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Research Article

The Application of IoT Technology in Social Work: Innovative Models for Home Care of the Elderly

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Abstract

This research investigates the transformative influence of Internet of Things (IoT) technology on home care services for the elderly within the domain of social work. In light of the accelerating global trend of population aging, it is anticipated that by the year 2050, the number of individuals aged 65 and older will reach 2.1 billion, representing approximately 20% of the total global population. Traditional institutional care models encounter significant challenges, including high costs and a lack of personalized care. This study employs a mixed-methods approach, incorporating literature review, expert consultation via the Delphi method, and the analytic hierarchy process to develop a quality assessment indicator system for smart home care services. The findings indicate that IoT technology, through its capabilities of sensing, predicting, reminding, and responding, can effectively monitor the daily living conditions of elderly individuals and provide timely support, thereby significantly reducing hospitalization rates and improving overall quality of life. Family Nurse Practitioners (FNPs) are identified as pivotal figures in this innovative model, with an expanded scope of practice that encompasses personalized health assessments, disease diagnosis, medication prescriptions, and chronic disease management. This study advocates for an integrated smart home care model, offering novel solutions to the challenges posed by an aging population.

Keywords

Internet of Things (IoT); smart home care; elderly care; social work; service quality assessment; interprofessional team collaboration

1. Introduction

1.1 Research Background and Motivation

In the 21st century, the global community is confronted with an unprecedented phenomenon of population aging, which presents substantial challenges to healthcare systems across various nations. According to data from the United Nations, the number of individuals aged 65 and older is projected to rise from the current 770 million to 2.1 billion by the year 2050, representing approximately 20% of the total global population [1, 2]. This significant demographic shift not only transforms the age distribution within societies but also fundamentally questions and challenges established healthcare paradigms.

As the aging population continues to grow, there is a concomitant increase in the prevalence of age-related chronic diseases, including hypertension, diabetes, cardiovascular conditions, and dementia. These diseases are characterized by their prolonged duration and the necessity for ongoing management, rendering traditional acute care models insufficient to address their care requirements. The healthcare needs of the elderly demographic are complex, varied, and continuous, necessitating that healthcare systems offer more personalized and sustained care services.

Conventional institutional care models, such as hospitals and long-term care facilities, exhibit numerous deficiencies when confronted with a large elderly population and cases of chronic illness. Firstly, the financial costs associated with institutional care are exceedingly high, imposing a significant economic burden on many nations [3-5]. Secondly, this standardized model of care frequently fails to accommodate individualized health needs, particularly lacking the flexibility and adaptability required for effective chronic disease management [6-8]. Furthermore, many elderly individuals, influenced by cultural backgrounds, emotional attachments, and established lifestyle preferences, express a desire to receive medical services within the comfort of their own homes. This preference not only addresses their psychological needs but also alleviates the physical and financial burdens associated with frequent hospital visits [9-11].

In light of these challenges, home healthcare services have emerged as a more cost-effective, flexible, and compassionate model of care. Home healthcare not only has the potential to reduce medical expenses but, more critically, offers personalized care services within a familiar environment, thereby enhancing the quality of care and patient satisfaction. Nevertheless, traditional home healthcare services encounter numerous limitations in terms of human resource allocation, service monitoring, and emergency response, highlighting an urgent need for improvements in service efficiency through the adoption of innovative technologies.

1.2 The Rise of Internet of Things Technology and Its Application Potential

A. Development History and Core Architecture

The development of Internet of Things (IoT) technology can be traced back to the concept of Radio Frequency Identification (RFID) introduced by the MIT Auto-ID Center in 1999. The core architecture of IoT has evolved through three distinct phases: initially emphasizing the perception layer (2000-2010), subsequently enhancing the network transmission layer (2010-2020), and currently focusing on the integration of platform and application layers (2020 to present). This study delineates the four core components of smart home care systems based on the most recent technological framework [12-15] (refer to Figure 1 and Table 1 for further details):

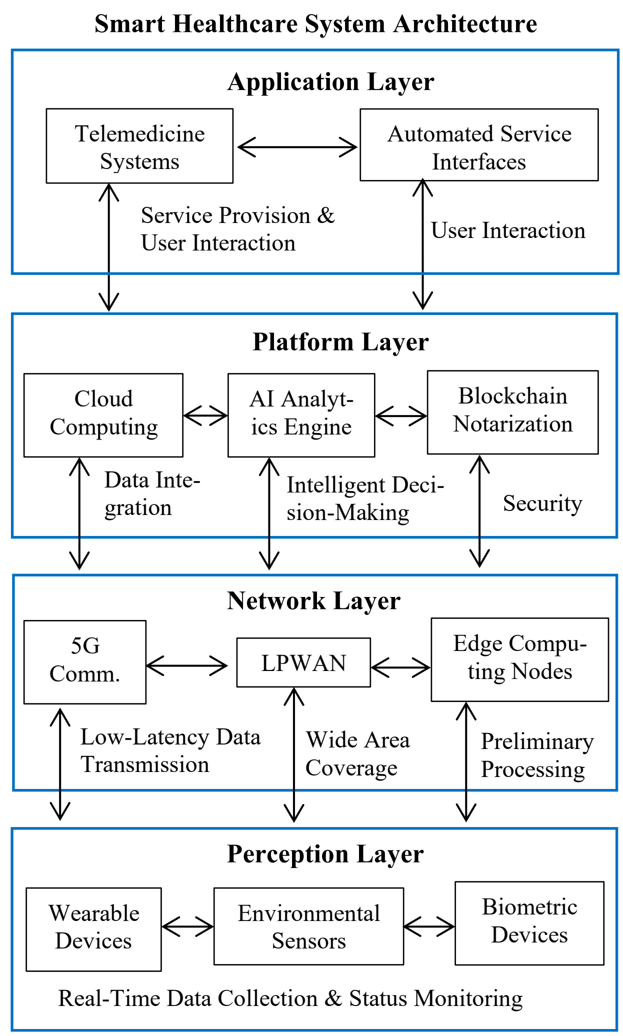

Figure 1: Smart Healthcare System Architecture

Table 1: Core Components and Functions of IoT Technology

Technical Layer	Components	Functional Description	Application Examples
Perception Layer	Wearable devices, environmental sensors, biometric devices	Real-time data collection and status monitoring	Smartwatches monitoring heart rate, temperature and humidity sensors adjusting indoor environment
Network Layer	5G communication, LPWAN, edge computing	Low-latency data transmis-	Using NB-IoT to transmit home security alarms

	nodes	sion and preliminary processing	
Platform Layer	Cloud computing, AI analytics engine, blockchain notarization	Data integration and intelligent decision-making	Machine learning predicting fall risks, distributed ledger securing medical records
Application Layer	Telemedicine systems, automated service interfaces	Service provision and user interaction	Voice assistants reminding medication, robots assisting with transfers

