RESEARCH DISSERTATION

THE KNOWLEDGE, ATTITUDE AND PRACTICE OF PHARMACISTS TOWARDS THE USE AND DEVELOPMENT OF ROBOTIC PHARMACIES IN HOSPITAL PHARMACY SETTINGS IN INDIA.

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CANDIDATE DECLARATION

I hereby declare that this dissertation, titled "The Knowledge, Attitude And Practice Of Pharmacists Towards the Use And Development Of Robotics Pharmacies In Hospital Pharmacies Settings In India" submitted in partial fulfillment of the MSc in Digital Transformation, is a result of my independent research. I properly cited and acknowledged all sources and materials used in this study.

I confirm that I did not copy or plagiarize any part of this work from any other source, including the work of other students.

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EHR	Electronic Health Record
PIS	Pharmacy Information System
ADC	Automated Dispensing Cabinets
AI	Artificial Intelligence
CAGR	Compound Annual Growth Rate

ABSTRACT

This study explores the knowledge, attitudes, and behaviours of Indian pharmacists on the adoption and usage of robotic pharmacies in hospital settings. It aims to determine the advantages, disadvantages, and accuracy of robotic pharmacy systems in terms of medication administration and patient safety. Using a pragmatic research mindset and a deductive technique, the study gathered qualitative and quantitative data from 85 pharmacists via an online survey. The findings show that, while there is considerable interest and positive feedback regarding robotic pharmacies, significant limitations such as financial restrictions, regulatory compliance, and labor adaptability prevent widespread implementation. The research's results show that there is a positive correlation between the perceived benefits of robotic pharmacy and their current and future use in hospitals. Pharmacists understand whether these technologies may reduce drug errors, increase operational efficiency, and improve patient safety. However, concerns regarding job displacement, machine dependability, and managing complex medication remain. The study emphasizes the importance of extensive training programs, cost-benefit analyses, and staff transition management measures in order to optimize the benefits of robotic pharmacies. The study's hypotheses testing indicated beneficial connections between knowledge, attitudes, and the use of robotic systems, emphasizing the relevance of education and training in fostering acceptance and successful implementation. Despite the limitations, the promise for robotic pharmacies to transform healthcare delivery by enhancing medication management is clear. Future advances in artificial intelligence and machine learning are projected to improve these systems capabilities.To summarize, while robotic pharmacies provide considerable benefits, overcoming the previously mentioned challenges through strategic planning, regulatory compliance, and education is critical for their successful integration into Indian hospital pharmacies. The study offers useful information for stakeholders and policymakers seeking to develop best practices and promote the effective implementation of robotic pharmacies, eventually increasing patient care and operational efficiency.

Keywords: Robotic pharmacies, Medication management, Patient safety, Hospital pharmacies, India, Pharmacist attitudes, Technological adoption, Healthcare automation, Training programs, Regulatory compliance.

1.INTRODUCTION

1.1 Purpose, justification and significance of the study

The primary purpose of this study is to explore the knowledge, attitudes, and practices of pharmacists in India towards the development and implementation of robotic pharmacies in hospital settings. The advent of technology has brought about significant changes in various sectors, including healthcare (Garcia-Zubia *et al.*, 2010). One such technological advancement is the introduction of robotic pharmacies, which promise to revolutionize the way pharmacies operate by increasing efficiency, reducing errors and improving patient safety. However, the successful implementation of these systems requires a thorough understanding of their functionalities, benefits and potential challenges, which is what this study aims to achieve (Stasevych and Zvarych, 2023).

In the context of Indian hospital pharmacies, the use of advanced technologies like robotic pharmacies is still in its developing stages. Despite the advantages they offer, these systems have been slow to be embraced, mainly because people lack understanding about how they work and their benefits (Fitzpatrick, 2004). There is also resistance to change and worries about the cost and whether they will bring enough returns (Beard, 2017). This study intends to get insights into pharmacists opinions and experiences with robotic pharmacies, as they are at the forefront of drug administration and patient care. These insights could inform strategies for effective adoption of robotic pharmacies (Jayakrishnan and Kiron, 2021). The study additionally investigates at the advantages of using robotics in hospital pharmacies in India, how knowledgeable pharmacists are about robotic pharmacies, which challenges need to be overcome before they are adopted, and how accurate hospital pharmacies using advanced automation are at managing prescriptions. These goals will direct the process of gathering and analyzing data and are in accordance with the research questions .

The study will engage with pharmacists working across a diverse array of hospitals throughout India and collect data using a questionnaire. It is anticipated that the findings of this study will guide policy decisions, inform training programmes,, and contribute to the development of best practices for the integration of robotic pharmacies in hospital settings in india and beyond (Rendrayani *et al.*, 2022).

The significance of this study lies in its potential to contribute to the body of existing knowledge on the use , development and implementation of robotic pharmacies in hospital settings in India. The landscape of pharmacy practice in Indian hospitals relies heavily on manual processes with limited automation, notably lacking widespread integration of robotic pharmacy systems. This gap highlights opportunities and challenges. Pharmacists often lack knowledge of robotic system's functionalities and benefits. Standardized guidelines are absent, hindering effective integration. Attitudinal barriers and a lack of tailored research further impede adoption, therefore this project aims to provide insights into current practices, identifies areas for improvement, and offers evidence-based strategies for enhanced integration, ultimately improving medication management and patient safety.

1.2 Research questions and objectives

To better understand the current use and future development of robotic pharmacies this project will focus on the following objectives:

1. To examine the level of knowledge among pharmacists regarding robotic pharmacies.
2. To examine the attitude towards the use and possible development of robotics in hospitals.
3. To identify the benefits of using robotics in hospital pharmacies.
4. To identify the challenges for the adoption of robotic pharmacies.
5. To investigate the level of accuracy in medication management in hospital pharmacies using advanced automation.

The study is guided by four main research questions:

1. To what extent do pharmacists in Indian hospital settings possess the necessary knowledge about robotic pharmacy systems, including their functionalities, benefits, and potential challenges?
2. What are the attitudes and perceptions of pharmacists in India towards the implementation of robotic pharmacies in hospital settings, and how do these attitudes influence their acceptance and readiness for such technological advancements?

3. What are the current practices and experiences of pharmacists in Indian hospitals in utilizing or integrating robotic pharmacy systems, and what are the perceived challenges and barriers in the practical implementation of these technologies?

4. What are the perceived challenges and barriers in the practical implementation of these technologies?

5. What are the opportunities going forward for the use and development of robotic pharmacies?

1.3 Structure of the dissertation

The rest of the dissertation is structured as Chapter 2 thoroughly examines relevant literature, consolidating existing research findings and pinpointing knowledge gaps. Moreover, it constructs a conceptual framework, incorporating suitable theories. This framework serves as a compass, directing the research exploration and framing subsequent analyses. The Chapter 3 will include the research methodology of the study where this section serves the dual purpose of providing justification for and interpreting the chosen methodological approach employed in the execution of research. Then, Chapter 4 presents the findings and analysis of the study which includes the collected data, the conducted analysis and the insights derived from it. Chapter 5 discusses the conclusion and recommendation, suggests areas for future research. This study will contribute to the body of knowledge on the development of robotic pharmacies in hospital settings and provide valuable insights for stakeholders involved in the implementation of such technologies.

2. LITERATURE REVIEW

2.1 Introduction

The introduction of robotic pharmacies in hospitals within hospital settings represents a significant advancement in medication management practices, offering potential solutions to challenges faced by traditional pharmacy systems. In India where healthcare framework continues to evolve among increase in patients demands and technological advancements, the development and adoption of robotic pharmacies hold particular significance (Kent, 2021). This secondary research aims to explore the perspectives, beliefs, and actions of pharmacists concerning the integration and operation of robotic pharmacies in hospital pharmacy settings throughout India.

2.2 Medication management in hospital pharmacies

Traditional medication management in Indian hospital pharmacies relies on manual processes and paper-based systems. Pharmacists and technicians manually dispense medications based on handwritten prescriptions, leading to time-consuming procedures and a higher risk of errors (Alahmari *et al.*, 2022). Patient information, medication orders, and inventory records are documented on paper, resulting in inefficiencies and vulnerability to record loss. Inventory management involves manual counting and tracking, leading to issues like stockouts and expired medications (Bragazzi *et al.*, 2020). The lack of advanced technology for verification and automation further compounds inefficiencies and risks (Dhayalan *et al.*, 2021). Comprehensive technology integration is essential for optimizing medication management and ensuring patient safety (Alahmari *et al.*, 2022).

In Indian hospital pharmacies, current medication management practices have evolved to incorporate advanced technologies and streamlined processes. Hospitals now use electronic health record systems (EHRs) for medication ordering and documentation, improving access to patient information (Hantool *et al.*, 2022). Pharmacy information systems (PIS) automate prescription processing, inventory control, and billing, enhancing accuracy and efficiency (Cortes *et al.*, 2019). Barcoding technology helps match medications with patient records, reducing errors. Automated dispensing systems handle storage and retrieval, ensuring safety (Mulac *et al.*, 2021). Medication reconciliation processes prevent errors during care transitions. Pharmacists play a crucial role in patient care, provide counselling and monitor drug therapy. These efforts prioritize patient safety and quality of care (Soffar, 2018).

Figure 1 : PHARMACY MANAGEMENT SYSTEM *(Genex, 2020): This diagram illustrates a pharmacy management system, focusing on efficiency, accuracy, and inventory control. The components include the Medicine Master, Sales & Purchase Invoice, Barcode Scanner, Stock Adjustment , Expiry Alerts , and Supplier Master. Each element plays a vital role in streamlining operations and ensuring seamless management of medicines, sales, inventory, and supplier relations.*

Although traditional medication management methods have the advantage of familiarity an low initial investment, their drawbacks include risks of errors, inefficiencies, and limited scalability (Dhayalan *et al.*, 2021). Current practices offer benefits like improved accuracy, efficiency, and patient safety, but they also pose challenges such as high costs, reliance on technology, and training requirements (Hammoud, 2022). The shift toward modern medication management demonstrates a commitment to enhancing patient care and safety through innovation and technology integration. Despite the commendable efforts of pharmacy professionals during the COVID-19 pandemic instances of malpractice and the distribution of spurious essential items underscore the need to uphold ethical standards aligned with global guideline (Li *et al.*, 2021). Reestablishing and reinforcing pharmacy practice standards remains imperative to safeguard patient safety and enhance overall healthcare outcomes (Hethel, 2022).Technical considerations such as ensuring system backups and incorporating workflow design into the implementation process are critical. Formal goals, objectives, and key success indicators should be defined to measure progress

and effectiveness (Krämer *et al.*, 2019). Anticipating and managing challenges during implementation is also necessary to mitigate disruptions and ensure smooth integration of the new system. By following these strategies, hospitals can effectively navigate pharmacy system changes while maximizing patient care and operational outcomes (Hogan-Murphy, 2022).

2.3. Robotic pharmacies

Robotic pharmacies have emerged as a disruptive invention in healthcare, with origins reaching back to the late 20th century. Early pioneers such as Swisslog Healthcare (previously TranspoNet) (Healthcare, 2023), Omnicell, and Parata Systems established the foundation for automated pharmacy systems, with an emphasis on improving medicine dispensing efficiency and minimizing mistakes in hospitals and healthcare institutions (Parata, 2024). While determining the precise first deployment is difficult, big hospital networks and retail pharmacy chains were among the early adopters, performing intensive research and clinical trials to assess the efficacy and safety of these technologies. Robotic pharmacy technology quickly gained popularity and became a vital part of modern healthcare infrastructure across the world. Today, these technologies serve an important role in optimizing pharmacy processes, reducing mistakes, and enhancing patient care. Innovation continues to drive the sector (ScriptPro, 2024).

Robotic pharmacies, which make use of robotics, automation, and artificial intelligence are an innovative approach to inventory management and drug delivery. These pharmacies use automated dispensing devices that can handle a variety of drugs and dose formats to accelerate the procedure (Barrett *et al.*, 2012). They monitor stock levels and expiry dates using real-time inventory management, which reduces waste and guarantees medicine supply (Kent, 2021). Prescriptions are entered by pharmacists into the system, which precisely obtains and delivers drugs, minimizing mistakes and improving patient safety. Certain robotic pharmacies are open continuously and provide easy access to prescription drugs. Proactive management and easy interaction are made possible by remote monitoring and integration with electronic health records. Robotic pharmacies are highly adaptable and expandable, serving a variety of healthcare environments and offering enhanced drug administration accuracy and efficiency while opening the door for future technology developments in the field (Rodriguez-Gonzalez *et al.*, 2019).

The adoption and implications of automated and robotic systems in pharmacies. It investigates technology during inpatient order preparation and assesses the overall influence. The use of Automated Dispensing Cabinets (ADC) in pharmacies, studies the role of transparency and individualized feedback in improving technician adherence to barcode verification of automation on pharmacy services. Although automation offers improved safety, cost efficiency, and speed, it requires significant workflow restructuring and standardization to maximize these advantage (Omnicell, 2024) Since 1992, Omnicell has been dedicated to refining supplies and medication management in hospitals with its robotic drug dispensing solutions streamlining tasks like pill dispensing and inventory management across US and UK pharmacies (Omnicell, 2023). Omnicell's methods, including Chaotic Storage and Channel-Fed Dispensing, cater to different needs. In Kochi, India, the Rowa Smart System at Aster Medcity Hospital and Mitra, the RoboDoc by Invento Robotics in Bengaluru, revolutionized medicine distribution and reduced infection risks during the pandemic, respectively(Rowa, 2024). Pune's Sakar Robotics furthers this innovation with healthcare robots marking a significant shift in medication management in India, prioritizing patient safety and pharmacy efficiency (J. Craig, 2013). Medimat, the latest offering from Omnicell is designed specifically for community pharmacies. This advanced dispensing robot automates tasks such as unpacking medication, tracking specific drugs and managing stock, thus liberating pharmacy teams from time consuming duties and minimising dispensing errors (Garcia-Zubia *et al.*, 2010).

