positive outlook, particularly among service workers, well-educated individuals, and older adults, although ethical concerns significantly impact opinions more than perceived usefulness. These studies

collectively emphasizes the dual nature of robotic integration in healthcare: while robots can enhance efficiency, precision, and patient care, their widespread adoption is challenged by technical, ethical, and experiential factors that must be addressed to maximize their potential benefits.

2.2.4 SOCIOECONOMIC FACTORS IMPACTING PERCEPTIONS

The integration of robotics and AI in healthcare is reshaping patient care and medical procedures, but socioeconomic factors significantly influence perceptions and acceptance of these technologies. The "Socioeconomic Factors Impacting Perceptions" is explored across several cited articles, revealing how demographic variables like age, education, and occupation shape attitudes towards robotics in healthcare. For instance, Laursen et al. (2022) highlight that younger individuals and those with higher education levels are more likely to accept diagnostic robots, emphasizing the role of education and IT experience in enhancing acceptance. Similarly, Vichitkraivin and Naenna (2021) found that younger medical staff in Thai government hospitals were more receptive to robot adoption, while technical knowledge posed a barrier. Andtfolk et al. (2022) observed that well-educated people and service workers showed more support for humanoid robots, with ethical concerns significantly influencing their perceptions. Broadbent et al. (2010) further illustrate how people over 40, despite recognizing the potential benefits, harbor concerns about the reliability and safety of robots, highlighting the need to address individual concerns and attitudes. These studies collectively underscore the critical impact of socioeconomic factors on the perception and acceptance of healthcare robotics, indicating that targeted education and addressing ethical concerns are essential for broader adoption.

Studies have shown that financial limitations, infrastructure challenges, and lack of technical knowledge among healthcare professionals can hinder the adoption of robotics in healthcare settings (Cresswell et al., 2018). These factors are crucial in developing countries, where economic capacity and healthcare infrastructure are often limited. For instance, the study by Vichitkraivin and Naenna (2021) highlighted the importance of staff intentions and support for robot adoption, but also pointed out that technical knowledge is a significant barrier. Additionally, the high costs associated with advanced robotic systems and the potential job losses for healthcare workers create economic and social concerns that need to be addressed (Vijayakuymar and B, 2022). By understanding and addressing these socioeconomic factors, it is possible to enhance the acceptance and implementation of robotic technologies in healthcare, leading to improved patient outcomes and more efficient healthcare delivery.

Socioeconomic factors play a significant role in shaping perceptions and adoption of robotic technologies in healthcare. Vichitkraivin and Naenna (2021) reveal that factors such as safety concerns and staff willingness are crucial for the adoption of healthcare robots in Thai hospitals. They

found that younger medical practitioners were more open to adopting new technologies, highlighting how individual and demographic factors impact acceptance. Similarly, Łukasik et al. (2020) explored future healthcare professionals attitudes towards assistive robots for elderly care, finding that nursing students were more receptive to everyday robot uses compared to medical students who prioritized privacy concerns. This study underscores the influence of educational background and anticipated use cases on perceptions of robotics. Additionally, Sahoo and Choudhury (2023) emphasized the importance of understanding human dynamics such as trust and cultural norms for the successful integration of mobile robots in healthcare. They argue that these socioeconomic factors, along with ethical issues like privacy and patient autonomy, affect how these technologies are accepted and implemented. Overall, these studies highlight that socioeconomic factors, including professional background, age, and cultural norms, significantly influence the acceptance and effective use of robotics in healthcare.

Papadopoulos et al. (2023) emphasized the importance of culturally and socioeconomically sensitive training programs for social assistance robots (SARs). They found that socioeconomic and cultural dimensions such as variability between collectivist and individualistic societies, profoundly affect technology acceptance and training needs, indicating that tailored educational approaches are necessary for effective implementation. Additionally, Georgadarellis et al. (2024) explored how education and exposure to technology influence nurses perceptions of robots, revealing that increased familiarity through educational resources can alter perceptions positively. This suggests that socioeconomic factors, including access to educational tools and resources, are critical in shaping healthcare professionals acceptance of robotics. These studies collectively highlight that socioeconomic factors, such as cultural context, and education level, are integral to understand and improve the adoption of robotic technologies in healthcare.

2.3 GAPS IN LITERATURE REVIEW

The current literature on the adoption of robotics in healthcare highlights several significant areas but also reveals notable research gaps. While existing studies emphasize the importance of education and familiarity with robotic systems among healthcare professionals, there is limited quantitative data on the specific knowledge and comfort levels across different regions and settings. Most studies focus on developed countries or provide qualitative insights without extensive quantitative analysis. So there is a need for further research to offer valuable regional insights and contribute to a more comprehensive understanding of how education and training impact the adoption of robotics in different healthcare settings. The studies also identifies several factors influencing the adoption of robotics, including safety concerns, perceived benefits, and technical knowledge. However, there is a lack of region-specific studies that explore these factors in depth within the context of public healthcare systems.

The existing studies discuss the general benefits and limitations of integrating robotics in healthcare, but there is a need for more focused research that evaluates these aspects within specific healthcare environments. The impact of socioeconomic factors on the adoption of robotics in healthcare is well-documented, yet detailed analyses considering the diverse socioeconomic backgrounds within specific regions are lacking. Many studies do not adequately address the variability in cultural and socioeconomic conditions, which can significantly influence technology adoption. Further research should be conducted to thoroughly analyze how variables such as age, education, occupation, and access to technology affect the acceptance and integration of robotics in the healthcare sector. Addressing these research gaps will provide a robust foundation for developing targeted strategies to promote the effective and widespread use of robotics in healthcare. Doing so, will reduce concerns, create a more welcoming environment, and ensure that these technologies are accessible and beneficial to all.

2.4 SUMMARY

The successful integration of robotics into healthcare hinges on a complex interplay of factors related to both technological advancements and the human elements involved. The adoption of robotic technologies has been notably accelerated by the COVID-19 pandemic, which underscored their potential to enhance patient care during crises. However, the path to effective implementation is shaped by several critical elements, including education, training, socioeconomic factors, and personal attitudes.

Education and training are pivotal in determining how well healthcare professionals accept and utilize robotic technologies. Professionals who are well-versed in robotics and receive comprehensive, culturally sensitive training are more likely to embrace these innovations. Effective training programs should address both technical skills and non-technical aspects, ensuring that healthcare workers are comfortable with the technology and can integrate it into their daily practices. This training must be designed to cater to diverse needs and backgrounds to ensure broad acceptance and effectiveness.

Socioeconomic factors also play a significant role in shaping attitudes towards robotics. Younger and more educated healthcare professionals generally exhibit a greater openness to new technologies. They often have better access to educational resources and IT experience, which facilitates their acceptance and use of robotics. Conversely, older professionals and those with less educational background may face barriers such as concerns about safety, high costs, and technical knowledge deficits. Financial constraints and ethical considerations, including data privacy and job displacement concerns, further complicate the adoption process. Addressing these barriers through hands-on

practice, enhanced educational resources, and support systems specific to individual and institutional needs is crucial.

The perceived usefulness and ease of use of robotic technologies are essential factors influencing their adoption. Healthcare professionals need to see the clear benefits of robotics, such as improved precision in treatments, reduced human error, and enhanced operational efficiency. However, these benefits must be weighed against the high costs associated with robotic systems and the need for extensive training. Privacy concerns and the potential for job displacement must also be carefully managed to alleviate concerns and create a more welcoming environment.

Cultural and personal experiences significantly impact how robotics are received. Tailoring educational programs to address cultural sensitivities and individual concerns can enhance acceptance. The pandemic has highlighted the advantages of robotics in managing healthcare crises, which has boosted their acceptance and highlighted their value. To achieve widespread and effective integration, it is essential to navigate the associated challenges carefully. This includes developing robust training programs, creating supportive regulatory frameworks, and addressing ethical concerns thoughtfully.

Overall, the integration of robotics in healthcare offers considerable promise for improving patient care and operational efficiency. To fully realize these benefits, it is essential to address the diverse factors influencing adoption, including providing targeted education, ensuring robust support systems, and considering cultural and socioeconomic contexts. By focusing on these areas, the healthcare sector can effectively harness the potential of robotic technologies, leading to enhanced care delivery and operational improvements while navigating the complexities and challenges associated with their implementation.

CHAPTER 3

3.0 RESEARCH METHODOLOGY

The research methodology, grounded in the Research Onion framework, delves into the perception and adoption of robotics in Kerala's healthcare sector. The conceptual framework is based on the Technology Acceptance Model (TAM) to understand factors influencing the acceptance and adoption of robotics.The methodology, structured in layers of the Research Onion, includes: research philosophy, approach, strategy, and data collection methods. A quantitative approach using structured surveys collects data from diverse healthcare professionals through online questionnaires. Statistical analysis will reveal trends and correlations across demographic groups, providing a comprehensive understanding of robotics adoption in healthcare.

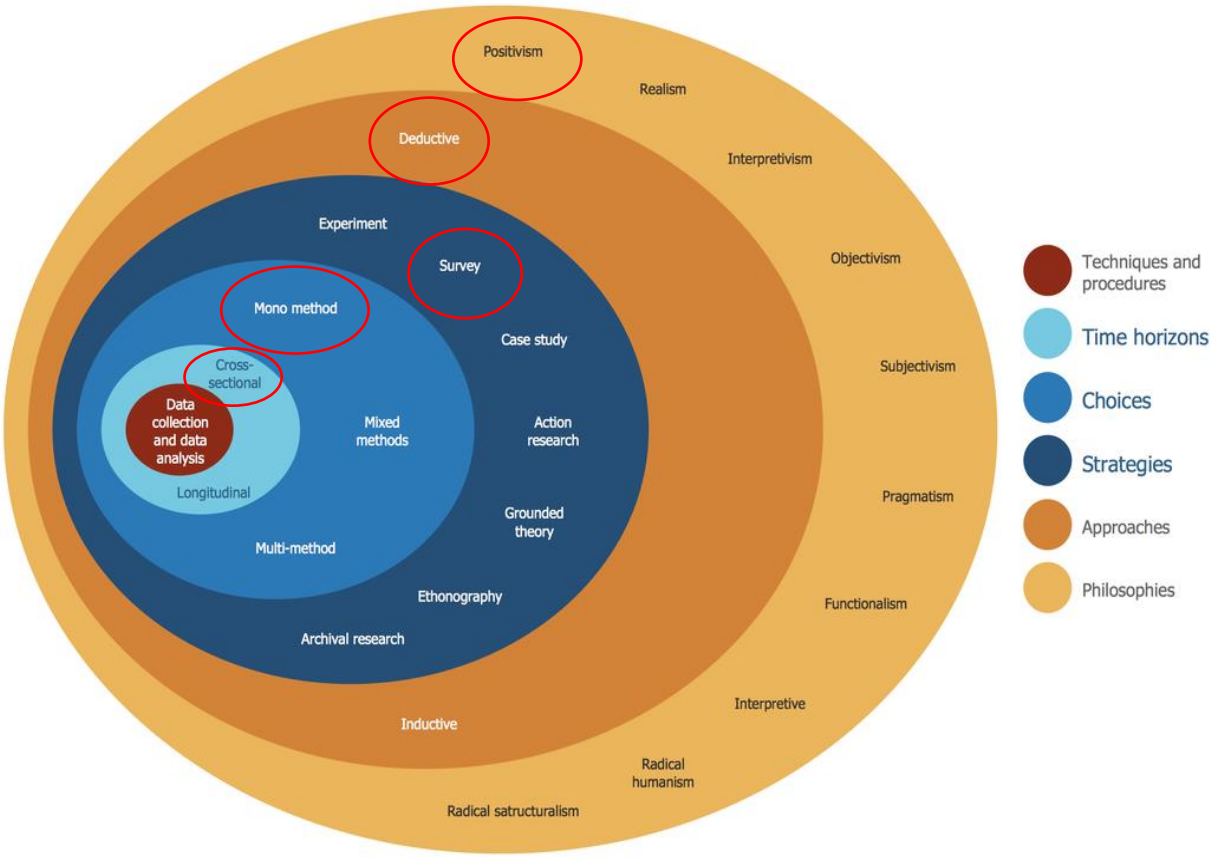

Figure 2: Research Onion (Borg, 2023)

3.1 CONCEPTUAL FRAMEWORK

The conceptual framework for this study is based on the Technology Acceptance Model (TAM). The Technology Acceptance Model is a well-established theory for understanding and predicting technology adoption which is developed by Fred Davis in 1989 (Holden and Karsh, 2010). TAM provides a systematic approach to exploring the factors that influence healthcare professionals acceptance of robotics in their work environment in Kerala. The model highlights two primary factors that determine technology acceptance: Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) (Holden and Karsh, 2010). Perceived Usefulness refers to the extent to which individuals believe that using a system will enhance their job performance. In healthcare robotics, PU might be influenced by improvements in patient outcomes, procedural efficiency, and overall healthcare delivery. If professionals perceive that robotic technologies can significantly reduce surgical time or increase precision, their likelihood of adoption is higher. Perceived Ease of Use denotes the degree to which using a system is considered as effortless. For healthcare professionals, this includes the easiness of using robotic system, their integration into existing workflows, and the training required.

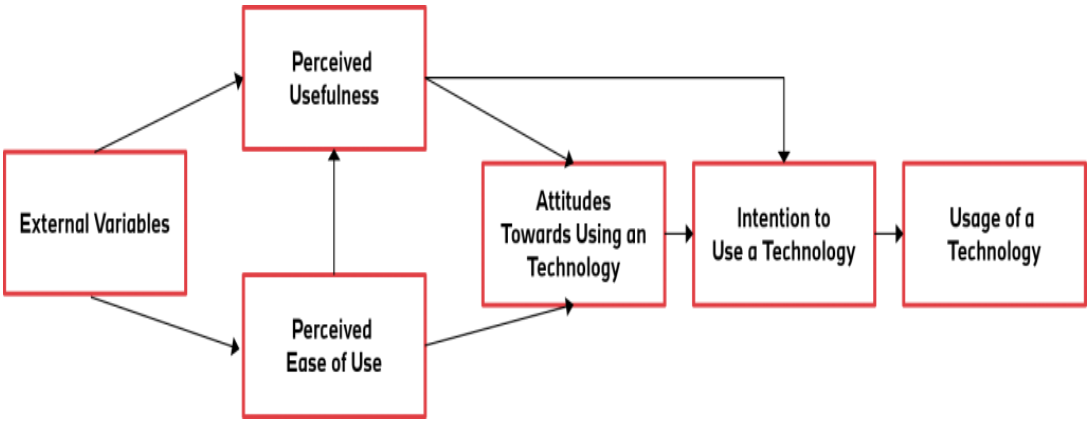

Figure 3: Technology Acceptance Model (Anon, n.d.)

Beyond PU and PEOU, TAM considers certain other variables affecting these perceptions. In Kerala's healthcare sector, factors such as demographics, organizational support, and technological attributes, play significant roles. Age, gender, and professional experience may affect how robotic technologies are perceived and adopted, with younger or more technologically exposed professionals potentially showing higher acceptance. Organizational support, including training programs and technical support, significantly impacts robotics acceptance. Additionally, the reliability, cost-effectiveness, and integration of robotic systems with current infrastructure are crucial.

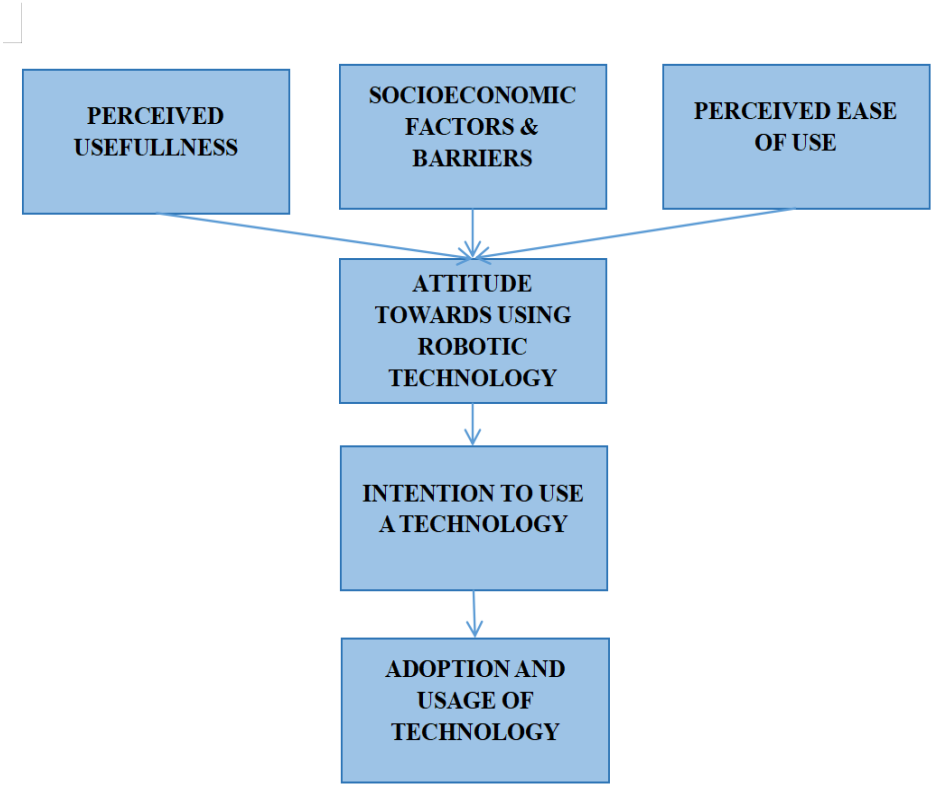

Figure 4: Conceptual Framework (Created by author)

TAM also suggests that PU and PEOU influence an individual's attitude toward using technology, which affects their Behavioral Intention to Use (BI). This intention is a predictor of Actual System Use (Holden and Karsh, 2010); therefore, if healthcare professionals are inclined to use robotic technologies, this intention will likely lead to actual adoption. By examining these factors, the study provides valuable insights offering guidance on promoting and implementing robotics in healthcare settings.

3.2 RESEARCH PHILOSOPHY

A research philosophy is a belief about how data should be collected, analyzed, and used. It distinguishes between what is known to be true (epistemology) and what is believed to be true (doxology) (Anon, n.d.).The two main philosophies are positivism and interpretivism. Positivism sees reality as objective and measurable, favoring deductive, quantitative methods to observe and describe stable phenomena through repeatable observations. In contrast, interpretivism views reality as complex and socially constructed, emphasizing subjective interpretation and qualitative methods. These philosophies guide how research is approached and conducted (Saunders *et al.*, 2009).

My study, "Assessing Perception and Adoption of Robotics Among Healthcare Professionals in Kerala: A Quantitative Study on Public Acceptance Within the Healthcare Sector", follows a positivist approach. Adopting a positivist approach is particularly suitable for this research as it seeks to measure specific perceptions and identify factors influencing the adoption of robotics among healthcare professionals. This involves assuming an objective reality where healthcare professionals knowledge, comfort levels, and attitudes towards robotics can be measured and quantified. Structured surveys are used to gather quantitative data. Scientific methods and statistical analysis are employed to test hypotheses related to safety concerns, perceived benefits, and socioeconomic factors shaping healthcare professionals attitudes.