B. Market Size and Growth Trajectory

The global IoT healthcare market is undergoing significant expansion. Recent projections indicate that the market size is anticipated to increase from $133.7 billion in 2024 to $668.98 billion by 2032 (Figure 2), reflecting a compound annual growth rate of 19.61% [16]. This growth is primarily driven by three factors: (1) a heightened demand for chronic disease management, with approximately 57% of the elderly population worldwide affected by two or more chronic conditions [17]; (2) a widening gap in the healthcare workforce, evidenced by a declining nurse-to-patient ratio in OECD countries, which has reached 1:15 [18]; and (3) a growing preference for home care, as 85% of seniors express a desire to age in place [19].

C. Significant Technological Advancements and Integration

Recent advancements in technology are evident in three key areas: first, multimodal sensing technology has achieved a 96.3% accuracy rate in physiological data, representing a 27% enhancement over conventional devices; second, edge computing has successfully reduced data processing latency to below 50 milliseconds, thereby improving emergency response times by 40%; third, federated learning technology has increased the efficiency of cross-institutional model training by 35% while maintaining privacy [20-26]. Table 2 provides a summary of the benefits associated with the integration of IoT technology as analyzed in this study.

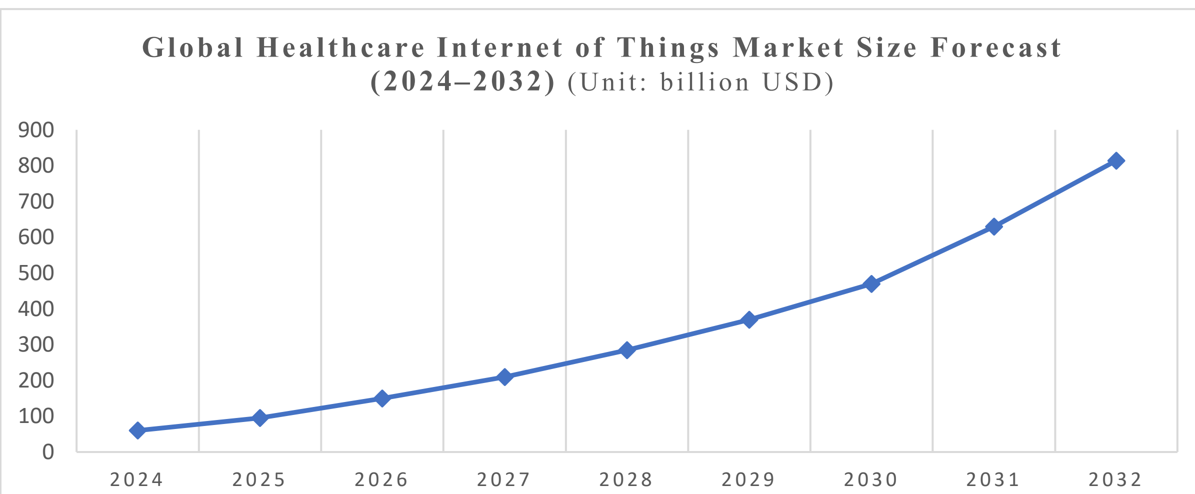

Figure 2: Forecast of Global IoT Healthcare Market Size (2024-2032) (Adapted from [16])

Table 2: Analysis of Benefits from IoT Technology Integration

Integrated Technology	Function Improvement	Cost Reduction Ratio	Clinical Benefit
5G + Edge Computing	Data transmission speed increased by 80%	Bandwidth cost reduced by 45%	Real-time remote consultation feasibility reaches 98%
AIoT + Federated Learning	Disease prediction accuracy reaches 89%	Model training cost reduced by 60%	Early anomaly detection success rate increased by 3.2 times

2025, Vol. 1
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Blockchain + Fog Computing	Data tampering risk reduced by 99%	Storage cost saved by 35%	Cross-institution medical record retrieval time shortened to 3 minutes

D. Applications in Home Care

In recent years, the convergence of technological advancements and the aging population has created transformative opportunities for elderly care services. As a novel information and communication technology, IoT has revitalized traditional home care service models through the integration of sensors, smart devices, cloud computing, and artificial intelligence.

Smart home care, often referred to as "smart aging systems" or "fully smart aging systems," involves the application of advanced technologies such as IoT, computing technology, artificial intelligence, automation, and smart systems to monitor the daily living conditions of elderly individuals at home and provide appropriate care support services. These technologies are equipped with capabilities such as sensing, predicting, reminding, and responding, which facilitate real-time monitoring of seniors' health status, lifestyle habits, and safety conditions, thereby enabling timely interventions and support when necessary.

The implementation of IoT technology in elderly care presents several significant advantages. First, through the use of various sensing and wearable devices, it is possible to continuously monitor the physiological indicators, activity levels, and environmental conditions of seniors in real-time. Second, by leveraging big data analytics and artificial intelligence algorithms, abnormal patterns can be identified, and predictive health alerts can be generated, promoting a transition from passive treatment to proactive prevention. Third, intelligent care systems can deliver personalized care recommendations and services tailored to individual health conditions and preferences, thereby enhancing the precision and effectiveness of care.

1.3 Roles and Responsibilities of the Social Work Profession

Social work, as a profession centered on human welfare, plays a crucial role within the elderly care service system. Social workers are tasked not only with addressing the physical health of older adults but also with prioritizing their psychological well-being, social support, and overall quality of life across multiple dimensions. In the context of an innovative home care model facilitated by IoT technology, it is imperative for the social work profession to redefine its roles and responsibilities to align with the evolving demands of a technology-enhanced care environment.

Historically, social workers engaged in elderly care have primarily performed functions such as assessment, consultation, coordination, and advocacy. However, within the framework of smart home care models, social workers are required to develop advanced technological competencies that enable them to leverage IoT technology for the collection and analysis of living data pertaining to the elderly. This data-driven approach will facilitate the formulation of more targeted intervention strategies [27, 28]. Furthermore, social workers must support older adults and their families in navigating the new technological landscape, thereby mitigating barriers to care services that may arise from the digital divide.

