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Remote Patient Monitoring System Adoption Framework: Case Study from Malaysia and Pakistan

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ABSTRACT

The COVID-19 pandemic has accelerated the digital transformation of healthcare monitoring systems, particularly the adoption of remote patient monitoring (RPM). RPM systems provide patients with a sense of security and fast access to competent care, reducing unnecessary hospital visits and infection risks. Remote Patient Monitoring (RPM) systems have only gained rapid adoption in the wake of the COVID-19 pandemic, but various contextual factors still hinder their use in Malaysia and Pakistan. RPM has become a crucial element of the contemporary healthcare delivery model, as it provides better accessibility, persistent monitoring of the patient, and decision-making about the patient. Nevertheless, its use in developing nations like Malaysia and Pakistan is still far-fetched as a result of technological, organizational, environmental, and human factors. The proposed study uses a qualitative research design to investigate the perceptions of the stakeholders via semi-structured interviews with the clinicians, IT staff and the management personnel. Key patterns that define the adoption of RPM were identified through thematic analysis, which resulted in the creation of an empirically based conceptual framework. The framework combines the model of Technology-Organization-Environment (TOE) and human-focused factors to get a holistic overview of adoption preparedness. The soundness and contextual appropriateness of the framework were proven by validation by experts. The research offers practical implications to health institutions and policymakers interested in enhancing the RPM implementation plans in different clinical settings.

Keywords:
Remote Patient Monitoring (RPM); MIoT in Healthcare; Adoption Framework; Malaysia, Pakistan

1. Introduction

A form of telemedicine technology called remote patient monitoring (RPM) devices allows medical professionals to keep an eye on patients from a distance, typically from home or outside of conventional clinical settings. There is a growing exponential rate of RPM interventions in the United. States of America since 2020 [1]. The COVID-19 pandemic worsened remote patient care solution

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requirements. There was a great shortage of resources in the form of clinicians and equipment. and ability in health care systems [2-4], and patients had to socially isolate themselves to curb the transmission. of COVID-19. With changes and relaxation of regulations by the United States of America to attract reimbursements toward the same, the country made a significant change. Health care providers aim to achieve the benefits of RPM. possible gains in three principal directions (1) improving. quality through providing more personalized care; (2) scale. through increasing their customer (patient) base; and (3) obtaining new reimbursement opportunities by adapting to the changes. in payment policies [1,3]. The enthusiasm and optimism for the advantages of RPM have been enhanced. Enhancing patient care and, at the same time, increasing the health system market are evidence of RPM. cutting down hospitalizations and hospital stay of some, asthma, like cardiovascular disease or chronic obstructive. pulmonary disease [5,6]. Reduced traveling time, cost reduction, and more access to services are generally attributed as beneficial to patients, and many eHealth interventions are. described as successes [7]. Other scholars, however, oppose it by arguing that. RPM interventions might fail to deliver on the promise. One study finds that patient health factors are not affected by the RPM interventions, such as weight, percent of body fat, and blood pressure [8], and other studies on this subject cause apprehension regarding the scope. An indication that an RPM intervention can be scaled. in a meaningful way to enhance patient outcomes and in a provable fashion. reduce health care costs [3].

