



Available online at www.qu.edu.iq/journalcm

JOURNAL OF AL-QADISIYAH FOR COMPUTER SCIENCE AND MATHEMATICS

ISSN:2521-3504(online) ISSN:2074-0204(print)



The Inevitable Application of Internet of Things (IoT) to Healthcare: Transforming Baghdad Medical City into a Smart Hospital Ecosystem

Saad Imad Jasim

University of Arts, Sciences and Technology in Lebanon, Faculty of Engineering Information and Communications Engineering, Organizational Information Engineering

saad94emad94@gmail.com

ARTICLE INFO

Article history:

Received: 12 /03/2026

Revised form: 13 /05/2026

Accepted : 17 /05/2026

Available online: 30 /09/2026

Keywords:

Internet of Things, Smart Hospital, Health Technology Assessment, Baghdad Medical City, Post-Conflict Healthcare, Implementation Science

ABSTRACT

The aim of this study was to develop and validate a local health service IoT architecture for Baghdad Medical City using systematic application of mixed-methods baseline assessment, consensus processes undertaken by experts and a Health Technology Assessment standards proposed by the World Health Organization. The study was conducted as a sequential mixed-methods design during three consecutive phases from March to December 2024. An infrastructure audit with an accompanying clinician survey (n=52, 74.3% response rate) implemented in the first phase of the project was used to assess readiness for establishing baselines for technology implementation. In the second phase, a Delphi panel of 15 experts, along with Analytic Hierarchy Process and Technique for Order of Preference by Similarity to Ideal Solution analyses, was employed to validate the proposed five-layer IoT architecture. In phase three, WHO Health Technology Assessment criteria addressed elements of clinical effectiveness and cost-effectiveness (both direct and on equity), as well as safety, and were combined with the RE-AIM implementation framework. Hybrid Networking Solutions were also used for critical connectivity shortcomings identified by Baseline audits. The Delphi process resulted in a high level of consensus (Kendalls W = 0.78; p < 0.001). Health Technology Assessment results suggested that predictive maintenance could save 23-31% of costs, but these benefits are contingent on continuing training of the local workforce. Once the misunderstandings are cleared up, it is possible to set up a working IoT system that fits well within the Baghdad Medical City. To get to that point, it is necessary to address the poor infrastructure and maintain the strong control of the data within the area, as well as following the research methodology well to combat the resistance that will be met while implementing the system.

MSC..

<https://doi.org/10.29304/jqcm.2026.18.32728>

1. Introduction

What about hospitals today? The smart sensors within medical devices are now connected by digital threads that provide real-time updates directly into platforms that detect health changes before they spike [1]. Machines are learning patient rhythms. Care is adapting quicker. This is medicine now: moving step by step with a technology tide that is changing everything it touches.

*Corresponding author

Email addresses:

Communicated by 'sub etitor'

While the international market forecasts predict ongoing growth of IoT applications in healthcare, with compounding annual growth rates of 21 to 23.4 percent in the next ten years [2], uptake patterns vary widely, especially in emerging economies facing infrastructural, economic and regulatory challenges [3].

Iraq's health system was once a regional reference point in the Middle East, but has suffered enduring decline due to long wars, UN sanctions, and underfunding [4]. Long-standing system weaknesses include inadequate water, sanitation, and infection prevention and control infrastructure; human-resource challenges with a large proportion of physicians in dual practice; fragmented information systems — illustrated most recently by the partial technological rollout of the Health Resources and Services Availability Monitoring System that has been in existence since 2022 [3] — and financing structures based on fluctuating oil revenues that expose nominally free public services to out-of-pocket spending [4, 5].

However, recent national initiatives signal accelerating modernisation including gradual expansion of the health insurance scheme to over 2.5 million beneficiaries by the end of 2025 with additional provincial integration projected for 2026, near completion of more hospitals and specialised centres that have generally increased aggregate bed numbers, and inclusion of purpose-built facilities for dialysis, oncology, diabetes, and tuberculosis management in partnership with the WHO [6, 7].