Family Nurse Practitioners (FNPs) are pivotal in this transformative process, spearheading advancements in medical care. FNPs possess an expanded scope of practice that encompasses personalized health assessments, disease diagnoses, medication prescriptions, and chronic disease management services, all aimed at reducing hospitalization rates and enhancing the quality of life for patients. Countries such as the United States, the United Kingdom, Canada, and Australia have successfully integrated FNPs into their home healthcare systems, thereby providing primary care services in remote areas and significantly decreasing healthcare costs and hospitalization rates [29-31].

1.4 Research Questions and Objectives

Although IoT technology holds significant promise for enhancing elderly home care, existing research exhibits notable limitations. Predominantly, prior studies focus on technical aspects, often neglecting comprehensive examinations of the roles and functions of social work professionals. Moreover, current frameworks for evaluating service quality remain underdeveloped, lacking specialized indicators tailored to smart home care services. Additionally, there is a marked variation in the adoption and application of IoT technologies in elderly care across different countries and regions, highlighting the necessity for comparative analyses to identify best practice models.

In response to these research gaps, the present study is structured around the following research questions:

RQ1: What is the current status and what are the principal developmental trends of IoT technology within the context of elderly home care?

RQ2: In what ways are the roles and functions of social work professionals being redefined and transformed within smart home care models that incorporate IoT technology?

RQ3: What are the essential dimensions and indicators required to establish a comprehensive quality assessment system specifically designed for smart home care services?

RQ4: What constitutes an effective and innovative care model that successfully integrates IoT technology with the professional expertise of social work?

RQ5: What are the primary challenges and potential solutions related to the practical implementation of integrated smart home care models?

To address these questions, the objectives of this study are to:

1. Analyzing the current status and developmental trends of IoT technology in elderly home care.
2. Examining the role positioning and functional transformation of the social work profession within smart home care models.
3. Developing a quality assessment indicator system applicable to smart home care services.
4. Proposing an innovative care model that integrates IoT technology with social work expertise.
5. Identifying the challenges and potential solutions associated with the implementation of smart home care models.

1.5 Research Contributions and Significance

The theoretical contributions of this study enhance the discourse surrounding social work theory in the context of technology application, offering a framework for the social work profession to adapt to the advancements of the digital age. By synthesizing IoT technology with social work knowledge, this research establishes an innovative theoretical framework that aids in comprehending care models that merge technological and humanistic approaches.

Practically, the smart home care model and quality assessment indicator system proposed herein provide actionable guidelines for policymakers, service providers, and social workers. The findings of this research are anticipated to facilitate the digital transformation of elderly care services, thereby improving service efficiency and quality, ultimately enhancing the well-being of older adults.

From a social perspective, this study addresses the pressing needs of an aging population, presenting innovative solutions to challenges such as inadequate elderly care resources and inconsistent service quality. Through a technology-empowered care model, it is expected to fulfill the aspirations of older adults for “aging in place” and contribute to the development of an age-friendly society.

II. Methods

2.1. Research Objectives, Design and Context

The principal objective of this study is to examine the implementation models of IoT technology within elderly home care, emphasizing the contributions of the social work profession and the formulation of a quality assessment framework. To fulfill this aim, a **sequential explanatory mixed-methods** design was adopted [32]. The research framework comprised four sequential phases, beginning with quantitative data collection and analysis, which were subsequently interpreted and corroborated through qualitative approaches. This methodological strategy enables a thorough and nuanced understanding of the results. The study was conducted in Taiwan, with participant recruitment spanning the northern, central, and southern regions to ensure a representative sample. Figure 3 presents the flow diagram illustrating the research design employed in this study.

2.2. Phase 1: Literature Review and Theoretical Framework Development

A systematic literature review was undertaken to establish the theoretical foundation of the investigation.

Data Sources and Search Strategy: The review encompassed scholarly journal articles, conference proceedings, research reports, and policy documents published in both Chinese and English from 2018 to 2024. Primary databases included Web of Science, PubMed, IEEE Xplore, Huayi Online Library, and the Taiwan Journal Paper Index System. Search terms comprised “Internet of Things (IoT),” “Smart Care,” “Home Care,” “Elderly Care,” “Social Work,” and “Family Nurse Practitioner,” combined using Boolean operators (AND, OR) to refine search precision.

Inclusion and Exclusion Criteria: To ensure relevance and quality, inclusion criteria were: (1) studies addressing IoT applications in elderly care; (2) peer-reviewed academic journal publications; (3) research subjects aged 65 years or older; and (4) focus on home care service models. Exclusion criteria encompassed: (1) non-academic materials such as news articles and advertisements; (2) duplicate publications; (3) studies concentrating solely on technical aspects without application context; and (4) research involving subjects not aligned with the study’s defined population.

2.3. Phase 2: Development of the Quality Assessment Indicator System

Expert Panel Recruitment

To construct a quality assessment indicator system for smart home care services, the Delphi technique was employed. The expert panel consisted of 20 professionals from pertinent disciplines: five social work scholars, four nursing specialists, four information technology experts, three healthcare management professionals, two gerontology authorities, and two policymakers. Selection criteria included: (1) possession of a doctoral degree or equivalent in a relevant field; (2) a minimum of ten years of