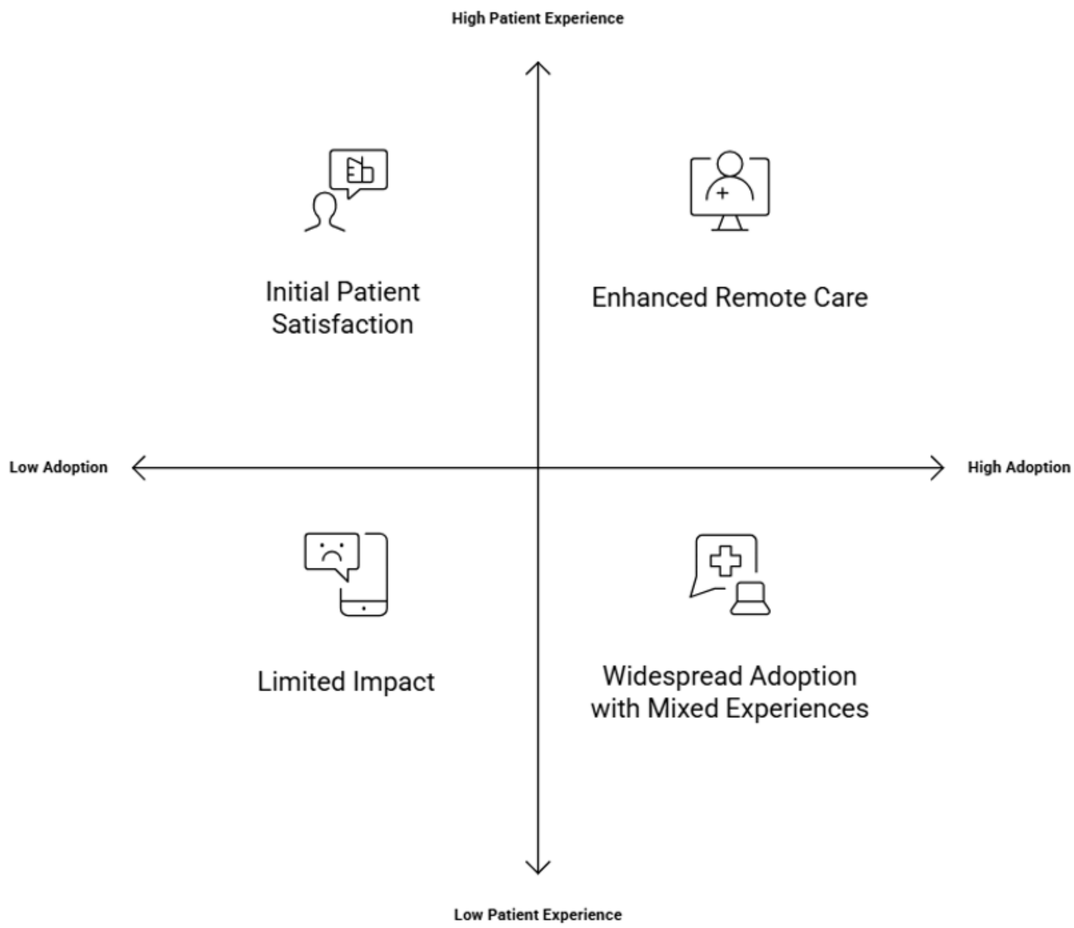

Fig. 1. Impact ot TOE based approach on health care

1.1 Background Study

The word "telemedicine" encompasses both clinical and non-clinical contexts and a range of health applications. Patient care, illness diagnosis, medical facilities, and several other health-related services are all included in the broad category of telemedicine. Non-clinical objectives like continuing health education and patient training on the usage of different technologies could be achieved through telemedicine. Particularly in Malaysia and Pakistan, remote patient monitoring (RPM) systems have emerged as a significant advancement in healthcare, addressing a range of problems related to patient care and treatment accessibility. Usefulness, privacy, and user education all affect the development and use of Remote Patient Monitoring (RPM) systems. While privacy guarantees patient trust and regulatory compliance, usability is essential for accessibility, engagement, and compliance. Usefulness, privacy, and user education all have an impact on the development and use of Remote Patient Monitoring (RPM) systems. While privacy guarantees patient trust and regulatory compliance, usability is essential for accessibility, engagement, and compliance. By filling in the knowledge gap, user education increases adoption rates and optimizes advantages [4]. To incorporate these elements, pilot programs are put into place, secure-by-design principles are incorporated, usability issues are addressed through participatory workshops with stakeholders, and organized training sessions are offered. Feedback systems are used after implementation to improve usability and handle privacy issues. To adjust to evolving user needs and technology changes, ongoing education initiatives are maintained. The new paradigm can enhance greater adoption rates, improved user experiences, and ongoing trust in RPM systems by giving priority to these issues, allowing for major improvements in healthcare delivery in Malaysia and Pakistan. focusing on usability, privacy, and user education is vital for fostering trust, enhancing user engagement, and ensuring the effective implementation of RPM systems in healthcare. These factors contribute to a positive experience for patients, leading to better health outcomes and greater acceptance of remote monitoring technologies.