3.3 RESEARCH APPROACH

The research onion framework is a systematic approach to conducting research, starting from the outermost layer and moving inward (Thesismind, 2019). The outer layer, known as the research philosophy, lays the foundation for the entire research process and determines the method used in the second layer (Thesismind, 2019). This second layer includes two main approaches: inductive and deductive. The inductive approach focuses on creating new theories, while the deductive approach involves developing hypotheses based on existing theories and formulating a research strategy to test them (Thesismind, 2019). This study uses the deductive approach, which aligns well with positivist philosophy. It involves using structured methods like questionnaires to gather data. This data is then

used to validate pre-existing hypotheses regarding how robotics are accepted and perceived in healthcare. Adhering to this approach thereby contributes to a broader understanding of robotics in healthcare settings.

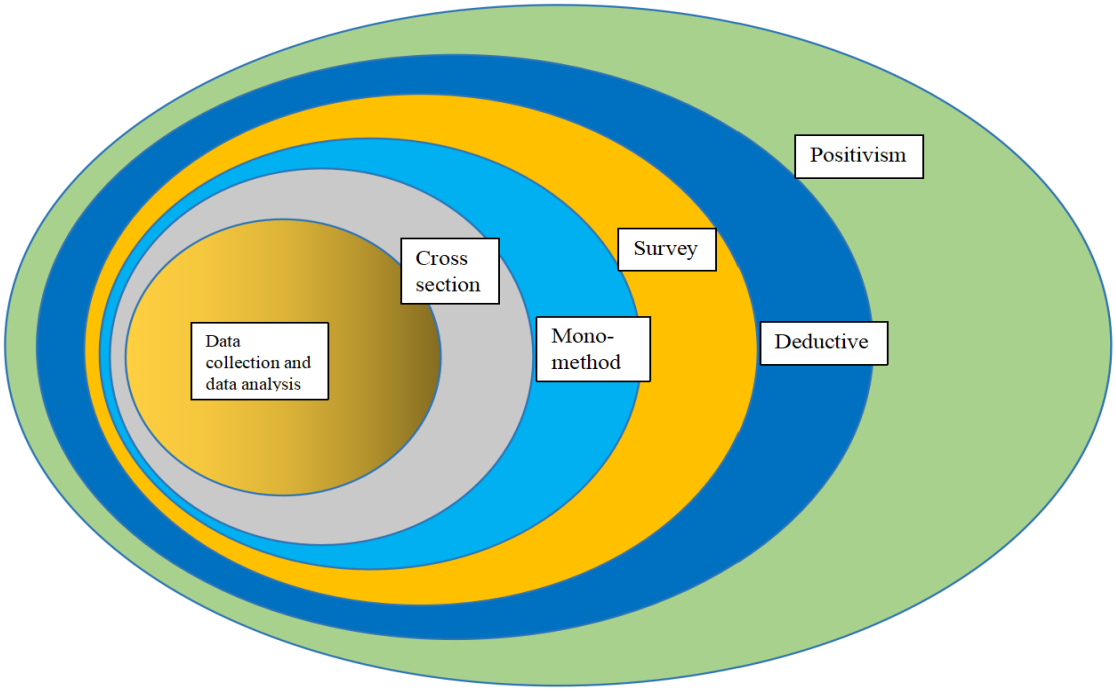

Figure 5: Research onion framework based on the study (created by author)

3.4 RESEARCH STRATEGY

A research strategy outlines how a researcher plans to carry out their study . It includes various methods such as experimental research, case studies, interviews, and surveys (Thesismind, 2019). My study employs the survey strategy, which is often linked with the deductive method involving the testing of hypotheses derived from existing theories. Surveys are a cost-effective and efficient means of collecting large amounts of reliable data, making them particularly suitable for quantitative research projects . By sampling a representative portion of the population, surveys facilitate the collection of extensive data, enabling the observation and analysis of various contributing variables (Thesismind, 2019). In my research on the adoption and perception of robotics among healthcare professionals, the survey strategy allows for the systematic gathering of data on attitudes, knowledge, comfort levels, and other relevant factors. This comprehensive dataset will be used to validate hypotheses about robotics in healthcare, offering a detailed understanding of the topic within the context of Kerala.

3.4.1 STUDY PARTICIPANTS

The study includes healthcare professionals such as doctors, nurses, and pharmacists employed in hospitals, clinics, and other healthcare facilities across Kerala. Participants should have at least some experience in the healthcare field to ensure they possessed the necessary professional expertise. They also need to have some knowledge of or exposure to robotic technologies to provide relevant insights into the adoption and perception of robotics. Eligible participants were required to be currently employed, residing in Kerala, and aged between 18 and 64 years. Additionally, they need to understand, read, and respond to survey questions in English. These criteria were designed to ensure that the study captured informed perspectives from experienced professionals regarding the integration of robotics in healthcare.

3.4.2 SAMPLE SIZE CALCULATION

The sample size calculation for my study was determined using a formula that targets an 80% confidence interval with a 7% margin of error, which recommended a sample size of 84. According to the 2022 health human resources data, the total number of healthcare professionals in Kerala, including pharmacists, government doctors, and registered nurses, is reported to be 415,262. This data, which includes 79,601 pharmacists, 6,169 government doctors, and 329,492 registered nurses, is actively maintained in the CEIC under India Premium Database's Health Sector – Table IN.HLB002: Health Human Resources (CEIC,2022, n.d.).

$$\text{Sample size} = \frac{\frac{z^2 \times p\,(1-p)}{e^2}}{1 + \left(\frac{z^2 \times p\,(1-p)}{e^2 N}\right)}$$

Figure 6: Formula for sample size calculation (survey monkey 2024, n.d.)

For this calculation :

n is the sample size required.

N represents the total number of healthcare professionals in Kerala.

Z is the Z-value corresponding to an 80% confidence level, which is 1.282.

p is the estimated proportion of the population with the attribute of interest, assumed to be 0.5 for maximum variability.

E is the margin of error, set at 7% (0.07).

This calculation ensures a robust statistical representation of the population. However, due to time constraints, we received 70 valid responses. This number aligns with the narrowed focus of the study and allows for more detailed and meaningful data collection within the given timeframe, while still providing valuable insights into the adoption and perception of robotics in the region.

3.4.3 DATA COLLECTION

Data collection for this survey is conducted online, targeting healthcare professionals in Kerala via email and professional networks. This method ensures efficient distribution and convenient participation. The survey, comprising 28 questions, is organized into three main sections.

The first section includes consent questions, ensuring respondents are informed about the study's objectives and voluntarily agree to participate, thus upholding ethical standards and data integrity.

The second section features screening questions to confirm participants meet the study's inclusion criteria, ensuring relevance and enhancing the validity of the data by selecting individuals with appropriate experience in Kerala's healthcare sector.

The third section focuses on participants knowledge and perceptions of robotics in healthcare. It assesses familiarity with robotic technologies, experiences, and comfort levels in their use. This part explores safety concerns, perceived benefits, and drawbacks, while also investigating factors influencing acceptance, such as practical benefits, limitations, and socioeconomic factors like age and education.

3.5 RESEARCH CHOICES

The fifth layer of the research onion is called the choices, and it decides what type of data are being used in the research (Thesismind, 2019). This study utilizes a mono method quantitative research approach. It systematically collects and analyzes numerical data to explore trends, patterns, and attitudes towards robotics adoption in healthcare. Using statistical tools and structured surveys, the study aims to precisely quantify healthcare professionals acceptance and perceptions of robotics. This method provides robust, generalizable results, offering clear insights into specific research questions, making it highly suitable for examining robotics acceptance within the healthcare sector.

3.6 RESEARCH TIME HORIZON

The fifth layer of the research onion, known as the time horizon, outlines the duration required to complete the project (Thesismind, 2019). For this study, a cross-sectional time horizon was used, focusing on collecting data at a specific point in time (Thesismind, 2019). The survey was created using Google Forms. The survey link was then distributed to healthcare professionals via various online platforms, ensuring it reached a wide audience quickly. To enhance the reach and ensure a sufficient sample size, healthcare professionals who received the survey were encouraged to share it with other colleagues within their network. The data collection period commenced on July 21, 2024, and continued until August 8, 2024, providing a concise timeframe for gathering responses.

3.7 ETHICAL CONSIDERATIONS

Ethical considerations are paramount in this study to ensure the protection and respect of all participants. Prior to participating, all individuals were required to provide their voluntary agreement to take part in the study. Participants were informed about their right to withdraw from the study at any time, ensuring that their participation was fully voluntary and transparent. The survey was designed to maintain anonymity, safeguarding participants identities and personal information. Before data collection began, the research proposal was submitted to the Griffith College Research Ethics Committee for review and approval, ensuring compliance. Data confidentiality was strictly observed, with all responses stored securely on a password-protected laptop. These measures collectively ensured that the study complied with all ethical guidelines and regulations.

3.8 DATA ANALYSIS AND VISUALIZATION

The data gathered on healthcare workers perspectives and utilization of robotics in Kerala was analyzed using a combination of descriptive and inferential statistical methods. Descriptive statistics, such as frequencies were determined to give an overall view of the responses. Inferential analysis, including chi-square tests, regression analysis and correlation test were employed to ascertain meaningful relationships and variations between different variables. Additionally, the study explored relationships between individuals confidence in using robots and their age as well as their occupation.

Various graphical representations such as bar charts and pie charts were used to illustrate the key findings. These visual tools helps in effectively communicating the distribution of responses, the extent of knowledge and comfort with robotics, and the perceived benefits and challenges associated with their use. By employing these, the study's insights were made more understandable for stakeholders, facilitating informed decision-making regarding the integration of robotics in healthcare

3.9 LIMITATIONS OF THE METHODOLOGY

Even though the study was conducted carefully, it has some limitations. The reliance on self-reported data may introduce response bias, as participants might overestimate or underestimate their knowledge and comfort levels with robotics. The sample size, although adequate for preliminary insights, may not fully represent the diverse views of all healthcare professionals in Kerala. Reduced participation from certain categories of professionals and specific age groups could lead to limitations in data analysis. Time constraints also limited the depth of data collection and analysis. These limitations suggest that further research with larger, more diverse samples including a broader range of age groups is still needed.

3.10 CONCLUSION

The research methodology in this study offers a structured approach to understanding the perception and adoption of robotics among healthcare professionals in Kerala. By utilizing the Technology Acceptance Model (TAM) and following a positivist research philosophy, the study ensures a thorough examination of the factors influencing robotics acceptance. The use of structured surveys and statistical analysis provides strong insights into the current state of robotics integration in healthcare. However, limitations in sample size, response bias and time constraints highlight the need for further research. Future studies should involve larger, more diverse samples to capture evolving perceptions and provide more generalizable findings. Despite these limitations, the methodology lays a solid foundation for informing policymakers and healthcare administrators about the potential facilitators and barriers for the wider implementation of robotic technologies in healthcare.

CHAPTER 4

4.0 DATA ANALYSIS AND FINDINGS

4.1 INTRODUCTION

The survey was distributed to participants, and a total of 71 responses were received. However, one respondent declined to participate, leaving us with 70 valid responses for analysis. To ensure the accuracy and reliability of the data, the single non-consenting response was omitted. The cleaned dataset was then subjected to thorough analysis using IBM SPSS software, which provided a robust platform for both descriptive and inferential statistical techniques.All the questions from the Google

Forms survey were included in the analysis. Data visualization tools such as pie charts, bar graphs, and tables were employed to present the findings in a clear and comprehensible manner. Additionally, statistical analyses, including Chi-square tests, regression, and correlation, were conducted to test various hypotheses. For questions that required attitudinal responses, coding was done based on the Likert scale to facilitate the analysis in SPSS. This comprehensive approach ensured that the findings were both insightful and statistically sound, offering a detailed understanding of the survey results.

4.2 DATA ANALYSIS

4.2.1 DEMOGRAPHIC DETAILS OF THE STUDY PARTICIPANT

4.2.1.1 AGE DISTRIBUTION

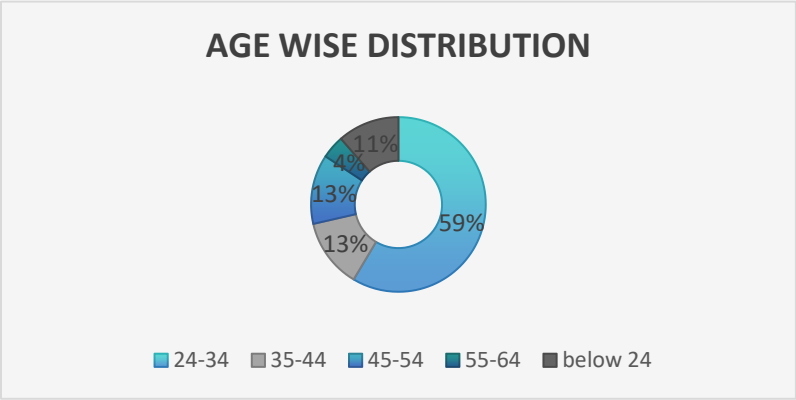

Figure 7: Age distribution of participants

This pie chart illustrates the age distribution of respondents in the study. The majority of participants fall within the 24-34 age group, with 41 respondents, representing 59% of the total sample. This is followed by the 35-44 and 45-54 age groups, each comprising 9 respondents (13%). A smaller portion of the participants are aged below 24, with 8 respondents (11%), and 55-64 years, with 3 respondents (4%). This demographic distribution suggests that younger healthcare professionals are more engaged or perhaps more accessible in this study, potentially reflecting a younger workforce in the healthcare sector in Kerala. This age distribution is significant, as younger professionals may have different perceptions and adoption rates of robotics compared to their older counterparts, possibly due to greater exposure to technology and innovation.

AGE	COUNTS	% OF TOTAL
24-34	41	59%
35-44	9	13%
45-54	9	13%
55-64	3	4%
below 24	8	11%

Table 1: Age distribution of participants

4.2.1.2 OCCUPATIONAL STATUS

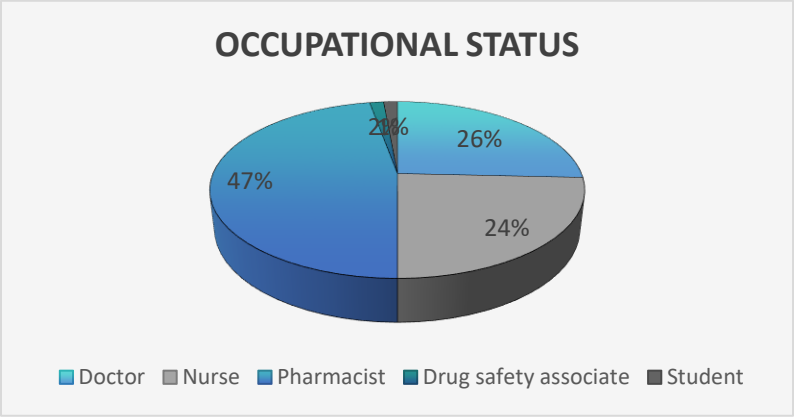

Figure 8: Occupational status

This chart breaks down the occupations of the respondents, with pharmacists comprising the largest group (33 respondents, 47%), followed by doctors (18 respondents, 26%) and nurses (17 respondents, 24%). There is one respondent each in the categories of drug safety associate and student, both representing 1% of the total. This data suggests that the study predominantly reflects the views of pharmacists, doctors, and nurses, who are typically the most involved in direct patient care and, thus, might be more affected by the integration of robotics in healthcare settings. Although representing smaller groups, the responses from drug safety associates and students still indicated support for robotics when considered individually.

OCCUPATION	COUNTS	% OF TOTAL
Doctor	18	26%
Nurse	17	24%
Pharmacist	33	47%
Drug safety associate	1	1%
Student	1	1%

Table 2: Occupational status

4.2.1.3 YEARS OF EXPERIENCE

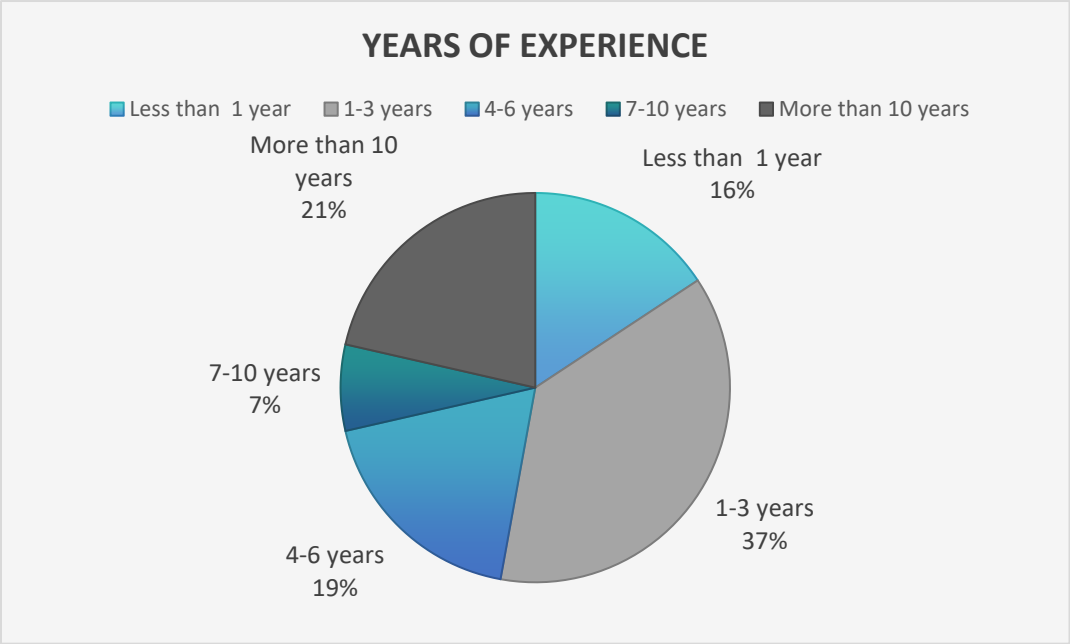

Figure 9: Years of experience

In terms of experience, the respondents are fairly distributed across different ranges. The largest group, representing 37% of the respondents (26 individuals), has 1-3 years of experience, followed by those with more than 10 years of experience, accounting for 21% (15 respondents). The least represented experience group is 7-10 years, with only 7% (5 respondents), followed by the 4-6 years group at 19%, and those with less than 1 year of experience at 16%. This distribution suggests that the study captures a wide range of perspectives from both relatively new entrants and experienced professionals. The presence of a significant number of respondents with more years of experience is particularly important, as it could provide insights into how the perception and adoption of robotics have evolved over time in the healthcare sector.