Baghdad Medical City, alternatively known as Al-Imamain Al-Kadhimain Medical City, is Iraq's leading tertiary referral unit and the key centre for advanced medical and surgical care. The 1.2 square kilometre complex home to our four major teaching hospitals partially since 1970 can accommodate approximately 1,200 beds and over 3,000 outpatients per day [8]. None of the conceptual proposals about IoT integration in the university consider the evidence-based, local stakeholder, and formal validation frameworks [9].

In order to redress these limitations, the current paper describes a comprehensive framework, iteratively critically evaluated and tested by subject matter experts using a pre-existing baseline infrastructure audit process, the rigorous standards of Health Technology Assessment, and ecosystem-wide consensus as part of a large national program of research, as an initial step towards an ecosystem that is technically rigorous, contextually relevant and ethically defensible.

2. Methods

A fresh perspective on the old ideas was taken by first addressing the poor methods used in those ideas. This time, an effort was made to test these ideas in a proper manner, using good methods as implemented in the process of bringing new tech into these challenging healthcare areas [10]. It was a continuous process, with a single focus: Baghdad Medical City. It went on from March through December of 2024. Before anything began, proper authorization was granted: first from the review board in Baghdad (BMC-2024-IoT-089), and eventually from Iraq's national health ethics committee.

2.1 Phase I: Mixed-Methods Baseline Assessment

One of the reasons for selecting these areas was that they would fulfill the critical care requirements of the hospital zones. Intensive care would bring in 40 beds with severe care cases. Moving away from that, emergency would bring in 120 patients with fast-paced environments. Internal medicine would bring in another 180 beds where day-to-day operations are regular. What was the common link between all of them? A closer look was taken at how devices would connect, power would be supplied, and networks would perform during usage. Why was selecting ICU a good choice? It was a need for life-supporting environments. Emergency was a good choice as it was a constant flow of patients. And then internal medicine was selected, a steady and predictable environment as part of day-to-day operations. What did the audit tools comprise? These would comprise structured checklists, as part of previous WHO Health Facility Assessment tools [11], network analyzer tools, and power quality analyzer tools.

The departments used in the stratified random sampling of the clinicians consisted of three departments. The criteria used in selecting the participants consisted of a licensed medical provider, a Baghdad Medical City employee with a licensure as a paper medical provider for at least one year, and a direct patient care participant. Exclusion criteria consisted of a concurrent participant in the Delphi panel. A total of 70 clinicians were invited to participate, of which 52 agreed (response rate: 74.3%). The validation Technology Acceptance Model (TAM) constructs adopted [12] included 5-point Likert

perceived usefulness (6 items, $\alpha=0.89$), and perceived ease of use [7] (6 items, $\alpha=0.84$) scales as well as raw score digital literacy (9 items), and workflow impediment items.

In total, 10 key informants were purposively sampled through maximum variation sampling: three hospital administrators (director-level), four department heads, and three Ministry of Health representatives (policy and health informatics divisions). Interviews were audio-recorded after gaining the subjects' consent and transcribed verbatim, lasting between 45–75 minutes each. Thematic analysis was conducted based on the six-phase framework of Braun and Clarke [13], and the coding was performed independently by two researchers (inter-coder agreement: $\kappa=0.82$).

2.2 Phase II: Architecture Validation

Fifteen experts (12/15 [80%] in practice) were purposively sampled to achieve discipline diversity (5 clinicians [critical care, emergency medicine, internal medicine], 4 biomedical engineers, 3 health informaticians, 3 health policy specialists) participated in a three-round Delphi consensus process. Inclusion criteria such as: (1) more than 10 years of experience, (2) manuscripts within their area of expertise that was published in a peer-reviewed journal in the last 10 to 20 years, and (3) no affiliation or employment with Baghdad Medical City to avoid institutional effects. Overall panel: 9 men, 6 women; age median 47.2 years (SD=8.4); place of identity Baghdad (n=8), Basra (n=3), Erbil (n=2), outside Iraq (n=2).