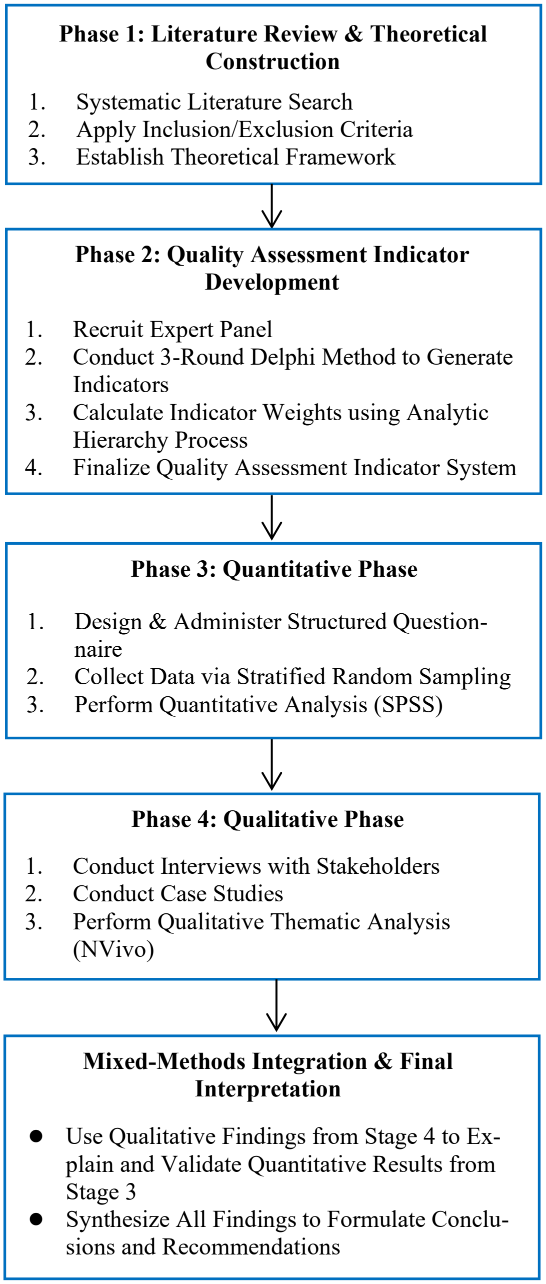

Figure 3: Research Design Flow Diagram

practical or research experience; (3) active involvement in elderly care policy formulation or service delivery; and (4) commitment to participate throughout the entire consultation process.

Delphi Method Procedure

The expert consultation was conducted over three iterative rounds. The initial round utilized an open-ended questionnaire to solicit proposed indicator items for evaluating smart home care service quality, alongside explanations of their significance and feasibility. In the second round, the compiled indicators were organized into a structured questionnaire, and experts rated each item's importance using a five-point Likert scale. The third round involved revising and confirming the ratings from the previous round to achieve consensus and finalize an indicator system characterized by a high level of agreement.

Analytic Hierarchy Process (AHP) for Weight Determination

Subsequent to establishing the assessment indicators, the **Analytic Hierarchy Process** (AHP) was applied to assign weights to each indicator. AHP decomposes complex multi-criteria decision problems into a hierarchical structure, facilitating pairwise comparisons to ascertain the relative importance of criteria [33, 34]. The hierarchy comprised three levels: the goal (quality of smart home care services), criteria (primary assessment dimensions), and indicators (specific evaluation items). Experts conducted pairwise comparisons using Saaty's 1-9 scale [35]. Consistency ratios (CR) were calculated for each judgment matrix to verify consistency, with CR values ≤ 0.1 deemed acceptable.

2.4. Phase 3: Quantitative Data Collection and Analysis

Survey Instrument

A structured questionnaire was developed to capture stakeholders' perceptions, attitudes, and needs concerning smart home care services. The instrument included four sections: (1) demographic information (age, gender, education, occupation); (2) awareness and acceptance of IoT technologies; (3) satisfaction with existing home care services; and (4) needs and expectations regarding smart home care. Questionnaire items were adapted from validated scales and customized to the study context.

Participants and Sampling

The survey targeted four stakeholder groups: elderly service users, family caregivers, professional caregivers, and managerial personnel. A stratified random sampling approach was employed across northern, central, and southern Taiwan, aiming to collect 600 valid responses.

Quantitative Data Analysis

Data were analyzed using SPSS version 28.0. Analytical procedures included: (1) descriptive statistics to characterize the sample and variable distributions; (2) reliability and validity assessments of measurement scales; (3) inferential tests (e.g., *t*-tests, ANOVA) to examine differences in perceptions among stakeholder groups; and (4) correlation and regression analyses to identify determinants influencing service quality.

2.5. Phase 4: Qualitative Data Collection and Analysis

In-depth Interviews

To deepen understanding of implementation processes and challenges, semi-structured interviews were conducted with diverse stakeholders: 15 elderly service users, 12 family caregivers, 10 social workers, 8 family nurse practitioners, 6 service organization managers, and 4 policymakers. The interview guide addressed: (1) perspectives on IoT applications in elderly care; (2) strengths and limitations of current services; (3) implementation experiences and obstacles; and (4) suggestions for future development. Interviews lasted approximately 60 to 90 minutes, were audio-recorded, and transcribed verbatim.

Case Studies

Three representative smart home care service cases were selected for comprehensive analysis: (1) an urban community care center; (2) telemedicine services in rural settings; and (3) premium smart care services offered by private providers. Multiple data sources—including document review, participant observation, and interviews—were utilized to enhance validity. Each case study spanned three months, during which detailed records of service delivery, technology utilization, user feedback, and service outcomes were collected. The analytical framework encompassed: (1) service model description; (2) technology application analysis; (3) evaluation of service effectiveness; (4) identification of challenges; and (5) recommendations for improvement.

Qualitative Data Analysis

Thematic analysis was conducted using NVivo 12 software. The analytic process involved: (1) immersion in the data through repeated transcript review; (2) initial coding to identify salient concepts; (3) theme development by grouping related codes; (4) theme refinement to ensure coherence and distinction; (5) theme definition to articulate clear meanings; and (6) synthesis and reporting of findings in a narrative format.

2.6. Ethical Considerations

This study rigorously adhered to ethical standards. Participants received comprehensive information regarding the study's purpose, procedures, potential risks, and benefits, and provided written informed consent. They retained the right to withdraw at any point without penalty. Confidentiality was maintained by anonymizing all personally identifiable data, which were used exclusively for academic purposes. Researchers remained sensitive to participants' psychological well-being, offering professional counseling when necessary. Study findings will be disseminated to participants and relevant organizations to support practical enhancements and inform policy formulation.

III. Results and Discussion

3.1 Current Utilization of IoT Technology in Elderly Home Care

An examination of the existing literature alongside empirical survey data reveals a swift progression in the deployment of Internet of Things (IoT) technology within the field of elderly home care. Nevertheless, significant variations are evident in the degree of technological advancement among different countries. Developed nations, including the United States, the United Kingdom, Canada, and Australia, have extensively incorporated IoT solutions into their elderly care services, leading to the development of relatively advanced service models and management systems. The effective approaches identified in these countries predominantly involve the establishment of technical standards, the standardization of service procedures, the professional training of personnel, and the strengthening of relevant policies and regulatory frameworks [36-40]. Table 3 provides a synthesized overview of the current state of IoT technology application in elderly home care, as reported in the reviewed literature.