YEARS OF EXPERIENCE	COUNTS	% OF TOTAL
Less than 1 year	11	16%
1-3 years	26	37%
4-6 years	13	19%
7-10 years	5	7%
More than 10 years	15	21%

Table 3: Years of experience

4.2.2 LEVEL OF AWARENESS OF USE ROBOTICS IN HEALTHCARE

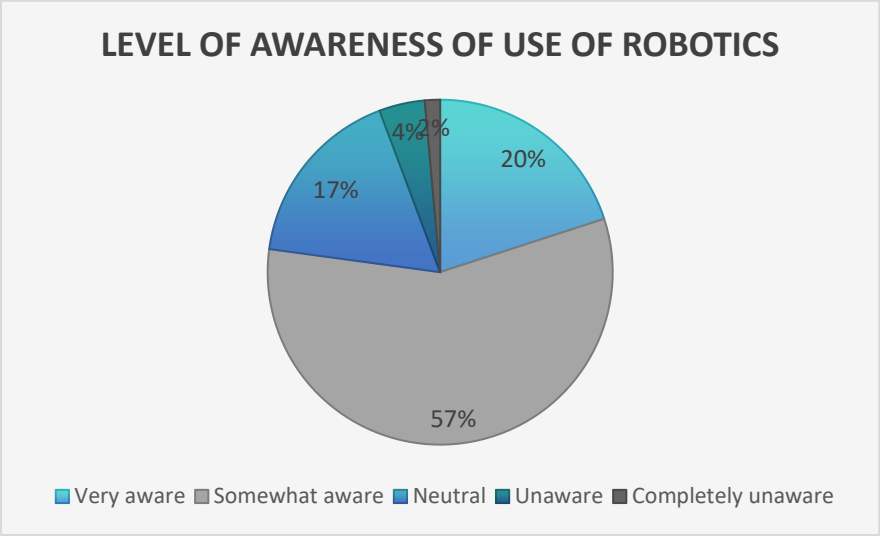

Figure 10: Level of awareness of use of robotics

This chart illustrates that the majority of respondents are at least somewhat aware of robotics in healthcare. Specifically, 40 respondents (57%) are "somewhat aware," and 14 respondents (20%) are "very aware." Additionally, 12 respondents (17%) are neutral, while only a small minority are either unaware (3 respondents, 4%) or completely unaware (1 respondent, 2%). This high level of awareness suggests that robotics is a recognized and possibly discussed topic among healthcare professionals in Kerala. The general awareness level could be attributed to the increasing global integration of robotics in healthcare and media coverage.

LEVEL OF AWARENESS	COUNTS	% OF TOTAL
Very aware	14	20%
Somewhat aware	40	57%
Neutral	12	17%
Unaware	3	4%
Completely unaware	1	2%

Table 4: Level of awareness of use of robotics

4.2.3 FREQUENCY OF ENCOUNTERING ROBOTICS IN CURRENT ROLE

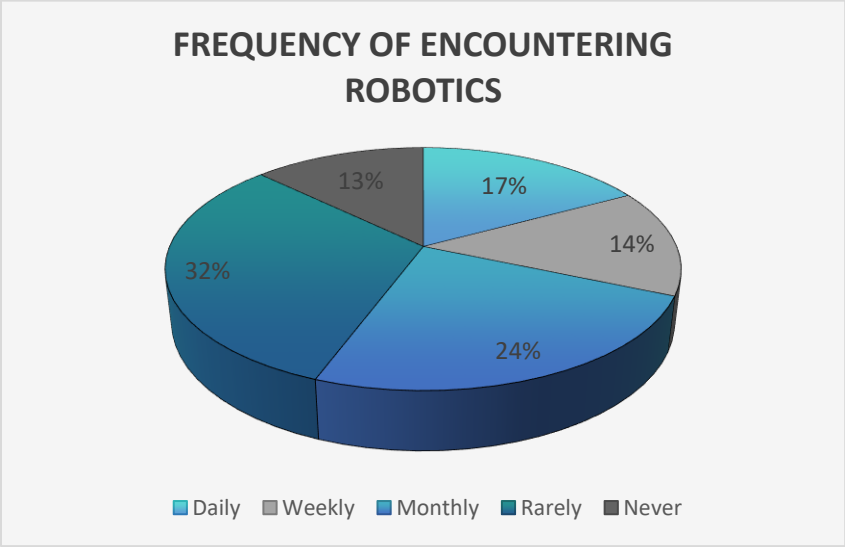

Figure 11: Frequency of Encountering Robotics in Current Role

This chart depicts the frequency with which respondents encounter robotics in their roles. It reveals that most of them encounter robotics rarely (22 respondents, 32%) or monthly (17 respondents, 24%). A smaller group encounters robotics weekly (10 respondents, 14%) or daily (12 respondents, 17%), while 9 respondents (13%) have never encountered robotics in their current roles. This suggests that, while awareness of robotics is high, direct interaction with robotic systems remains relatively infrequent among the healthcare professionals surveyed. This could imply that robotics technology has not yet been fully integrated into daily healthcare operations in Kerala or is being used selectively in certain areas.

FREQUENCY OF ENCOUNTERING ROBOTICS	COUNTS	% OF TOTAL
Daily	12	17%
Weekly	10	14%
Monthly	17	24%
Rarely	22	32%
Never	9	13%

Table 5: Frequency of Encountering Robotics in Current Role

4.2.4 FORMAL TRAINING ON USE OF ROBOTICS IN HEALTHCARE

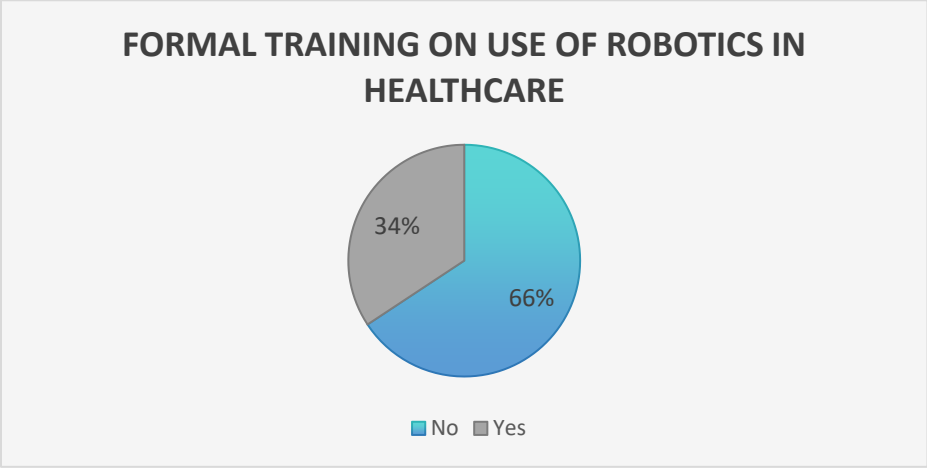

Figure 12: Formal training on use of robotics in healthcare

The chart on formal training reveals that a significant majority of respondents (46, or 66%) have not received formal training in robotics, compared to 24 respondents (34%) who have. This lack of formal training could be a critical barrier to the effective adoption of robotics in healthcare settings. Without proper training, healthcare professionals may feel less confident in utilizing robotic systems, potentially hindering the technology's ability to enhance efficiency and improve patient care.

TRAINING ON USE OF ROBOTICS	COUNTS	% OF TOTAL
No	46	66%
Yes	24	34%

Table 6: Formal training on use of robotics in healthcare

4.2.5 PERCEPTION OF ROBOTICS IMPACT ON FACILITY EFFICIENCY

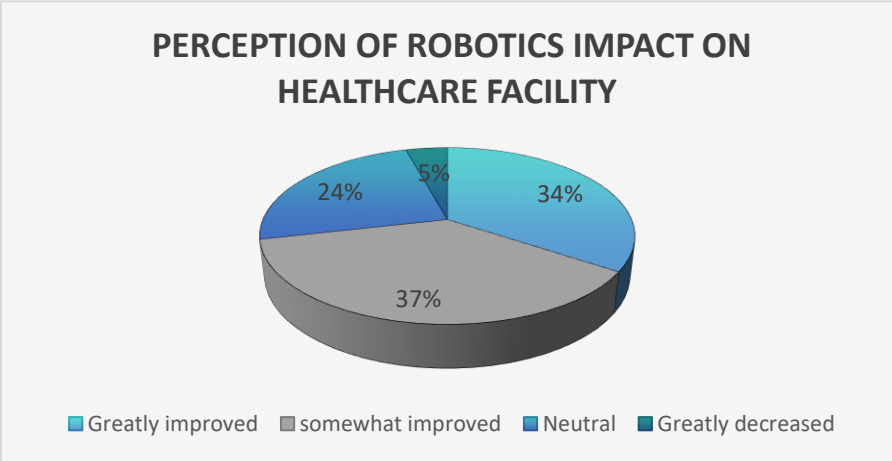

Figure 13: Perception of Robotics Impact on Facility Efficiency

IMPACT OF ROBOTICS IN HEALTHCARE FACILITY	COUNTS	% OF TOTAL
Greatly improved	24	35%
somewhat improved	26	37%
Neutral	17	24%
Greatly decreased	3	4%

Table 7: Perception of Robotics Impact on Facility Efficiency

The table indicates that respondents generally perceive robotics as having a positive impact on the efficiency of healthcare facilities. A total of 26 respondents (37%) believe that robotics has "somewhat improved" efficiency, while 24 respondents (35%) think it has "greatly improved" efficiency. Only 3 respondents (4%) believe that robotics has "greatly decreased" efficiency, and 17 respondents (24%) have a neutral response. This overall positive perception suggests that among

those with experience in robotics, the technology is largely viewed as a beneficial tool for enhancing operational efficiency. The minimal negative responses might reflect concerns related to initial implementation challenges or workforce adaptability.

4.2.6 COMFORT LEVEL WITH USING ROBOTICS IN HEALTHCARE

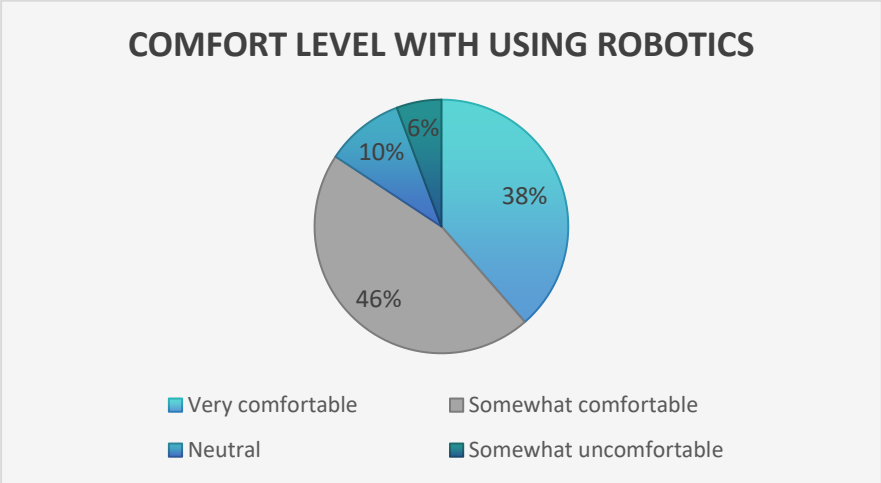

Figure 14: Comfort Level with Using Robotics in Healthcare

This pie chart illustrates that the comfort level of respondents with the idea of using robotics in healthcare is predominantly positive. Thirty-two respondents (46%) are "somewhat comfortable," and twenty-seven (38%) are "very comfortable" with using robotics. In contrast, only a small number of respondents are neutral (7 respondents, 10%) or somewhat uncomfortable (4 respondents, 6%). This indicates a general openness towards robotics among healthcare professionals in Kerala, with many appearing ready to embrace the technology. The minority of respondents who are uncomfortable may highlight concerns related to the technology's reliability, complexity, or resistance to adopting new technologies.

COMFORT LEVEL OF USING ROBOTICS	COUNTS	% OF TOTAL
Very comfortable	27	38%
Somewhat comfortable	32	46%
Neutral	7	10%
Somewhat uncomfortable	4	6%

Table 8: Comfort Level with Using Robotics in Healthcare

4.2.7 CONCERNS REGARDING THE USE OF ROBOTICS IN HEALTHCARE

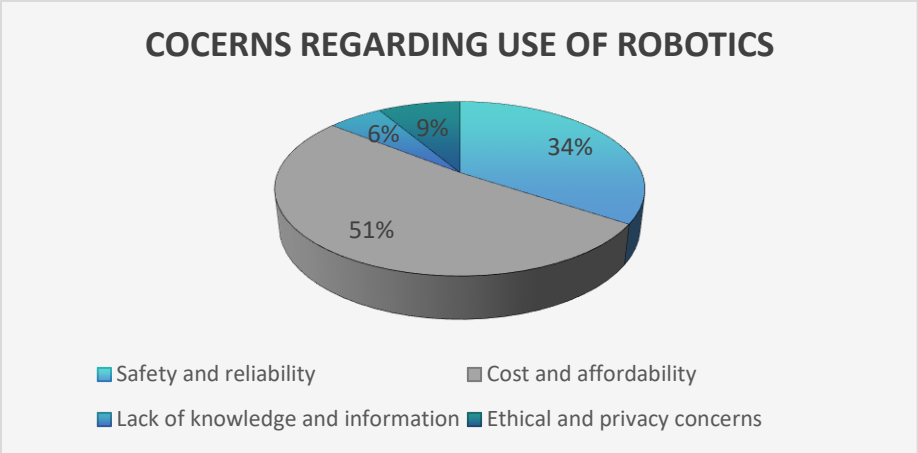

Figure 15: Concerns Regarding the Use of Robotics in Healthcare

This pie chart addresses the primary concerns healthcare professionals have regarding the adoption of robotics in their field, based on 70 responses. The most significant concern, identified by 36 respondents (51%), was the cost and affordability of integrating robotics into healthcare practices, highlighting financial implications as a major barrier to adoption. Safety and reliability were also prominent concerns, with 24 respondents (34%) emphasizing the need for proven and consistent performance in robotic applications to gain trust among medical staff. A smaller group, 4 respondents (6%), expressed concerns due to a lack of sufficient information and knowledge about robotics, pointing to a gap in education and exposure. Additionally, ethical and privacy concerns, identified by 6 respondents (9%), contribute to the cautious approach towards robotics, though these issues are less prominent compared to cost and safety concerns.

CONCERNS REGARDING USE OF ROBOTICS	COUNTS	% OF TOTAL
Safety and reliability	24	34%
Cost and affordability	36	51%
Lack of knowledge and information	4	6%
Ethical and privacy concerns	6	9%

Table 9: Concerns Regarding the Use of Robotics in Healthcare

4.2.8 PERCEPTIONS ON SAFETY OF ROBOTICS IN HEALTHCARE SETTINGS

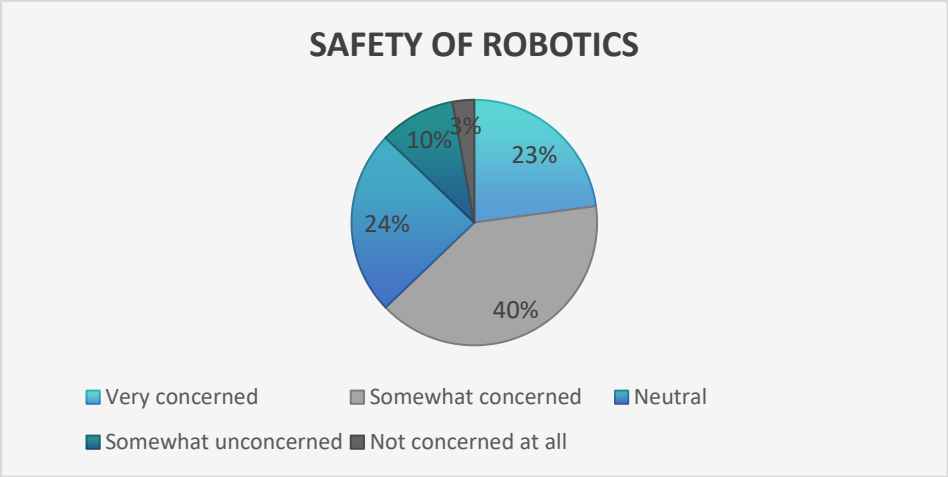

Figure 16: Perceptions on Safety of Robotics in Healthcare Settings

SAFETY OF ROBOTICS	COUNTS	% OF TOTAL
Very concerned	16	23%
Somewhat concerned	28	40%
Neutral	17	24%
Somewhat unconcerned	7	10%
Not concerned at all	2	3%

Table 10: Perceptions on Safety of Robotics in Healthcare Settings

This table presents the level of concern regarding the safety of using robotics in healthcare settings, based on 70 responses. The data shows that 63% of respondents expressed some level of concern, with 16 respondents (23%) being very concerned and 28 respondents (40%) somewhat concerned. Additionally, 17 respondents (24%) remained neutral, while a smaller portion, 7 respondents (10%), were somewhat uncot concerned at all. These findings underscore the ongoing concerns about the implementation of robotic technologies in medical environments in Kerala.

4.2.9 BELIEFS ABOUT ROBOTICS LEADING TO MEDICAL ERRORS

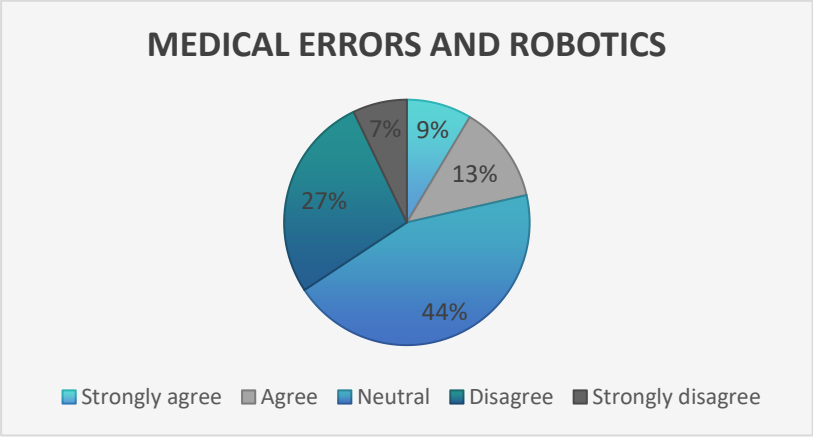

Figure 17: Beliefs About Robotics Leading to Medical Errors

This chart reveals a range of perspectives among healthcare professionals regarding the potential for robotics to lead to medical errors. Out of 70 participants, opinions were divided, with a notable 44% of respondents choosing to remain neutral, indicating a significant level of uncertainty or lack of consensus on this issue. A smaller proportion of respondents expressed concern, with 9% strongly agreeing and 13% agreeing that robotics could contribute to medical errors. On the other hand, a larger combined group of 27% disagreed, and 7% strongly disagreed with this notion, suggesting that while some professionals are cautious about potential risks, others are more confident in the safety and reliability of robotic technologies in medical settings. This mixed response highlights the need for further evidence and discussion on the role of robotics in reducing or contributing to medical errors.