Figure 2: MEDICINE AUTOMATED DISPENSING SYSTEM CRS 225*(ScriptPro, 2024b): Channel-fed dispensing systems store drugs in individual metal or plastic channels, with each channel*

dedicated to a specific drug type or medication. These systems boast significantly faster picking speeds, around 4 seconds, compared to chaotic storage. They excel in quickly dispensing single packs, offering advantages such as speed, precision, and reduced search time for pharmacists and patients. Moreover, channel-fed systems contribute to error reduction by ensuring accurate dispensing. However, considerations include proper organization of channels to avoid mix-ups and the need for regular maintenance to prevent channel blockages or malfunctions.

Figure 3 :ROBOMAT ROBOTIC DISPENSING SYSTEM*(Omnicell, 2024b): In chaotic storage systems, robots arrange medication packs on shelves in what appears to be a disorganized manner, aiming to optimize space efficiency by tessellating packs together and utilizing available shelf space effectively. These systems are particularly well-suited for hospitals with extensive formularies, as they allow for the efficient storage of thousands of drugs. One of the main advantages of chaotic storage is space optimization, minimizing wasted shelf space by fitting packs closely together. Additionally, chaotic storage systems offer versatility, accommodating a wide variety of drug sizes*

In regions like the UK and Denmark, pharmacy robots are revolutionizing community pharmacies by reducing the time spent manually locating prescriptions (mhealth, 2018). This automation allows technicians and pharmacists to dedicate more time to patient care

(Loria, 2023). These systems not only enhance operational efficiency but also contribute to error reduction and shorter patient waiting times (Kent, 2021).

2.4. The benefits of robotic pharmacies

Robotic pharmacy dispensing systems revolutionize medication management, benefiting pharmacies patients and healthcare professionals alike (Qureshi and Sajjad, 2017). These systems reduce pharmacist's burdens of manual prescription filling, allowing them to focus on patient care and clinical responsibilities (Sharma *et al.*, 2021). Through advanced technologies like barcodes and comprehensive reporting, they significantly reduce the risk of human error in medication dispensation while efficiently managing high prescription volumes (Küng *et al.*, 2021). Pharmacists assume an expanded role within healthcare teams providing clinical and preventive care services alongside dispensing duties, facilitated by sophisticated robotic systems. Enhanced collaboration among stakeholders improves patient outcomes and satisfaction levels. With stringent security measures and automated tasks such as inventory management robotic pharmacies optimize pharmacy operations, ensuring competitiveness and elevating patient safety (Motari *et al.*, 2021). The new techniques and artificial intelligence aims to imitate human intelligence function, so this technique is not only beneficial for increasing productivity but also removing hazardous and heavy work from workers (Jarab *et al.*, 2023). In essence, robotic pharmacies empower pharmacists, streamline operations and enhance overall efficiency, ultimately benefiting both healthcare providers and patients (ScriptPro, 2024).

Pharmacy robots play a crucial role in digitizing and enhancing work processes within pharmacies (Stasevych and Zvarych, 2023). They handle tasks such as processing electronic prescriptions, dispensing medications to customers, and managing returns of short-dated or expired medicines to wholesalers. By automating these processes, pharmacy robots not only save time but also contribute to cost savings (Willach Pharmacy, 2024)

Compared with traditional drug management methods, robotic pharmacies provide a number of benefits (Kunal Munjaji *et al.*, 2014). First, by reducing the possibility of dose errors and improving patient safety by precisely measuring and delivering prescriptions, they improve these systems second efficiency-boosting automation of jobs like inventory

control and dispensing (Takase *et al.*, 2022). Robotic pharmacies are also open all the time, which increases accessibility and convenience by ensuring that patients may obtain medication whenever they need it. Through real-time dosage monitoring, shortage prevention, and reduced pharmaceutical waste they help simplify inventory management. Because they require fewer staff members to manage operations, robotic pharmacies help reduce labor costs over time, even though the initial investment is large and also they provide uniformity (Kent, 2021). Furthermore, they ensure uniformity and consistency in medication dispensing protocols, which contributes to increased patient satisfaction. Finally, robotic pharmacies demonstrate adaptability and scalability adjusting to evolving healthcare facility requirements and expanding seamlessly without significant infrastructure alterations. Altogether, these benefits establish robotic pharmacies as a groundbreaking innovation in the domain of medication management and healthcare delivery.

2.5 The accuracy of robotic pharmacies

Robotic pharmacies are reshaping healthcare landscapes both in India and globally, with innovations extending various areas (Stasevych and Zvarych, 2023). In surgeries, robotic systems are increasingly prevalent, even in smaller public hospitals, with cost competitiveness rising due to domestic alternatives (Khatib and Ahmed, 2020).The integration of AI and machine learning into radiology and pathology continues to advance, facilitating quicker sorting of images and enhancing diagnostic accuracy (Pianykh *et al.*, 2020). Voice AI tools like Augnito, detecting voice biomarkers for diseases are gaining grip, freeing up healthcare professional's time for patient care (Augnito, 2023). Moreover, robotic solutions in pharmaceutical manufacturing and drug dispensing are revolutionizing efficiency and accuracy, crucial for patient safety among rising medication errors worldwide (Qureshi and Sajjad, 2017).

Robotic pharmacies are rapidly evolving, driven by advances in technology aimed at improving efficiency, accuracy, and patient safety. These changes are essential for maintaining safe and trustworthy pharmaceutical services in a variety of healthcare settings (Kent, 2021). First, robotic pharmacies are equipped with innovative automation technology that accelerate the prescription fulfilment procedure. Robots can conduct operations including dispensing pharmaceuticals, labelling, and packing with accuracy and consistency,

reducing the risk of mistakes associated with manual handling (Makarova *et al.*, 2019). Furthermore, advances in artificial intelligence (AI) and machine learning allow these robots to continually acquire knowledge and adapt, improving their abilities over time (Guide, 2023).

Robotic pharmacies create confidence by closely following to quality control standards and regulatory rules, guaranteeing that pharmaceuticals are handled and dispensed with accuracy. Advanced security mechanisms protect patient data and enforce confidentiality. Their accessibility and convenience aid underprivileged communities, since they operate around the clock to ensure quick medication access. In healthcare settings, they improve workflow efficiency, minimizing mistakes and freeing up pharmacists to focus on patient care. Overall, these improvements demonstrate their potential to transform pharmaceutical services, providing safe and efficient treatment while instilling confidence in both patients and healthcare practitioners.

Robots perform tasks consistently and precisely(Hong and Wu, 2023). Barcode scanning verifies orders and matches them with patient information, reducing dispensing errors (Küng *et al.*, 2021). Inventory management systems track stock levels and expiration dates in real-time. Integration with electronic health record systems enhances accuracy by reducing transcription error. Quality control mechanisms and error detection algorithms further ensure precise dispensing (Hantool *et al.*, 2022). Regular maintenance, calibration, and staff training are crucial for optimal performance and patient safety in robotic pharmacies (Takase *et al.*, 2022).

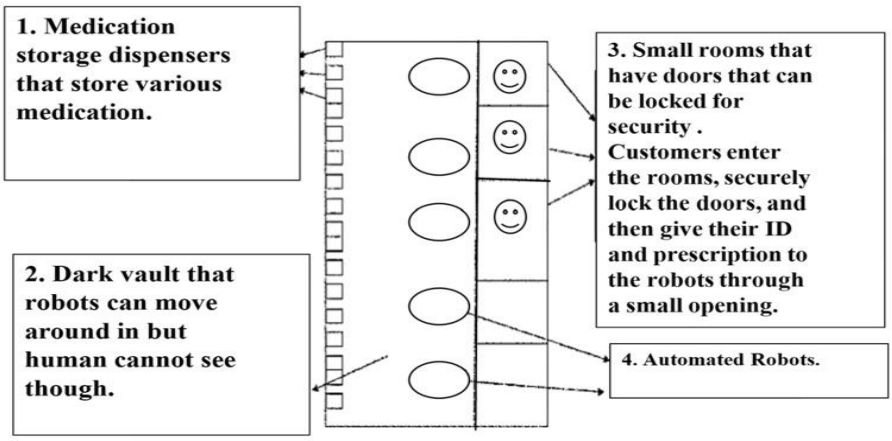

Figure 4 :ARCHITECTURE OF PHARMACY AREA *(Alahmari et al., 2022): The arrangement of the pharmacy area is shown, also known as its physical structure or implementation. Customers may enter and pick an open room, which is safely locked from the inside. There is also an area to keep pharmaceuticals and dispensers, with light and temperature controls to ensure medication purity. This design allows for numerous customers to be serviced at once.*

2.6 The challenges of robotic pharmacies

The introduction of robotic pharmacies presents a series of hurdles that necessitate attention. Firstly, there is a notable lack of financial incentives as investing in such systems demands substantial capital posing challenges for smaller pharmacies (Jarab *et al.*, 2023). Demonstrating long-term cost-effectiveness is imperative. Additionally, regulatory compliance remains a significant concern with strict adherence to safety and privacy standards essential (Khatib and Ahmed, 2020). When comparing pre-automation with post-automation the workload of the pharmacy was predominantly reduced. The errors associated with dispensing were also reduced in post-automation which emphasizes the advantage of robotics (James *et al.*, 2013).

Intellectual property issues add another layer of complexity requiring a careful balance between innovation and legal protections. Moreover, market competition intensifies as more pharmacies adopt robotic solutions, necessitating differentiation strategies (Motari *et al.*, 2021). Finally, variations in generic substitution policies across regions pose challenges for accurate dispensing. In essence, while robotic pharmacies offer considerable advantages, addressing these challenges is vital to ensure safe and efficient medication management (Soffar, 2018).

Robots are limited to performing whatever they have been designed to perform; they are emotionless machines. Even if they are automated, a variety of software problems might occur and cause malfunctions (Panchal, 2020). Furthermore, there is a chance that robots will occasionally make mistakes in their daily tasks. Patients may receive the wrong medicine if there is an equipment fault. Robots usually carry out fewer jobs than humans and are dependent on a continuous power source for functioning (mhealth, 2018). Their implementation frequently results in the replacement of human occupations, and their setup necessitates knowledge. Moreover, a variety of malfunctions might happen, leading to service delays and interruptions. Robotic malfunctions and interruptions are frequent occurrences, highlighting the difficulties in using them (Dolic *et al.*, 2019).

2.7 Current Knowledge and Attitude of pharmacist's

In India, the concept of robotic pharmacies is still in its infancy compared to other countries. However, there is growing interest and discussion around the potential benefits they could bring to the Indian healthcare system. Theories surrounding robotic pharmacies in India revolve around several key areas. Firstly, there is a focus on addressing medication errors, with the belief that automation can significantly reduce mistakes in dispensing medications, thus enhancing patient safety. Additionally, there is speculation about the potential for robotic pharmacies to improve efficiency by streamlining processes and allowing pharmacists to dedicate more time to patient care. Another theory suggests that these pharmacies could expand access to healthcare services, particularly in remote areas, by overcoming geographical barriers. Integration with telemedicine platforms is also theorized, offering the possibility of remote prescribing and medication dispensing. While initial costs may be a concern, there's a belief that over time, the benefits of automation could lead to cost savings for both healthcare providers and patients. However, the implementation of robotic pharmacies in India will require careful consideration of regulatory frameworks, workforce impact, and technological advancements. As the field continues to evolve, ongoing research and collaboration will shape the future of robotic pharmacies in India (Teja *et al.*, 2014).

Robotic pharmacies in India are particularly gaining in urban areas where there is a high demand for pharmaceutical services. These systems automate various tasks such as sorting,

counting, and packaging medications, thereby reducing human errors and freeing up pharmacists time to focus on patient care and counselling. Moreover, robotic pharmacies in India are also helping to address challenges such as medication shortages and counterfeit drugs by ensuring accurate dispensing and inventory management(Stasevych and Zvarych, 2023).

On a global scale, countries like the United States, Japan, and several European nations have been at the forefront of implementing robotic pharmacy technologies for several years. These systems range from fully automated robotic dispensaries to robotic medication dispensing cabinets within hospitals and healthcare facilities. The adoption of such technologies has been driven by the need to cope with increasing medication volumes, improve patient safety, and optimize workflow efficiency in pharmacies (Quest, 2024) .

Furthermore, advancements in robotics, artificial intelligence, and machine learning are continually enhancing the capabilities of robotic pharmacy systems worldwide. These advancements include features such as real-time inventory tracking, personalized medication packaging, and integration with electronic health records for seamless patient care coordination. Overall, the evolution of robotic pharmacies both in India and worldwide signifies a transformative shift in pharmacy practice towards greater automation, precision, and patient-centric care. While challenges such as initial investment costs and regulatory compliance remain, the potential benefits in terms of medication safety, efficiency, and accessibility are compelling drivers for continued innovation and adoption in the pharmaceutical industry (MRINetwork, 2024),.

Experience plays a crucial role in the efficiency and effectiveness of robotic pharmacy systems. Pharmacists who have spent years working with these systems become adept at seamlessly integrating them into their workflow, reducing manual effort and streamlining processes. They excel in identifying and correcting possible pharmaceutical distribution problems due to their thorough awareness of the system's specifications. Additionally, experienced pharmacists adapt well to system updates and changes, quickly learning new features and functionalities. Their accumulated experience enhances their ability to use the robotic system accurately and troubleshoot effectively. However, challenges arise for newer pharmacists who may initially struggle with system navigation and integration, potentially leading to workflow disruptions and errors that could compromise patient safety. Despite

these challenges, the accumulated experience of seasoned pharmacists positively impacts robotic pharmacy systems, contributing to improved efficiency, accuracy, and user familiarity over time (ElLithy *et al.*, 2023).

2.8 Future use of robotic pharmacies in hospitals in India and worldwide

With current technological advancements, robotic pharmacy systems are expected to become even more sophisticated and adaptable. These systems will likely integrate innovations like artificial intelligence, machine learning, and enhanced robotic automation. In the future, robotic pharmacies may offer advanced features such as personalized dosing, precise medication compounding, and customized packaging for individual patients (Khan *et al.*, 2023).

The India pharmacy automation market, valued at USD 110.55 million in 2023, is projected to reach USD 240.09 million by 2031, with a compound annual growth rate (CAGR) of 10.18% from 2024 to 2031. The steady growth is attributed to the expanding population and aging demographics, resulting in a surge in prescription volumes. With over 10% of India's population aged above 60 years and a total population exceeding 1.4 billion, the rise in geriatric individuals and prevalence of chronic illnesses are driving the demand for prescriptions. Automated pharmacies have the potential to alleviate the strain on the healthcare system, offering growth prospects for the pharmacy automation market in India (Markets& Data, 2023).