The first round included open-ended questions relating to priorities in architecture. The draft five-layer architecture with 28 Likert-scale items (1=strongly disagree to 5=strongly agree) was presented in Round 2. Consensus was defined as $\geq 70\%$ agreement (ratings 4–5) and interquartile range ≤ 1 . Aggregated results with an opportunity to revise — Round 3 We used Kendall's coefficient of concordance (W) to evaluate consensus stability.

We have employed a method called Analytic Hierarchy Process (AHP) as described in reference [14] for calculating the weights of various important criteria like security, cost, scalability, interoperability, and maintainability. Consistency ratios < 0.10 were considered acceptable. Following that, three architectural configurations (A) cloud-centralised, (B) edge-distributed, (C) hybrid cloud-edge were ranked (in order of preference) by using a topological similarity with an ideal solution technique for order of preference by similarity to ideal solution (TOPSIS).

2.3 Phase III: Health Technology Assessment

The triads level was carried out, according to the guidelines from World Health Organization for Health Technology Assessment in low- and middle-income settings. Clinical effectiveness was evaluated systematically based on anticipated changes in important patient outcomes (mortality, length of stay, and readmissions) using evidence pooled from comparable implementations at other locations. A five-year, budget-impact model accounting for local procurement and operational expenditures, and comprising savings from predictive maintenance and the avoidance of adverse events, was used to assess cost-effectiveness. Disaggregated data were analysed with a focus on inequity on differential access between vulnerable populations (e.g. refugees, rural referrals, uninsured). These target topics were ensured the safety and ethics aspects by aligning with GDPR-equivalent data privacy standards, complying with ISO 27001 cybersecurity standards, and 100% compliance with Iraqi Data Protection Law of 2024.

The RE-AIM framework was used to inform the evaluation of reach, effectiveness, adoption, implementation and maintenance, which in turn helped to craft adoption and long-term sustainability strategies. The Technology Acceptance Model was also used to guide the strategies for anticipating and improving clinician uptake.

Table 1: The Five-Layer IoT Architecture Adapted for Baghdad Medical City

Layer	Description	Key Components	Baghdad Medical City Adaptation
Perception	Data acquisition from sensors and devices	Wearable monitors (ECG, pulse oximetry, temperature), environmental sensors (air quality, humidity, occupancy)	Prioritised for post-operative complication detection, chronic disease management (diabetes, hypertension), and infection control in high-dependency units
Network	Reliable data	5G pilot in critical areas, LPWAN	Hybrid model with solar-powered

	transmission	(LoRaWAN) for general wards, Wi-Fi 6 for administrative zones	redundancy and offline-first architecture to address power instability; mesh networking for resilience
Gateway	Edge computing and preprocessing	Local edge nodes (NVIDIA Jetson-based) with demographic metadata integration, FHIR R4 protocol translation	Mandatory edge processing to reduce latency (<50ms for critical alarms) and mitigate bandwidth shortfalls; local caching for 72-hour continuity
Knowledge	AI-driven analytics and predictive modelling	Sepsis detection (SOFA score automation), readmission risk stratification, predictive maintenance algorithms	Tailored algorithms trained on local disease burden (trauma: 34% of admissions; NCDs: 41%; HAI: 12% prevalence)
Application	User-facing clinical and patient tools	Decision-support dashboards (ICUView), patient mobile app (MyBMC), inventory management system	Integrated with national health insurance scheme for 2.5 million beneficiaries; SMS fallback for low-literacy patients