BELIEFS ABOUT ROBOTICS LEADING TO MEDICAL ERRORS	COUNTS	% OF TOTAL
Strongly agree	6	9%
Agree	9	13%
Neutral	31	44%
Disagree	19	27%
Strongly disagree	5	7%

Table 11: Beliefs About Robotics Leading to Medical Errors

4.2.10 BENEFIT OF USING ROBOTICS IN SURGERIES

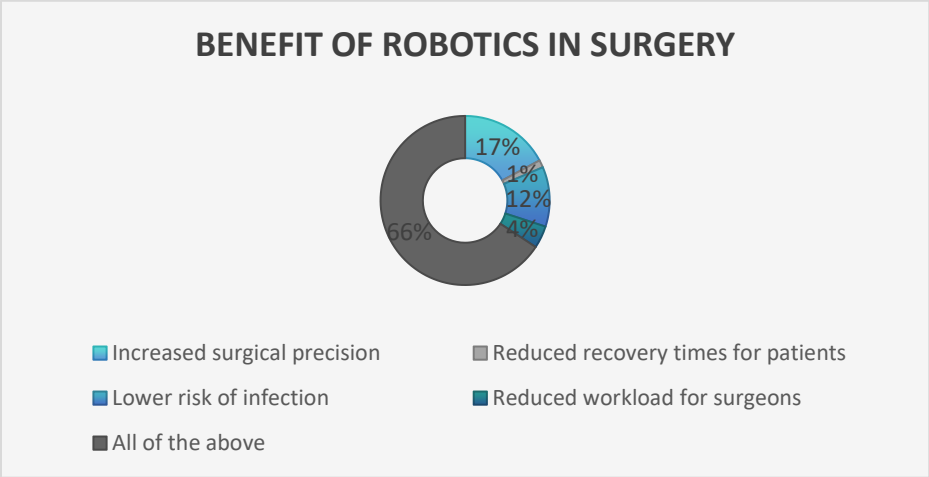

Figure 18: Benefit of using robotics in surgeries

BENEFIT OF ROBOTICS IN SURGERIES	COUNTS	% OF TOTAL
Increased surgical precision	12	17%
Reduced recovery times for patients	1	2%
Lower risk of infection	8	11%
Reduced workload for surgeons	3	4%
All of the above	46	66%

Table 12: Benefit of using robotics in surgeries

This table shows the responses from 70 participants which highlighted several key advantages of using robotics in surgeries. A significant majority, 46 respondents (66%), recognized the comprehensive benefits of robotic surgery, selecting "All of the Above" to encompass increased surgical precision, reduced recovery times for patients, lower risk of infection, and reduced workload for surgeons. Specifically, 12 respondents (17%) identified increased surgical precision as a primary benefit, while 8 respondents (11%) noted the lower risk of infection. Fewer respondents focused on reduced recovery times for patients (2%) and reduced workload for surgeons (4%) as standalone benefits. These findings underscore a broad recognition of the multifaceted advantages that robotic technologies can bring to surgical practices, particularly in enhancing precision, safety, and efficiency.

4.2.11 ROBOTICS AND QUALITY OF PATIENT CARE

The survey responses indicate a generally positive perception of the impact of robotics on the quality of patient care. Of the 70 respondents, a significant majority—74%—either strongly agreed (27%) or agreed (47%) that robotics enhances the quality of patient care. This strong endorsement suggests that healthcare professionals recognize the potential of robotic technologies to improve outcomes for patients. The advanced precision, consistency, and reliability offered by robotics are likely seen as key factors in reducing human error, optimizing treatment procedures, and ultimately leading to better patient experiences and outcomes. However, a smaller percentage of respondents remained neutral (22%), or disagreed (4.%), indicating that while the overall sentiment is positive, there are still some reservations or uncertainties about the effectiveness of robotics in improving patient care.

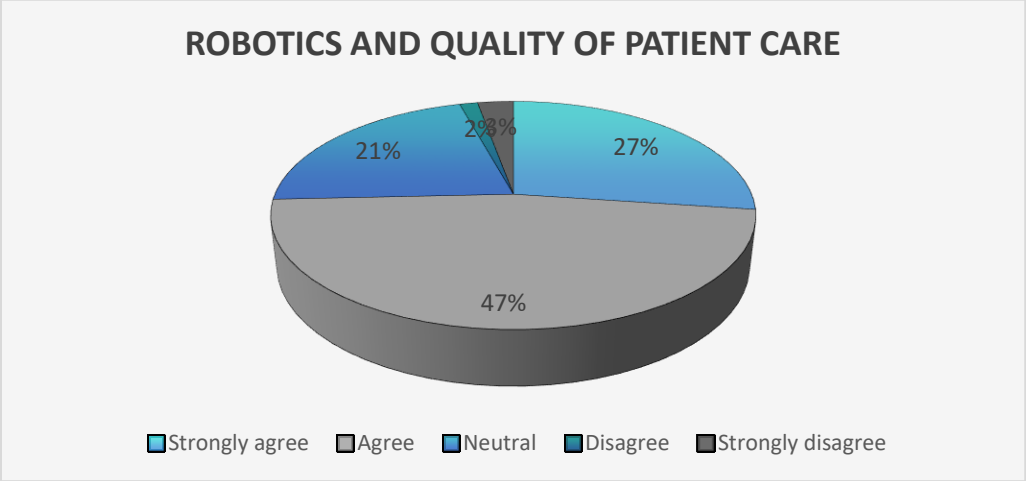

Figure 19: Robotics and Quality of Patient Care

ROBOTICS AND QUALITY OF PATIENT CARE	COUNTS	% OF TOTAL
Strongly agree	19	27%
Agree	33	47%
Neutral	15	22%
Disagree	1	1%
Strongly disagree	2	3%

Table 13: Robotics and Quality of Patient Care

4.2.12 ROBOTICS ENHANCING HEALTHCARE DELIVERY EFFICIENCY

In addition to quality of care, the survey also explored perceptions of how robotics impacts the efficiency of healthcare delivery .The data shows that the results were similarly positive, with 79% of

respondents agreeing (50%) or strongly agreeing (29%) that robotics enhances healthcare delivery efficiency. This suggests that many healthcare professionals view robotics as a valuable tool in streamlining operations, reducing the time and effort required for various tasks, and allowing for faster and more accurate patient services. The ability of robotics to perform repetitive tasks with precision, manage data, and assist in complex procedures likely contributes to these positive views. Only a small minority (2%) disagreed, and 19% remained neutral, indicating that while most respondents see clear benefits, a few may still be assessing the actual impact of robotics on efficiency in practice.

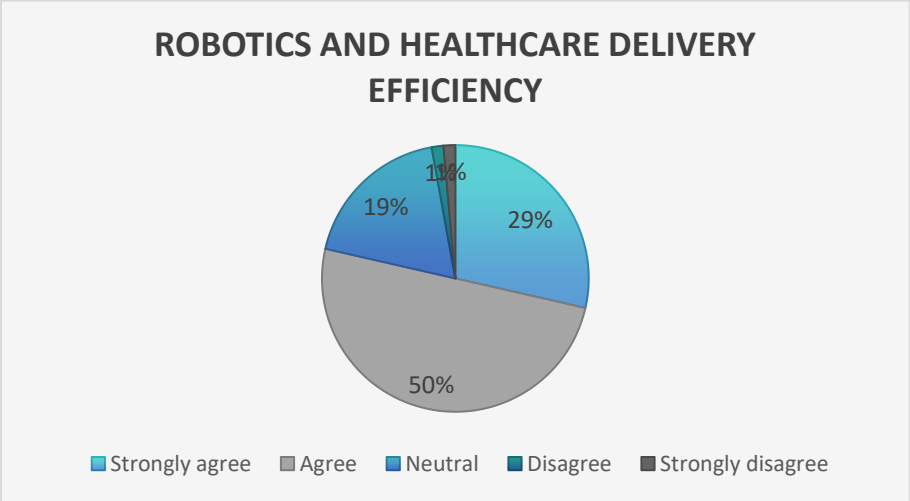

Figure 20: Robotics Enhancing Healthcare Delivery Efficiency

ROBOTICS AND HEALTHCARE DELIVERY EEFICIENCY	COUNTS	% OF TOTAL
Strongly agree	20	29%
Agree	35	50%
Neutral	13	19%
Disagree	1	1%
Strongly disagree	1	1%

Table 14: Robotics Enhancing Healthcare Delivery Efficiency

4.2.13 ROBOTICS IN REDUCING WORKLOAD FOR HEALTHCARE PROFESSIONALS

Another critical aspect explored in the survey was the potential for robotics to reduce the workload of healthcare professionals. The chart shows that a significant majority, 80%, either agreed (47%) or strongly agreed (33%) that robotics could alleviate the demands placed on healthcare staff. This

suggests that many professionals see robotics as a means to lighten their workload by taking over routine, labor-intensive, or complex tasks, allowing them to focus more on patient care and other critical responsibilities. This reduction in workload could lead to improved job satisfaction and further enhancing the overall effectiveness of healthcare systems. The small percentage of respondents who disagreed (1%) or were neutral (19%) might reflect varying levels of exposure to or experience with robotic technologies in their work environments.

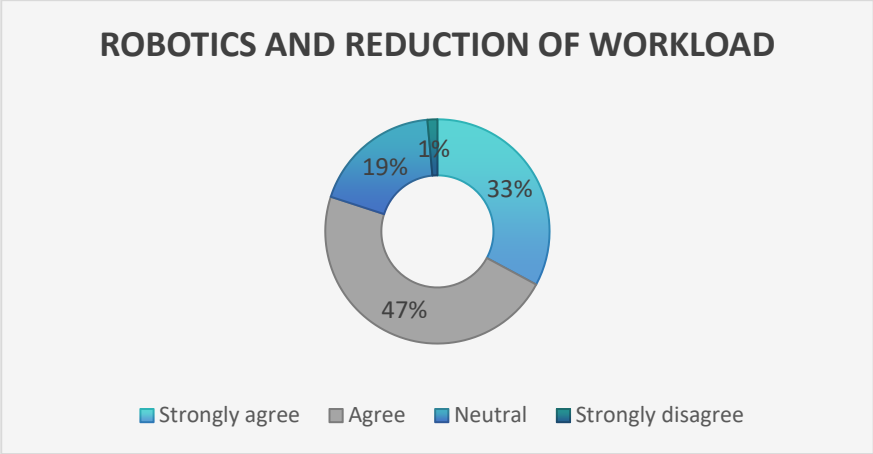

Figure 21: Robotics Reducing Workload for Healthcare Professionals

ROBOTICS AND REDUCTION OF WORKLOAD	COUNTS	% OF TOTAL
Strongly agree	23	33%
Agree	33	47%
Neutral	13	19%
Strongly disagree	1	1%

Table 15: Robotics Reducing Workload for Healthcare Professionals

4.2.14 ENCOUNTERED LIMITATIONS WITH ROBOTICS

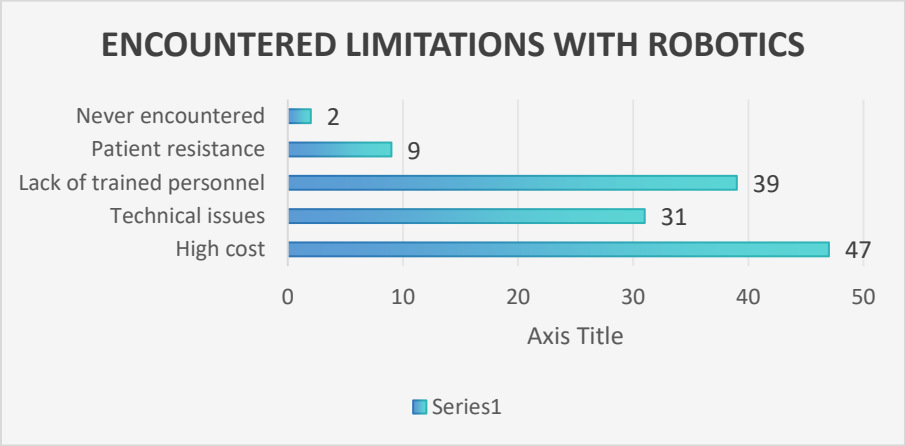

Figure 22: Encountered Limitations with Robotics

ROBOTICS AND ENCOUNTERED LIMITATIONS	COUNTS	% OF TOTAL
High cost	47	38%
Technical issues	31	24%
Lack of trained personnel	39	30%
Patient resistance	9	7%
Never encountered	2	1%

Table 16: Encountered Limitations with Robotics

This table shows limitations encountered with robotics, gathered through a checkbox-style question that allowed participants to select multiple issues, reveals key barriers in adoption. Among the 128 total responses, 38% identified high cost as a significant challenge, reflecting concerns about the financial burden of implementing robotics. Technical issues were noted by 24% of responses, highlighting problems such as software malfunctions and mechanical failures. A lack of trained personnel was cited in 30% of responses, underscoring the need for specialized skills in operating robotic systems. Additionally, 7% of responses pointed to patient resistance, while 1% indicated that they had never encountered these limitations, emphasizing the varied experiences with robotics in healthcare.

4.2.15 IMPACT OF ROBOTICS ON PATIENT CARE

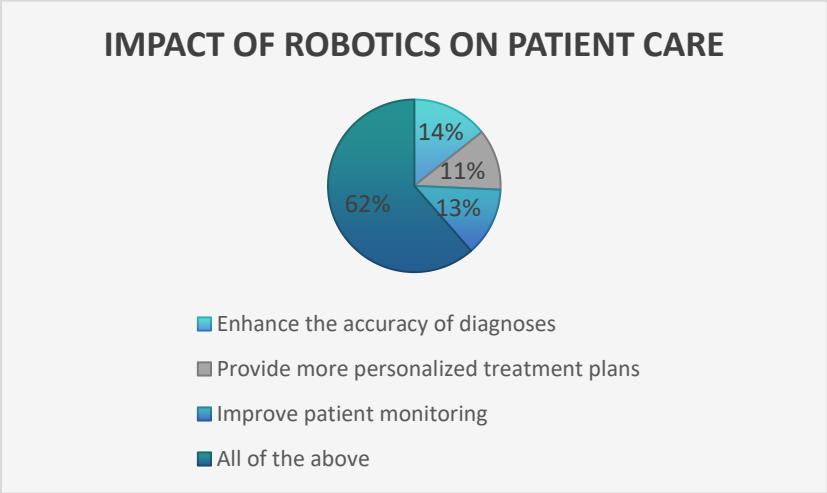

Figure 23: Impact of Robotics on Patient Care

IMPACT OF ROBOTICS ON PATIENT CARE	COUNTS	% OF TOTAL
Enhance the accuracy of diagnosis	10	14%
Provide more personalized treatment plans	8	12%
Improve patient monitoring	9	13%
All of the above	43	61%

Table 17: Impact of Robotics on Patient Care

This table explains the impact of robotics on patient care. Among the 70 responses collected, 61% recognized that robotics could enhance patient care in multiple ways, selecting "All of the above" to indicate improvements in diagnosis accuracy, personalized treatment plans, and patient monitoring. Specifically, 14% of respondents highlighted robotics role in enhancing the accuracy of diagnosis, while 12% pointed to its ability to provide more personalized treatment plans. Additionally, 13% emphasized the improvement in patient monitoring. These responses indicate a strong belief among healthcare professionals that robotics can significantly advance the quality and effectiveness of patient care.

4.2.16 ROBOTICS ROLE IN IMPROVING OPERATIONAL EFFICIENCY

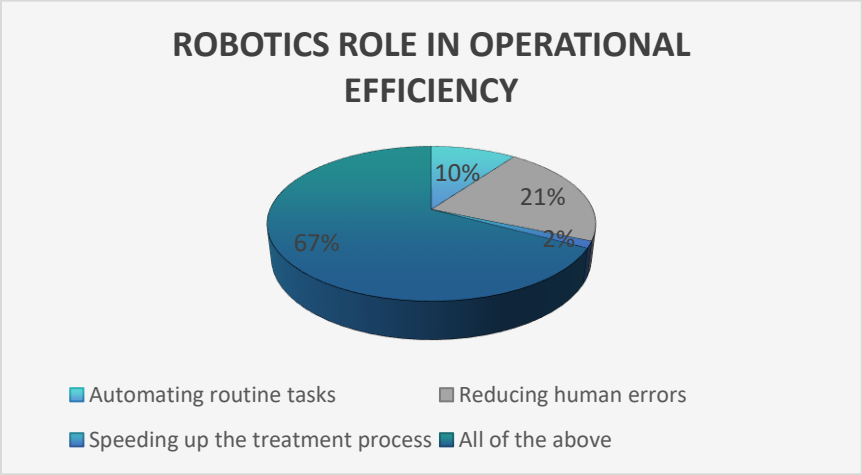

Figure 24: Robotics Role in Improving Operational Efficiency

This pie chart highlights the perceived impact of robotics on various aspects of healthcare operations, with a total of 70 responses. A significant majority, 47 respondents (67%), selected "All of the above," indicating that robotics is seen as beneficial in automating routine tasks, reducing human errors, and speeding up the treatment process. Specifically, 15 respondents (22%) emphasized the reduction of human errors as a key benefit of robotics, underscoring its potential to enhance accuracy and reliability in healthcare settings. Meanwhile, 7 respondents (10%) highlighted the automation of routine tasks, which can free up healthcare professionals for more complex duties. Only 1 respondent (1%) focused solely on the role of robotics in speeding up the treatment process, suggesting that while this benefit is recognized, it may be viewed as part of a broader set of efficiencies provided by robotics.