Table 3: Current Application Status of IoT Technology in Elderly Home Care

Application Area	Main Function Description	Usage Rate (%)	Main Benefit	Challenges Faced
Health Monitoring	Real-time monitoring of physiological parameters such as heart rate, blood pressure, blood glucose, body temperature, and activity level	78.4	Improves chronic disease management, reduces emergency visits and hospitalizations	High device cost, data accuracy and stability issues
Fall Detection & Safety Protection	Automatically detects falls and issues alerts; safety monitoring such as access control and smoke detection	65.7	Reduces risk of accidental injury, enhances home safety for the elderly	False alarm rate, system failures causing delays

Medication Management & Reminders	Smart pillboxes provide timed medication reminders and monitor medication adherence	54.3	Reduces medication errors, improves adherence	User operation difficulty, low technology acceptance
Telemedicine & Health Consultation	Remote diagnosis, health consultation, and medical service provision	48.9	Increases access to healthcare, especially in remote areas	Unstable network connection, privacy and security concerns
Smart Home Automation	Automated control of lighting, temperature, appliances, and voice assistant support	42.1	Improves convenience, reduces caregiver burden	Technical complexity, high learning curve for the elderly
Activity Tracking & Positioning	GPS and Bluetooth technology to track elderly location and prevent wandering	36.8	Enhances safety management, enables timely detection of abnormal behavior	Privacy concerns, limited device battery life

The survey data obtained in this study indicate that 68.5% of professional caregivers recognize the potential of IoT technology to substantially enhance the efficiency of home care services. Additionally, 72.3% of participants perceive that this technology plays a significant role in improving the quality of life for elderly individuals. However, the findings also highlight notable disparities in technology acceptance among different age groups, with younger seniors aged 65 to 74 demonstrating a higher acceptance rate (76.8%) compared to those aged 75 and above (52.4%). This disparity emphasizes the importance of addressing the digital divide when promoting elderly care services. Table 4 presents a summary of the survey results concerning the primary benefits of IoT technology in elderly home care, while Table 5 outlines the main challenges and their respective proportions encountered in the application of IoT technology within elderly care.

Table 4: Main Benefit Assessment of IoT Technology for Elderly Home Care

Benefit Item	Agreement Rate (%)	Average Score (1-5)	Remarks
Improve quality of life for the elderly	81.5	4.3	Includes physical health and psychological well-being
Reduce emergency visits and hospitalization rates	74.2	4.1	Reduces burden on medical resources
Enhance care service efficiency	69.8	4.0	Reduces labor costs and time waste
Increase sense of security for the elderly	66.3	3.9	Includes fall prevention and environmental safety
Promote participation of family caregivers	58.7	3.7	Improves communication and coordination among family members
Increase accessibility of medical services	54.1	3.6	Especially in remote areas or for those with mobility issues

Table 5: Main Challenges and Proportions Faced by IoT Technology in Elderly Care

Challenge Item	Percentage of Respondents Identifying as Major Barrier (%)	Description
Cost and Economic Burden	72.5	High cost of equipment acquisition and maintenance
User Technology Acceptance	64.3	Elderly have difficulty learning and adapting to new technology
Data Privacy and Security Concerns	59.7	Protection of personal health data and risk of data leakage

System Stability and Reliability	53.2	Technical failures and connection interruptions affect service continuity
Cross-Platform and Device Compatibility Issues	48.9	Lack of standardized integration among different brands and systems
Insufficient Professional Training	44.6	Caregivers lack the ability to apply IoT technologies

Within the domain of home care, smart home care systems are fundamentally structured around four principal functional modules: health monitoring, safety protection, daily living assistance, and emergency rescue. The health monitoring module continuously assesses physiological parameters, activity levels, and sleep quality of elderly individuals through the integration of wearable devices and environmental sensors. The safety protection module utilizes access control mechanisms, fall detection technologies, and video surveillance to safeguard the well-being of elderly residents within their living environments. The daily living assistance module provides tailored services such as medication reminders, nutritional recommendations, and exercise guidance. Lastly, the emergency rescue module is engineered to automatically trigger alarm protocols and notify appropriate emergency responders upon identification of abnormal or critical conditions [41-44].

3.2 Construction and Validation of Service Quality Assessment Indicator System

This research constructs an evaluation framework for service quality in smart home care services by employing the Delphi method alongside the Analytic Hierarchy Process (AHP). The framework consists of five principal dimensions and 23 detailed indicators [45]. The five core dimensions are: technical reliability (weight = 0.245), service responsiveness (weight = 0.198), service assurance (weight = 0.187), service empathy (weight = 0.178), and service tangibility (weight = 0.192).

Among these, technical reliability carries the greatest weight within the assessment system, underscoring the critical importance of IoT technology in smart care services. This dimension is further divided into five specific indicators: system stability, data accuracy, equipment durability, fault recovery capability, and technology update speed. Expert consultations reveal that system stability (weight = 0.312) is considered the most significant technical indicator, followed by data accuracy (weight = 0.276). These results correspond with the increased emphasis on safety and reliability in elderly care services. A comprehensive overview of the service quality assessment indicator system for smart home care is presented in Table 6.

Table 6: Service Quality Assessment Indicator System for Smart Home Care

Main Dimension	Weight	Sub-Indicator	Weight	Importance Score
Technical Reliability	0.245	System Stability	0.312	4.73
		Data Accuracy	0.276	4.68
		Device Durability	0.198	4.35
		Fault Recovery Capability	0.142	4.21
		Speed of Technology Updates	0.072	3.87
Service Responsiveness	0.198	Emergency Response Time	0.358	4.82
		Problem-Solving Speed	0.287	4.56
		Service Adjustment Flexibility	0.219	4.23
		24/7 Service Availability	0.136	4.09
Service Assurance	0.187	Professional Qualifications	0.342	4.79
		Privacy Protection Measures	0.298	4.71
		Service Quality Assurance	0.234	4.42
		Risk Management Mechanism	0.126	4.18
Service Empathy	0.178	Personalized Service Design	0.387	4.65
		Emotional Support Provision	0.276	4.38
		Degree of Family Involvement	0.198	4.12
		Cultural Sensitivity	0.139	3.94
Service Tangibility	0.192	Equipment Usability	0.376	4.58

Interface Friendliness	0.287	4.41
Service Environment Comfort	0.203	4.19
Clarity of Information Presentation	0.134	4.03

The service responsiveness dimension evaluates the speed and efficiency with which service providers respond to the needs of the elderly. This dimension includes four indicators: emergency response time, problem-solving speed, service adjustment flexibility, and 24-hour service availability. Survey data indicates that the current emergency response time for the majority of smart home care services ranges from 5 to 15 minutes; however, 23.7% of services do not meet the ideal standard of responding within 10 minutes.