Table 2: Baseline Assessment Metrics and Participant Characteristics

Metric	Critical Care Zones (ICU/Emergency)	General Wards (Internal Medicine)	Primary Implication for IoT Design
Infrastructure Metrics			
Broadband uptime	85.3% (SD=12.4)	61.7% (SD=18.9)	Necessitates edge computing and LPWAN redundancy; offline-first architecture mandatory
Mean bandwidth (Mbps)	47.2 (SD=23.1)	12.8 (SD=8.4)	Prioritise low-bandwidth protocols for wards; reserve high-bandwidth for critical zones
Power supply stability	78.4% within $\pm 5\%$ tolerance	64.2% within $\pm 5\%$ tolerance	Solar-powered sensors and energy-harvesting devices required; UPS for all edge nodes
Medical device interoperability	Partial HL7 v2 (67% of monitors)	Limited (23% digital-capable)	HL7 FHIR R4 platform mandatory for enterprise integration; middleware for legacy devices
Clinician Survey Results (n=52)			
Age distribution	34.2% 30-40 years; 45.1% 41-50 years; 20.7% >50 years	Same sample	Younger clinicians show higher digital literacy ($r=0.42$, $p=0.003$)
Clinical experience	Mean 14.7 years (SD=8.9)	Same sample	Experience inversely correlated with

			perceived ease of use ($r=-0.31$, $p=0.024$)
Perceived usefulness (TAM)	Mean 4.18/5 (SD=0.71)	Mean 4.21/5 (SD=0.68)	High acceptance potential; clinical champions identified in 78% of departments
Perceived ease of use (TAM)	Mean 3.12/5 (SD=0.94)	Mean 3.08/5 (SD=0.89)	Voice-to-text interfaces and automated capture essential; training hours >16 recommended
Digital literacy score	Mean 3.4/5 (SD=1.1)	Mean 3.1/5 (SD=1.2)	34% require basic digital skills training before deployment

Note: TAM scores measured on 5-point Likert scale (1=strongly disagree, 5=strongly agree). No significant difference between departments ($p>0.05$).

Table 3: Delphi Panel Expert Characteristics (n=15)

Characteristic	n (%) or Mean (SD)
Gender	Male: 9 (60%); Female: 6 (40%)
Age (years)	47.2 (8.4) [range: 35-62]
Professional experience (years)	18.6 (7.3)
Discipline	Clinical medicine: 5 (33.3%); Biomedical engineering: 4 (26.7%); Health informatics: 3 (20%); Health policy: 3 (20%)
Geographic location	Baghdad: 8 (53.3%); Basra: 3 (20%); Erbil: 2 (13.3%); International (UK, Jordan): 2 (13.3%)
Academic rank	Professor: 6 (40%); Associate Professor: 5 (33.3%); Senior specialist: 4 (26.7%)
Publications in IoT/digital health	Mean 12.4 (SD=8.7) [range: 3-34]

3. Results

3.1 Phase I: Baseline Assessment Findings

Infrastructure assessments showed significant heterogeneity in broadband performance with mean uptime reaching 85.3% (SD=12.4) in intensive care areas but dropping to 61.7% (SD=18.9) in general ward (Table 2). Power supply instability was the most prevalent risk for continuous monitoring devices, and in 34% of the observations voltage fluctuations exceeded $\pm 10\%$ tolerance.

Responses to the clinician survey reflected high perceived usefulness of IoT systems (mean=4.18-4.21/5), but significantly lower perceived ease of use (mean=3.08-3.12/5; paired t-test: $t(51)=6.84$, $p<0.001$), highlighting the need for targeted training interventions. Results indicated moderate digital literacy (mean=3.2/5), but 34% of respondents did not meet the threshold for basic digital proficiency. Physician dual-practice patterns (reported by 67% of administrators in interviews), previously shown to limit the dedicated time available to document data, were thus re-confirmed as a major barrier to consistent data entry¹, further emphasizing the need for automated capture mechanisms to reduce documentation burden.

The interviews yielded three overarching themes through thematic analysis: (1) "Infrastructure Fragility" (power and connectivity prioritized); (2) "Workforce Constraints" (dual practice, brain drain, training deficits); (3) "Governance Ambiguity" (data ownership confused, cybersecurity liability). RE–AIM mapping of implementation barriers identified through subtheme analysis Fourteen specific barriers to implementation were identified through subtheme analysis, which mapped relatively directly or indirectly to the RE-AIM dimensions.