ROBOTICS ROLE IN OPERATIONAL EFFICIENCY	COUNTS	% OF TOTAL
Automating routine tasks	7	10%
Reducing human errors	15	22%
Speeding up the treatment process	1	1%
All of the above	47	67%

Table 18: Robotics Role in Improving Operational Efficiency

4.2.17 BARRIERS IN TRAINING FOR ROBOTIC TECHNOLOGIES

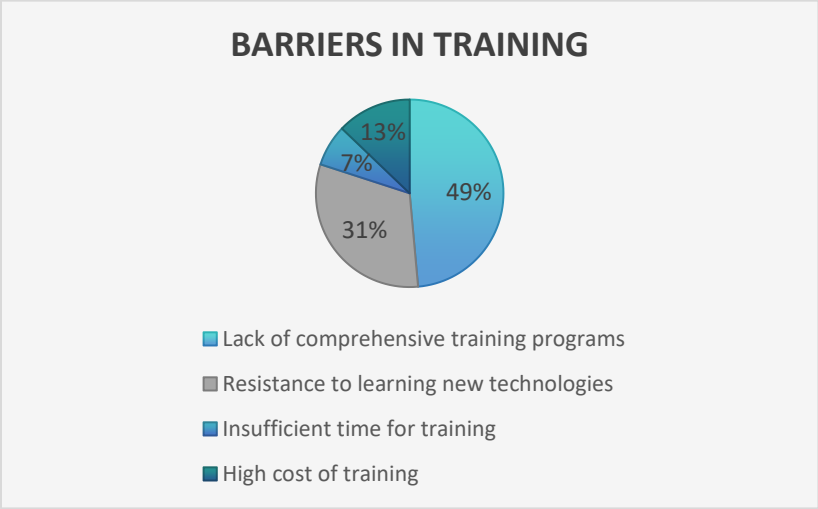

Figure 25: Barriers in Training for Robotic Technologies

BARRIERS IN TRAINING	COUNTS	% OF TOTAL
Lack of comprehensive training programs	34	49%
Resistance to learning new technologies	22	31%
Insufficient time for training	5	7%
High cost of training	9	13%

Table 19: Barriers in Training for Robotic Technologies

The table suggest that nearly half of the respondents, 34 out of 70 (49%), identified the lack of comprehensive training programs as the primary barrier, indicating a significant need for more structured and accessible training opportunities. Resistance to learning new technologies was cited by 22 respondents (31%), highlighting a cultural or psychological barrier that can hinder the effective integration of robotics. Additionally, 9 respondents (13%) pointed to the high cost of training as a notable obstacle, suggesting that financial constraints play a role in limiting access to necessary education. Finally, 5 respondents (7%) mentioned insufficient time for training, underscoring the difficulties healthcare professionals face in balancing their demanding schedules with the need for ongoing education. These findings suggest that addressing these barriers is crucial for the successful implementation of robotics in healthcare

4.2.18 PERCEIVED BENEFITS VS. LIMITATIONS OF ROBOTICS

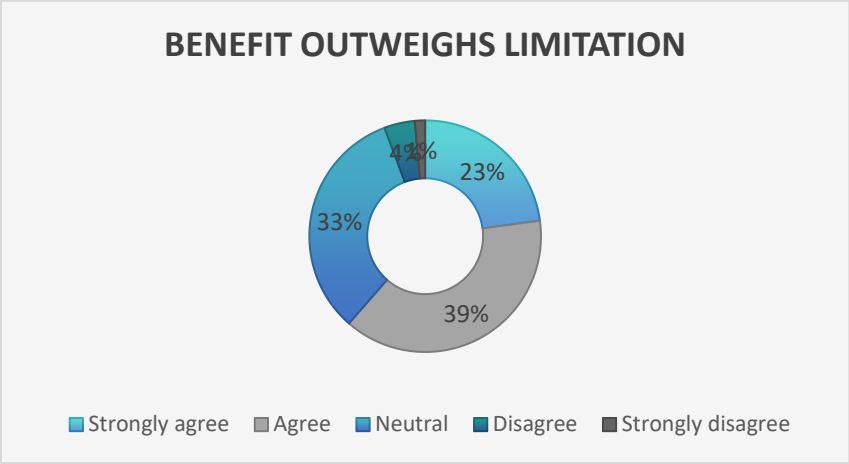

Figure 26: Perceived Benefits vs. Limitations of Robotics

BENEFIT OUTWEIGHS LIMITATION	COUNTS	% OF TOTAL
Strongly agree	16	23%
Agree	27	39%
Neutral	23	33%
Disagree	3	4%
Strongly disagree	1	1%

Table 20: Perceived Benefits vs. Limitations of Robotics

The table presents responses on whether the benefits of robotics outweigh its limitations, based on the views of the participants. Out of the total respondents, 39% (27 respondents) agreed that the benefits indeed outweigh the limitations, reflecting a positive outlook on the integration of robotics in healthcare. Additionally, 23% (16 respondents) strongly agreed, further reinforcing this favorable perception. A significant portion, 33% (23 respondents), remained neutral, indicating that they see an equal balance between benefits and limitations. On the other hand, a small percentage expressed doubt, with 4% (3 respondents) disagreeing and 1% (1 respondent) strongly disagreeing. These results suggest that there is overall optimism about robotics in healthcare.

4.2.19 SUGGESTIONS FOR ENHANCING ROBOTICS INTEGRATION

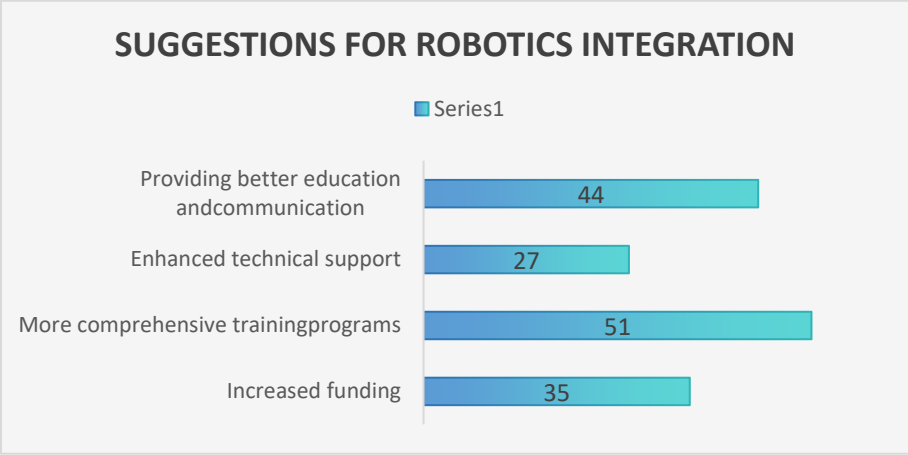

Figure 27: Suggestions for Enhancing Robotics Integration

SUGGESTIONS FOR ROBOTICS INTEGRATION	COUNTS	% OF TOTAL
Increased funding	35	22%
More comprehensive trainingprograms	51	33%
Enhanced technical support	27	17%
Providing better education andcommunication	44	28%

Table 21: Suggestions for Enhancing Robotics Integration

The table presents suggestions for improving the integration of robotics in healthcare, based on a checkbox-style question. Out of the total responses, 33% highlighted the need for more comprehensive training programs, indicating a strong demand for better education and skill development to effectively use robotics. Providing better education and communication was also a significant suggestion, with 28% of responses, emphasizing the importance of clear information and understanding among healthcare professionals. Increased funding was suggested by 22% of respondents, reflecting concerns about the financial barriers to adopting robotics. Additionally, 17% pointed to the need for enhanced technical support, indicating that ongoing assistance and troubleshooting are crucial for the successful integration of these technologies. These suggestions underline the approaches needed to address the challenges of robotics adoption in healthcare.

4.2.20 TRANSFORMATIVE IMPACT OF ROBOTICS ON THE FUTURE OF HEALTHCARE

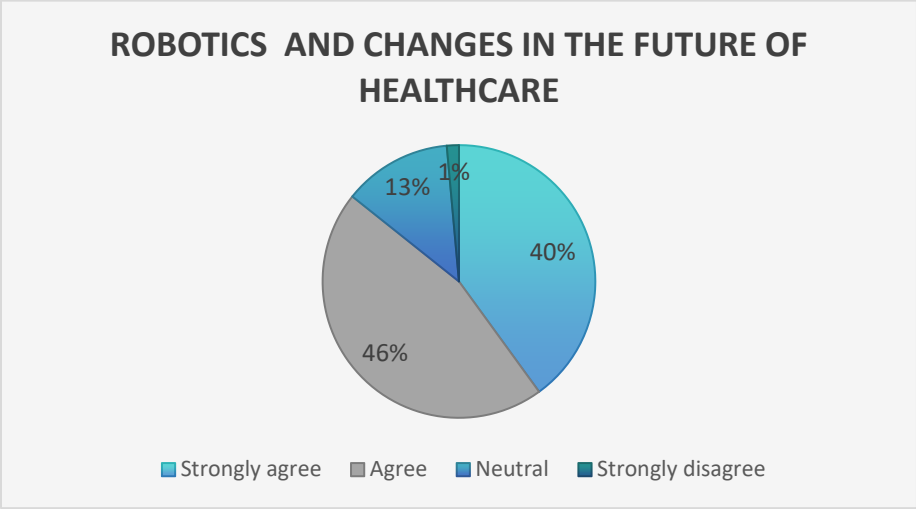

Figure 28: Future Impact of Robotics on Healthcare

The pie chart shows that a significant 86% expressed optimism about robotics, with 40% (28 respondents) strongly agreeing and 46% (32 respondents) agreeing that robotics will significantly change the future of healthcare. This overwhelming majority indicates a positive outlook towards the integration of robotics, suggesting that many healthcare professionals see technology as a key driver of future advancements in their field. Meanwhile, 13% (9 respondents) remained neutral, possibly indicating some uncertainty, and only a small minority, 1% (1 respondent), strongly disagreed, reflecting minimal doubt about the potential impact of robotics in healthcare.

SIGNIFICANT IMPACT OF ROBOTICS IN FUTURE OF HEALTHCARE	COUNTS	% OF TOTAL
Strongly agree	28	40%
Agree	32	46%
Neutral	9	13%
Strongly disagree	1	1%

Table 22: Future Impact of Robotics on Healthcare

4.2.21 CURRENT INTEGRATION OF ROBOTICS IN FACILITIES

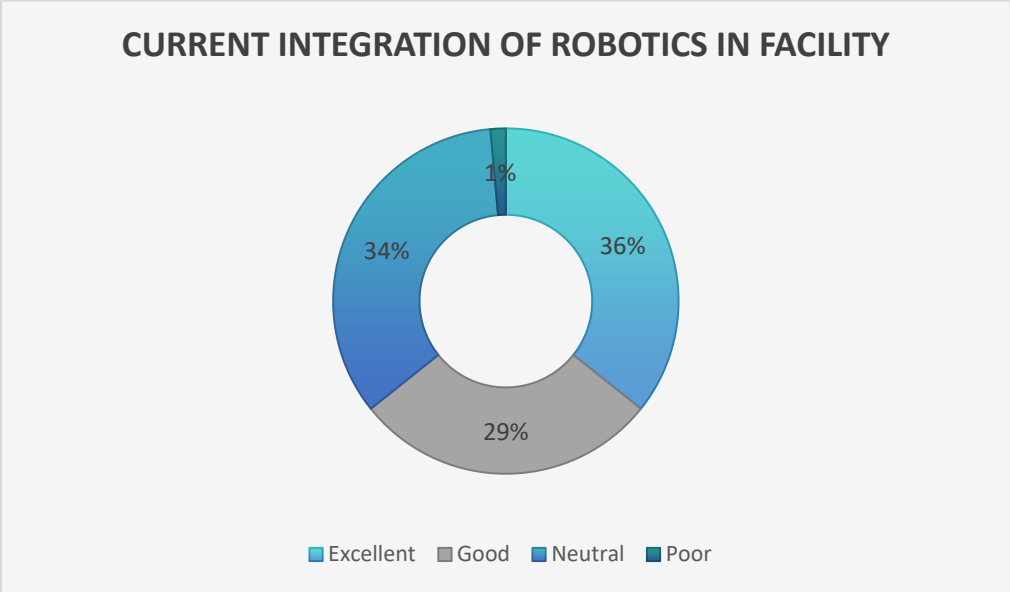

Figure 29: Current Integration of Robotics in Facilities

This chart reveals a generally positive perception. Out of the total responses, 36% (25 respondents) rated the integration as "Excellent," indicating that over a third of the participants believe their facility is effectively incorporating robotics into their operations. Additionally, 29% (20 respondents) rated it as "Good," suggesting that while there is room for improvement, a significant portion of respondents are satisfied with the current level of robotics integration. On the other hand, 34% (24 respondents) remained neutral, which may reflect uncertainty. Only 1% (1 respondent) rated the integration as "Poor," indicating minimal dissatisfaction with the current state of robotics in healthcare settings.

CURRENT INTEGRATION OF ROBOTICS IN FACILITY	COUNTS	% OF TOTAL
Excellent	25	36%
Good	20	29%
Neutral	24	34%
Poor	1	1%

Table 23: Current Integration of Robotics in Facilities

4.2.22 SUPPORT FOR INTEGRATING MORE ROBOTICS

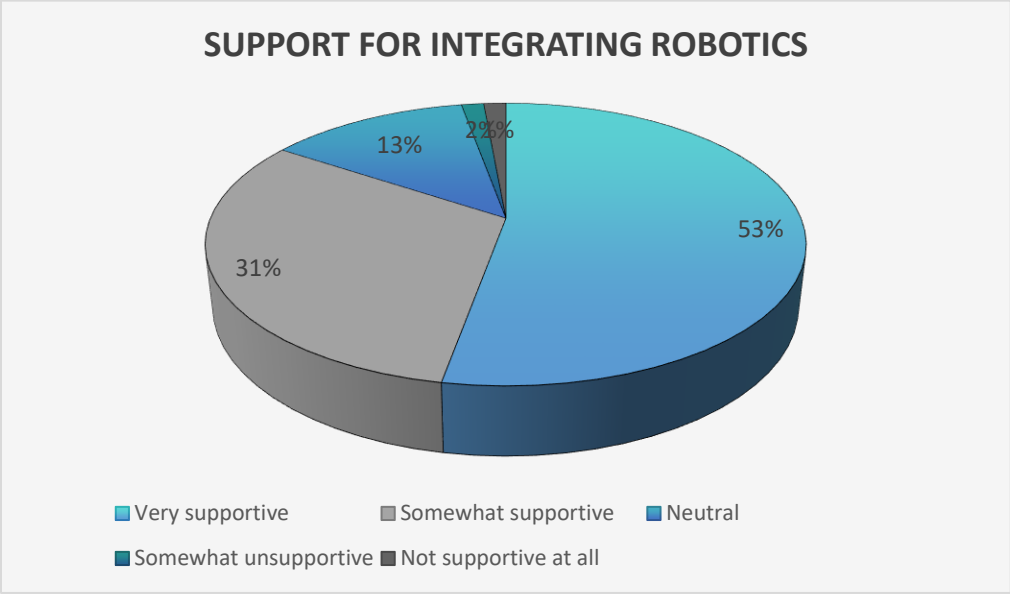

Figure 30: Support for Integrating More Robotics

SUPPORT FOR INTEGRATING ROBOTICS	COUNTS	% OF TOTAL
Very supportive	37	53%
Somewhat supportive	22	32%
Neutral	9	13%
Somewhat unsupportive	1	1%
Not supportive at all	1	1%

Table 24: Support for Integrating More Robotics

The table on support for integrating robotics in healthcare shows that a majority, 53% (37 respondents), indicated they are "Very supportive" of robotics integration, reflecting a high level of willingness to adopt this technology. Additionally, 32% (22 respondents) are "Somewhat supportive," suggesting that a significant portion of respondents are open to robotics. Meanwhile, 13% (9 respondents) remained neutral, indicating a lack of strong opinion either for or against integration. Only 1% (1 respondent) each were "Somewhat unsupportive" or "Not supportive at all," indicating minimal opposition to the integration of robotics in healthcare. These results highlight a generally favorable attitude towards robotics among the respondents, with most showing support for its implementation in healthcare settings.

4.3 STATISTICAL ANALYSIS

4.3.1 HYPOTHESIS 1 : ASSESSING KNOWLEDGE AND COMFORT IN UTILIZING ROBOTICS WITHIN HEALTHCARE SETTINGS.

The data provided in the frequency tables offers insights into healthcare professionals levels of awareness about the current use of robotics in healthcare, as well as their comfort with the idea of incorporating robotics into their daily healthcare practice. These findings are essential in understanding the extent to which robotics is recognized and accepted within the healthcare industry.

4. What is your level of awareness about the current use of robotics in healthcare?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completely unaware	1	1.4	1.4	1.4
	Neutral	12	17.1	17.1	18.6
	Somewhat aware	40	57.1	57.1	75.7
	Unaware	3	4.3	4.3	80.0
	Very aware	14	20.0	20.0	100.0
	Total	70	100.0	100.0	

Table 25: Frequency table for hypothesis 1 (on awareness)

This frequency table shows respondents awareness of robotics in healthcare. Among the 70 respondents, 57.1% are "Somewhat aware," indicating moderate familiarity with the technology, while 20% are "Very aware," reflecting a strong understanding. Smaller groups include 17.1% who are "Neutral," 4.3% who are "Unaware," and 1.4% who are "Completely unaware" of robotics in healthcare.

8. How comfortable are you with the idea of using robotics in your daily healthcare practice?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Neutral	7	10.0	10.0	10.0
	Somewhat comfortable	32	45.7	45.7	55.7
	Somewhat uncomfortable	4	5.7	5.7	61.4
	Very comfortable	27	38.6	38.6	100.0
	Total	70	100.0	100.0	

Table 26: Frequency table for hypothesis 1 (on comfort levels)

The above frequency table shows that 45.7% of respondents are "Somewhat comfortable" with using robotics in their daily practice, indicating general openness to the technology. Additionally, 38.6% are "Very comfortable," reflecting strong confidence in incorporating robotics. However,10% are "Neutral," and 5.7% are "Somewhat uncomfortable," indicating some uncertainty and hesitation.

The findings strongly support the hypothesis that healthcare professionals in Kerala have a high level of knowledge and comfort in utilizing robotics within healthcare settings. The high percentage of respondents who are "Somewhat aware" or "Very aware" indicates that knowledge about robotics is indeed widespread among these professionals. Additionally, the significant number of professionals who feel comfortable whether "Somewhat comfortable" or "Very comfortable" with using robotics further reinforces the hypothesis.

4.3.1.1 ASSESSING THE RELATIONSHIP BETWEEN THE LEVEL OF AWARENESS AND LEVEL OF COMFORT

The crosstabulation analysis provides insights into the relationship between healthcare professionals awareness of robotics and their comfort level with using robotics in daily practice. This analysis helps to understand how familiarity with robotics influences the ease with which professionals are willing to integrate this technology into their routine work.

4. What is your level of awareness about the current use of robotics in healthcare? * 8. How comfortable are you with the idea of using robotics in your daily healthcare practice? Crosstabulation

Count

		8. How comfortable are you with the idea of using robotics in your daily healthcare practice?				
		Neutral	Somewhat comfortable	Somewhat uncomfortable	Very comfortable	Total
4. What is your level of awareness about the current use of robotics in healthcare?	Completely unaware	0	0	1	0	1
	Neutral	1	7	2	2	12
	Somewhat aware	5	22	1	12	40
	Unaware	1	2	0	0	3
	Very aware	0	1	0	13	14
Total		7	32	4	27	70

Table 27: Contigency table for hypothesis 1

The crosstabulation reveals that a significant number of respondents who are "Somewhat aware"(40 respondents) and "Very aware"(14 respondents) of robotics in healthcare also report being "Somewhat comfortable" or "Very comfortable" with using robotics in their daily practice. This suggests that increased awareness of robotics correlates with higher comfort levels in its application, indicating that familiarity with the technology plays a crucial role in its acceptance among healthcare professionals.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	44.155[a]	12	<.001
Likelihood Ratio	35.428	12	<.001
N of Valid Cases	70		

a. 15 cells (75.0%) have expected count less than 5. The minimum expected count is .06.

Table 28: Chi square test on hypothesis 1

The Pearson Chi-Square value of 44.155, with a p-value of less than 0.001, indicates a statistically significant association between the level of awareness (knowledge) about robotics in healthcare and the level of comfort in using robotics. This suggests that as healthcare professionals awareness of robotics increases, their comfort in utilizing this technology also significantly improves.