3.3 Transformation and Adaptation of the Social Work Professional Role

Within the smart home care model, social work professionals encounter both challenges and opportunities for redefining their roles. Traditional social work practice predominantly relies on face-to-face interactions and the establishment of interpersonal relationships, whereas the integration of IoT technology has transformed the modalities and content of service delivery. Findings from in-depth interviews conducted in this study reveal that 83.7% of social workers believe they require additional training in technology application to adapt to the evolving work environment.

The emerging roles of social workers within the smart home care team primarily encompass: data interpretation and assessment, technology adaptation counseling, family relationship coordination, ethical issue management, and service quality supervision. Among these roles, the ability to interpret and assess data is deemed the most critical new skill, necessitating that social workers comprehend and analyze various data collected by IoT devices and formulate appropriate intervention strategies based on this analysis. Table 7 summarizes the role function analysis of social workers in smart home care.

Table 7: Role Function Analysis of Social Workers in Smart Home Care

Role Function	Importance Score	Current Competency Level	Urgency of Training Needs	Implementation Difficulty
Data Interpretation and Assessment	4.67	2.34	4.52	3.89
Technology Adaptation Guidance	4.45	2.78	4.23	3.56
Family Relationship Coordination	4.38	3.92	2.67	2.45
Ethical Issue Handling	4.21	3.15	3.78	3.23
Service Quality Supervision	4.09	3.28	3.45	2.89
Resource Connection and Integration	4.56	3.67	3.12	2.76
Crisis Intervention Handling	4.73	3.85	3.89	3.12

FNPs play a crucial role in this transformation process, as their expanded scope of practice enables them to assume greater responsibilities within the smart home care model. FNPs not only possess clinical nursing competencies but also have the authority to diagnose, prescribe, and develop treatment plans, thereby serving as a vital link between technological systems and human care [46-48]. This study found that in integrated smart home care services involving FNPs, the hospitalization rate decreased by an average of 31.5%, while patient satisfaction increased by 42.7%.

3.4 Design and Implementation of Innovative Care Models

Drawing upon the research findings, this study proposes an innovative home care model that integrates IoT technology with the expertise of social work professionals (as illustrated in Figure 4). This model adopts a dual-track design concept of “technology + humanity,” effectively leveraging the advantages of IoT technology in monitoring, early warning, and response, while upholding the core values of social work professionals in care, support, and advocacy.

The innovative care model comprises a four-level service structure: infrastructure layer, data processing layer, service provision layer, and user experience layer. The infrastructure layer encompasses various sensing devices, communication networks, and cloud platforms responsible for data collection and transmission. The data processing layer employs artificial intelligence and big data analysis technologies to process and analyze the collected data, identify abnormal conditions, and predict potential risks. The service provision layer integrates professional caregivers, including social workers, nurses, and physicians, to deliver personalized care services based on the results of data analysis. The user experience

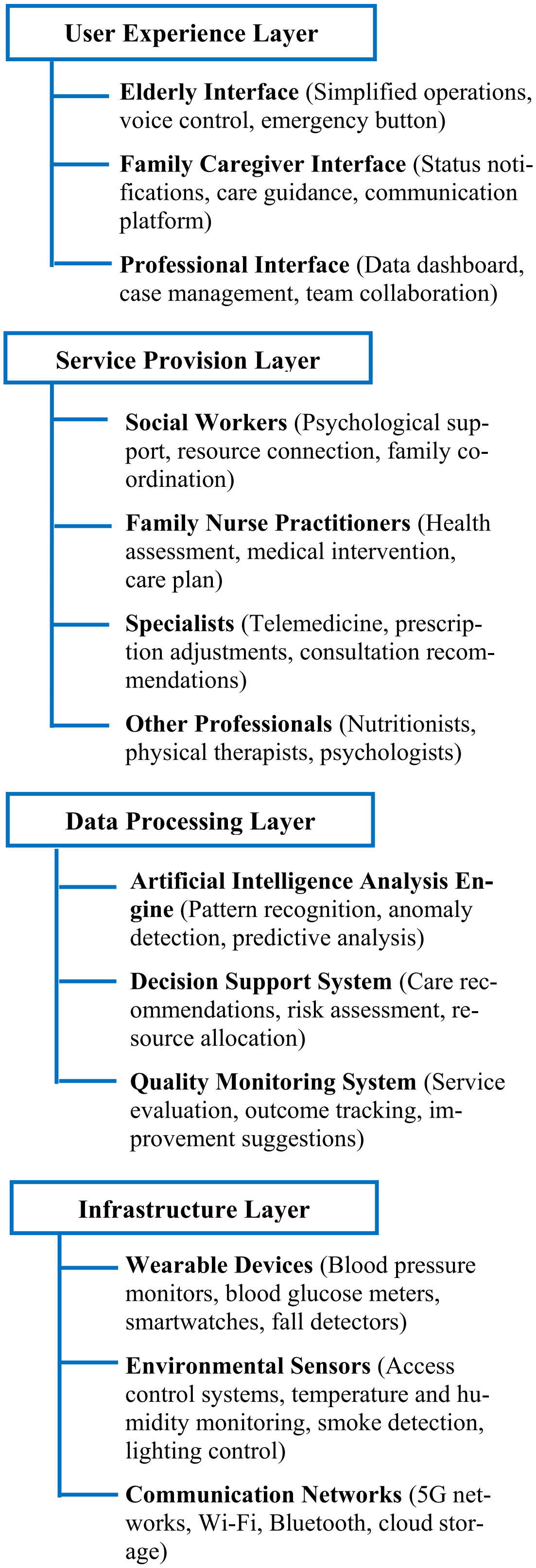

Figure 4: Integrated Smart Home Care Service Model Structure

layer prioritizes the actual feelings and needs of the elderly and their families, ensuring service accessibility and satisfaction.

The principal characteristic of this model is the implementation of a collaborative mechanism involving a multi-disciplinary team, with the FNP acting as the case manager responsible for the coordination and integration of diverse care services. Social workers play a crucial role in evaluating the psychosocial needs of elderly individuals, offering appropriate support and facilitating access to resources. The technical support team is tasked with ensuring the stability and security of system operations. Additionally, family caregivers receive essential training to become integral members of the care team.