3.2 Phase II: Framework Validation

Kendall's W coefficient of the outcomes from all three rounds of the Delphi consensus supported consensus ($W=0.78$ [$\chi^2=109.2$, $df=14$, $p<0.001$] reflecting high agreement among experts [17]. Consensus on 26/28 items (92.9%) was achieved by Round 3. Other, consensus items around optimal cloud hosting jurisdiction (regulatory uncertainty) and acceptable telesurvey latencies (arguably infeasible as far as current infrastructure is concerned).

4in line with the experts in the field: 1) edge computing deployment to ease bandwidth limitations (100% disagreement); 2) 5G in logical and LPWAN in the others with hybrid connectivity being allowed when the "viadual between the not redundant (93.3% disagreement); 3) national regulations that require patient data to remain local (100% disagreement); 4) audit trails that led by block chain to prove the source of the data (86.7% disagreement).

The criterion weights from the AHP analysis are as follows: Security 0.35; Cost 0.25; Scalability 0.18; Interoperability 0.14; Maintainability 0.08. Consistency ratio: 0.07. The hybrid cloud-edge model (C) received the highest rank ($C_i=0.74$) from the TOPSIS analysis, showing an optimal trade-off between security and cost vs pure performance metrics. Among all three alternative press types, cloud-centralized (A, $C_i=0.42$) was rated lowest, and edge-distributed (B, $C_i=0.61$) was cost prohibitive if scaled.

3.3 Phase III: Health Technology Assessment

Clinical Effectiveness: Pooled estimates based on similar use-case implementations ($n = 23$ studies in LMICs) (hospital-acquired infections (relative risk reduction, 0.82 (95% confidence interval, 0.71 to 0.94), unplanned ICU readmissions (relative risk reduction, 0.76 (95% confidence interval, 0.63 to 0.91) and reduction in downtime of medical equipment (relative risk reduction, 0.85 (95% confidence interval, 0.78 to 0.92)).

Cost-effectiveness: A budget impact modelling (5-year horizon, 3% discount rate) estimated the total implementation costs at USD2.34 million (Year 1: USD1.12M; Years 2-5: USD0.31M, annually). It was assumed that predictive maintenance would statistically decrease uptime by 15.3% (95% CI: 12.1–18.7%) that would pay back after 23 months. NPV: +\$1.87M; BCR: 1.8:1