In conclusion, the findings suggests that healthcare professionals in Kerala generally possess a good level of knowledge and comfort regarding the use of robotics in healthcare. This aligns well with the proposed hypothesis, indicating that as awareness of robotics increases, so does the comfort level in using it. These findings imply that continued education and exposure to robotics could further enhance the integration of this technology into healthcare settings, supporting the ongoing adoption and use of robotics in the field.

4.3.2 HYPOTHESIS 2: ASSESSING PUBLIC ATTITUDES TOWARDS ROBOTICS IN HEALTHCARE

For this hypothesis three key predictors were included. The first predictor is Q10_recode, which represents safety concerns about robotics. The second predictor is Q15_recode, which captures the perceived benefit of robotics in reducing the workload of healthcare professionals. The third predictor is Q14_recode, which reflects the perceived benefit of robotics in enhancing efficiency in healthcare delivery. The dependent variable in this model is Q24_recode, which represents public support for integrating more robotics into the healthcare system. This variable helps to measure the overall acceptance and willingness of the public to embrace greater use of robotics in healthcare settings

The variables Q15_recode, Q14_recode, Q10_recode, and Q24_recode are the recoded versions of the original survey questions 15, 14, 10, and 24, respectively. These variables were recoded in SPSS software to facilitate regression analysis.

The responses to these questions were numerically coded to quantify the levels of agreement or concern. For instance, responses such as "Strongly Agree" or "Very Concerned" were assigned a value of 5, reflecting the highest level of agreement or concern. Similarly, other responses were assigned descending numerical values, which allowed for a more precise statistical analysis of the relationships between these predictors and the dependent variable.

This recoding process enabled the model to analyze how safety concerns, perceived benefits in reducing workload, and enhancing efficiency influence public support for the integration of robotics in healthcare. By transforming the data into a numeric format, the analysis could better assess and predict trends in public opinion regarding robotics in healthcare settings.

4.3.2.1 REGRESSION ANALYSIS

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.766[a]	.587	.568	.56730

a. Predictors: (Constant), Q10_recode, Q15_recode, Q14_recode

Table 29: Model summary (hypothesis 2)

The model summary provides key insights into the strength and explanatory power of the regression model. The correlation coefficient (R) is 0.766, indicating a strong positive relationship between the predictors safety concerns, perceived benefits of reducing workload, and enhancing efficiency and the dependent variable, public support for robotics (Q24_recode). The R^2 value of 0.587 suggests that approximately 58.7% of the variability in public support for robotics is explained by these three predictors. Additionally, the adjusted R^2 of 0.568 provides a more accurate measure of the model's explanatory power by accounting for the number of predictors, confirming that the model remains robust even when adjusted for complexity.

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	30.202	3	10.067	31.282	<.001[b]
	Residual	21.241	66	.322		
	Total	51.443	69			

a. Dependent Variable: Q24_recode

b. Predictors: (Constant), Q10_recode, Q15_recode, Q14_recode

Table 30: ANOVA Table

The ANOVA table further validates the significance of the regression model. The F-statistic is 31.282, with a p-value of less than 0.001, indicating that the overall regression model is statistically significant. This means that the predictors safety concerns, perceived benefits of reducing workload, and enhancing efficiency collectively have a significant impact on public support for integrating robotics into healthcare. The high F-statistic and low p-value demonstrate that the relationship observed between the predictors and the dependent variable is not due to random chance, reinforcing the reliability of the model's findings.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.799	.433		1.846	.069
	Q15_recode	.314	.148	.292	2.123	.038
	Q14_recode	.537	.146	.507	3.672	<.001
	Q10_recode	.021	.067	.025	.317	.752

a. Dependent Variable: Q24_recode

Table 31: Regression analysis of hypothesis 2

The variable Q15_recode (Perceived Benefit: Reducing Workload) was found to be statistically significant in influencing public support for robotics, as indicated by a p-value of 0.038 ($p < 0.05$). The coefficient (B) of 0.314 suggests that for every unit increase in the perception that robotics reduces workload, public support for robotics increases by 0.314 units, assuming all other factors remain constant. The standardized coefficient (Beta) of 0.292 and a t-value of 2.123 further reinforce the positive relationship between the perception of workload reduction and public support for integrating robotics in healthcare. The t-value of 2.123 is used to assess the significance of the relationship between the predictor (Q15_recode) and the dependent variable (Q24_recode). A t-value above 2 is typically considered strong evidence against the null hypothesis, suggesting that the predictor has a statistically significant impact on the dependent variable.

The variable Q14_recode (Perceived Benefit: Enhancing Efficiency) is statistically significant in influencing public support for robotics, as evidenced by a p-value of less than 0.001 ($p < 0.05$). With a coefficient (B) of 0.537, this variable has the largest impact among the predictors in the model. The standardized coefficient (Beta) of 0.507 and a t-value of 3.672 indicate a strong positive relationship between the perception of enhanced efficiency due to robotics and public support. Specifically, for every unit increase in the belief that robotics enhances efficiency, public support for integrating robotics in healthcare increases by 0.537 units.

The variable Q10_recode (Safety Concerns) was analyzed to determine its impact on public support for robotics. The results show a coefficient (B) of 0.021 and a standardized coefficient (Beta) of 0.025, with a t-value of 0.317 and a p-value of 0.752. Since the p-value is greater than 0.05, this variable is not statistically significant, indicating that concerns about the safety of robotics do not have a meaningful influence on public support for integrating robotics in healthcare within this model. It indicates that, the perception of safety issues does not play a crucial role in shaping public opinion on robotics in this context.

In conclusion, the regression analysis reveals that public attitudes towards robotics in healthcare are significantly more influenced by perceived benefits, such as efficiency and workload reduction, than by safety concerns. This finding strongly supports the hypothesis that positive perceptions of robotics functional advantages are key drivers of public support. Since safety concerns were not found to significantly impact public support, it suggests that these concerns do not play a crucial role in shaping public opinion. Therefore, to enhance public endorsement of robotics, it is important to focus on promoting the practical benefits that robotics can offer in healthcare settings.

4.3.3 HYPOTHESIS 3: ASSESSING THE INTEGRATION OF ROBOTICS IN HEALTHCARE FACILITIES AND IMPROVEMENT IN EFFICIENCY AND PATIENT OUTCOMES.

4.3.3.1 FREQUENCY TABLES

23. Overall, how would you rate the integration of robotics in your healthcare facility?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		100	58.8	58.8	58.8
	Excellent	25	14.7	14.7	73.5
	Good	20	11.8	11.8	85.3
	Neutral	24	14.1	14.1	99.4
	Poor	1	.6	.6	100.0
	Total	170	100.0	100.0	

Table 32: Frequency table of hypothesis 3 (integration of robotics)

The table indicates a total of 26.5% of respondents rated the integration of robotics in their healthcare facility as either excellent (14.7%) or good (11.8%), indicating a favorable view among these participants. Additionally, 14.1% provided a neutral rating, suggesting they neither strongly support nor oppose the integration. Only 0.6% rated the integration as poor, showing minimal dissatisfaction. Overall, the majority of responses are positive, with very few negative opinions, reflecting a generally favorable reception of robotics in healthcare settings.

14. How much do you agree with the statement: "Robotics can enhance the efficiency of healthcare delivery"?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		100	58.8	58.8	58.8
	Agree	35	20.6	20.6	79.4
	Disagree	1	.6	.6	80.0
	Neutral	13	7.6	7.6	87.6
	Strongly agree	20	11.8	11.8	99.4
	Strongly disagree	1	.6	.6	100.0
	Total	170	100.0	100.0	

Table 33: Frequency table of hypothesis 3 (robotics on enhancing efficiency)

The data shows that a significant majority of respondents, 58.8%, believe that robotics can enhance healthcare delivery efficiency, with 20.6% agreeing and 11.8% strongly agreeing. A smaller portion, 7.6%, are neutral, indicating some uncertainty or indifference about robotics' impact on efficiency. Only 1.2% of respondents disagree, with 0.6% disagreeing and another 0.6% strongly disagreeing. The cumulative percentages indicate that nearly 100% of respondents either agree, strongly agree, or remain neutral, suggesting widespread optimism or acceptance of robotics role in improving healthcare efficiency.

13. How much do you agree with the statement: "Robotics can improve the quality of patient care"?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		100	58.8	58.8	58.8
	Agree	33	19.4	19.4	78.2
	Disagree	1	.6	.6	78.8
	Neutral	15	8.8	8.8	87.6
	Strongly agree	19	11.2	11.2	98.8
	Strongly disagree	2	1.2	1.2	100.0
	Total	170	100.0	100.0	

Table 34: Frequency table of hypothesis 3 (robotics and quality of patient care)

The table shows that a significant majority of respondents, 58.8%, believe that robotics can improve the quality of patient care, with 19.4% agreeing and 11.2% strongly agreeing. Additionally, 8.8% of respondents are neutral, neither agreeing nor disagreeing with the statement. Only a small portion, 1.8%, disagrees, including 0.6% who disagree and 1.2% who strongly disagree. The cumulative percentage highlights the progression of agreement, showing that nearly 99% of respondents either agree or are neutral about the positive impact of robotics on patient care quality. This indicates a strong overall positive perception toward the role of robotics in enhancing patient care.

4.3.3.2 CORRELATION ANALYSIS

To perform the correlation analysis, responses of the questions 14, 15, and 24 were numerically coded and renamed as Q14_recode, Q15_recode, and Q24_recode, respectively. The responses were quantitatively assigned points to facilitate statistical analysis, with the highest level of agreement or approval, such as "Strongly Agree" or "Excellent," given 5 points. Lesser degrees of agreement or satisfaction were coded in a descending manner. This coding method allows for a standardized evaluation of responses, enabling a clear, quantitative assessment of correlations among variables regarding perceptions and support for robotics in healthcare.

Correlations

		Q14_recode	Q23_recode
Q14_recode	Pearson Correlation	1	.609**
	Sig. (2-tailed)		<.001
	N	70	70
Q23_recode	Pearson Correlation	.609**	1
	Sig. (2-tailed)	<.001	
	N	70	70

**. Correlation is significant at the 0.01 level (2-tailed).

Table 35: Correlation analysis (Q14 and Q23)

This correlation table shows a strong positive relationship between **Q14_recode** (Perceived Benefit: Enhancing Efficiency in Healthcare Delivery) and **Q23_recode** (Rating of Robotics Integration in Healthcare Facility), with a Pearson correlation coefficient of 0.609. This correlation is statistically significant at the 0.01 level ($p < 0.001$), indicating a meaningful association between these two variables. In simpler terms, as the perception of robotics' ability to enhance efficiency increases, the rating of robotics integration within the healthcare facility also tends to be higher. This suggests that healthcare professionals who view robotics as a tool for improving efficiency are more likely to positively rate its integration in their facilities.

Correlations

		Q23_recode	Q13_recode
Q23_recode	Pearson Correlation	1	.477**
	Sig. (2-tailed)		<.001
	N	70	70
Q13_recode	Pearson Correlation	.477**	1
	Sig. (2-tailed)	<.001	
	N	70	70

**. Correlation is significant at the 0.01 level (2-tailed).

Table 36: Correlation analysis (Q13 and Q23)

The above correlation table examines the relationship between **Q23_recode** (Rating of Robotics Integration in Healthcare Facility) and **Q13_recode** (Perceived Impact on Reducing Workload). The Pearson correlation coefficient here is 0.477, indicating a moderate positive relationship between these two variables. This correlation is also statistically significant at the 0.01 level ($p < 0.001$), implying that as the perception of robotics impact on reducing workload improves, the rating of its integration in healthcare facilities tends to be more favorable. This suggests that healthcare professionals who believe robotics effectively reduces workload are more inclined to give a positive rating to the overall integration of robotics in their workplace.

To summarize, the findings support the hypothesis that the integration of robotics in healthcare facilities is perceived to offer significant benefits, particularly in improving efficiency and reducing workload. The strong positive correlations between these perceived benefits and the overall rating of robotics integration suggest that healthcare professionals who recognize these advantages are more likely to view the integration favorably.

4.3.4 HYPOTHESIS 4: IMPACT OF SOCIOECONOMIC FACTORS SUCH AS AGE AND OCCUPATION ON PUBLIC PERCEPTIONS OF ROBOTICS IN HEALTHCARE.

4.3.4.1 OCCUPATION AND ACCEPTANCE OF ROBOTICS

Crosstab

Count

		2. Occupation						
		Clinical pharmacist	Doctor	Drug safety associate	Nurse	Pharmacist	Student	Total
24. Overall, how supportive are you of integrating more robotics into the healthcare system?	Neutral	0	2	0	1	5	1	9
	Not supportive at all	0	0	0	0	1	0	1
	Somewhat supportive	1	4	1	9	7	0	22
	Somewhat unsupportive	0	0	0	1	0	0	1
	Very supportive	0	12	0	6	19	0	37

Total	1	18	1	17	32	1	70

Table 37: Crosstabs of hypothesis 4 (occupation and acceptance of robotics)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	22.054[a]	20	.338
Likelihood Ratio	19.613	20	.482
N of Valid Cases	70		

a. 24 cells (80.0%) have expected count less than 5. The minimum expected count is .01.

Table 38: Chi square test of hypothesis 4 (occupation and acceptance of robotics)

The table for crosstab and associated Chi-Square tests analyze the distribution of support for integrating more robotics into the healthcare system across various occupations including clinical pharmacists, doctors, drug safety associates, nurses, pharmacists, and students. Notably, doctors and pharmacists show a higher tendency to be "Very supportive." Despite these observable differences in support levels among different professional groups, the Pearson Chi-Square test result (22.054 with a p-value of .338) and the Likelihood Ratio (19.613 with a p-value of .482) reveal no statistically significant association between occupation and support levels for robotics integration. All p-values exceed the typical significance threshold of 0.05, indicating that occupation does not significantly influence attitudes towards the integration of robotics within this sample. This suggests that the observed differences in support among occupational groups, while present, do not meet the statistical threshold for significance in a Chi-square test, potentially due to the sample size or dispersion of responses within groups.

4.3.4.2 AGE AND ACCEPTANCE OF ROBOTICS

Crosstab

Count

		1. Age					
		24-34	35-44	45-54	55-64	Below 24	Total
24. Overall, how supportive are you of integrating more robotics into the healthcare system?	Neutral	7	0	0	1	1	9
	Not supportive at all	1	0	0	0	0	1
	Somewhat supportive	11	4	6	0	1	22
	Somewhat unsupportive	0	0	0	1	0	1
	Very supportive	22	5	3	1	6	37
Total		41	9	9	3	8	70

Table 39: Crosstabs of hypothesis 4 (age and acceptance of robotics)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	34.698[a]	16	.004
Likelihood Ratio	21.331	16	.166
N of Valid Cases	70		

a. 22 cells (88.0%) have expected count less than 5. The minimum expected count is .04.

Table 40: Chi square test of hypothesis 4 (age and acceptance of robotics)

The crosstab reveals that younger age groups, particularly those between 24-34 years, are more likely to be "Very supportive" of integrating more robotics, which supports the Pearson Chi-Square test

result showing a significant difference across age groups (p = .004). This indicates that younger individuals have a higher tendency to embrace robotics, likely due to greater technological affinity and exposure. However, the Likelihood Ratio's non-significant result (p = .166) suggests that while there is some trend towards age-related differences, it might not be as pronounced across all categories, potentially affected by the small sample size in each age category leading to low expected counts in many cells. This complex relationship highlights that different age groups vary in their acceptance and expectations of using robotics in healthcare, emphasizing the impact of generational differences.

In conclusion, the findings from the crosstabs and Chi-Square tests partially support the hypothesis that socioeconomic factors, specifically age, significantly impact public perceptions of robotics in healthcare. While the data indicates that younger age groups are more supportive of robotics, suggesting a correlation with technological familiarity and exposure, the non-significant results across the other category, such as occupation, suggest a more complex influence. The significant age-related support contrasts with the broader occupational indifference, highlights that while age plays a critical role, other socioeconomic factor like occupation may require further investigation to fully understand their impact on perceptions of robotics in healthcare.

4.4 DISCUSSION

The data analysis offers a comprehensive view of how robotics is reshaping healthcare in Kerala, highlighting a notable trend of acceptance, particularly among younger healthcare professionals. The data reveals that these younger age groups are particularly supportive of robotics, suggesting a stronger correlation with their technological familiarity and exposure. This demographic shift aligns with findings by Laursen et al. (2022), who observed that younger individuals are more likely to adopt robotics due to better education and greater familiarity with technology. This generational comfort with technology suggests a promising future where robotics are seamlessly integrated into medical practices.

Support for robotics is further influenced by healthcare professionals direct experiences with these technologies. As noted by Osaka et al. (2023), those who frequently use robotics perceive greater benefits, supporting the study's first hypothesis that knowledge and comfort with robotics significantly drive acceptance. The findings indicate that healthcare professionals in Kerala generally possess a good level of knowledge and comfort with the use of robotics in healthcare, aligning well with the proposed hypothesis that increased awareness of robotics correlates with higher comfort levels of using it. However, the analysis also reveals a significant gap in formal robotics training, which is seen as a major barrier to adoption. This finding highlights the critical need for robust

training programs, a necessity also emphasized by healthcare professionals and supported by Papadopoulos et al. (2023) for effective integration.

The findings of study also highlighted the perceived benefits of robotics, such as enhanced efficiency, surgical precision, reduced recovery time that are well-supported by existing literature. These results highlight widespread understanding of the diverse benefits that robotic technologies offer to surgical practices, especially in improving precision, safety, and efficiency. This generally favorable view indicates that among users with robotics experience, the technology is predominantly seen as a valuable asset for boosting operational efficiency.Troccaz et al. (2019) review the evolution of medical robotics, recognizing improvements in surgical precision. Cresswell et al. (2018), robotics in healthcare offers significant opportunities to improve patient outcomes which results in less trauma and faster recovery for patients. The study also reveals that public attitudes towards robotics in healthcare are significantly more influenced by perceived benefits, such as efficiency and workload reduction, than by safety concerns. This finding strongly supports the hypothesis that positive perceptions of robotics functional advantages are key drivers of public support.

The analysis indicates that a substantial majority of healthcare professionals believe robotics can reduce medical errors and enhance patient outcomes, mirroring Parre and Sujatha (2021) who emphasize robotics potential to minimize human error and improve patient care. This perspective underscores the transformative impact robotics could have on healthcare efficiency and safety.

However, the study also highlights significant barriers to the widespread adoption of robotics, such as high costs, technical challenges, and resistance from healthcare staff. These concerns, particularly the financial burden of implementing robotics, are emphasized as substantial challenges. As noted by Vänni and Salin (2019) and Vijayakumar and B (2022), these issues require extensive strategic planning and policy-making to effectively tackle financial and technical obstacles, ensuring the successful integration of robotics in healthcare settings.

Overall, the enthusiasm for robotics among healthcare professionals in Kerala, particularly among the younger demographic, is clear, but the actual integration into daily practice is still in progress. Addressing the highlighted training gaps and supporting policies and infrastructure development are crucial for fully realizing the potential of robotics in healthcare. If these strategic elements are effectively aligned, they could significantly improve healthcare outcomes and operational efficiencies in Kerala, setting the stage for further research and successful implementation strategies. This discussion not only confirms the study's hypotheses but also underscores the need to address both the opportunities and challenges ahead for integrating robotics into healthcare settings.