The increase of chronic disorders, particularly diabetes and hypertension, is driving market expansion. With India carrying a tremendous burden, pharmacy automation has the potential to reduce pharmacist effort, minimize mistakes, and increase efficiency. Collaboration among major players intends to enhance automated solutions, generating consistent market expansion from 2024 to 2030, fueled by factors such as population growth, aging demographics, increased illness prevalence, pharmacist awareness, technical advancements, and industry efforts (Markets& Data, 2023).

Beyond India, global trends indicate a peak in robotics adoption in pharmaceutical manufacturing, promising streamlined operations and improved drug availability (Fairchild, 2022). Ultimately, the future of robotic pharmacies lies in their capacity to elevate patient

care, streamline processes and enhance safety across healthcare systems worldwide (Krämer *et al.*, 2019). In healthcare, robotics and AI are transforming various dimensions. Robotic systems are optimizing drug production and packaging in pharmaceutical manufacturing, while AI facilitates drug discovery through comprehensive data analysis (Sharma *et al.*, 2021). Automated pharmacy robots are reducing errors in medication dispensing, while AI adapts drug dosages for improved patient outcomes. Robotic-assisted surgery enables precise procedures with AI supporting real-time decision-making (Tree, 2024). AI aids in detecting abnormalities from medical images and robots automate pathology analysis(Fitzpatrick, 2004). Telemedicine robots are enhancing healthcare access, while AI algorithms are advancing disease monitoring and treatment planning (Stasevych and Zvarych, 2023). Addressing challenges and ethical considerations, it is crucial to balance automation with human compassion and ensure data privacy and accountability in AI-driven decisions.

2.9 CONCEPTUAL FRAMEWORK

The conceptual framework for this study on the knowledge, attitude, and practice of pharmacists towards the use and development of robotic pharmacies in hospital pharmacy settings in India is primarily deductive (Streefkerk, 2019). The deductive approach of this study aims to validate pre-existing theories and hypotheses regarding pharmacist's perceptions and behaviours towards robotic pharmacies in Indian hospital settings. This framework suggests relationships between independent variables (years of experience, working sector and exposure to technology) and dependent variables, including knowledge, attitudes and experiences related to robotic pharmacies.

The researcher plans to gather both qualitative and quantitative data to get a thorough understanding and identify patterns in the pharmacist's knowledge and practices contributing to the existing knowledge available through academic and non-academic resources. Owing to this deductive framework, perceived benefit and ease of use serve as mediating variables in the association between technological exposure and pharmacist adoption of robotic pharmacies. Assumptions include the belief that pharmacist's knowledge, attitudes, and experience with robotic pharmacies are influenced by a variety of personal and organizational factors (Rendrayani *et al.*, 2022). Pharmacist's perceptions and

behaviours are believed to be shaped by their understanding of the technology, their attitude toward implementation, and organizational support. Contextual considerations include aspects of the Indian healthcare system, regulatory environment, infrastructure, and cultural attitudes toward technology adoption. Factors such as limited resources, training opportunities, and infrastructure limitations can affect a pharmacist's ability to effectively manage a robotic pharmacy (Stasevych and Zvarych, 2023).

3.RESEARCH METHODOLOGY

3.1 OVERVIEW

Research Philosophy	Pragmatism
Research approach	Deductive approach
Strategy	Mono-method strategy
Method	Questionnaire (survey) which is shared online
Questionnaire Framework	28 questions in the survey
Participant	Aiming 75-100 pharmacists

Table 1 Research methodology overview

3.2 RESEARCH PHILOSOPHY

This research investigates the adoption and usage of robotic pharmacies in Indian hospital settings through a combination of primary and secondary research. The secondary research involves a literature review from various sources such as college libraries-books, official sites, and Google Scholar, using keywords like pharmacy robots, medication dispensing, robotics, and pharmacy automation. This study adopts a pragmatic approach since it aims to address current problems and practical uses of robotic pharmacy systems in Indian hospital settings (Jansen, 2023). Pragmatism corresponds with the research's aims of assessing pharmacist’s knowledge, attitudes, and practices around robotic pharmacies, as well as identifying possible benefits and problems. By focusing on practical implications and consequences, this method aims to give actionable insights that can educate decision-making and enable the

proper integration of robotic technology into pharmacy practice, eventually enhancing drug administration and patient care outcomes.

3.3 RESEARCH APPROACH

The research approach for this study on the knowledge, attitude, and practice of pharmacists towards the use and development of robotic pharmacies in hospital pharmacy settings in India is primarily deductive, beginning with clearly defined objectives and research questions. These objectives include identifying the benefits, challenges, and level of accuracy associated with using robotic pharmacies in hospitals. In deductive research, a theory, hypothesis, or generalisation is the starting point, and it is subsequently tested by observation and data collection. Using a top-down approach, the researcher formulates a general hypothesis before testing it with detailed observations. Deductive research is frequently employed to verify a theory or investigate a well-established notion (Burney and Saleem, 2008). The study adopts a deductive approach as it builds upon existing knowledge and theories regarding the use of robotic pharmacies. By leveraging existing theories and insights, the study seeks to empirically validate and extend the current understanding of pharmacist's perceptions and behaviours towards robotic pharmacy systems. . Also, there are 9 hypotheses regarding the knowledge, attitude and practice of pharmacist working in the hospital pharmacy setting in India. These hypothesises will be tested through the process of data collection first followed by data analysis. The research questions are formulated to comprehensively address these objectives, focusing on assessing the knowledge level, attitudes, perceptions, and current practices of pharmacists regarding robotic pharmacy systems. Data collection is conducted through a survey targeting 75-100 pharmacists working in Indian hospital settings, ensuring relevance to the study context. I used Andrew Fisher's formula for sample size calculation to ensure sufficient statistical power and precision. This formula is advantageous for its flexibility in estimating sample sizes based on desired confidence levels and population proportions. The survey questionnaire covers various aspects related to the use and development of robotic pharmacies, including knowledge about functionalities, benefits, challenges, attitudes towards implementation, and current practices. Participants are recruited from Indian hospital settings using methods such as email invitations, LinkedIn outreach, and other social media platforms, with measures in place to ensure confidentiality, anonymity, and voluntary participation. Data analysis involves qualitative approach and the data analysed by

both qualitative and quantitative method are analysed using descriptive statistics, charts, and graphs. The qualitative data are analysed using identifying themes and patterns in participant's responses. Overall, this structured research approach provides a comprehensive framework for investigating pharmacist's perspectives on robotic pharmacies in Indian hospital pharmacy settings.

3.5 RESEARCH HYPOTHESIS

Hypothesis 1:

Ho: There is no positive relationship between the benefits of robotic pharmacies and their use in hospital pharmacies.

H1: There is a positive relationship between the benefits of robotic pharmacies and their use in hospital pharmacies

Hypothesis 2

Ho: There is no positive relationship between the knowledge and current use of robotics in hospital pharmacies.

H1: There is a positive relationship between the knowledge and current use of robotics in hospital pharmacies.

Hypothesis 3

Ho: There is no positive relationship between the knowledge and future implementation of robotics in hospital pharmacies.

H1: There is a positive relationship between the knowledge and future implementation of robotics in hospital pharmacies.

Hypothesis 4

Ho: There is no positive relationship between the attitude and current use of robotics in hospital pharmacies.

H1: There is a positive relationship between the attitude and current use of robotics in hospital pharmacies.

Hypothesis 5

Ho: There is no positive relationship between the attitude and future implementation of robotics in hospital pharmacies.

H1: There is a positive relationship between the attitude and future implementation of robotics in hospital pharmacies.

Hypothesis 6

Ho: There are no existing challenges for the adoption of robotic pharmacies in hospitals.

H1: There is an existing challenge for the adoption of robotic pharmacies in hospitals.

Hypothesis 7

Ho: There is no positive relationship between a high accuracy and the use of robotics in hospital pharmacies.

H1: There is a positive relationship between a high accuracy and the use of robotics in hospital pharmacies.

Hypothesis 8

Ho: There is a positive relationship between years of experience and knowledge about robotics in hospital pharmacy

H1: There is no positive relationship between years of experience and knowledge about robotics in hospital pharmacy.

Hypothesis 9

Ho: There is a positive relationship between attitude towards the training of robotic pharmacy systems.

H1: There is no positive relationship between attitude towards the training of robotic pharmacy systems.

3.6 RESEARCH STRATEGY

The research strategy for this mono-methods study involves the use of surveys with questionnaires to gather qualitative and quantitative data on the knowledge, attitudes, and practices of pharmacists regarding the use and development of robotic pharmacies in Indian hospital settings. The survey consists of both open-ended and closed-ended questions,

allowing for the collection of rich, detailed responses. The survey questions were designed to address each of the research objectives such as, identifying benefits, examining knowledge levels, exploring attitudes, identifying challenges, and investigating accuracy levels in medication management. Randomised sampling methods was employed to ensure representation from a diverse range of hospital pharmacies across India. The questionnaire begins with gathering information such as years of experience, working sector and exposure to technology from participants, followed by a combination of objective and hypothesis-driven questions. Data collection was conducted through online platforms depending on accessibility and convenience for participants.

The data analysis plan for the survey questionnaire incorporates a comprehensive approach to both open-ended and closed-ended items. Qualitative analysis approaches were used to group responses to the open-ended questions into themes and patterns. This analysis involves the following steps: extracting relevant information from open-ended answers, putting data into groups or themes according to patterns that appear repeatedly, Sorting and organizing the answers according to each theme that can be found. Summarizing the main concepts and conclusions for every theme. Analysing and combining the classified data to draw conclusions or indicate new information. Through a systematic study of the qualitative data, this theme method guarantees a deeper understanding of the viewpoints of the respondents.

Likert scales and categorical data are used in closed-ended questions, which were subjected to quantitative analysis techniques. The response distributions were summarized using descriptive statistics, such as means, frequencies, percentages, and standard deviations. Clear representations like graphs and charts were employed to convey these results. In order to provide a thorough and reliable interpretation of the survey results, the overall data analysis approach combines quantitative measurements from closed-ended questions with qualitative findings from open-ended questions.

The study employs a hypothesis-based approach, where in hypothesis are formulated and subsequently tested based on the responses obtained during the data collection phase. Statistical analyses such as correlation (spearman's correlation) was utilized to examine the relationships proposed in the hypothesis. There is software used to analyse the data by SPSS

software. Using correlational analysis to test hypotheses related to the relationships between independent and dependent variables. For example, examining the relationship between knowledge about robotic pharmacies (independent variable) and current use of robotics in hospital pharmacies (dependent variable) in the 2nd hypothesis. A retrospective cross-sectional design will be utilized to understand evolving pharmacy practices due to new technology, capturing pharmacist experiences and quantifying emerging trends. After analysis, the results from the qualitative stage was used to understand the comprehensive pharmacist's viewpoint on robotic pharmacies. Findings was disclosed truthfully and transparently, acknowledging data sources and limitations.

3.7 TYPE OF DATA AND DATA COLLECTION

The research collected both qualitative and quantitative data. The data was collected through open-ended questions and closed-ended questions using an online questionnaire in a survey format .

As part of the data analysis process, the survey questionnaires—both closed-ended and open-ended were collected and analysed. Open-ended responses were categorized into themes through the use of qualitative analysis methods. For instance, several issues including time savings, job displacement, patient safety, medication errors, obstacles, and attitudes are analysed from the questions. Quantitative data was collected through closed-ended questions, specifically capturing years of experience. For instance, the distribution of participant's years of experience was visualized through graphs, alongside the qualitative insights, using techniques such as pie charts, bar charts, and line plots. These answers have been gathered to provide support of the main objectives.

Closed-ended questions were collected qualitatively by using nominal and ordinal data. The survey will gather information such as years of experience, qualifications, and employment sector from the question number Q1 to Q5(E.g. Qualification level of pharmacist and years of experience). Responses were collected on prior experience with robotic pharmacy systems, perceptions of benefits and challenges, attitudes towards robotics, accuracy, efficiency, patient safety, implementation barriers, job displacement concerns, medication errors, and willingness to engage with robotic systems. The obtained nominal and ordinal data were analyzed using descriptive statistics. Descriptive statistics, such as percentage,

mean, and frequency distribution, summarized the data. For example, based on the survey responses, a graph was plotted to illustrate the distribution of participants agreement levels with the statement."Q26: Are you concerned about the potential job displacement caused by the introduction of robotic pharmacies? Y/N). Visual representation of data will be analysed by using pie chart, bar chart and line plot.

3.8 PARTICIPANTS

The study examines the attitudes, knowledge, and behaviors of pharmacists in hospital pharmacy settings across India. The respondents must have, 2-20 years of experience and a minimum Bachelor's degree in pharmacy or higher. Pharmacists from government, private, and corporate institutions are included, which allows a thorough examination of attitudes regarding robotic pharmacy in various healthcare settings. The study is exclusively conducted with pharmacists who work in both robotic pharmacies and traditional hospital pharmacies. The pharmacists working in robotic pharmacies possess firsthand knowledge of how these systems operate, while those in traditional hospital pharmacies may vary in their awareness, knowledge, and attitudes toward robotic pharmacy. Their critical involvement in integrating robotic pharmacy systems emphasizes the importance of their direct knowledge, which provides essential insights into the difficulties and potential in Indian healthcare facilities. This study seeks to improve knowledge by including multiple perspectives from various age groups and healthcare settings, ultimately contributing to the progress of robotic pharmacy use across the country.

4. FINDINGS AND ANALYSIS

4.1 RESPONSE RATE

The study evaluated pharmacists knowledge, attitudes, and practices about the usage and development of robotic pharmacies in hospital settings in India, with a sample size of 75-100 participants and 85 responding. The findings indicate a mixed environment while many pharmacists expressed awareness and even interest about robotic pharmacy systems, concerns about cost, technical integration, and potential job displacement were common. Current techniques varied, with some institutions already using robotic equipment and others depending entirely on manual methods. Financial constraints and technological challenges, combined with a lack of comprehensive training programs, were major barriers to adoption. Improvement recommendations include investing in training and education activities, undertaking cost-benefit evaluations, and addressing concerns about job displacement and system reliability. This study gave insight on the The challenges of integrating robotic pharmacies into Indian hospital settings highlight the necessity for specific efforts to maximize their potential benefits while limiting associated limitations.