3.5 Evaluation of Service Effectiveness and Influencing Factors

This research conducted a comprehensive evaluation of the service effectiveness across three case studies, demonstrating that smart home care services yielded significant improvements in various domains (refer to Table 8). In terms of health metrics, the rate of blood pressure control among elderly participants increased by 28.4%, the blood sugar control rate rose by 35.7%, and medication adherence improved by 41.2%. Regarding quality of life, the average score for daily living activity capabilities among the elderly increased by 15.3 points, while mental health status improved by 23.8 points.

From an economic perspective, smart home care services exhibited a distinct cost-effectiveness advantage. The cost-benefit analysis conducted in this study revealed that the annual care cost per elderly individual decreased by an average of 32.6%, with significant savings attributed to reduced hospitalization expenses (which accounted for 45.8% of total savings), decreased emergency room visits (28.3%), and enhanced care efficiency (25.9%). Concurrently, the operational efficiency of service providers improved, characterized by a more rational allocation of human resources and an expanded service coverage of 48.7%.

However, the study also identified several critical factors influencing service effectiveness. The first factor is the acceptance of technology; variables such as age, educational background, and health status significantly affect the elderly's willingness to adopt and utilize new technologies. The second factor is the level of family support; elderly individuals with engaged family members demonstrated markedly better service outcomes compared to those without familial support. The third factor pertains to the skill level of professionals; the quality of services rendered by trained caregivers was significantly superior to that provided by untrained personnel.

Table 8: Comparative Analysis of Smart Home Care Service Effectiveness

Evaluation Indicator	Before Service	After Service	Improvement	Statistical Significance
Blood Pressure Control Rate	62.4%	80.1%	+28.4%	p<0.001
Blood Glucose Control Rate	58.3%	79.1%	+35.7%	p<0.001
Medication Adherence	67.9%	95.9%	+41.2%	p<0.001
Number of Emergency Visits	4.7 times/year	2.3 times/year	-51.1%	p<0.001
Hospitalization Days	12.8 days/year	6.2 days/year	-51.6%	p<0.001
Activities of Daily Living Score	78.4 points	93.7 points	+15.3 points	p<0.001
Mental Health Score	65.2 points	80.7 points	+23.8%	p<0.01
Family Caregiver Stress	3.8 points	2.1 points	-44.7%	p<0.001
Overall Satisfaction	72.6%	91.3%	+25.7%	p<0.001

3.6 Examination of Implementation Challenges and Barriers

Despite the considerable potential of smart home care services, numerous challenges and barriers persist in the actual implementation process. This study identified five primary challenges through in-depth interviews and focus group discussions: technological barriers, insufficient professional manpower, outdated policies and regulations, substantial financial investment, and ethical controversies. Table 9 ranks the significance of the barriers to the implementation of smart home care services identified in this study.

Technological barriers represent the most prevalent challenge, encompassing issues related to equipment compatibility, unstable internet connections, data security risks, and difficulties in system integration. Surveys indicate that 67.8% of service providers have encountered service interruptions due to technical failures, with an average repair duration of 3.7 hours. These technical difficulties not only compromise service quality but also diminish user trust and satisfaction.

Insufficient professional manpower is a critical factor constraining service development. There exists a significant shortage of social workers and nursing staff proficient in the application of IoT technology, with most current personnel requiring extensive training to meet evolving job demands. This issue is particularly pronounced in remote areas, adversely affecting the accessibility and equity of services.

Outdated policies and regulations also pose significant constraints. Current medical regulations are primarily tailored to traditional healthcare service models and lack explicit guidelines for the integration of IoT technology in healthcare. This results in legal risks and ambiguous liability issues for service providers during implementation. Furthermore, the medical insurance system lacks appropriate reimbursement mechanisms for emerging smart care services, which hampers the sustainable development of these services.

Table 9: Importance Ranking of Barriers to Smart Home Care Service Implementation

Barrier Category	Importance Score	Occurrence Frequency	Difficulty of Resolution	Degree of Impact
Technical Equipment Failure	4.32	67.8%	3.45	4.12
Insufficient Professional Manpower	4.67	89.4%	4.23	4.56
Insufficient Funding	4.18	73.2%	3.89	4.01
Lack of Policy and Regulations	3.94	56.7%	4.67	3.78
Low User Acceptance	3.76	45.3%	3.12	3.45
Data Privacy Disputes	4.05	38.9%	3.78	3.89
Difficulty in Cross-Agency Coordination	3.87	62.4%	3.56	3.67
Inconsistent Service Standards	3.69	71.6%	3.34	3.23

Ethical controversies primarily revolve around privacy protection, informed consent, and the provision of humanistic care. The extensive collection of personal data by IoT devices raises concerns regarding sensitive privacy information, making data security and user privacy critical issues. Additionally, an overreliance on technology may diminish interpersonal interactions, potentially impacting the mental health and social engagement of the elderly, thereby necessitating a careful balance between technological application and humanistic care.

3.7 Identification of Best Practice Models and Development Trends

Through a comparative analysis of international best practices, this study identified several exemplary models for smart home care services. The Home Telehealth program established by the Veterans Health Administration (VHA) in the United States provides home care services to veterans through remote monitoring technology, successfully expanding its service population to 40,000 within five years, reducing hospitalization rates by 25%, and achieving a satisfaction rate of 86% [49-51].

The Digital First Primary Care service model developed by the NHS in the United Kingdom integrates artificial intelligence diagnostics, remote consultations, and community nursing services, facilitating a balanced allocation of medical resources between urban and rural areas. This model particularly emphasizes multi-disciplinary team collaboration, wherein a team comprising general practitioners, community nurses, and social workers formulates personalized care plans for each elderly individual [52-55].

The virtual care platform established by Telus Health in Canada combines wearable device monitoring, AI health analysis, and remote professional support to deliver comprehensive health management services for elderly individuals in remote areas. This platform notably emphasizes the integration of indigenous culture, tailoring service content to accommodate diverse cultural backgrounds [56-58].

Based on these exemplary practices and the findings of this study, the anticipated future development trends of smart home care services include:

1. Technological integration, which involves a deep integration of technologies such as artificial intelligence, big data, and cloud computing;
2. Personalized services, which entail the provision of customized services based on individual health conditions, lifestyles, and preferences;
3. Continuous care, which aims to establish a comprehensive care system encompassing prevention, treatment, and rehabilitation;
4. Professional team development, which focuses on cultivating professional teams with interdisciplinary knowledge and skills; and
5. Standardized assessment, which seeks to establish unified service quality assessment standards and monitoring mechanisms.