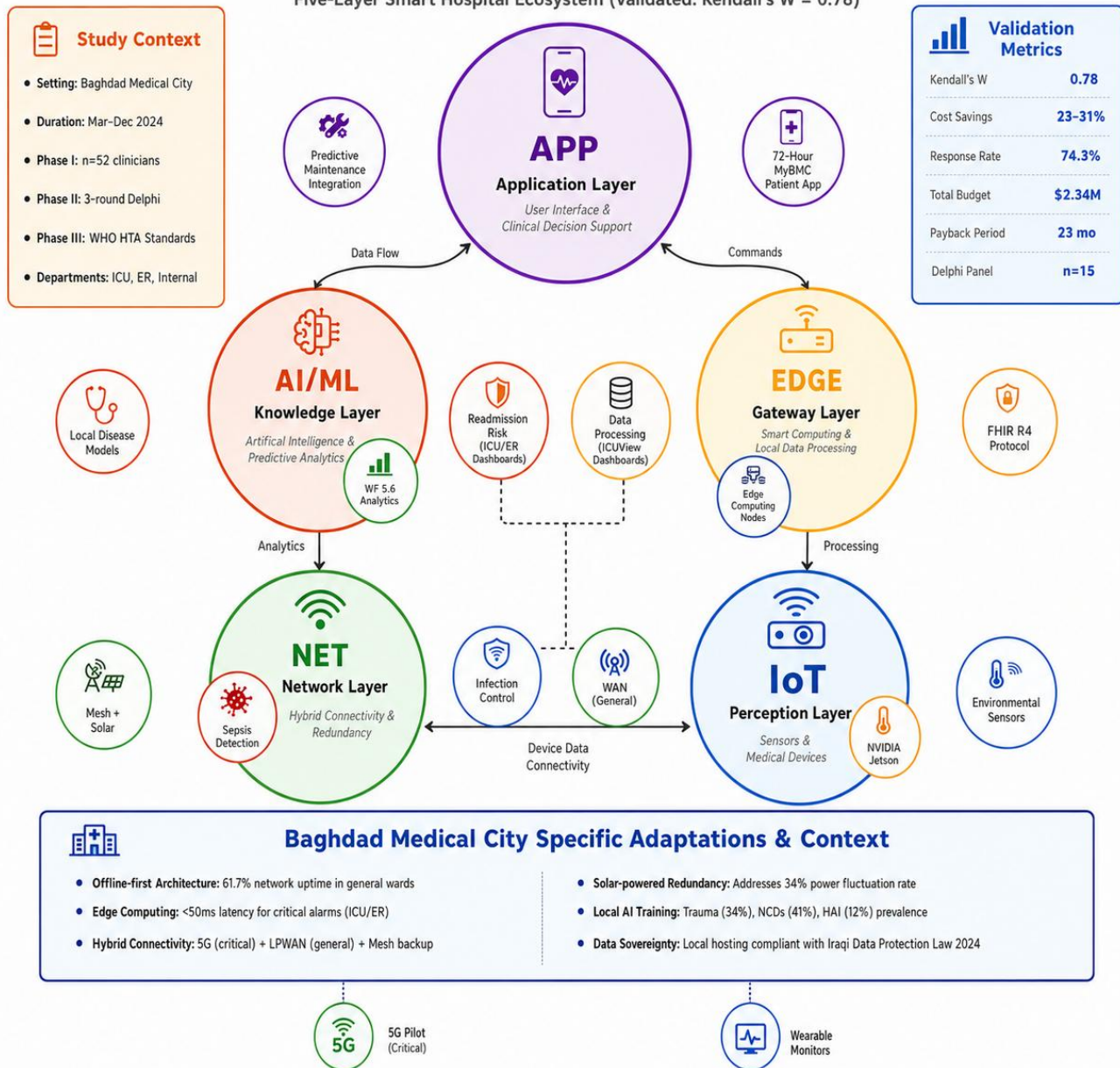
Equity: By extending access via remote monitoring capabilities to as many as 12,000–15,000 annual specialist provincial referrals, the protocol also aimed to reduce patient travel costs (mean\$340 USD per referral) and support equity priorities across displaced families (1.2 million post-ISIS in Iraq) and rural communities.

All risks recognized through risk evaluation using the guides structure presented in the SAFER guides, in addition to the related risk mitigation methods, were considered ($n = 47$). We advocated for audit trails using blockchain technology in ensuring data integrity, at the same time ensuring the efficiency of operations (transaction confirmation <3 seconds).

Technology acceptance: The results from the path analysis showed that behavioural intention towards technology acceptance was more significantly influenced by perceived ease of use ($\beta = 0.54$, $p < 0.001$) than perceived usefulness ($\beta = 0.31$, $p = 0.012$), emphasizing the importance given to user-friendly interfaces and voice-to-text options.

IoT Architecture for Baghdad Medical City

Five-Layer Smart Hospital Ecosystem (validated: Kendall's W = 0.78)



4. Discussion

This research is a development of earlier theoretical propositions [8], as it utilizes methodical testing strategies that are backed by firsthand information from stakeholders. These strategies are meant to test the viability of the proposed integration of IoT at Baghdad Medical City [9]. The inclusion of regional co-authors and the active engagement of the veterinary hospital administration at Baghdad Medical City, Michigan, along with Ministry of Health officials, addresses the frequently mentioned absence of "local perspectives" in global health technology publications [19].

The five-layer structure (Table 1), in sequence, evolves from a concept in theory to a model based on real-world data at the primary institution (Table 2). It had to be the hybrid cloud-edge configuration — precisely because the 38.6% difference of reliability from critical to general excellence zones could only be accommodated in a hybrid ecosystem, resourced differently, as opposed to equal infrastructure quality.