4.2 DEMOGRAPHIC INFORMATIONS

4.2.1 EXPERIENCE OF PHARMACIST PROFESSIONALS IN YEARS

The survey found that the majority of respondents (53%) have 2-5 years of experience, indicating that mid-career pharmacists dominated the sample. This is followed by 25% with 5-10 years of experience, and 21% with 0-2 years. Only one percent have a minimum of 10 years of experience. This shows that opinions on robotic pharmacies are predominantly held by individuals who are almost new or mid-level in their employment, perhaps reflecting a more open attitude to technological developments in hospital pharmacy settings across India.

Years of experience	No of response	Percentage
0-2 years	18	21%
2-5 years	45	53%
5-10 years	21	25%
<10 years	1	1%
Grand Total	85	100%

Table 2 Represents the year of experience

4.2.2 QUALIFICATION OF PHARMACIST PROFESSIONALS

The data contains responses from 85 Indian pharmacists about the use and development of robotic pharmacy in hospitals. The majority of respondents (50) have a bachelor's degree in pharmacy, 20 have a master's, and 15 have a doctorate. This diversified educational background shows that the survey generates a wide range of perspectives. A majority of bachelor's degree holders might focus on practical issues, while those with higher degrees may provide more academic and strategic insights. This variety of expertise contributes to a thorough knowledge of pharmacists views and behaviors regarding robotic pharmacies.

Qualification levels	No. of response
Bachelor's in pharmacy	50
Doctorate in pharmacy	15
Master's in pharmacy	20
Grand Total	**85**

Table 3 Represents the qualification level of pharmacist

4.2.3 WORKING SECTOR OF PHARMACIST PROFESSIONALS

The data indicates that out of 85 pharmacists surveyed about their knowledge, attitude, and practice towards robotic pharmacies in Indian hospital settings, 75 work in the private sector and 10 in the public sector. This suggests a strong predominance of private sector respondents, making up approximately 89% of the total, compared to 11% from the public sector. The overwhelming representation from the private sector could influence the findings, potentially highlighting perspectives and experiences that are more prevalent in private healthcare settings. This distribution is crucial for understanding the sector-specific attitudes and readiness towards adopting robotic technologies in hospital pharmacies.

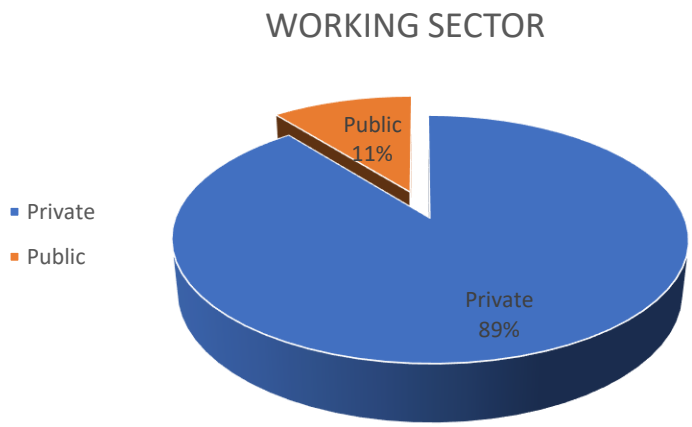

Figure 5 Represents the Pie chart of working sector: This pie chart illustrates the distribution of pharmacists surveyed based on their working sector. The majority (89%) are employed in the private sector, while a smaller proportion (11%) work in the public sector. This distribution highlights the predominance of private sector pharmacists among the survey respondents.

4.2.3 LANGUAGE FLUENCY IN PHARMACIST PROFESSIONALS

The study found that nearly all respondents (84 out of 85) are fluent in English. This high level of English proficiency had a positive impact on the survey and data collection. It makes sure that pharmacists, who most likely answered the survey questions in English, could access, understand, and reply to them efficiently. This proficiency also enabled participants to understand and provide informed opinions on complex topics such as scientific literature, technological documentation, and training materials related to robotic pharmacies. As a result, the data collected was more reliable and reflective of the pharmacists true knowledge and attitudes towards robotic pharmacy systems.

Fluency in English	No. of Responses
No	1
Yes	84
Grand Total	**85**

Table 4 The table represents the language fluency of pharmacists

4.3 ROBOTIC PHARMACY RELATED ANALYSIS

4.3.1. PHARMACIST WORKING IN HOSPITAL PHARMACIES

The data reveals that out of 85 respondents, 77 are pharmacists working in hospital pharmacies, while the remaining 8 are working in community pharmacies or industries. This suggests a strong representation of pharmacists within hospital pharmacy settings among the surveyed population. The title suggests a study on pharmacists views regarding the use and development of robotic pharmacies in Indian hospital settings. With the majority of respondents being hospital pharmacists, their insights are likely to provide valuable perspectives on the subject matter.

Pharmacist working in hospital pharmacy	No.of Responses
No	8
Yes	77
Grand Total	**85**

Table 5 The table represents the no.of pharmacist working in hospital

4.3.2 PHARMACIST WORKING IN ROBOTIC PHARMACIES

The Pie chart and the table provide insights into the use of robotics in Indian pharmacy by showing the number of respondents working in robotic pharmacies. Out of 85 pharmacists surveyed, 38 confirmed using robotics in the workplace, while 47 did not. The respondents come from both public and private sectors. For the 47 who are not using robotics, it is possible that they work in environments where robotic systems are available but not utilized due to various reasons such as lack of training, technical issues, or resistance to change. This demonstrates a balanced scenario in which a significant portion of pharmacists have integrated robotic technologies, while a notable number have yet to do so. The study emphasizes the importance of further investigation to understand the elements influencing pharmacists decisions about adopting robotic pharmacy systems in India.

Pharmacist working in a robotic pharmacy	No.of responses
No	47
Yes	38
Grand Total	**85**

Table 6 : Represents the no.of pharmacist working in robotics

4.3.3 TRAINING STATUS IN ROBOTICS USAGE AMONG PHARMACISTS

From the total of 85 pharmacist 38 are working in robotic hospital pharmacies. In that 38 pharmacists, all of them (100%) surveyed responded "Yes," indicating that they have received enough training to use robotics.

Yes, have you been trained to use robotics in your workplace or other?	No. of Responses
Yes	38
Grand Total	**38**

Table 7: Represents the training status of pharmacist

4.3.4 TRAINING IS NECESSARY FOR WORKING WITH ROBOTIC PHARMACIES

Is training Necessary	No of response
No	10
Yes	75
Grand Total	**85**

Table 8: The pharmacist opinions on the necessity of training for working with robotic pharmacies

According to the findings the bar chart represents " the vast majority of the participants (75 out of 85) believe that training is required for working with robotic pharmacies. This indicates that pharmacists widely recognize the significance of sufficient training in order to perform effectively within this technological environment. However, a minority of 10 respondents did not believe that training was necessary. However, the wide agreement among the majority indicates a widespread appreciation among the pharmacy profession of the critical role that training plays in optimizing the use of robotic pharmacy systems in hospitals.

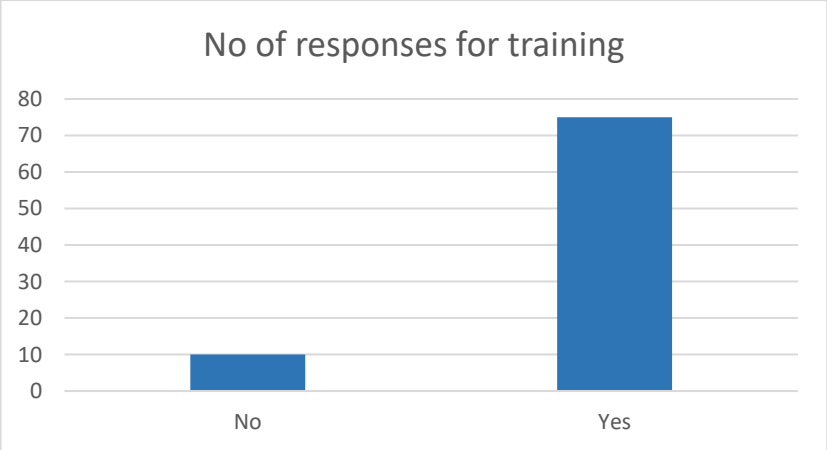

Figure 6 Pharmacist response for the necessity of working with robotic pharmacies: This bar chart displays the number of responses from pharmacists regarding the necessity of training for working with robotic pharmacies. The majority's view underscores the recognized importance of adequate training in effectively utilizing robotic pharmacy systems.

4.2.5 ROBOTIC PHARMACIES ARE BENEFICIAL?

According to this research study, the majority of pharmacists surveyed believe that robotic pharmacies are beneficial with as score 76 out of 85. While only 9 out of 85 do not. Overall, the study shows positive attitudes towards robotic pharmacies among Indian pharmacists.

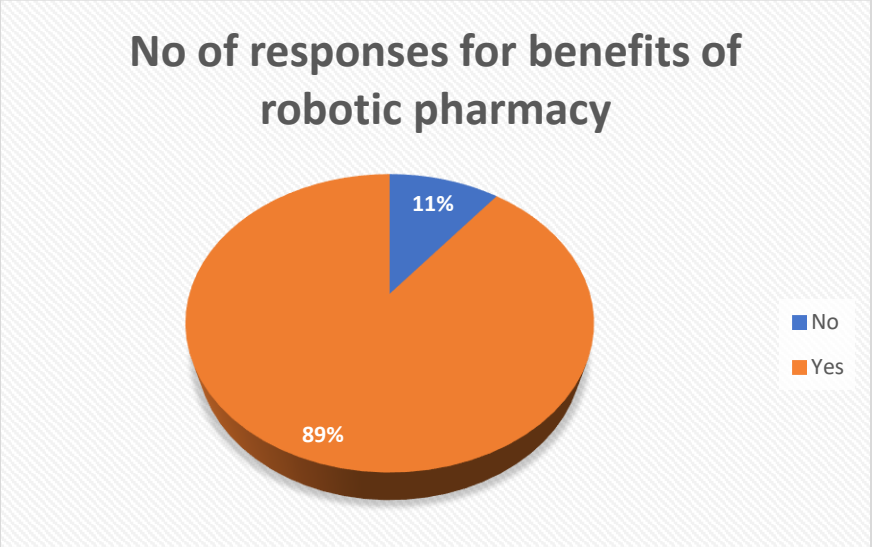

Figure 7 : The pharmacist responses on the perceived benefits of robotic pharmacies : This indicates a strong consensus among pharmacists about the positive impact of robotic pharmacies.

4.3.5 THE BENEFITS OF ROBOTIC PHARMACIES POSITIVELY IMPACT THEIR USE IN HOSPITAL PHARMACIES.

According to the surveys, the majority of pharmacists believe that the benefits of robotic pharmacies improve their use in hospital settings. Among the 85 responders, 61 agreed and 7 strongly agreed with this statement. Meanwhile, 8 remain indifferent, 5 disagreed, and 4 strongly disagreed. Overall, findings show that pharmacists have a strong positive opinion of the impact of robotic pharmacies in hospitals.

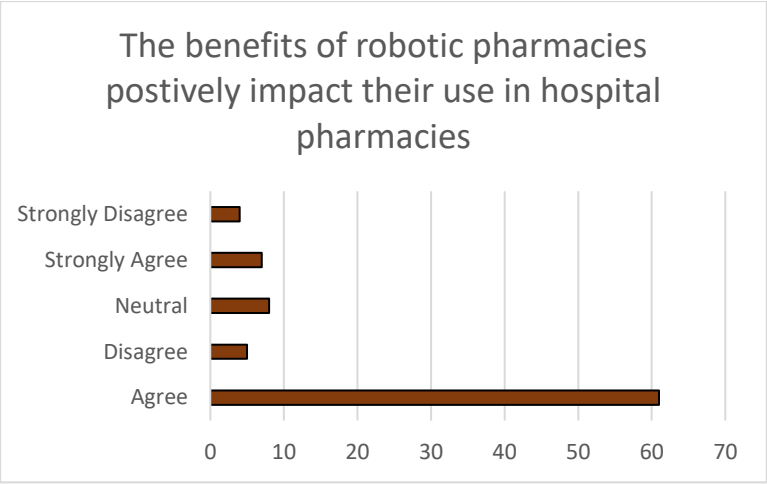

Figure 8 The bar chart showing the benefits of robotic pharmacies : This bar chart shows the levels of agreement among pharmacists regarding the statement that the benefits of robotic pharmacies positively impact their use in hospital pharmacies.

4.3.6 ENOUGH INFORMATION SHARING ABOUT ROBOTIC PHARMACIES AMONG PHARMACISTS.

According to the survey, the majority of pharmacists believe that sufficient information is shared about the use of robotic pharmacies. Of the 85 respondents, 66 answered yes, while 19 answered no. This suggests that most pharmacists feel well-informed about robotic pharmacies.

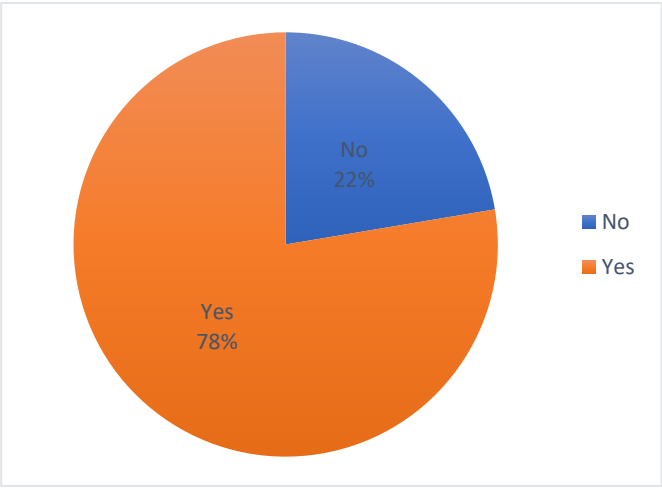

Figure 9 Pharmacists Perception of Sufficient Information Sharing About Robotic Pharmacies : This pie chart illustrates the percentage of pharmacists who believe there is sufficient information sharing about robotic pharmacies

4.3.7 KNOWLEDGE ABOUT ROBOTICS INFLUENCES ITS CURRENT USE

According to the questionnaire, the majority of pharmacists believe that understanding robotics influences its use in hospital pharmacies. Out of 85 respondents, 17 said it significantly influences, 61 said it somewhat influences, and just 7 said it has no influence. This suggests that most pharmacists believe understanding of robots influences its current use in hospitals.