1.2 Literature Review

The COVID-19 pandemic has highlighted the importance of remote patient monitoring (RPM) in healthcare. RPM enables patient health information to be transmitted remotely to healthcare providers, allowing them to be monitored and taken into immediate action. Research has shown that RPM can improve healthcare and reduce costs, making it a topic of global importance. [5] reveals the effectiveness form in the treatment of chronic diseases and shows a positive impact on patient productivity and healthcare resource utilization. Similarly,[6], the Internet of Things (IoT) has revolutionized healthcare by enabling the integration of sensors into medical devices and wearables. These IoT devices collect real-time health data, providing healthcare [7] providers with deeper insight into patient health. This technology has the potential to revolutionize patient care by enabling the monitoring and planning of personalized treatment plans for the technological environment. Discuss the use of IoT in healthcare, highlighting its role in disease prevention, medication management, and remote patient monitoring. Additionally, [9], the integration of RPM and IoT has the potential to transform healthcare in Malaysia and Pakistan by increasing access to healthcare and improving patient outcomes. By addressing the unique challenges, such as healthcare infrastructure, technology barriers, cultural factors, financial constraints, and policy issues, these countries face, and utilizing these transformative technologies, partners can work to create a better future for their communities. This research contributes to this effort by providing important insight into how an adoption framework can be developed and successfully adopted in Malaysia and Pakistan. Even before the COVID-19 pandemic, the healthcare systems of the world were already facing very severe structural issues, such as rising healthcare costs and declining access, particularly in rural and underserved populations [13,14]. These problems in the long run led to overworked facilities and overworked healthcare systems, reducing the chances of these systems effectively serving all patients. With the increase in population ageing and chronic illnesses becoming increasingly common, conventional healthcare frameworks are viewed to be unsustainable, and telemedicine is anticipated to be a viable healthcare model, namely, viable and acceptable with older adults [15]. These difficulties were highlighted by the pandemic, increasing the gaps in the development of healthcare solutions and making it clear that digital health solutions, such as RPM, might be a key factor in eliminating the accessibility problem and treating chronic care beyond the conventional healthcare models. To have a more in-depth insight into the RPM adoption process, this review is based on the notions of the Diffusion of Innovation (DOI) theory. DOI gives a guide to the study of the adoption and diffusion of new technology within a social system. Some of these factors include Technological, Organizational, and Environmental. They may be used to comprehend obstacles and facilitators that affected the uptake of RPM. Researchers have proposed frameworks that guide telemedicine and RPM implementation, such as the Technology–Organization–Environment framework (TOE) and other acceptance/adoption models to assess implementation [11]. One such example is a narrative review that used Diffusion of Innovation theory and found that relative advantages, compatibility, and observability are important determinants of RPM uptake [14]. Recently, telehealth adoption studies have expanded classical acceptance models by incorporating contextual elements (including risk perception, trust, and system-level conditions) [15]. Nevertheless, current models tend to either consider technological, organizational, environmental, and human factors separately or ignore contextual peculiarities of low- and middle-income environments[14]. Consequently, a discrepancy exists in an integrated, empirically based RPM adoption framework that encompasses socio-technical complexities and local contextual influences

and associated health-related costs. Nevertheless, the uptake or adoption of the above systems has. was very slow, and consequently, their rollout. It has yet to take off, particularly in developing countries, where it is likely to have the most effect.