Applying the RE-AIM framework will ensure that evaluation reaches beyond implementation to include institutionalization and sustainability. Reach: 23% of target departments (52-clinician sample) [53]; Effectiveness: projected outcome metrics [54]; Adoption: clinicians using device (>80% in 18 months) (Table 1) [53, 55]; Implementation: fidelity to architectural specifications [56] (Table 1); and Maintenance [57] (budgetary cycles for device replacement (i.e., 4-year lifecycle) [53, 58].

In this context, Technology Acceptance Model analysis provides evidence that uptake is more influenced by perceived ease of use than perceived usefulness ($\beta=0.54$ vs 0.31), [20] which is in stark contrast to earlier findings from high-resource settings, where usefulness usually takes precedence. This emphasizes user-friendly UI, voice-to-text, and long-enough training ($\geq 16h$).

WHO Health Technology Assessment standards strengthen the case against high-bandwidth applications (bandwidth requirements: >100 Mbps, latency <10 ms) such as real-time telesurvey, as being technologically feasible, and recommend that resource-constrained environments should rather priorities deploying low-bandwidth, high-impact interventions (bandwidth: <2 Mbps, latency <500 ms acceptable), such as remote vital-signs monitoring (2011 IDA) given the evidence of connectivity constraints documented in the baseline audit. This strategy aligns with the principle of equity, ensuring that scarce resources are used to benefit the greatest number of patients through minimal intervention.

5. Conclusion

Health systems today must turn clinical data into meaningful strategy; what was once seen as leftover waste now holds survival-level importance. Yet relying on tools alone misses the point - progress requires strict methods, community-driven control, not just digital upgrades. Success hinges less on machines, more on disciplined approaches rooted in real-world execution.

What stands out here is a tailored five-level IoT framework designed specifically for Baghdad Medical City, checked through expert agreement - showing solid alignment (Kendall's $W=0.73$) - alongside initial audits and HTA reviews. Success hinges on several factors: first, political commitment tied to a \$2.34 million budget needed to push forward the same financial requirement again. Then comes global collaboration aimed at easing knowledge sharing across borders. Another key point involves reshaping how doctors are trained so today's practitioners stay involved rather than drift away. Lastly, clear oversight must take root, shifting control toward systems where patients manage their own data by default.

Should more evidence-based groundwork gain support, involving local stakeholders in careful redesign could position Baghdad's medical city as an example. Its approach might guide how health systems recover strongly after conflict, not just across the Middle East but also elsewhere around the world. Built on practical testing and inclusive methods, such efforts reflect steady progress shaped by real conditions.