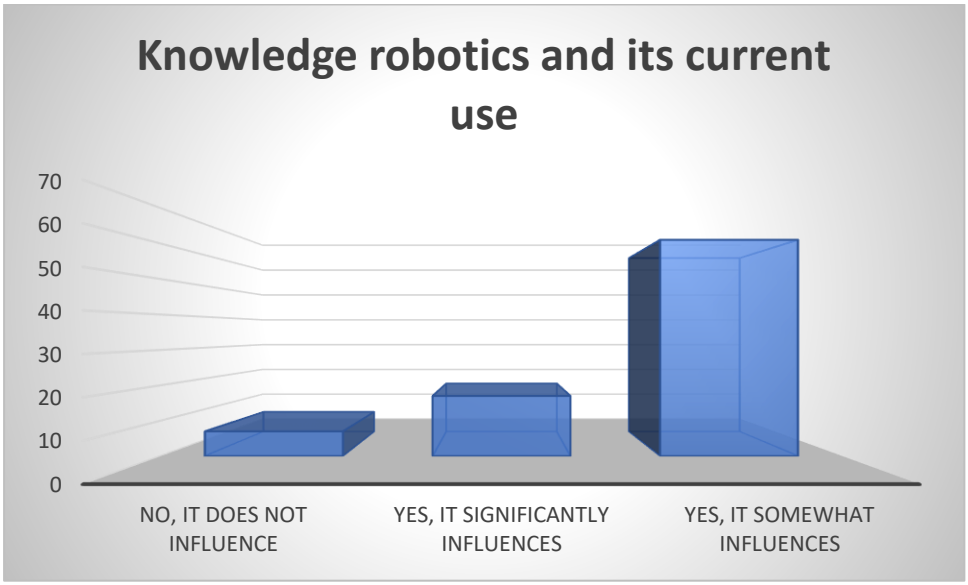

Figure 10 Influence of Knowledge about Robotics on its Current Use in Hospital Pharmacies: This data suggests that the majority of pharmacists believe that their understanding of robotics has a notable impact on its current utilization in hospital settings

4.3.9 IMPACT OF ROBOTICS KNOWLEDGE ON FUTURE IMPLEMENTATION IN HOSPITAL PHARMACIES.

The Pie chart shows that most pharmacists believe knowledge about robotics will impact its future implementation in hospital pharmacies. Out of 85 respondents, 56 agree (66%) and 12 strongly agree (14%). Furthermore, 11 are neutral (13%), and only 6 disagree (3%) or strongly disagree (4%). This indicates that the majority of pharmacist believe that understanding robotics will influence its future use in hospitals.

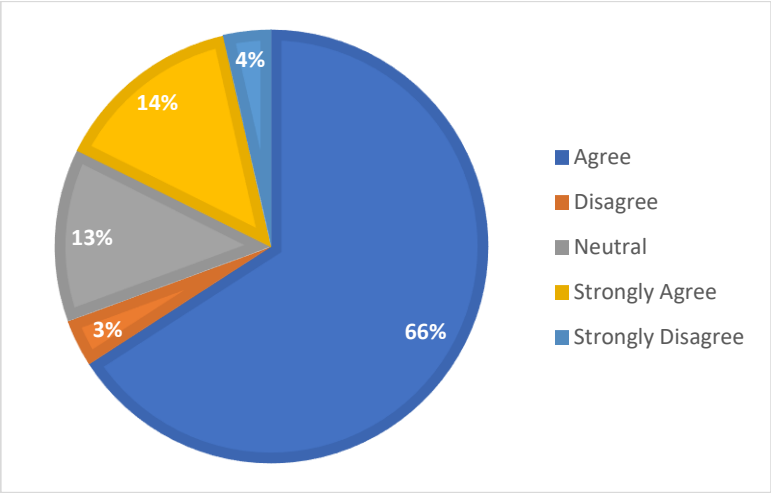

Figure 11 Impact of Knowledge about Robotics on Future Implementation in Hospital Pharmacies : The majority consensus indicates that pharmacists believe knowledge about robotics will significantly influence its future use in hospital settings.

4.3.8 PHARMACISTS ATTITUDES TOWARDS ROBOTICS IN HOSPITAL PHARMACIES

The survey indicates that most pharmacists have a positive attitude towards robotics in hospital pharmacies. Out of 85 respondents, 75 have a positive attitude, while only 10 have a negative attitude. This shows that the majority of pharmacists view robotics in hospitals favourably. The potential for reducing medication errors, improving efficiency, expanding access to healthcare, and integrating with telemedicine are compelling reasons for their favourable views. Worldwide success stories and technology improvements serve to encourage these mindsets. Worldwide success stories and technology improvements serve to encourage these mindsets.

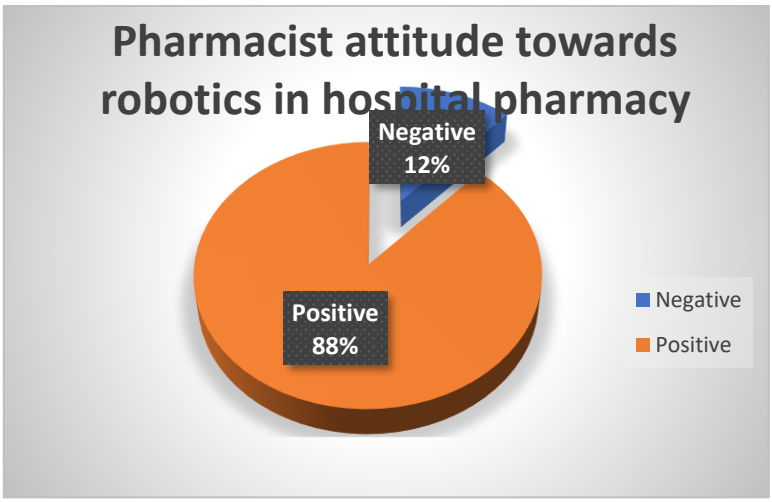

Figure 12 : Pharmacist attitude towards robotic in hospital pharmacy : This shows that the majority of pharmacists view the integration of robotics in hospital pharmacy settings favourably.

4.3.10 IMPACT OF NEGATIVE ATTITUDES ON ROBOTICS USE IN HOSPITALS

According to the survey, the majority of pharmacists believe that having an idea toward robotics influences its current utilization in hospital pharmacies. 10 of the 85 respondents believe it has a significantly influence , while 62 say it has somewhat influence. Only 13 assume it has no effect. This indicates that most pharmacists believe that having a knowledge level about the robotic pharmacy will somewhat influence the implementation of robotics in hospitals.

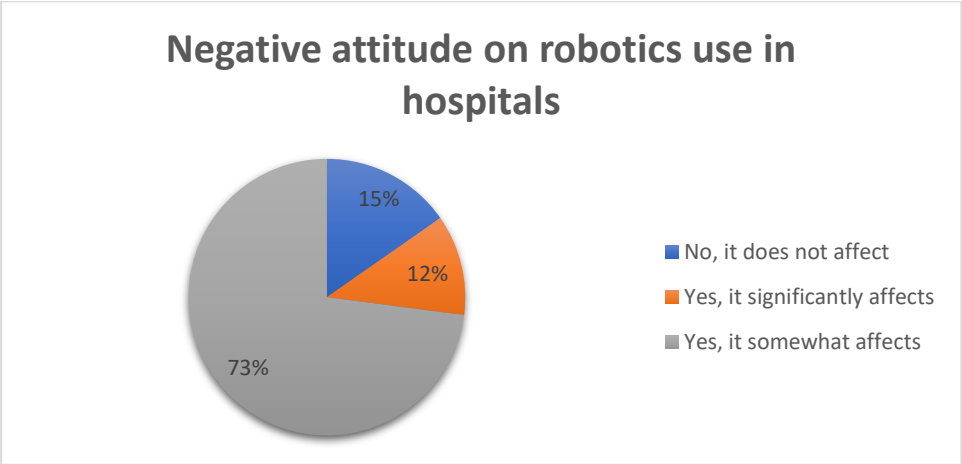

Figure 13 Influence of negative attitude towards the use of robotic in hospitals

4.3.11 INFLUENCE OF POSITIVE ATTITUDES ON FUTURE IMPLEMENTATION OF ROBOTICS IN HOSPITAL PHARMACIES

This means that the majority of pharmacists agree(66%) or strongly agree(12%) that a good attitude toward robotics will influence its future implementation in hospital pharmacy. However, a small minority disagrees(3%) or strongly disagrees with this concept. Overall, the research reveals that most pharmacists see a relationship between having a good attitude toward robotics and its future implementation in hospital pharmacies.

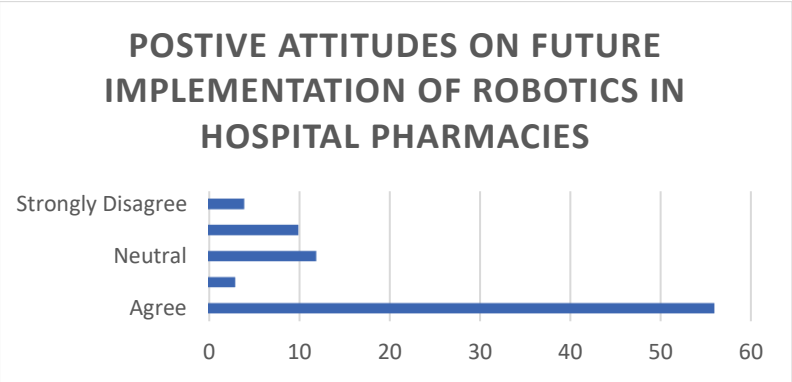

Figure 14 Positive attitudes on future implementation of robotics in hospital pharmacies

4.3.12 CHALLENGES IN ADOPTING ROBOTIC PHARMACIES IN HOSPITAL SETTINGS

It indicates that the vast majority of pharmacists (76 of a total of 85) see at least some barriers to the implementation of robotic pharmacy in hospitals, with a smaller proportion (5 out of 85) seeing severe challenges. Only a small minority (4 of 85) say there are no challenges. Overall, the statistics indicate that the majority of pharmacists see barriers to the implementation of robotic pharmacies in hospital settings.

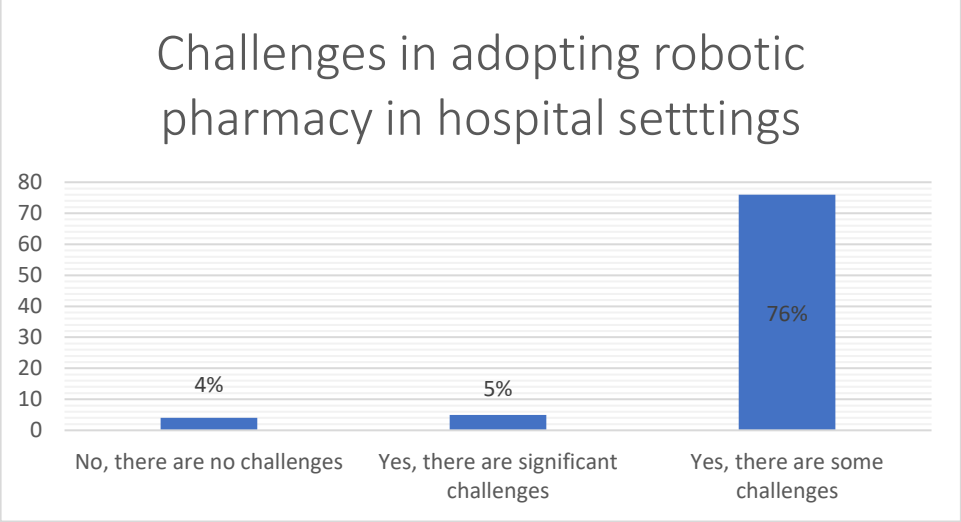

Figure 15 The challenges in adopting robotic pharmacies : The data highlights that a majority of pharmacists recognize the presence of challenges in implementing robotic pharmacy systems in hospitals.

4.3.13 ACCURACY OF ROBOTICS IN CURRENT PRACTICE

The outcomes of the survey show differences in pharmacists perceptions of the accuracy of robotics in pharmacy practice. While the majority of responders (59 out of 85) are confident in the high accuracy of these methods, 26 remain doubtful. This disparity highlights the profession's

diverse opinions, with some pharmacists supporting the accuracy of robotics while others are doubtful.

Furthermore, the data indicate that perceptions of accuracy influence pharmacists judgments about the impact of robotic systems on their utilization in hospital pharmacies. 49 out of 54 respondents agree that robotics has a beneficial impact on pharmacy practice. In contrast, even among those who doubt the accuracy of robotics, a majority of 27 out of 33 respondents recognize its impact on pharmacy operations. These findings highlight the importance of addressing several views and ensuring correct information distribution in order to promote the efficient integration of robotic technologies into pharmacy practice.