1.2.1 Technological, Organizational, and Environmental (TOE) Factors

This study is planned to use the conceptual framework of the Technological-Organizational-Environmental (TOE) model, which will provide a systematic perspective for analysing the changes affecting the adoption of Remote Patient Monitoring (RPM) systems within the healthcare environment [10]. According to the framework, the perception of usefulness and reliability of RPM solutions is determined by technological factors, including system compatibility, accuracy of data, and system connectivity. The capability and the desire of the institution to implement RPM in current processes are defined by organizational factors such as the support of the leadership, the availability of resources, and the digital competence of the staff members. In the meantime, there exist external adoption pressures or incentives brought about by environmental factors, including national policies, regulatory guidelines, vendor support, and patient readiness. Together, these three TOE dimensions interrelate to guide the adoption, implementation, and validation of RPM systems, thus providing the building blocks of the proposed conceptual framework in Malaysia and Pakistan.

1.2.2 Challenges and Barriers

The establishment of massive change in healthcare, especially in those fields as patient self-management and Remote Patient Monitoring (RPM) have a lot of systemic and cultural challenges. Research Gaps and Retrospective of the Current Study. Based on the above review, a number of gaps in the existing knowledge can be identified: Few qualitative studies examining the stakeholder views (clinicians, IT staff, administrators) towards the adoption of RPM, particularly in developing countries. Absence of coordinated structures that bind technical preparedness, organizational competence, policy environment, and human consideration. A lack of evidence regarding the interaction that exists between contextual factors (e.g., regulatory environment, reimbursement policies, patient demand, digital literacy) to affect the success of RPM implementation. Limited research supporting frameworks with empirical data on stakeholders or rigorous qualitative research. This paper will fill these gaps by conducting semi-structured interviews with open-ended questions with key stakeholders and conducting thematic analysis to formulate a holistic context-sensitive RPM adoption framework.

Table 1
Comparison of Remote Patient Monitoring (RPM) Adoption in Malaysia and Pakistan

Category	Malaysia	Pakistan
Government Initiatives	Strong digital health push (MyHDW, telemedicine blueprint).	Emerging programs, mostly urban-based with govt/NGO support.
Healthcare Infrastructure	Advanced hospitals integrating IoT & RPM.	Limited; pilot projects, urban-rural disparity.
System Adoption	Moderate; issues with trust, service quality, and integration.	Low; limited awareness, poor internet, and affordability issues.
Technology Used	IoT-enabled RPM, real-time monitoring, and mobile apps.	Basic telehealth, SMS/mobile-based monitoring.
User Satisfaction	Growing satisfaction (service & system quality improving).	Positive feedback in pilots; limited large-scale data.
Data & Privacy	Ongoing governance, policies tackling interoperability.	Nascent governance; weak regulatory frameworks.
Accessibility	Good in urban/suburban; rural reach improving.	Major urban-rural gap; rural underserved.
Cost & Affordability	Subsidies and insurance support but cost is still a barrier.	High-cost barrier; minimal subsidies/insurance.
Training & Support	Practitioner training integrated in digital health programs.	Very limited training for healthcare providers.
Interoperability	Efforts to standardize EHRs across providers.	Fragmented systems; isolated pilots with low integration.
Patient Empowerment	Patient portals, access to health records.	Early-stage engagement; limited patient tools.
Chronic Disease Mgmt.	Focus on diabetes, hypertension, and cardiovascular care.	Emerging pilots for diabetes & respiratory illness.
COVID-19 Response	Accelerated RPM adoption, reduced hospital visits.	Increased adoption, but gaps in infra & policy.
R&D Activity	Strong R&D, academic studies on RPM adoption.	Limited R&D; dependence on imported tech & collaborations.
Policy Support	National digital health policies promoting RPM scale-up.	Early-stage policies; uneven provincial/national alignment.