CHAPTER 5

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 SUMMARY OF THE STUDY

The study provides an in-depth examination of the acceptance and use of robotics among healthcare professionals in Kerala, using a robust dataset of 70 valid responses. Utilizing IBM SPSS software for data analysis, the study incorporated various statistical techniques to understand the demographic impacts, level of awareness, frequency of encountering robotics, and the perceived benefits and challenges associated with robotics in healthcare settings. Notably, the study found a significant inclination towards robotics among younger healthcare professionals. This enthusiasm indicates a generational shift towards a more technologically integrated approach in medical practices, highlighting a readiness to adopt advanced technologies. This demographic trend is significant as it signals the evolving landscape of healthcare where technology plays a pivotal role.

However, the study also highlights a significant gap in formal robotics training among healthcare professionals. Despite a high level of awareness about the potential benefits of robotics such as increased efficiency, improved precision in procedures, and reduced error rates there is a distinct lack of hands-on experience and formal education in this area. This discrepancy suggests that while professionals are aware of the advantages of robotics, they are not adequately equipped with the necessary skills to integrate these technologies effectively into daily practices.

Moreover, the study finds that professionals who possess a high level of knowledge and awareness are more comfortable with robotics compared to those with lesser awareness and knowledge. This difference underscores the importance of knowledge as a foundational element for comfort and effective technology integration.

The gap between theoretical awareness and practical interaction with robotics indicates that healthcare professionals, despite their theoretical preparedness, lack the practical skills and comfort needed to fully embrace these technologies. This situation highlights the urgent need for comprehensive training initiatives and the development of interactive, hands-on learning experiences. Enhancing training programs would not only boost the proficiency and confidence of healthcare workers in using robotics but also accelerate the adoption and integration of these technologies into regular healthcare services in Kerala. Addressing these educational and experience gaps is crucial for maximizing the potential of robotics to enhance healthcare delivery in the region, ensuring that professionals are not only aware of but also skilled in utilizing these advanced tools in their practices.

5.2 RELEVANCE OF THE STUDY

The relevance of this study is underscored by its timely focus on the transformative potential of robotics in healthcare, a sector increasingly influenced by rapid technological advancements as explained by Hockstein et al. (2007). As healthcare systems worldwide struggle with challenges such as rising costs, staffing shortages, and the need for precision in complex medical procedures, robotics emerges as a pivotal innovation capable of addressing these issues. This research is especially pertinent to Kerala's healthcare system, which exhibits a high level of awareness of robotics capabilities yet shows varied levels of acceptance and integration across different healthcare settings.

The findings of the study are crucial for several reasons. The study highlight the specific factors that influence the acceptance and utilization of robotics in healthcare, such as age, professional role, and exposure to technology. Even though professional role did not show a statistically significant relationship with robotics adoption likely due to the small sample size in certain professions. Understanding these factors allows policymakers and healthcare administrators to identify the segments of the healthcare workforce that may require more targeted interventions, such as specialized training programs or awareness campaigns, to foster a more receptive environment for technology integration.

Moreover, the study contributes valuable insights that can guide the strategic development and policy creation necessary to effectively integrate advanced technologies into healthcare services. By emphasizing both the enthusiasm for and the hesitations regarding robotics, the study equips decision-makers with a balanced perspective, enabling them to address concerns and leverage favorable attitudes to promote broader adoption. In doing so, this research not only aids in enhancing the efficiency and effectiveness of healthcare delivery in Kerala but also establishes a model for other regions considering similar technological adoptions in their healthcare systems.

5.3 LIMITATIONS OF THE STUDY

The study provides valuable insights into the integration of robotics in healthcare but faces several limitations that affect the robustness of its conclusions. Firstly, the study's limitation in sample size and the limited duration of the study may not adequately capture the diversity of healthcare settings across Kerala, potentially limiting the generalizability of the findings. Secondly, the responses predominantly came from specific professional groups ,pharmacists, doctors, and nurses with fewer contributions from other roles, which raises the possibility that the results are biased towards these professions and may not fully represent the perspectives of all healthcare workers. Additionally, the study’s reliance on self-reported data introduces the risk of response bias, where participants might provide socially desirable answers or responses that do not accurately reflect their actual experiences

and behaviors. This could lead to biased findings and reduce the reliability of the study's outcomes. These limitations underline the need for cautious interpretation of the results and highlight the necessity for methodological improvements in future research, such as increasing the sample size, extending the study duration, and broadening the respondent base to include a wider range of healthcare professionals.

5.4 STRENGTHS OF THE STUDY

The strengths of this study are prominently displayed through its comprehensive analytical approach, detailed demographic insights, and relevance to current technological trends in healthcare. By utilizing advanced statistical methods, such as IBM SPSS software, to analyze the data, the study enhances the credibility of its findings, ensuring that conclusions drawn about the integration of robotics in healthcare are well-supported. Additionally, the study delves deeply into the demographic variables affecting the acceptance and usage of robotics, providing a better understanding of how factors like age influence healthcare professionals receptiveness to new technologies. This level of detail is crucial for effectively tailoring future training and adoption strategies. Furthermore, the study's focus on robotics in Kerala adds significant value to technological integration within healthcare settings, ensuring that the research remains highly relevant and practical. By addressing these aspects, the study not only sheds light on the current state of robotics in healthcare but also guides future technological implementations, making it a valuable asset for both academic researchers and healthcare policymakers.

5.5 FUTURE DIRECTIONS

The study conducted on the integration of robotics in Kerala's healthcare sector not only provides comprehensive current insights but also lays the groundwork for extensive future research and practical applications. The potential expansion of research to include broader geographic and demographic scopes stands as a pivotal next step. By extending the study to encompass a wider range of healthcare professionals and settings, future research could enhance the generalizability of the findings. This expansion would allow researchers to verify whether the trends observed in Kerala hold true in other regions with varying economic, cultural, and technological landscapes, thereby providing a richer, more diversified understanding of how robotics can be integrated across diverse healthcare systems.

Additionally, the dynamic nature of technology and its integration into healthcare underscores the need for longitudinal studies. Such research would track changes in perceptions and actual use of robotics over time, offering valuable insights into the evolving relationship between healthcare professionals and robotics technology. As robotics becomes more embedded in healthcare practices,

longitudinal studies could help identify emerging trends, shifts in acceptance, and the long-term effects of robotics on healthcare delivery. These insights would be crucial for healthcare administrators and policymakers to understand the sustained impacts and possibly emerging issues that arise with prolonged use of robotics in medical settings.

Furthermore, the study highlights a significant training gap which suggests a prime area for intervention studies. Future research could focus on developing and evaluating targeted training programs tailored for healthcare professionals. By examining how enhanced training influences the acceptance and efficiency of robotics use, researchers could provide evidence-based recommendations to improve educational initiatives.

Moreover, policy and implementation research is crucial to address the financial and technical barriers that currently hinder the broader adoption of robotics. Creating and assessing policies that facilitate the integration of robotics could lead to more strategic and effective approaches, ensuring that the deployment of these technologies maximizes benefits while minimizing disruptions.

Overall, these future directions aim to build on the initial findings to foster a deeper understanding and more effective implementation of robotics in healthcare. This continued research will be essential for leveraging robotic technologies to enhance healthcare outcomes not only in Kerala but potentially on a global scale.

In conclusion, this study underscores the growing enthusiasm for robotics among Kerala's younger healthcare professionals, primarily driven by their technological familiarity and exposure. It identifies a demographic trend where younger professionals demonstrate significant support for robotics, aligning with findings by Laursen et al. (2022). Despite recognizing the benefits of enhanced efficiency, surgical precision, and reduced recovery times, the study highlights a critical gap in formal training as a major barrier to wider adoption. Support for robotics correlates with direct experiences, as professionals who frequently use these technologies report significant benefits, confirming the hypothesis that comfort and knowledge of robotics drive acceptance, as supported by Osaka et al. (2023). The findings indicate that while healthcare professionals in Kerala are generally knowledgeable and comfortable with robotics, enhanced training programs are crucial to overcome adoption challenges and fully integrate these technologies into medical practice. Such training is essential for operational efficiency and minimizing medical errors to improve patient outcomes, as echoed by Cresswell et al. (2018) and Parre and Sujatha (2021). Moreover, public attitudes towards robotics in healthcare are significantly more influenced by perceived benefits, such as efficiency and workload reduction, rather than safety concerns, suggesting that positive perceptions of robotics' functional advantages are key drivers of public support. However, challenges such as high costs, technical complexities, and staff resistance necessitate strategic policy interventions to address

financial and logistical obstacles, as emphasized by Vänni and Salin (2019) and Vijayakumar and B (2022), ensuring successful integration of robotics into healthcare settings.

CHAPTER 6

REFERENCE

Andtfolk, M. *et al.* (2022) 'Attitudes toward the Use of Humanoid Robots in Healthcare—a Cross-Sectional Study'. *AI & SOCIETY*, 37(4), pp. 1739–1748. DOI: 10.1007/s00146-021-01271-4.

Alla, S. and Pazos, P. 'Healthcare Robotics: Key Factors That Impact Robot Adoption in Healthcare'.

BenMessaoud, C., Kharrazi, H. and MacDorman, K.F. (2011) 'Facilitators and Barriers to Adopting Robotic-Assisted Surgery: Contextualizing the Unified Theory of Acceptance and Use of Technology'. *PLoS ONE*, 6(1), p. e16395. DOI: 10.1371/journal.pone.0016395.

Bora, G.S. *et al.* (2020) 'Robot-Assisted Surgery in India: A SWOT Analysis'. *Indian Journal of Urology : IJU : Journal of the Urological Society of India*, 36(1), pp. 1–3. DOI: 10.4103/iju.IJU_220_19.

Borg, D. (2023) *Exploring the Depths of Research Design: Revealing the Layers of the Research Onion*. Available at: https://www.linkedin.com/pulse/exploring-depths-research-design-revealing-layers-onion-borg-ellul (Accessed: 30 July 2024).

Broadbent, E. *et al.* (2010) 'Attitudes and Reactions to a Healthcare Robot'. *Telemedicine Journal and E-Health: The Official Journal of the American Telemedicine Association*, 16(5), pp. 608–613. DOI: 10.1089/tmj.2009.0171.

CEIC,2022, 2022. *Number of Pharmacists: Registered: Kerala | Economic Indicators | CEIC*. Available at: https://www.ceicdata.com/en/india/health-human-resources-number-of-pharmacists-registered/number-of-pharmacists-registered-kerala (Accessed: 25 August 2024).

Ch3.Pdf. Available at: http://www.is.cityu.edu.hk/staff/isrobert/phd/ch3.pdf (Accessed: 29 July 2024a).

Collins, V. (2023) *Global Perspectives: How Different Countries Are Adopting Healthcare Robotics*. *Urban Robotics*. Available at: https://urbanrobotics.net/global-adoption-of-healthcare-robotics/ (Accessed: 14 July 2024).

Cresswell, K., Cunningham-Burley, S. and Sheikh, A. (2018) 'Health Care Robotics: Qualitative Exploration of Key Challenges and Future Directions'. *Journal of Medical Internet Research*, 20(7), p. e10410. DOI: 10.2196/10410.

Cruz, E., Oliveira, S. and Correia, A. (2024) *Robotics Application in the Hospital Domain: Operator-Patient- Robot Interface*. DOI: 10.20944/preprints202406.1161.v1.

Deo, N. and Anjankar, A. 'Artificial Intelligence With Robotics in Healthcare: A Narrative Review of Its Viability in India'. *Cureus*, 15(5), p. e39416. DOI: 10.7759/cureus.39416.

Di Lallo, A. *et al.* (2021) 'Medical Robots for Infectious Diseases: Lessons and Challenges from the COVID-19 Pandemic'. *IEEE Robotics & Automation Magazine*, 28(1), pp. 18–27. DOI: 10.1109/MRA.2020.3045671.

Georgadarellis, G.L. *et al.* (2024) 'Nursing Perceptions of Robotic Technology in Healthcare: A Pretest–Posttest Survey Analysis Using an Educational Video'. *IISE Transactions on Occupational Ergonomics and Human Factors*, 12(1–2), pp. 68–83. DOI: 10.1080/24725838.2024.2323061.

González Aguña, A. *et al.* (2023) 'Care Robotics: An Assessment of Professional Perception in the Face of the COVID-19 Pandemic'. *Healthcare*, 11(7), p. 946. DOI: 10.3390/healthcare11070946.

Healthcare Robots: Overview of the Top 10 Use Cases | HowToRobot. (2024) Available at: https://howtorobot.com/expert-insight/healthcare-robots (Accessed: 22 July 2024).

Hockstein, N.G. *et al.* (2007) 'A History of Robots: From Science Fiction to Surgical Robotics'. *Journal of Robotic Surgery*, 1(2), pp. 113–118. DOI: 10.1007/s11701-007-0021-2.

Holden, R.J. and Karsh, B.-T. (2010) 'The Technology Acceptance Model: Its Past and Its Future in Health Care'. *Journal of Biomedical Informatics*, 43(1), pp. 159–172. DOI: 10.1016/j.jbi.2009.07.002.

Kaiser, M.S. *et al.* (2021) 'Healthcare Robots to Combat COVID-19'. In Santosh, K.C. and Joshi, A. (eds.) *COVID-19: Prediction, Decision-Making, and Its Impacts*. Singapore: Springer, pp. 83–97. DOI: 10.1007/978-981-15-9682-7_10.

Kar, S. (2019) 'Robotics in HealthCare'. In *2019 2nd International Conference on Power Energy, Environment and Intelligent Control (PEEIC)*. 2019 2nd International Conference on Power Energy, Environment and Intelligent Control (PEEIC). pp. 78–83. DOI: 10.1109/PEEIC47157.2019.8976668.

Korn, O., Akalin, N. and Gouveia, R. (2021) 'Understanding Cultural Preferences for Social Robots: A Study in German and Arab Communities'. *ACM Transactions on Human-Robot Interaction*, 10, pp. 1–19. DOI: 10.1145/3439717.

Laursen, M.S. *et al.* (2022) 'Factors Facilitating the Acceptance of Diagnostic Robots in Healthcare: A Survey'. In *2022 IEEE 10th International Conference on Healthcare Informatics (ICHI)*. 2022 IEEE 10th International Conference on Healthcare Informatics (ICHI). pp. 442–448. DOI: 10.1109/ICHI54592.2022.00066.

Lochan, K., Suklyabaidya, A. and Roy, B.K. (2023) 'Chapter 9 - Medical and Healthcare Robots in India'. In Boubaker, O. (ed.) *Medical and Healthcare Robotics*. Medical Robots and Devices: New Developments and Advances. Academic Press, pp. 221–236. DOI: 10.1016/B978-0-443-18460-4.00010-X.

Łukasik, S. *et al.* (2020) 'Role of Assistive Robots in the Care of Older People: Survey Study Among Medical and Nursing Students'. *Journal of Medical Internet Research*, 22(8), p. e18003. DOI: 10.2196/18003.

MIR, M.M. *et al.* (2023) 'Application of Artificial Intelligence in Medical Education: Current Scenario and Future Perspectives'. *Journal of Advances in Medical Education & Professionalism*, 11(3), pp. 133–140. DOI: 10.30476/JAMP.2023.98655.1803.

Mishra, D.R.K. *Global Trends in Robotic Surgery Adoption and Utilization*. Available at: https://www.laparoscopyhospital.com/worldlaparoscopyhospital/index.php?pid=459&p=15 (Accessed: 14 July 2024).

Muraleedharan Ph.D, M. and Chandak, A. (2021) 'Emerging Challenges in the Health Systems of Kerala, India: Qualitative Analysis of Literature Reviews'. *Journal of Health Research*, ahead-of-print. DOI: 10.1108/JHR-04-2020-0091.

NSF 21-559: National Robotics Initiative 3.0: Innovations in Integration of Robotics (NRI-3.0) | NSF - National Science Foundation. Available at: https://new.nsf.gov/funding/opportunities/national-robotics-initiative-30-innovations/503641/nsf21-559/solicitation (Accessed: 5 August 2024).

Osaka, K. *et al.* (2023) 'Differences in Healthcare Professionals' Perceptions of Robots' Usefulness, Challenges, Cautions, Ethical Issues, and Intermediary Roles by the Experience of Robot Use'. In *2023 IEEE/SICE International Symposium on System Integration (SII)*. 2023 IEEE/SICE International Symposium on System Integration (SII). pp. 1–4. DOI: 10.1109/SII55687.2023.10039341.

Ohwoekevwo, J., Ikpe, A. and Ekanem, I. (2024) 'Overview of the Role of Medical Robotics in Day-to-Day Healthcare Services: A Paradigm Shift in Clinical Operations'. *Ibom Medical Journal*, 17, pp. 192–203. DOI: 10.61386/imj.v17i2.422.

Papadopoulos, I. *et al.* (2023) 'Views about Perceived Training Needs of Health Care Professionals in Relation to Socially Assistive Robots: An International Online Survey'. *Contemporary Nurse*, 59(4–5), pp. 344–361. DOI: 10.1080/10376178.2023.2238095.

Parre, M.D. and Sujatha, B. (2021) 'Novel Human-Centered Robotics: Towards an Automated Process for Neurorehabilitation'. *Neurology Research International*, 2021, p. 6690715. DOI: 10.1155/2021/6690715.

Poulsen, J.L. *et al.* (2022) 'Factors Affecting Workflow in Robot-Assisted Surgery: A Scoping Review'. *Surgical Endoscopy*, 36(12), pp. 8713–8725. DOI: 10.1007/s00464-022-09373-w.

Puliatti, S., Mazzone, E. and Dell'Oglio, P. (2020) 'Training in Robot-Assisted Surgery'. *Current Opinion in Urology*, 30(1), pp. 65–72. DOI: 10.1097/MOU.0000000000000687.

Rusch, P. *et al.* 'Recommendations for a Standardised Educational Program in Robot Assisted Gynaecological Surgery: Consensus from the Society of European Robotic Gynaecological Surgery (SERGS)'. *Facts, Views & Vision in ObGyn*, 11(1), pp. 29–41.

Robotic Surgery Outlook and Its Future. (2020) *CB Insights Research*. Available at: https://www.cbinsights.com/research/robotic-surgery-outlook-startups-funding-tech/ (Accessed: 28 July 2024).

Sahoo, S.K. and Choudhury, B. (2023) 'Challenges and Opportunities for Enhanced Patient Care with Mobile Robots in Healthcare'. *Journal of Mechatronics and Artificial Intelligence in Engineering*, 4. DOI: 10.21595/jmai.2023.23410.

Sanusi, E. (2023) 'A Review of Identity and Roles of Robotics in the Healthcare Industry'. *Journal of Robotics Spectrum*, pp. 144–154. DOI: 10.53759/9852/JRS202301014.