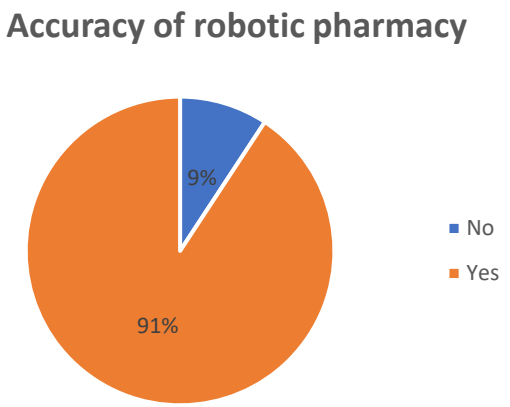

Figure 16 Accuracy level of while using robotic pharmacies

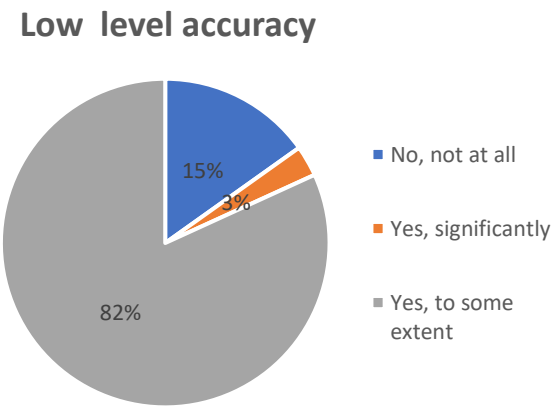

Figure 17 Represents the low level accuracy

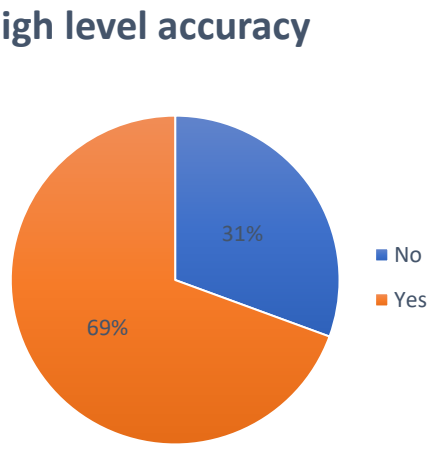

Figure 18 Represents the high level of accuracy

4.3.14 ROBOTIC PHARMACIES LEAD TO TIME SAVING

The data from the survey indicates that the vast majority of respondents, totalling 79 out of 85, believe that robotic pharmacies can lead to time-saving and efficiency in medication dispensing processes. Only a small minority of 6 respondents hold the opposite view, suggesting that most pharmacists see robotic pharmacies as beneficial for streamlining medication dispensing and improving efficiency.

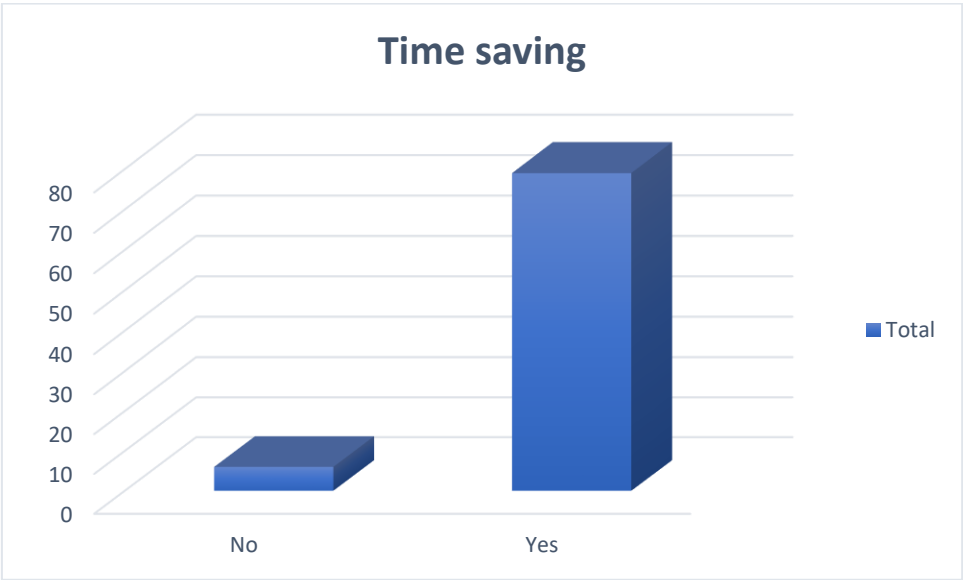

Figure 19 : Pharmacists Perception of Time-Saving Benefits of Robotic Pharmacies : This indicates that most pharmacists believe robotic pharmacies contribute to increased efficiency and time savings in medication dispensing processes.

4.3.15 ROBOTIC PHARMACY CAN INCREASE PATIENT SAFETY

The findings from the survey suggest that the majority of respondents, 73 out of 85, believe that robotic pharmacies can improve patient safety in hospital pharmacy operations. In contrast, only 12 people share a different viewpoint. It also suggests that most pharmacists believe robotic pharmacies would improve patient safety in hospital pharmacy settings.

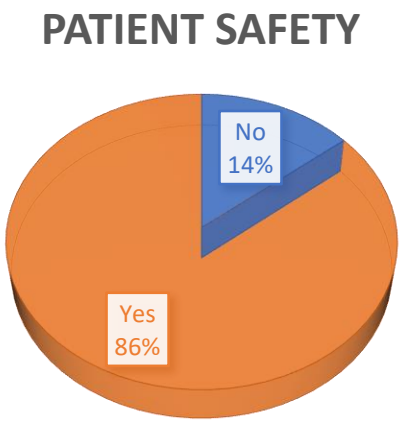

Figure 20 : Pharmacists Perception of the Impact of Robotic Pharmacies on Patient Safety

4.3.16 ROBOTIC PHARMACY LEDS TO JOB DISPLACEMENT

According to the survey results, 58 of the 85 respondents expressed concerns about potential job displacement as a result of the implementation of robotic pharmacies, while 27 did not. This study shows that the majority of pharmacists are concerned about job displacement as a result of the introduction of robotic pharmacies.

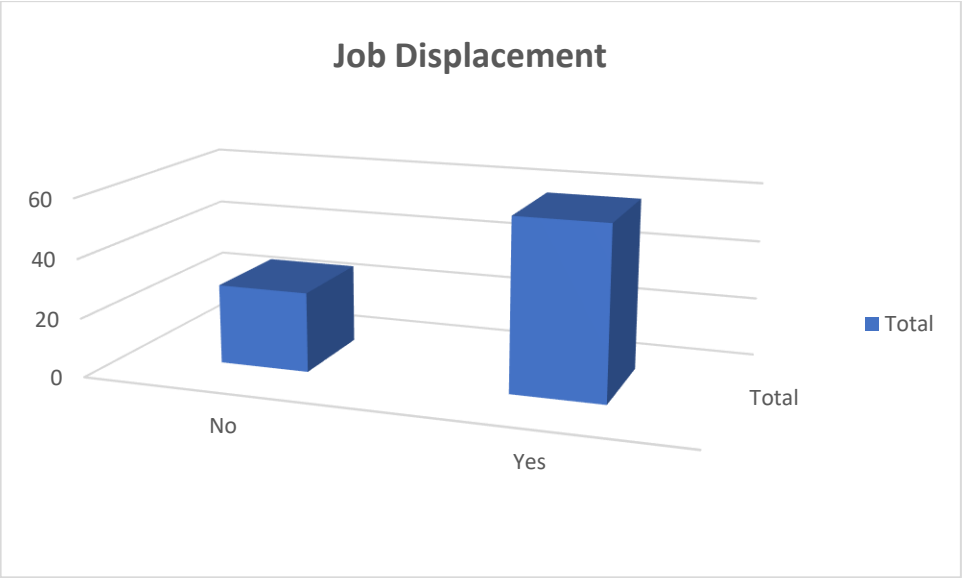

Figure 21 : This bar chart represent the pharmacist perception for the job displacement

4.3.17 ROBOTIC PHARMACY LEADS TO MEDICATION ERROR

According to the survey, 74 of the 85 respondents reported a decrease in medication errors after using advanced automation in their pharmacy, whereas 11 did not. This study reveals that the majority of pharmacists have seen a reduction in medication errors since implementing sophisticated automation in their pharmacy operations.

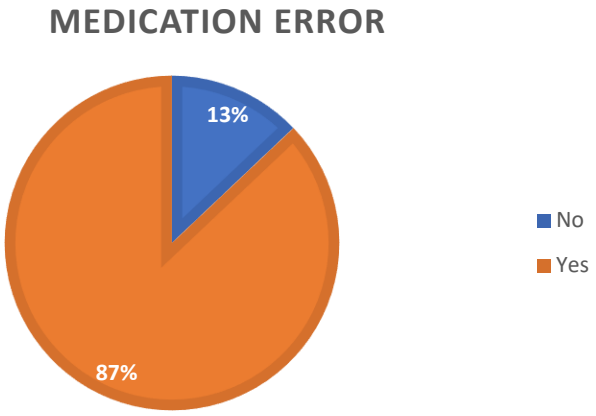

Figure 22 : The pie chart represents the percentage of medication error

4.2.18 WILLING TO BE WORK WITH ROBOTIC PHARMACIES

From the survey results, out of 85 respondents, 77 expressed willingness to work with robotic pharmacy systems if they were implemented in their workplace, while only 8 indicated otherwise. This data suggests that the vast majority of pharmacists are open to the idea of working with robotic pharmacy systems if they were introduced in their workplace.

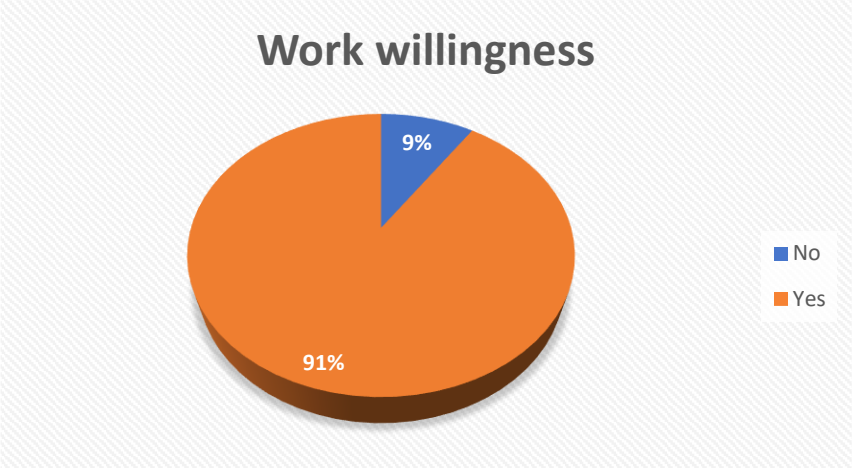

Figure 23: The Pie chart represents the pharmacist willing to work with robotics

4.4 THEMATIC REPRESENTATION OF OPEN-ENDED QUESTIONNAIRES

4.4.1. BENEFITS OF ROBOTIC PHARMACIES

The findings show pharmacists varying viewpoints on the use of robotic pharmacies in Indian hospital settings. While many people recognize the potential benefits, such as increased accuracy, efficiency, and patient safety, others have fears. Concerns have been raised about machine reliability, their ability to handle complex medication dispensing, particularly for narcotics, and the Indian healthcare system's readiness for such advanced technology. Furthermore, there is uncertainty about the robots ability to substitute human expertise and care, raising worries about potential errors in prescription interpretation and medicine administration. These opposing viewpoints highlight the minor concerns and problems associated with integrating robotic pharmacy systems, indicating a cautious approach to their implementation with the need for increased operational efficiency and patient care.

4.4.2 ROBOTICS KNOWLEDGE AND AWARENESS AMONG PHARMACISTS

The findings indicate a multifaceted approach to spreading robotics expertise among pharmacists, with emphasis on a variety of modalities including as training programs, internet resources, collaborative workshops, and continuing education. These paths attempt to provide pharmacists with the necessary abilities to operate, maintain, and maintain robotic devices efficiently. Using online platforms, social media, and conventional mediums such as leaflets and posters makes it easier to convey information and engage people. Collaboration with industry experts and researchers offers access to the latest knowledge while also encouraging innovation in pharmacy procedures. Pharmacists can obtain practical experience with robotics by participating in demos and workshops. Finally, this holistic plan intends to empower pharmacists to efficiently integrate robotics into their workflow, thus improving patient care and pharmacy operations.

4.4.3 HOW PHARMACISTS CAN GAIN A POSITIVE ATTITUDE TOWARDS ROBOTICS IN HOSPITAL PHARMACIES.

The responses indicate many techniques for developing a good attitude toward robotics among pharmacists in hospital pharmacies. First, education and training programs are emphasized as critical for providing pharmacists with a thorough awareness of the benefits and functionality of robotic systems. Hands-on experience with these technologies strengthens their capabilities and increases confidence in their use. Transparent communication and participation in decision-making processes regarding robot installation serve to reduce concerns and develop trust among pharmacy employees. Furthermore, presenting success stories of robotics adoption and stressing benefits such as workload reduction, efficiency, and improved patient care outcomes helps to build a good impression of these technologies. Overall, a combination of education, training, hands-on experience, communication, and participation in decision-making processes is essential for building a positive attitude towards robotics among pharmacists in hospital pharmacies.

4.4.4 CHALLENGES FOR THE ADOPTION OF ROBOTIC PHARMACIES

The challenges associated with the implementation of robotic pharmacies in hospitals are diverse, including financial, regulatory, and workforce issues. Cost investment appears as a

major limitation, with initial high installation costs frequently acting as a large barrier to adoption. Regulatory compliance and interaction with current technologies complicate the implementation process, necessitating careful planning and respect to standards. Furthermore, worries about job displacement and employee resistance to change highlight the significance of comprehensive training and workforce adaptation methods. Patient acceptability and trust are also important considerations, as the shift to robotic pharmacies may raise concerns about dependability, safety, and the influence on patient care. Overall, overcoming these difficulties involves working together to balance technology with human expertise, ensure regulatory compliance, and develop trust among both staff and patients in the reliability and effectiveness of robotic pharmacy.

4.4.5 ROBOTIC PHARMACIES ENHANCING TIME-SAVING AND EFFICIENCY IN MEDICATION DISPENSING PROCESSES

The responses provide two different viewpoints on the impact of robotic pharmacies on drug distribution procedures. While one position emphasizes the significant time-saving and efficiency improvements enabled by robotic systems, highlighting streamlined automation of processes such as sorting, counting, labeling, and packaging drugs, the opposing viewpoint expresses doubt about these benefits. Concerns have been expressed about the necessity for additional checks and precise directions to assure accurate administration, as well as the possibility of higher time consumption owing to different patient needs and counseling requirements. Furthermore, maintenance requirements, such as charging time for robotic devices, are mentioned as significant obstacles that could impair operational efficiency. Despite these issues, the broad consensus among the healthcare profession tends to lean towards recognizing the significant time-saving benefits of robotic pharmacies driven by automation and enhanced accuracy in medication dispensing processes.