Category	Malaysia	Pakistan
Challenges	Integration issues, user adoption, privacy, and cost.	Infra gaps, digital literacy, affordability, and weak regulation.
Telecom Infrastructure	Available high-speed internet; 4G/5G expansion.	Uneven; mostly 3G/4G in urban, poor rural coverage.
Provider Engagement	Positive, with growing adoption in hospitals.	Mixed; traditional providers are hesitant due to a lack of training.
Outcomes	Reduction, proactive care, improved monitoring.	Early potential is shown, but limited impact data are available.
Future Directions	AI integration, rural expansion, improved patient experience.	PPPs planned; infra and policy strengthening needed.

Table 2
Overview of Key Findings and Research Directions for RPMTS Deployment

Dimension	Rewritten Findings	Rewritten Observations and Implications for Research
Position	Most RPM are deployed in post-hospital environments to monitor chronic conditions that were originally diagnosed within clinical settings. Only a small portion are implemented in pre-clinical contexts for screening, prevention, or diagnostic purposes.	As chronic diseases continue to rise, the expansion of RPMTSs remains crucial. Deploying RPMTSs in pre-clinical environments can support early detection, preventive care, and timely medical intervention. This highlights a need for deeper research into pre-clinical deployment strategies and how they can strengthen proactive healthcare delivery.
Levels of integration	In post-hospital contexts, RPMTSs are usually integrated into existing clinical workflows. However, systems deployed in pre-hospital or primary care settings tend to function independently and are seldom aligned with formal clinical processes (e.g., quantified-self applications).	Strong integration is essential to reduce the workload of conventional healthcare systems. Lack of integration limits usability and clinical value, particularly in primary care. Future research must focus on developing frameworks that ensure seamless clinical integration of RPMTSs, especially in early-stage care settings.
Functional versatility	RPMTSs used in chronic disease management usually target a single disease and monitor disease-specific symptoms and vital signs. In contrast, pre-clinical RPMTSs are more flexible, often addressing multiple potential conditions.	Single-disease RPMTSs may limit scalability, while multi-disease systems can increase adoption potential. However, multi-disease systems require improved interpretative capacity to prevent user confusion. Research should focus on developing automated interpretation and decision-support tools to enhance user understanding and system reliability.
Accessibility	Accessibility remains restricted, especially in pre-clinical and primary care settings due to weak legal frameworks, data privacy challenges, and unclear regulations. Even in post-hospital settings, focusing on a single chronic condition limits the potential number of beneficiaries.	Widespread adoption requires comprehensive legal, regulatory, and data-protection frameworks. The narrow disease-specific focus also limits scalability. Future research must address issues of regulatory support, privacy, and broader patient inclusion to ensure equity and access across diverse healthcare settings.

Dimension	Rewritten Findings	Rewritten Observations and Implications for Research
Main intervention purpose	Healthcare providers primarily use RPMTSs to manage the increasing burden of chronic diseases and associated service demand. They are also utilized to reduce rising healthcare costs while seeking to maintain or improve care quality.	While cost reduction and workload management are common goals, prevention and early detection may offer far greater long-term benefits. Research should investigate how preventive-oriented RPMTS models can reduce disease progression and minimize overall healthcare expenditure.
Main design approach	Although user-centred and patient-centered design approaches are widely recognized as essential for RPMTS success, fewer than half of RPMTSs employ these methods. Structured user involvement throughout the system lifecycle remains limited.	Engaging users during conceptualization, design, and implementation significantly improves adoption, scalability, and sustainability. Research should explore practical models to incorporate patient/user feedback throughout the RPMTS development process to ensure systems meet real-world needs.

2. Methodology

The proposed research methodology adopts a qualitative approach, emphasizing an in-depth exploration of stakeholder experiences, perceptions, and contextual insights over numerical data. This approach is especially suitable for understanding the multifaceted adoption of RPM systems in healthcare. Below is the detailed explanation of each methodology component.