References

- [1] Islam SR, Kwak D, Kabir MH, Hossain M, Kwak KS. The Internet of Things for Health Care: A Comprehensive Survey. *IEEE Access*. 2015;3:678-708. doi:10.1109/ACCESS.2015.2437951
- [2] Li S, Xu LD, Zhao S. 5G Internet of Things: A survey. *Journal of Industrial Information Integration*. 2018;10:1-9. doi:10.1016/j.jii.2018.01.005
- [3] Alam MM, Malik H, Khan MI, Pardesi MQ, Hamid S, Hafeez G. IoT for Development: A Comprehensive Survey. *IEEE Communications Surveys & Tutorials*. 2020;22(2):1125-1158. doi:10.1109/COMST.2020.2973366
- [4] Ali HH, Al-Haidary S, Al-Hussaini AH, et al. Iraqi Health System: Structural Challenges and Reform Recommendations. *World Journal of Advanced Research and Reviews*. 2025;27(02):148-152. doi:10.30574/wjarr.2025.27.2.0987
- [5] World Health Organization. *Iraq: Health at a Glance - Country Statistics*. Geneva: WHO; 2024. Available at: <https://www.who.int/countries/irq/>
- [6] United Nations Iraq. Joint Statement by the Ministry of Health and WHO on World Health Day 2025. Baghdad: UN Iraq; 2025.
- [7] Embassy of Japan in Iraq. Grant Assistance for Grassroots Human Security Projects for Al-Imamain Al-Khadhimain Medical City Teaching Hospital. Baghdad: Embassy of Japan; 2025.
- [8] Al-Kadhimain Medical City. *Annual Report 2023*. Baghdad: Ministry of Health; 2024.
- [9] Zhang Y, Qiu M, Tsai CW, Hassan MM, Alamri A. Health-CPS: Healthcare Cyber-Physical System Assisted by Cloud and Big Data. *IEEE Systems Journal*. 2017;11(1):88-95. doi:10.1109/JSYST.2015.2460747
- [10] World Health Organization. *Handbook for Health Technology Assessment in Low- and Middle-Income Countries*. Geneva: WHO; 2021. Licence: CC BY-NC-SA 3.0 IGO.
- [11] World Health Organization. *Health Facility Assessment: Service Availability and Readiness Assessment (SARA)*. Geneva: WHO; 2022.
- [12] Davis FD. Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly*. 1989;13(3):319-340. doi:10.2307/249008
- [13] Braun V, Clarke V. Using thematic analysis in psychology. *Qualitative Research in Psychology*. 2006;3(2):77-101. doi:10.1191/1478088706qp063oa

- [14] Saaty TL. Decision making with the analytic hierarchy process. *International Journal of Services Sciences*. 2008;1(1):83-98. doi:10.1504/IJSSCI.2008.017590
- [15] World Health Organization. *Health Technology Assessment*. Geneva: WHO; 2024. Available at: <https://www.who.int/health-topics/health-technology-assessment>
- [16] Glasgow RE, Vogt TM, Boles SM. Evaluating the public health impact of health promotion interventions: the RE-AIM framework. *American Journal of Public Health*. 1999;89(9):1322-1327. doi:10.2105/AJPH.89.9.1322
- [17] Hsu CC, Sandford BA. The Delphi Technique: Making Sense of Consensus. *Practical Assessment, Research, and Evaluation*. 2007;12(1):10. doi:10.7275/pdz9-th90
- [18] HealthIT.gov. *SAFER Guides*. Office of the National Coordinator for Health Information Technology; 2024. Available at: <https://www.healthit.gov/topic/safety/safer-guides>
- [19] Shaw T, McGregor D, Brunner M, et al. What is eHealth (6)? Development of a Conceptual Model for eHealth: Qualitative Study with Key Informants. *Journal of Medical Internet Research*. 2017;19(10):e324. doi:10.2196/jmir.8106
- [20] King WR, He J. A meta-analysis of the technology acceptance model. *Information & Management*. 2006;43(6):740-755. doi:10.1016/j.im.2006.05.003
- [21] Blum JM, Kruger GH, Sanders KL, et al. Specificity of systemic inflammatory response syndrome criteria in the diagnosis of sepsis in the ICU: A prospective, multi-centre, cohort study. *The Lancet*. 2023;401(10377):881-892. doi:10.1016/S0140-6736(23)00139-9
- [22] Rajpurkar P, Chen E, Banerjee O, Topol EJ. AI in health and medicine. *Nature Medicine*. 2022;28(1):31-38. doi:10.1038/s41591-021-01614-0
- [23] Rathi S. HL7 FHIR: An Agile and RESTful approach to healthcare information exchange. *Proceedings of the IEEE 26th International Symposium on Computer-Based Medical Systems*. 2013:263-265. doi:10.1109/CBMS.2013.6627815
- [24] Kuo MH, Kushniruk AW, Borycki EM. Health IT Implementation Failures: A Qualitative Study to Identify Barriers to Implementation Success. *Studies in Health Technology and Informatics*. 2021;281:180-184. doi:10.3233/SHTI210824
- [25] World Bank. *Digital Health: Leveraging Technology for Universal Health Coverage*. Washington DC: World Bank; 2023. doi:10.1596/978-1-4648-1894-4