4.4.6 ROBOTIC PHARMACIES CAN INCREASE PATIENT SAFETY IN HOSPITAL PHARMACY OPERATIONS

The data indicate a significant variations in opinions regarding the influence of robotic pharmacies on patient safety in hospital pharmacy operations. The supporters of robotic pharmacies claim that these systems significantly improve patient safety by automating

medication dispensing processes, lowering the risk of human error and ensuring precise medication selection and dispensing through advanced technologies such as barcode scanning and electronic verification systems. They also underline the importance of proper medication tracking, traceability, and labeling in promoting better pharmaceutical safety procedures. Others, in contrast, are concerned about the potential limitations and risks linked with robotic pharmacies, such as technological restrictions, the chance of errors, and pharmaceutical complexity. They emphasize concerns about the dependability and effectiveness of robotic systems in maintaining patient safety. Despite these differing perspectives, it's evident that the implementation of robotic pharmacies introduces both opportunities and challenges in enhancing patient safety within hospital pharmacy operations.

4.4.7 MAIN OBSTACLES TO IMPLEMENTING ROBOTIC PHARMACIES IN INDIAN HOSPITAL SETTINGS

The responses identify three significant barriers to adopting robotic pharmacy in Indian hospital settings. One important concern is the limited adoption of robotic technology due to issues with infrastructure management and technological readiness. Insufficient space, regulatory issues, and the high initial cost of implementation all contribute to the slow adoption of robotic pharmacies. There are also worries concerning workforce adaptability and training, as well as labor shortages, which may restrict the proper integration of robotic technologies into pharmacy operations. Economic constraints, such as the expense of maintenance and repairs, add to the obstacles of using robotic pharmacies. Other difficulties identified include regulatory approval procedures, data privacy and security concerns, and the necessity for ongoing labor skill development. Overall, these limitations underscore Overall, these limitations highlight the complicated relationship of variables that must be addressed in order to effectively implement robotic pharmacy in Indian hospital settings.

4.4.8 JOB DISPLACEMENT CONCERNS IN BY THE INTRODUCTION OF ROBOTIC PHARMACIES

These responses indicate a variety of viewpoints on how robotic pharmacies will affect job displacement in the pharmacy sector. Concerns have been expressed regarding how automation may reduce the necessity for human labor, particularly in duties typically

handled by pharmacists and pharmacy technicians, such as medicine dispensing and inventory management. Despite these concerns, there is recognition of the possibility of new career possibilities in pharmacy, contingent on reskilling and adjusting to the changing market.

Despite concerns about job displacement, there is agreement on the significance of taking early steps to manage the transition properly. To reduce job displacement, suggestions include workforce training, skill upgrading, and encouraging human-robot collaboration. Furthermore, several responders emphasize that while automation may change specific work functions, it also allows pharmaceutical professionals to focus on higher-value activities like patient counseling and drug management to improve patient care and pharmacy operations. Overall, there is expectation that robotic pharmacies will enhance efficiency and generate new opportunities for healthcare professionals, emphasizing the importance of balancing the benefits of automation with maintaining of pharmacy career opportunities.

4.4.9 DECREASE IN MEDICATION ERRORS SINCE IMPLEMENTING ADVANCED AUTOMATION IN YOUR PHARMACY

The responses indicate different opinions on how advanced automation in pharmacy settings affects medication mistakes. While some respondents report fewer errors as a result of the precision of robotic equipment and streamlined processes, others have not noticed a similar trend. This gap is attributed to factors such as a lack of direct experience and the continuous significance of pharmacist supervision. These opposing opinions illustrate the complex relationship between automation and mistake reduction, emphasizing the importance of a balanced approach that combines technical developments with human attentiveness to ensure patient safety in pharmacy operations.

4.4.10 ATTITUDES TOWARDS IMPLEMENTING ROBOTIC PHARMACY SYSTEMS IN THE WORKPLACE

The responses indicate differing perspectives on working with robotic pharmaceutical systems in the workplace. While some show their willingness to accept this technological innovation, noting benefits such as reduced workload and useful experience with robotics,

others are concerned. Those who refuse to work with robotic systems frequently claim reasons such as disinterest in pharmacy, a lack of trust in technology, or concerns about the perceived complexity or excessive workload connected with operating machines. Overall, these comments demonstrate a wide range of attitudes toward the incorporation of robotic systems into pharmacy practice, from excitement and preparedness to mistrust and challenge.

4.5 TEST FOR HYPOTHESIS

Hypothesis 1:

Ho: There is no positive relationship between the benefits of robotic pharmacies and their use in hospital pharmacies.

H1: There is a positive relationship between the benefits of robotic pharmacies and their use in hospital pharmacies.

Correlations

			Dependent variable	Independent variable
Spearman's rho	Dependent variable	Correlation Coefficient	1.000	-.130
		Sig. (2-tailed)	.	.236
		N	85	85
	Independent variable	Correlation Coefficient	-.130	1.000
		Sig. (2-tailed)	.236	.
		N	85	85

Table 9 : calculation for the spearman's correlation coefficient

Spearman's rho correlation coefficient between the independent variable (benefits of robotic pharmacies) and the dependent variable (their use in hospital pharmacies) is 0.308.

- The p-value associated with this correlation coefficient is 0.004, which is less than the significance level of 0.05

In this survey, there is a relationship between the benefits and the use of robotic pharmacies. The majority of pharmacists supported the notion that better benefits lead to increased use. From the survey results, 80% of respondents indicated that they see benefits in using robotic pharmacies. Therefore, conclude that there is a positive relationship between the benefits of robotic pharmacies and their use in hospital pharmacies. Thus, there is evidence to reject the null hypothesis (Ho) and accept the alternative hypothesis (H1).

Hypothesis one is true

Hypothesis 2

Ho: There is no positive relationship between the knowledge and current use of robotics in hospital pharmacies.

H1: There is a positive relationship between the knowledge and current use of robotics in hospital pharmacies.

The study establishes a relationship between the knowledge and current use of robotics in hospital pharmacies, indicating that understanding robotics influences their use. In this survey, the majority of pharmacists responded that their knowledge impacts the utilization of robotic systems. Out of 85 respondents, 17 said it significantly influences (20%), 61 said it somewhat influences (72%), and just 7 said it has no influence (8%). This suggests that most pharmacists believe understanding robotics influences its current use in hospitals. The observed trend shows that knowledge of robotic pharmacy positively impacts its current use. Therefore, the null(Ho) hypothesis is rejected, and the alternative(H1) hypothesis is accepted.

Hypothesis two is true

Hypothesis 3

Ho: There is no positive relationship between the knowledge and future implementation of robotics in hospital pharmacies.

H1: There is a positive relationship between the knowledge and future implementation of robotics in hospital pharmacies.

This study demonstrates a relationship between knowledge and the future implementation of robotic pharmacy systems. Pharmacists believe that understanding robotics will positively influence its future use, as evidenced by the survey results where the majority indicated this belief. From the responses of 85 respondents, 56 agree (66%) and 12 strongly agree (14%). Furthermore, 11 are neutral (13%), and only 6 disagree (3%) or strongly disagree (4%). This indicates that the majority of pharmacists believe that understanding robotics will influence its future use in hospitals. It is clear that there is a positive correlation between knowledge and the future implementation of robotics in hospital pharmacies. The null hypothesis (H0) is rejected, and the alternative hypothesis (H1) is accepted.

Hypothesis 3 is true

Hypothesis 4

Ho: There is no positive relationship between the attitude and current use of robotics in hospital pharmacies.

H1: There is a positive relationship between the attitude and current use of robotics in hospital pharmacies.

his study shows a relationship between the attitude and current use of robotics in hospital pharmacies. Positive attitudes towards robotics are linked to higher usage rates, as pharmacists who view these systems favorably are more likely to integrate them into their practice. From the responses, 10 out of 85 respondents believe it has a significant influence (12%), while 62 say it has somewhat influence (73%). Only 13 assume it has no effect (15%). This indicates that most pharmacists believe that having a positive attitude towards robotic pharmacies will somewhat influence their implementation in hospitals. Based on this analysis, interpret that there is a positive correlation between the attitude and current use of robotics in hospital pharmacies. Therefore, the null hypothesis (Ho) is rejected, and the alternative hypothesis (H1) is accepted. Which is a positive relationship between the attitude and current usage of robotics in hospital pharmacies.

Hypothesis four is true

Hypothesis 5

Ho: There is no positive relationship between the attitude and future implementation of robotics in hospital pharmacies.

H1: There is a positive relationship between the attitude and future implementation of robotics in hospital pharmacies.

In this research, the attitude directly influences the future implementation of robotics in hospital pharmacies. Positive perceptions of robotics are associated with a higher chance of their use in the future because pharmacists who have a positive attitude toward these systems are more inclined to support and encourage for their adoption .The pharmacists agree (66%) or strongly agree (12%) with this concept, while a small minority disagrees (3%) or strongly disagrees. Overall, the research reveals that most pharmacists see a correlation between having a good attitude toward robotics and its future implementation in hospital pharmacies. This analysis proves that the nul(H0) hypothesis is rejected, and the alternative(H1) hypothesis is accepted, indicating a positive relationship between attitude and the future implementation of robotics in hospital pharmacies.

Hypothesis five is true

Hypothesis 6

Ho: There are no existing challenges for the adoption of robotic pharmacies in hospitals.

H1: There is an existing challenge for the adoption of robotic pharmacies in hospitals.

This study demonstrates that barriers to robotic pharmacies adoption exist, including those related to technology integration and cost. Most pharmacists agree that there are certain difficulties with robotic pharmacies. More specifically, 76 out of 85 pharmacists perceive at least some obstacles to the use of robotic pharmacy in hospitals, whereas just 5 out of 85 identify significant difficulties. Out of 85, just 4 people report no difficulties. Overall, the data show that the majority of pharmacists are aware of the difficulties in implementing robotic pharmacies in hospital environments.

Based on the interpretation, the null hypothesis is rejected and the alternative hypothesis is accepted, indicating that there are existing challenges to the adoption of robotic pharmacies in hospitals.

Hypothesis five is true

Hypothesis 7

Ho: There is no positive relationship between a high accuracy and the use of robotics in hospital pharmacies.

H1: There is a positive relationship between a high accuracy and the use of robotics in hospital pharmacies.

In this research robotics ensures great accuracy in medicine dispensing in hospital pharmacies, lowering human error and enhancing patient safety. Robotic solutions can also improve efficiency while freeing up pharmacists to concentrate on patient care and other important duties by streamlining pharmacy processes.

The survey results indicate that pharmacists opinions regarding robotics accuracy in pharmacy practice changed. Of the 85 responders, 59 express confidence in the high accuracy of these procedures, whereas 26 have doubts. This study shows that the employment of robotics in hospital pharmacies is positively correlated with high accuracy. Because of the data, which clearly show a relationship between high accuracy and robotics utilization in hospital pharmacies, the null hypothesis is rejected and acceptance of the alternative hypothesis.

Hypothesis seven is true

Hypothesis 8

Ho: There is no positive relationship between years of experience and knowledge about robotics in hospital pharmacy.

H1: There is a positive relationship between years of experience and knowledge about robotics in hospital pharmacy

According to this study, years of experience and robotics knowledge in hospital pharmacies are positively correlated. This implies that pharmacists knowledge of robots in hospital pharmacies develops with their years of practice.

The majority of the sample, as indicated by the survey results, are mid-career pharmacists, and the majority of respondents think that knowledge of robotics affects how hospital pharmacies employ it. This implies that more experienced pharmacists are probably better knowledgeable about robotics and its uses in their area of work.

Hypothesis 8 is true

Hypothesis 9

Ho: There is a positive relationship between attitude towards the training of robotic pharmacy systems.

H1: There is no positive relationship between attitude towards the training of robotic pharmacy systems.

Using survey data, we evaluated the relationship between pharmacist's attitudes about robotics in hospital pharmacies and their belief in the importance of training for working with robotic pharmacies. According to the survey, 75 out of 85 respondents are optimistic about robots, and 75 believe that training is essential to operate in robotic pharmacies. Only 10 of the participants have a negative attitude and believe training is unnecessary.

The findings demonstrate that the same amount of respondents (75 out of 85) have a positive attitude toward robotics and recognize the need for training, demonstrating a strong association. According to this relationship, there appears to be a favorable relationship between pharmacists opinions regarding robotics in hospital pharmacy and their belief in the importance of training.

Given the current data, indicates reject the null hypothesis (Ho) and accept the alternative hypothesis (H1), concluding that there is no significant positive relationship between the attitude towards the training of robotic pharmacy systems.

Hypothesis nine is true

4.6 DISCUSSION

This study investigates into Indian hospital pharmacists knowledge, attitudes, and practices regarding the use and advancement of robotic pharmacies. The study intends to investigate a number of important topics, including pharmacists knowledge of robotic pharmacies, their opinions about the application and future development of robotics in hospitals, the advantages that they see from utilizing robotics in hospital pharmacies, the difficulties that come with implementing robotic pharmacies, and the precision of medication management through advanced automation. It aims to give a thorough picture of the current state of robotic pharmacies today and their potential for the future to improve pharmaceutical services in India by comprehending these aspects.

4.6.1 THE BENEFITS OF USING ROBOTICS IN HOSPITAL PHARMACIES.

The discussion section of the study describes that robotic pharmacy dispensing systems improves drug administration for pharmacies, patients, and healthcare professionals(Qureshi and Sajjad, 2017). These techniques reduce the manual workload for pharmacists, allowing them to focus more on patient care(Sharma *et al.*, 2021). Advanced technologies in these systems reduce human mistakes and efficiently manage large prescription quantities (Küng *et al.*, 2021) .Furthermore, robotic pharmacies increase operational efficiency through automated inventory management and strong security measures, assuring patient safety while lowering labor costs (Kent, 2021), (Motari *et al.*, 2021),(Jarab *et al.*, 2023). However, problems remain, including worries about machine reliability and the ability to manage complicated drugs, highlighting the need for caution while implementing them(Takase *et al.*, 2022).

Despite these issues, surveys show a significant positive attitude about the impact of robotic pharmacies in hospital settings. Most Indian pharmacists favor these solutions, which improve accuracy, efficiency, and patient safety (Qureshi and Sajjad, 2017), (Sharma *et al.*, 2021) . Overall, the positive opinions and shown benefits of robotic pharmacies indicate that they are a significant advance in prescription management and healthcare delivery (ScriptPro, 2024), (Willach Pharmacy, 2024).