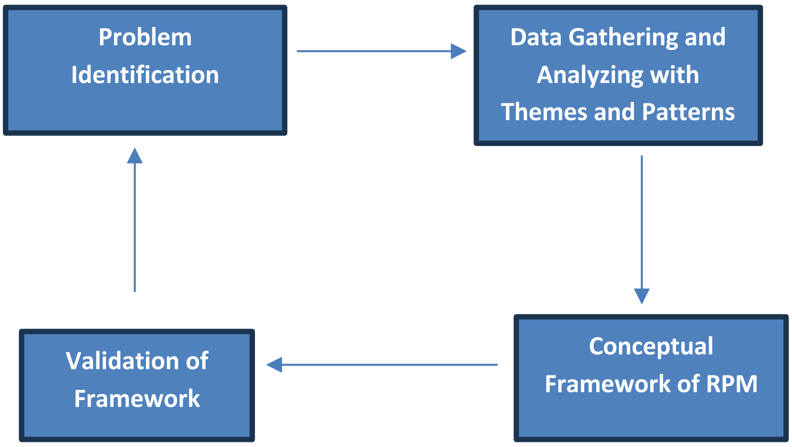

Fig. 2. Overview of Research Methodology

Fig. 3. Insight onto RPM through qualitative research

2.1 Conceptual Framework

Interviews: Conduct semi-structured interviews with key stakeholders, such as doctors, patients, and policymakers. This process captures detailed, personal narratives that shed light on their perceptions, challenges, and expectations concerning RPM. Thematic Analysis: Analyze the collected data using thematic analysis to identify recurring themes and patterns. This allows for a deeper understanding of the technological, environmental, organizational, and human factors that influence RPM adoption. Case Studies: Explore real-world instances of healthcare organizations that have implemented RPM systems. These case studies provide contextual insights, highlighting specific challenges, successes, and best practices during adoption. Stakeholder Perceptions: Gather qualitative insights into stakeholders' motivations, concerns, and attitudes toward RPM. This helps uncover barriers and enablers that might not be evident through numerical data [8].

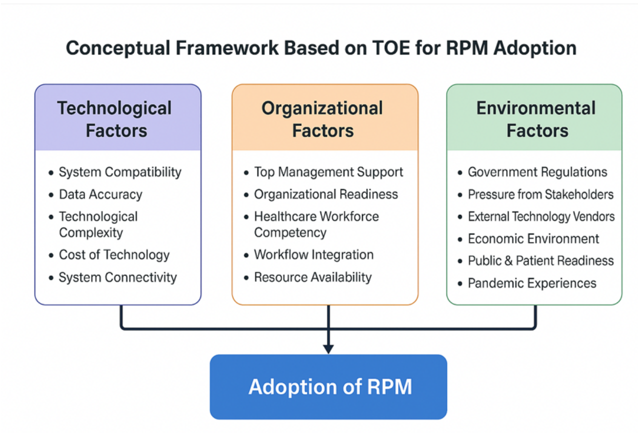

Fig. 4. Conceptual framework of Adoption RPM

2.2 Development and Design

For the design and development of a conceptual framework, the qualitative approach focuses on developing a conceptual model of ARPM (Adoption of Remote Patient Monitoring System) implementation based on the Technological, Organizational, and Environmental (TOE) model. Key stakeholders, including doctors, healthcare providers, IT technologists, and hospital management, were interviewed and surveyed in-depth to investigate their experiences, expectations, and challenges regarding RPM, using perception-based questions. The measurement obtained relies on the dimensions of the TOE, i.e., in technical preparedness, in organizational preparation, and in environmental factors, to make sure that the framework is inclined towards actual operating conditions. Thematic analysis is used to understand common trends based on insights to shape, enhance, and test the conceptual framework.