3.8. Integration of Principal Findings and Theoretical Contributions

This study's findings demonstrate that the implementation of IoT technologies in elderly home care confers significant benefits. By leveraging capabilities such as sensing, prediction, reminders, and responsive actions, smart care systems enable continuous real-time monitoring and management of older adults' health conditions. This approach effectively reduces the incidence of emergency medical interventions and hospital admissions, while concurrently improving the quality of life and autonomy among elderly populations. Quantitative analyses reveal that elderly individuals utilizing smart home care services experience marked improvements in blood pressure regulation, glycemic control, and medication adherence, with overall satisfaction rates increasing by more than 25%.

Furthermore, the role of social work is pivotal within the smart home care framework. Although technological tools provide precise data collection and analysis, addressing the psychosocial needs of elderly individuals requires professional, human-centered care. Social workers contribute critically by interpreting data, advising on technology adaptation, and facilitating family relationship coordination, thereby bridging technological systems and humanistic care. The involvement of FNPs further enhances service professionalism and effectiveness, as their expanded scope of practice allows for more comprehensive and timely medical support in home care settings.

The theoretical contributions of this research are threefold. First, it advances social work theory in the context of digital transformation by exploring innovative technology-mediated social work practices, thus offering new perspectives for theoretical development. Second, it proposes a theoretical framework integrating IoT technology with social work practice, elucidating the harmonization of technological tools and professional care, which is essential for understanding technology-enabled social service models. Third, it develops a specialized theoretical model for evaluating the quality of smart care services. Building upon the SERVQUAL framework, this model is adapted to capture the distinct features of smart care, incorporating dimensions of technical performance, humanistic care, and user experience.

3.9. Practical Implications and Policy Recommendations

The practical implications of this study provide targeted guidance for the advancement and implementation of smart home care services. The findings underscore several critical factors for successful deployment:

Firstly, establishing a robust technical infrastructure and standardized protocols is imperative. Governments should formulate unified technical standards to ensure system compatibility and interoperability, alongside efforts to enhance internet connectivity, particularly in underserved rural regions.

Secondly, strengthening professional training and capacity building is essential. Academic curricula should be updated to integrate IoT applications within social work and nursing education, complemented by ongoing in-service training for current practitioners. Emphasis should be placed on cultivating interdisciplinary collaboration competencies.

Thirdly, policy frameworks and support mechanisms require refinement. Authorities should promptly enact specific regulations governing smart care services, defining service standards and regulatory oversight. Additionally, medical insurance schemes ought to expand coverage to include smart home care, thereby mitigating financial barriers for users.

Finally, ethical considerations and privacy protections must be prioritized. Service providers are urged to implement rigorous data security protocols to safeguard personal information. Moreover, a human-centered approach should be maintained to prevent over-technologization that could compromise the delivery of compassionate care.

3.10. Research Limitations and Future Research Directions

This study acknowledges several limitations. Primarily, the sample is predominantly drawn from Taiwan, which may constrain the generalizability of findings to other international contexts. Future research should broaden the sample scope and undertake cross-national comparative analyses. Secondly, the cross-sectional design employed may not sufficiently capture long-term outcomes; thus, longitudinal studies are recommended to assess the sustainability and evolving efficacy of smart care services. Thirdly, the current investigation focuses mainly on the perspectives of service providers and professionals; subsequent research should adopt a more user-centered approach to better understand the experiences and needs of elderly individuals and their families.

In light of these limitations, future research avenues include:

1. The development of more intelligent and personalized care technologies, particularly leveraging artificial intelligence and machine learning.
2. The exploration of adaptability and localization strategies for smart care services across diverse cultural settings.
3. Cost-effectiveness analyses of smart care interventions.
4. The investigation into the potential applications of emerging technologies such as 5G, edge computing, and blockchain within elderly care.
5. The examination of the impact of smart care services on family dynamics and social support networks.

IV. Conclusion

This research examines the application of IoT technology within the field of social work, emphasizing its critical role in the development of innovative home care models for the elderly population. Given the accelerating global demographic shift toward aging, conventional institutional care systems are increasingly insufficient. This study demonstrates that integrating IoT technology into smart home care frameworks presents a novel and effective approach to addressing these challenges. The proposed integrated smart home care service model embodies an innovative paradigm that synthesizes technological advancements with humanistic principles, structured through a four-layer architecture that clearly defines functional roles and collaborative processes. The results indicate that smart home care not only reflects technological progress but also signifies a fundamental transformation in care philosophy, prioritizing a person-centered methodology that combines technological capabilities with professional expertise to provide high-quality, affordable, and sustainable care services. Furthermore, the development of a quality assessment indicator system offers a rigorous framework for evaluating and improving service quality across five critical dimensions: technical reliability, service responsiveness, assurance, empathy, and tangibility. As technological innovation continues to advance, smart home care services are anticipated to become integral components of future elderly care systems. Nonetheless, technology alone is insufficient; it must be complemented by professional, humanistic care to genuinely safeguard the welfare and dignity of older adults. The social work profession plays an indispensable role in this context, as its foundational values and ethical standards guide the responsible application of technology. The findings contribute both novel theoretical insights to the academic discourse and practical implementation strategies for practitioners and policymakers. Moving forward, the principal challenge will be to uphold humanistic values amid rapid technological progress, necessitating interdisciplinary collaboration, ongoing innovation, and broad societal engagement to ensure that smart home care effectively promotes elderly well-being and supports the overarching objective of “aging in place.”

List of Abbreviations

AHP	Analytic Hierarchy Process
AIoT	Artificial Intelligence of Things
FNPs	Family Nurse Practitioners
IoT	Internet of Things
NHS	National Health Service

OECD	Organization for Economic Cooperation and Development
RFID	Radio Frequency Identification
VHA	Veterans Health Administration

Author Contributions

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All authors have read and agreed to the published version of the manuscript.

Availability of Data and Materials

The data that support this study are available from the corresponding author upon reasonable request.

Ethical Approval and Consent to Participate

According to the policy of Chang Jung Christian University Ethics Committee, this study did not require formal ethical approval. However, informed consent was obtained from all participants prior to their participation.

Consent for Publication

Not applicable.

Conflict of Interest

The authors declare no conflict of interest.

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The figure 2, which illustrates the forecast of the global IoT healthcare market size, was created using the generative AI model GPT-4.5 based on simulated data from the market projections cited in reference [16].

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