4.6.2 KNOWLEDGE AMONG PHARMACISTS REGARDING ROBOTIC PHARMACIES

The integration of robotic pharmacy systems in India is gaining popularity due to its ability to reduce pharmaceutical errors, increase efficiency, and broaden healthcare access (Teja *et al.*, 2014). In metropolitan areas, these systems automate activities such as medicine sorting and packaging, allowing pharmacists to devote more time to patient care.

Globally, countries such as the United States, Japan, and numerous European nations have improved in their use of robotic pharmacy technologies to manage increasing pharmaceutical volumes and improve patient safety (Quest, 2024). Real-time inventory tracking and electronic health record integration are becoming common features in pharmaceutical procedures, promoting automation and precision (MRINetwork, 2024).

Pharmacists experience with robotic systems is critical. Experienced pharmacists successfully integrate these technology, detecting and resolving challenges, but beginner pharmacists might face initial challenges (ElLithy *et al.*, 2023). According to surveys, the majority of pharmacists are knowledgeable on robotic pharmacies, with 66 out of 85 respondents agreeing that there is adequate information sharing. Furthermore, 78 declare that knowing robots influences its application in hospitals and future implementations. Overall, pharmacists expertise and experience favorably impact the adoption and performance of robotic pharmacy systems, indicating that continued training and assistance are crucial for optimizing their benefits.

4.6.3 LEVEL OF ACCURACY IN MEDICATION MANAGEMENT IN HOSPITAL PHARMACIES USING ADVANCED AUTOMATION.

In accordance with previous research, this research emphasizes the exciting possibilities of robotic pharmacies and their advantages in improving precision, effectiveness, and patient safety. According to the majority of respondents (73 out of 85), robotic pharmacies enhance patient safety. These findings are consistent with the role of automation in decreasing medication errors as reported by(Qureshi and Sajjad, 2017). Similar to the efficiency benefits

found by (Makarova *et al.*, 2019), (Kent, 2021), 79 out of 85 respondents indicated significant time-saving benefits.

However, 26 respondents questioned the accuracy of robotic systems, emphasizing the necessity of routine maintenance, personnel training, and validation as stressed by (Takase *et al.*, 2022)in order to develop confidence. Although these concerns, 49 out of 54 respondents stated that the positive effects of robotics, highlighting the necessity of efficient information sharing and communication to reduce distrust. The effortless integration of robotic systems in hospital pharmacy can be facilitated by addressing these issues through appropriate implementation methods, regular education, and adherence to quality control standards. Overall, our research shows that even while most people view robotic pharmacies as helpful, optimizing their potential to improve patient safety and medication management will require resolving differing viewpoints and ensuring strong implementation.

4.6.4 ATTITUDE TOWARDS THE USE AND POSSIBLE DEVELOPMENT OF ROBOTICS IN HOSPITALS.

According to the survey, Indian pharmacists are becoming more interested in and have a positive view toward robotic pharmacies, which is consistent with worldwide trends in pharmacy automation. The majority of respondents (75 out of 85) had a positive opinion of robotic systems and acknowledge that they have the ability to decrease pharmaceutical errors and increase efficiency. These benefits are consistent with those reported in the literature by(Stasevych and Zvarych, 2023) and (Quest, 2024). Skilled pharmacists with the ability to integrate these technologies can improve patient safety and system effectiveness (ElLithy *et al.*, 2023). But a sizable minority (10 out of 85) have negative opinions, suggesting that in order to increase trust in robotic systems, specific education and training are required(Teja *et al.*, 2014), (Takase *et al.*, 2022). Resolving issues through open dialogue, participation in decision-making, and the presentation of success stories can all help to further a positive attitude (Soffar, 2018). Furthermore, controlling the initial investment costs and the difficulties associated with regulatory compliance is essential for wider adoption(MRINetwork, 2024). Overall, even though there is a lot of support for robotic pharmacies, their benefits must be utilized and the Indian healthcare system must advance

by addressing a variety of attitudes and making sure that effective implementation plans are in existence.

4.6.5 CHALLENGES FOR THE ADOPTION OF ROBOTIC PHARMACIES.

The literature and survey results both highlight a number of challenges that should be carefully considered before using robotic pharmacies. One of the main concerns is the cost of installation, which requires large initial investments and presents a special difficulty for smaller pharmacies (Jarab et al., 2023). Justifying these costs requires demonstrating long-term cost-effectiveness. Another significant obstacle is regulatory compliance, which demands a strict compliance to privacy and safety regulations (Khatib and Ahmed, 2020). Furthermore, the situation is complicated by market competition and intellectual property challenges, necessitating the development of differentiation strategies by pharmacies (Motari et al., 2021). However these challenges, the advantages of robotics are shown by post-automation benefits like decreased workload and dispensing errors (James et al., 2013).However, there are challenges associated with potential malfunctions and software problems, such as inaccurate drug delivery and disruptions in operations (Panchal, 2020; Dolic et al., 2019). According to the results of the survey, the majority of pharmacists believe that there are major obstacles to adoption, with a focus on workforce, regulatory, and financial issues. The successful integration of robotic pharmacy in hospital settings requires addressing these concerns through thorough training, workforce adaption measures, and maintaining patient and staff trust in the system's dependability and safety. Overcoming these obstacles and enhancing drug management involves finding a balance between human competence and technical improvements as well as following regulatory guidelines.

4.6.6 FUTURE IMPLEMENTATION OF ROBOTIC PHARMACIES IN INDIA AND WORLD WIDE

Technologies like artificial intelligence (AI), machine learning, and improved robotic automation will drive significant advances in robotic pharmacy in hospitals in India and around the world in the future. According to (Khan *et al.*, 2023)these developments will make specific dosing, accurate medicine formulation, and customized packaging possible. The potential for automated pharmacies to reduce pressure on the healthcare system is

highlighted by the growing population, aging demographics, and rise in chronic illnesses driving the Indian pharmacy automation market, which is predicted to reach USD 240.09 million by 2031(Markets& Data, 2023) .By decreasing medication errors and streamlining operations, robotic systems have the potential to optimize pharmaceutical manufacturing processes worldwide, increase drug availability, and improve patient care (Fairchild, 2022), (Sharma *et al.*, 2021).According to survey results, the majority of Indian pharmacists think that awareness of and favorable views about robots would have a big impact on how it is used in the future. This highlights the significance of education and developing positive perspectives(Stasevych and Zvarych, 2023) . Nonetheless, there are issues that must be resolved, including the expense of the initial investment, regulatory compliance, and worker adaptation. To overcome these obstacles and revolutionize pharmaceutical services globally, cooperation, technological developments, and creating a balance between automation and human competence are essential (Krämer *et al.*, 2019).

5.CONCLUSION

The study evaluated the knowledge, attitudes, and practices of pharmacists in India regarding robotic pharmacies in hospital settings, revealing both interest and concern. While many pharmacists expressed awareness and enthusiasm about robotic systems, significant barriers such as financial constraints, technological challenges, and workforce adaptability hinder widespread adoption. The primary concern among pharmacists is potential job displacement due to automation, highlighting the need for strategies to manage workforce transitions, such as reskilling and upskilling programs. Mid-career pharmacists dominated the sample, reflecting openness to technological advancements, with most recognizing the benefits of robotic pharmacies, such as increased accuracy, efficiency, and patient safety. However, issues like machine reliability and handling complex medications remain. The study's hypotheses indicated positive relationships between the perceived benefits, knowledge, and positive attitudes towards robotics and their current and future use in hospitals.

The findings underscore the need for comprehensive training programs, cost-benefit evaluations, regulatory compliance, loss of pre-existing skill and strategies to manage workforce transitions. Addressing these challenges is crucial to maximize the benefits of robotic pharmacies while mitigating associated limitations, ultimately enhancing patient care and operational efficiency in Indian hospital pharmacies. Pharmacists in India possess a substantial understanding of robotic pharmacy systems, recognizing their potential to significantly reduce medication errors, enhance efficiency, and improve patient care. While most pharmacists hold positive attitudes towards these technologies, a notable minority expresses concerns, emphasizing the need for targeted education and training to build trust and ensure effective implementation.

Integrating robotic pharmacies can decrease the manual workload for pharmacists, improve operational efficiency through automated inventory control, and increase patient safety by reducing errors. However, high initial installation costs, stringent regulatory compliance requirements, potential job displacement, and the need for ongoing maintenance and staff training pose significant obstacles. Addressing these issues with comprehensive approaches, such as worker reskilling, robust regulatory frameworks, and promoting human-robot collaboration, is critical. Future advancements in artificial intelligence, machine learning,

and robotic automation are expected to further enhance operational efficiency and personalized medication management. Balancing human expertise with technological advancements and ensuring regulatory compliance are essential to fully leverage the benefits of robotic pharmacies. Although robotic pharmacies have the potential to revolutionize healthcare, overcoming implementation challenges through strategic planning and education is necessary to realize their full potential in improving pharmaceutical services in India and globally.

5.1 LIMITATION OF THE STUDY

Sampling Bias: Considering that the sample could not be entirely representative of all hospital pharmacists in India, sampling bias is a possibility. This bias may have an impact on the findings generalizability and outcomes.

Self-Reporting Inaccuracies: Focusing entirely on self-reported data enhances the possibility of errors resulting from participants subjective interpretations, recollection bias, and social attractiveness bias. The accuracy of the data that was gathered may be impacted by these errors.

Time constraints: Hospital pharmacists with busy schedules might not have the opportunity to fully engage in the survey, potentially reducing the breadth of information acquired. Due to time constraints, responses may be rushed or incomplete, failing to accurately reflect the respondents genuine attitudes and experiences.

Rechecking: Rechecking the medicine involves a second pharmacist reviewing it to ensure compliance. This means that after the initial check by the first pharmacist, a second pharmacist examines the medication again to confirm it meets all regulatory and safety standards, thus ensuring accuracy and adherence to protocols.

5.2 RECOMMENDATIONS OF THE STUDY

The study suggests creating thorough training programmes and promoting continuous learning to provide pharmacists the abilities they need to work with robotic systems. To overcome financial obstacles, thorough cost-benefit assessments and funding options investigations are essential. Integration will go more smoothly if regulations are followed and helpful policies are promoted. It is crucial to address worker issues through job redesign, reskilling, and supportive measures. Efficiency will increase with better technological integration and the adoption of user-friendly technology. Building trust will require highlighting safety features, keeping an eye on performance, involving stakeholders, and expressing the advantages. Encouraging research and development will boost adoption even more, optimizing the advantages of robotic pharmacy systems and enhancing operational efficiency and patient care.

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APPENDIX A

QUESTIONNAIRES

NAME (optional):

EXPERIENCE (years):

QUALIFICATION LEVEL (degree, masters, or doctorate in pharmacy):

WORKING SECTOR(Public/Private):

Q1: Are you fluent in English? Y/N

- If yes, please proceed.

Q2: Are you a pharmacist working in a hospital pharmacy? Y/N

- If yes, please proceed

Q3: Do you use robotics in your workplace (pharmacy)? Y/N

- If yes, please answer all the question. If No, please answer only that applies.

Q4: If your answer was Yes, have you been trained to use robotics in your workplace or other? Y/N

Q5: Do you think the training was necessary for you to be familiar with the robotics? Y/N

Q6: From your practice working with robotic pharmacies, do you think they are beneficial?

- Yes
- No

Q7: If your answer was Yes, can you list 5 key benefits you feel are the most important?

Q8: If your answer was No, can you briefly explain why?

Q9: Do you believe that the benefits of robotic pharmacies positively impact their use in hospital pharmacies?

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

Q10: Do you think there is enough information shared about the use of robotic pharmacies among pharmacists?

- Yes
- No

Q11: Do you think that having the knowledge about robotics influences its current use in hospital pharmacies?

- Yes, it significantly influences
- Yes, it somewhat influences
- No, it does not influence

Q12: Do you believe that knowledge about robotics will impact its future implementation in hospital pharmacies?

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

Q13 : In your opinion, how the knowledge about robotics should be shared among the pharmacists? Please list 3

Q14: Do you think pharmacists have positive or negative attitude towards robotics in hospital pharmacies? Select that applies.

- Positive
- Negative

Q15: Do you think that a negative attitude towards robotics affects its current use in hospital pharmacies?

- Yes, it significantly affects
- Yes, it somewhat affects
- No, it does not affect

Q16: Do you believe that a positive attitude towards robotics will influence its future implementation in hospital pharmacies?

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

Q17: How pharmacists can gain a positive attitude towards robotics in hospital pharmacies? Please name 3.

Q18: Do you perceive any existing challenges for the adoption of robotic pharmacies in hospitals?

- No, there are no challenges
- Yes, there are some challenges
- Yes, there are significant challenges

Q19: If you believe there are challenges involving the adoption of robotic pharmacies in hospitals, can you please name 3 key challenges?

Q20: From your current practice, do you think the robotics are highly accurate?

- Yes
- No

Q21: If your answer was Yes, Do you believe that a high level of accuracy in robotic systems influences their use in hospital pharmacies?

- Yes, significantly
- Yes, to some extent
- No, not at all

Q22: If your answer was No, Do you believe that a low level of accuracy in robotic systems influences their use in hospital pharmacies?

- Yes, significantly
- Yes, to some extent
- No, not at all

Q23: Do you think robotic pharmacies can lead to time-saving and efficiency in medication dispensing processes? (Yes/No)

- If you answer was yes, can you please briefly explain why?
- If your answer was no, can you please briefly explain why?

Q24: Would you say that robotic pharmacies can increase patient safety in hospital pharmacy operations? (Yes/No)

- If you answer was yes, can you please briefly explain why?
- If your answer was no, can you please briefly explain why?

Q25: What do you see as the main obstacles to implementing robotic pharmacies in Indian hospital settings? Please name 3.

Q26: Are you concerned about the potential job displacement caused by the introduction of robotic pharmacies? Y/N

- If you answer was yes, can you please briefly explain why?
- If your answer was no, can you please briefly explain why?

Q27: Have you observed a decrease in medication errors since implementing advanced automation in your pharmacy? Y/N

- If you answer was yes, can you please briefly explain why?
- If your answer was no, can you please briefly explain why?

Q28: Would you be willing to work with robotic pharmacy systems if they were implemented in your workplace? Y/N

- If you answer was yes, can you please briefly explain why?
- If your answer was no, can you please briefly explain why?