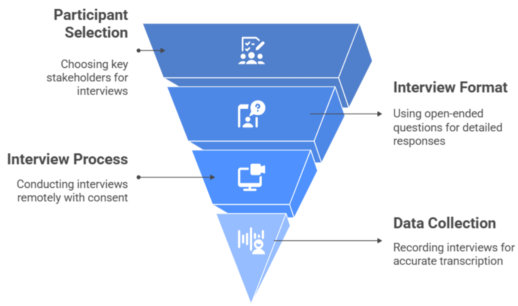

Fig. 5. Exploration of RPM factors

2.3 RPM Adoption Framework Validation Process

The RPM Adoption Framework validation was conducted in a multi-pronged manner:

- **Certain Expert Consultations**: The meetings with the healthcare technology and RPM specialists were held to assess the framework. Their qualitative responses can measure their relevance, flexibility, and value in the healthcare systems of Malaysia and Pakistan.
- **Field Studies:** It is confirmed, in a few healthcare environments, by interview, survey, and direct observation. This is done to determine its practicality, efficiency of operation, and where it could be improved.
- **Narrative Analysis**: Narratives and stories related to the framework, as told by healthcare providers, are analysed. It is a narrative method, which gives the idea of its practical significance, claims possible constraints, and shows its overall success.

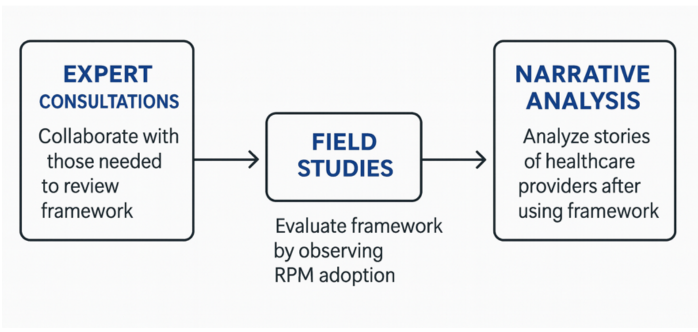

Fig. 6. Validation of RPM factors

4. Conclusions

A useful tool for assessing the adoption of remote patient monitoring (RPM) in healthcare is the TOE framework. It outlines the three primary determinants of its implementation. This paper has explored the multi-dimensional determinants in the adoption of RPM in Malaysia and Pakistan by combining observed qualitative evidence with the TOE framework and human-centered factors. The narrative of stakeholders described marked differences in technological readiness, organizational capability, environmental reinforcement, and human acceptance- all of which influence the sustainability and effectiveness of RPM implementation. The creation of these findings into a structured framework created the resulting adoption framework, which can guide decision-makers in assessing readiness, resource allocation, barriers, and user engagement. Expert consultations guaranteed that the framework was accurate and relevant in a practical way. Future research can build upon this study by implementing the framework in practical preliminary programs, including quantitative validation, or modernizing the model to fit other future digital health technologies.

5. Future Work

Although the Adoption Remote Patient Monitoring (ARPM) framework has been effectively developed and validated by this study, there are still several opportunities for additional research and improvement. Large-scale pilot studies in medical facilities throughout Pakistan and Malaysia should be the goal of future research to test the suggested framework empirically. This would make it possible to evaluate quantitatively how well the framework works to improve patient outcomes, lower healthcare costs, and boost system efficiency. Additionally, context-specific factors that might not have been fully captured during the initial framework development and validation phase will be identified with the aid of such empirical validation.

Future research should also investigate how to improve real-time data collection, security, and analytics by integrating cutting-edge technologies like blockchain, wearable sensors, artificial intelligence (AI), and the Internet of Things (IoT) into the ARPM framework. These technologies could improve the overall effectiveness and dependability of RPM systems by automating decision-making procedures and bolstering predictive healthcare capabilities. It is also advised that more research be done, especially in underserved and rural areas, to look at patient behavior and acceptance models through longitudinal studies. The long-term adoption of RPM systems will depend on an understanding of patients' digital literacy, privacy concerns, and sociocultural barriers.

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