Saunders, M., Lewis, P. and Thornhill, A. (2009) 'Understanding Research Philosophies and Approaches'. *Research Methods for Business Students*, 4, pp. 106–135.

Silvera-Tawil, D. (2024) 'Robotics in Healthcare: A Survey'. *SN Computer Science*, 5(1), p. 189. DOI: 10.1007/s42979-023-02551-0.

Sierra Marín, S.D. *et al.* (2021) 'Expectations and Perceptions of Healthcare Professionals for Robot Deployment in Hospital Environments During the COVID-19 Pandemic'. *Frontiers in Robotics and AI*, 8. DOI: 10.3389/frobt.2021.612746.

Simshaw, D. *et al.* (2016) (2739462) Available at: https://papers.ssrn.com/abstract=2739462. (Accessed: 19 July 2024).

Soljacic, F. *et al.* (2024) 'Robots in Healthcare as Envisioned by Care Professionals'. *Intelligent Service Robotics*, 17(3), pp. 685–701. DOI: 10.1007/s11370-024-00523-8.

Stasevych, M. and Zvarych, V. (2023) (3) 'Innovative Robotic Technologies and Artificial Intelligence in Pharmacy and Medicine: Paving the Way for the Future of Health Care—A Review'. *Big Data and Cognitive Computing*, 7(3), p. 147. DOI: 10.3390/bdcc7030147.

survey monkey 2024, 2024. *Sample Size Calculator, Formula, and Examples*. *SurveyMonkey*. Available at: https://www.surveymonkey.com/mp/sample-size-calculator/ (Accessed: 25 August 2024).

Technology Acceptance Model (TAM). *Innovation Acceptance Lab*. Available at: https://acceptancelab.com/technology-acceptance-model-tam (Accessed: 29 July 2024b).

Thesismind (2019) *Analysis of Saunders Research Onion*. *Thesismind*. Available at: https://thesismind.com/analysis-of-saunders-research-onion/ (Accessed: 3 August 2024).

Troccaz, J., Dagnino, G. and Yang, G.-Z. (2019) 'Frontiers of Medical Robotics: From Concept to Systems to Clinical Translation'. *Annual Review of Biomedical Engineering*, 21, pp. 193–218. DOI: 10.1146/annurev-bioeng-060418-052502.

Ummer, O. *et al.* (2021) 'Connecting the Dots: Kerala's Use of Digital Technology during the COVID-19 Response'. *BMJ Global Health*, 6(Suppl 5), p. e005355. DOI: 10.1136/bmjgh-2021-005355.

Vänni, K.J. and Salin, S.E. (2019) 'Attitudes of Professionals Toward the Need for Assistive and Social Robots in the Healthcare Sector'. In Korn, O. (ed.) *Social Robots: Technological, Societal and Ethical Aspects of Human-Robot Interaction*. Cham: Springer International Publishing, pp. 205–236. DOI: 10.1007/978-3-030-17107-0_11.

Vichitkraivin, P. and Naenna, T. (2021) 'Factors of Healthcare Robot Adoption by Medical Staff in Thai Government Hospitals'. *Health and Technology*, 11(1), pp. 139–151. DOI: 10.1007/s12553-020-00489-4.

Vijayakuymar, G. and B, S. (2022) 'Significance and Application of Robotics in the Healthcare and Medical Field'. *Transaction on Biomedical Engineering Applications and Healthcare*, 3(2). DOI: 10.36647/TBEAH/03.02.A003.

Weerarathna, I.N., Raymond, D. and Luharia, A. 'Human-Robot Collaboration for Healthcare: A Narrative Review'. *Cureus*, 15(11), p. e49210. DOI: 10.7759/cureus.49210.

APPENDICES

APPENDIX A : SURVEY

Assessing Perception And Adoption Of Robotics Among healthcare Professionals In Kerala : A Quantitative Study On Public Acceptance Of Robotics Within Healthcare Sector

Dear Participant,

My name is Christeena Mathew, I am pursuing an MSc in Digital Transformation at Griffith College, Dublin, Ireland. This survey is a crucial part of my dissertation, aimed at evaluating the knowledge, attitudes, and practices related to the adoption of robotics among healthcare professionals in Kerala.

Robotics in healthcare encompasses advanced technologies designed to enhance surgical precision, automate repetitive tasks, and improve overall operational efficiency. However, the successful integration of these technologies depends on the acceptance and readiness of healthcare professionals. Therefore, it is vital to assess their perceptions and willingness to adopt robotic systems to identify potential barriers and facilitators.

As a healthcare professional, you are invited to participate in this survey. The survey comprises of different sections. The first section gathers participant demographics. Sections two to five evaluate your knowledge, attitudes, practices regarding robotics in healthcare and aims to identify gaps and gather your opinions on improving the adoption and integration of robotics within the healthcare sector. Completing the survey will take approximately 10-15 minutes.

Please note that participation in this survey is voluntary, and you can withdraw at any time. All information and opinions provided will be treated confidentially and used solely for research purposes.

Thank you in advance for your valuable participation.

For more information please contact : christeena.mathew@student.griffith.ie

* Indicates required question

1. I understand the purpose of this study *

   Mark only one oval.

   - ◯ Yes
   - ◯ No

2. I voluntarily agree to participate in this survey *

   Mark only one oval.

   - ◯ Yes
   - ◯ No

Assessing Perception And Adoption Of Robotics Among healthcare Professionals In Kerala : A Quantitative Study On Public Acceptance Of Robotics Within Healthcare Sector

3. Are you between the ages of 24 and 64? (if your answer to the above question is "yes" please proceed with the survey) *

   Mark only one oval.

   - ◯ Yes
   - ◯ No

4. Have you been residing in Kerala, India for at least the past 1 year? (if your answer to the above question is "yes" please proceed with the survey) *

   Mark only one oval.

   - ◯ Yes
   - ◯ No

Assessing Perception And Adoption Of Robotics Among healthcare Professionals In Kerala : A Quantitative Study On Acceptance Of Robotics Within Healthcare Sector.

5. 1. Age *

Mark only one oval.

- ◯ Below 24
- ◯ 24-34
- ◯ 35-44
- ◯ 45-54
- ◯ 55-64
- ◯ 65 and above

6. 2. Occupation *

Mark only one oval.

- ◯ Doctor
- ◯ Nurse
- ◯ Pharmacist
- ◯ Other: _____

7. 3. How many years have you been working in healthcare? *

Mark only one oval.

- ◯ Less than 1 year
- ◯ 1-3 years
- ◯ 4-6 years
- ◯ 7-10 years
- ◯ More than 10 years

8. 4. What is your level of a
healthcare?

Mark only one oval.

- Very aware
- Somewhat aware
- Neutral
- Unaware
- Completely unawar

9. 5. How frequently do yo

Mark only one oval.

11. 7. How has robotics a

Mark only one oval.

- Greatly improved
- Somewhat impro
- Neutral
- Somewhat decrea
- Greatly decreased

12. 8. How comfortable a healthcare practice?

Mark only one oval.

- Very comfortable

14. 10. How concerned are

Mark only one oval.

- Very concerned
- Somewhat concern
- Neutral
- Somewhat unconce
- Not concerned at a

15. 11. Do you think that rol

Mark only one oval.

- Strongly agree

17. 13. How much do you
quality of patient care

Mark only one oval.

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

18. 14. How much do you
efficiency of healthcar

Mark only one oval.

20. 16. What are the main
facility? (Select all that

Check all that apply.

- [ ] High cost
- [ ] Technical issues
- [ ] Lack of trained perso
- [ ] Patient resistance
- [ ] Other: _____

21. 17. How do you think r

Mark only one oval.

- ◯ Enhance the accur

23. 19. What is a significan
professionals in using r

Mark only one oval.

- Lack of comprehen
- Resistance to learn
- Insufficient time fo
- High cost of trainin

24. 20. Do you think the be

Mark only one oval.

- Strongly agree

26. 22. How much do you a
change the future of he

Mark only one oval.

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

27. 23. Overall, how would
facility?

Mark only one oval.

APPENDIX B : ETHICS FORM

Innopharma education

GRIFFITH COLLEGE

Ethics Application & Declaration Form

DISSERTATION TITLE: Assessing Perception And Adoption Of Robotics Among healthcare Professionals In Kerala : A Quantitative Study On Acceptance Of Robotics Within Healthcare Sector.

RESEARCHER'S NAME: Christeena Mathew

PROGRAMME OF STUDY: Msc Digital Transformation

SUPERVISOR'S NAME: Rebecca Power

DECLARATION:
The information in this application form is accurate to the best of my knowledge. I undertake to abide by the principles outlined by Innopharma/Griffith College ethics policy in my research dissertation. I confirm that I have completed a full ethics assessment for my research dissertation as per the college guidelines. I will not begin my primary research until such approval from my supervisor and/or ethics Committee has been obtained.
I pledge to carry out my research according to the Innopharma/Griffith College academic integrity standards. Any results presented in my dissertation will be from my own, original research, I will reference and/or acknowledge any material or sources used in its preparation and I will not plagiarise the work of anyone else.

For Student:

STUDENT SIGNATURE: 

DATE: 24/06/2024

The research contained within this research dissertation proposal has been approved.

For Supervisor:
Ethics Committee Approval Required: Yes [X] No [ ]

SUPERVISOR SIGNATURE: DocuSigned by: Rebecca Power 53833FCEA05F40C...

DATE: 7/19/2024

For Ethics Committee (if required):
Ethics Committee Approval Given: Yes [ ] No [ ]

ETHICS COMMITTEE MEMBER SIGNATURE: N/A

DATE: RP 19 Jul 2024

NOTE: Supervisors are responsible for ensuring their students fill in this form correctly and that all ethical areas have been considered.

SECTION 1: DESCRIPTION OF RESEARCH STUDY

1.1 Purpose and objectives of research

Robotics integration in healthcare is a revolutionary development that assures to improve patient care, increase operational effectiveness, and lower the risk of human error. Notwithstanding these benefits, public and healthcare professional attitudes and acceptance of robotic technologies are critical to their successful implementation in healthcare settings. The purpose of this study, "Assessing Perception and Adoption of Robotics Among Healthcare Professionals in Kerala" is to determine healthcare professionals knowledge, confidence and comfort levels in utilizing robotics within healthcare settings. As a healthcare professional, it is important to understand these things. This can help find areas that need extra training and support making sure these technologies are used successfully and safely. It also aids in rectifying misunderstandings and educate people by offering valuable perspectives to optimize the use of robotics. Studying the socioeconomic factors can show the difference that may affect how the public sees and accept things. This research is important to me as a healthcare professional because it will give useful insights to help us use robots better in healthcare. By paying attention to and addressing the concerns and perceptions of healthcare professionals, we can make sure that new technologies are used well in kerala's healthcare system. This will help improve how patients are treated and how well the system works.

Objectives :

- Evaluate healthcare professionals knowledge and comfort levels in utilizing robotics within healthcare settings.
- To investigate the benefits and limitations of integrating robotics in healthcare facilities and identify factors shaping attitudes of healthcare professionals towards robotics in healthcare, including safety concerns and perceived benefits.
- To examine socioeconomic factors impacting healthcare professionals perceptions of robotics in healthcare setting.

1.2 Research methodology.

The primary way in which the study "Assessing Perception and Adoption of Robotics Among Healthcare Professionals in Kerala: A Quantitative Study on Acceptance Of Robotics Within Healthcare Sector" will be done by using surveys to collect data from healthcare professionals in Kerala. This choice is decided to obtain quantifiable data that can be assessed and analyzed to gain a clear understanding of people's thought processes and the level of adoption of robotics. The surveys will be made to see what healthcare workers know and think about using robots in healthcare. It is important to understand their opinions, potential concerns and the potential benefits that they see. The questionnaire will include closed ended questions for quantitative data.

Data will be obtained through sending the surveys through emails, professional networks. To encompass a broad spectrum of healthcare workers and facilities, we will utilize the method of stratified random sampling in our study. This include doctors, nurses and pharmacist in public and private hospitals. This research plan ensures that we comprehend the perspectives and utilization of robots by healthcare workers in Kerala. It encompasses a diverse range of healthcare professionals to gather a comprehensive understanding of their perspectives. The research aims to utilize numerical data to provide precise and valuable insights for healthcare decision making.

SECTION 2: POSSIBLE ETHICAL ISSUES

Answer 'yes' or 'no' to the following questions.

SUBJECT MATTER

Does the research proposal involve:

Research into specific company activities that would be deemed sensitive or confidential	No
Research into politically and/or racially/ethnically and/or commercially sensitive areas	No
Sensitive, personal, professional or corporate issues	No

RESEARCH PROCEDURES

Does the research proposal involve:

Research that might damage the reputation of companies or participants	No
Research that may negatively affect the reputation of Griffith College/Innopharma	No
Use of personal records without consent	No
Use of company data without consent	No
The offer of any inducements to participate	No
Audio or visual recording without consent	No
Using a language other than English	No

PARTICIPANTS

Does the research proposal involve:

People who are not competent and/or fluent in English	No
Does your research group include any of the following vulnerable groups	No

SECTION 3: STEPS TAKEN TO AVOID ETHICAL ISSUES

3.1. If your ethics relates to ***Subject Matter***, outline your action plan to work around any sensitive issues.

My research investigates the socioeconomic factors that influence public perceptions of robotics in healthcare settings. To achieve this, I am collecting data on participants age and profession. This information helps to understand how different demographic groups view the integration of robotics in healthcare. Hence strong protection for data will be put in place , like making sure the data is kept safe and only allowing certain people to see it, so that the privacy of participant is protected.

SECTION 4: ABOUT YOUR PARTICIPANTS

4.1. Outline your participant profile and why you have chosen them for this study

I have choosen participants who fulfills the following inclusion criteria:

- Doctors, nurses, and pharmacists,and healthcare professional working in hospitals, clinics, and healthcare facilities in Kerala.
- Individuals with at least one year of experience in the healthcare sector.
- Healthcare professionals who have had some level of knowledge or exposure to robotic technologies in their practice or through training.
- Participants must be currently employed and residing in Kerala.
- Participants aged 18 and above and below 64 to ensure they have sufficient professional experience.
- Individuals who can understand, read and respond to survey questions in English.

Robotics integration in healthcare is a revolutionary development that assures to improve patient care, increase operational effectiveness, and lower the risk of human error. As a healthcare professional, it is

important to understand these things. This can help find areas that need extra training and support making sure these technologies are used successfully and safely. It also aids in rectifying misunderstandings and educate people by offering valuable perspectives to optimize the use of robotics. Studying the socioeconomic factors can show the difference that may affect how the public sees and accept things. This research is important to me as a healthcare professional because it will give useful insights to help us use robots better in healthcare. By paying attention to and addressing the concerns and perceptions of healthcare professionals, we can make sure that new technologies are used well in kerala's healthcare system. This will help improve how patients are treated and how well the system works.

4.2 How do you plan to gain access to/contact/approach your participant(s).

Data will be obtained through sending the surveys through emails, professional networks. To encompass a broad spectrum of healthcare workers and facilities, we will utilize the method of stratified random sampling in our study. This include doctors, nurses and pharmacist in public and private hospitals. This research plan ensures that we comprehend the perspectives and utilization of robots by healthcare workers in Kerala. It encompasses a diverse range of healthcare professionals to gather a comprehensive understanding of their perspectives. The research aims to utilize numerical data to provide precise and valuable insights for healthcare decision making.

SECTION 5: INFORMATION, CONSENT AND CONFIDENTIALITY

5.1 **Participant Information Letter (PIL) for participants**

Please confirm below that your information letter covers:	
Description of the research topic and method	Yes
Details of what participation will involve	Yes
Rights to anonymity	Yes
Confidentiality	Yes
Rights to withdraw from the research	Yes
The contact details of the researcher and supervisor (if necessary)	Yes

5.2 **Informed Consent Form (ICF) for participants**

Please indicate below if your research requires a signed consent form by selecting the relevant option only:

No: my research study involves an online survey only and/or does not require signed consent

SECTION 6: STORAGE OF DATA

6.1. How will you store the research data and for how long? How will you manage data protection issues?

Research data will be stored securely in a password protected laptop. Data will be retained for a period compliant with institutional policies and regulatory requirements, typically for 2 years after publication or completion of the study.

SECTION 7: NON-DISCLOSURE AGREEMENT & STUDENT CONSENT

7.1 **Non-Disclosure Agreement (NDA)**
Will the final dissertation contain any information pertaining to any source what would warrant the use of a Non-Disclosure Agreement (NDA) e.g. industry-based research?

No

7.2 **Student consent**
If a Non-Disclosure Agreement (NDA) is not required, does the Student consent to allow their completed dissertation to be held/published by Innopharma/Griffith College?

Yes

SECTION 8: RECORDING AND RETENTION OF DISSERTATION VIVA

8.1 **Viva Recording**
The Dissertation viva will be recorded. This recording may be used to facilitate assessment by Innopharma staff, a third reader if necessary and/or if requested by the external examiner for the Programme. The recording will be held in line with current GDPR guidelines and will not be made publicly available.

SECTION 9: DOCUMENT CHECKLIST

NOTE: Applicants must attach the following documents in electronic format to the appendix.

Which documents are added to the appendix? Please tick N/A if not applicable:

9.1 Participant Information Letter (PIL) for participant	Yes
9.2 Informed Consent Form (ICF) for participant	N/A
9.3 Questions/survey for interviewees/focus groups etc	Yes
9.4 Any other documents e.g. Non-Disclosure Agreement	N/A

I confirm that this application is complete and all required documents are included in the appendix.

For Student:

STUDENT SIGNATURE: 

DATE: 24/06/2024

SECTION 10: APPENDIX

APPENDIX 1
Participant Information Leaflet

Research Topic: Assessing Perception and Adoption of Robotics Among Healthcare Professionals in Kerala: A Quantitative Study on Public Acceptance Within Healthcare Sector

Dear Participant,

My name is Christeena Mathew, I am pursuing an MSc in Digital Transformation at Griffith College, Dublin, Ireland. This survey is a crucial part of my dissertation, aimed at evaluating the knowledge, attitudes, and practices related to the adoption of robotics among healthcare professionals in Kerala.

Robotics in healthcare encompasses advanced technologies designed to enhance surgical precision, automate repetitive tasks, and improve overall operational efficiency. However, the successful integration of these technologies depends on the acceptance and readiness of healthcare professionals. Therefore, it is vital to assess their perceptions and willingness to adopt robotic systems to identify potential barriers and facilitators.

As a healthcare professional, you are invited to participate in this survey. The survey comprises of different sections. The first section gathers participant demographics. Sections two to five evaluate your knowledge, attitudes, practices regarding robotics in healthcare and aims to identify gaps and gather your opinions on improving the adoption and integration of robotics within the healthcare sector. Completing the survey will take approximately 10-15 minutes.

Please note that participation in this survey is voluntary, and you can withdraw at ary time. All information and opinions provided will be treated confidentially and used solely for research purposes.

Thank you in advance for your valuable participation.

For more information please contact : christeena.mathew@student.griffith.ie

I understand the purpose of this study*

I voluntarily agree to participate in this survey*