Online-Journals.org

iJOE International Journal of Online and Biomedical Engineering

iJOE | eISSN: 2626-8493 | Vol. 22 No. 11 (2026) | OPEN ACCESS

https://doi.org/10.3991/ijoe.v22i11.63320

SPECIAL FOCUS PAPER

Capabilities of Internal Audit to Assess Cost-Effectiveness of Wearable Health Monitoring Systems

Mohammed Idris[1] (✉), **Ahnaf Ali Alsmady**[2], **Osama Abdel Latif Mahd**[3], **Dinara Kassymova**[4]

[1]Applied Science Private University, Amman, Jordan

[2]University of Tabuk, Tabuk, Saudi Arabia

[3]Qatar University, Doha, Qatar

[4]Mukhametzhan Tynyshbayev ALT University, Almaty, Kazakhstan

m.idris@asu.edu.jo

ABSTRACT

The aim of the current research study is to shed light on the aspects of internal audit, including technical competency, risk-based auditing, compliance and regulatory auditing, value-for-money (VfM), vendor and contract management that have the ability to assess the cost-effectiveness of wearable health monitoring systems in Jordan. We depended on quantitative methodology to collect primary data through a questionnaire from 388 healthcare system auditors in Jordan. The main objective of the study is to investigate the ability to measure the cost-effectiveness of wearable health monitoring systems in Jordan's healthcare sector through the use of the internal audit previously mentioned dimensions. It is expected from the study to have theoretical and practical implications. Theoretically, the study contributes to audit theory by adding to the existing internal audit frameworks in digital health technology environments in developing economies. Practically, the results will help Jordanian healthcare institutions enhance the skills of their auditors, optimize investments in the wearable health monitoring systems (WHMS), and establish national standards for audits according to the national agenda for digitalization of the healthcare system.

KEYWORDS

internal audit, technical competency, risk-based auditing, compliance and regulatory auditing, value-for-money, health monitoring systems

1 INTRODUCTION

Cost-effectiveness in healthcare means comparing the economic value of an intervention, based on its cost, to the value of the intervention, based on its clinical results, and is typically expressed in terms of quality-adjusted life years (QALYs) and the incremental cost-effectiveness ratio (ICER). In this framework, wearable health monitoring systems (WHMS) have been gaining growing interest from the scientific and policy communities as a potential paradigm-shifting care delivery modality. The field of wearable health tech has advanced rapidly, transforming from basic fitness trackers to complex medical devices that can monitor and provide real-time data

Idris, M., Alsmady, A. A., Mahd, O. A. L., Kassymova, D. (2026). Capabilities of Internal Audit to Assess Cost-Effectiveness of Wearable Health Monitoring Systems. *International Journal of Online and Biomedical Engineering (iJOE)*, 22(11), pp. 36–48. https://doi.org/10.3991/ijoe.v22i11.63320

Article submitted 2026-08-22. Revision uploaded 2026-10-01. Final acceptance 2026-10-03.

© 2026 by the authors of this article. Published under CC-BY.

and insights and becoming an increasingly important tool for moving from reactive healthcare treatments to preventative measures [1].

Academic study of WHMS cost-effectiveness is still fairly young and is growing. In a systematic review published in the journal *Mayo Clinic Proceedings* [2], researchers analyzed the cost-effectiveness of a wide variety of wearable health devices, such as those that monitor respiratory rate, movement, fall risk, seizures, heart rate, insulin levels, and therapy, and wearable cardioverter defibrillator (WCD) devices [3–4]. This cross-domain applicability is reflected in the breadth of such coverage. The economics argument is bolstered by further comparative analyses: a meta-analysis of all studies evaluated showed a cost-effectiveness association between wearable devices and other measurement methods, with an estimated incremental net benefit of US$1,280, compared with traditional clinical methods; and wearable accuracy was compared with traditional clinical methods in 85% of cases, with 80% showing a cost-effectiveness association [5–6].

In a study titled "Technical, ethical, and regulatory issues in deployment of wearable health IoT devices–a survey," the researchers [7] were interested in finding the technical, ethical, and regulatory challenges in deploying the wearable health IoT devices, especially fitness trackers, heart rate monitors, and sleep wearables. The authors adopted a systematic literature review technique for the period of 2020 to 2025 to analyzes the compliance frameworks such as HIPAA and GDPR and technical security standards such as IEEE and ARM Platform Security Architecture. The research revealed the top compliance problems to be security misconfiguration, authentication issues, and insufficient access controls. It found that multi-stakeholder data governance and regulatory harmonization are crucial to ensuring safe, auditable wearable health systems.

Past research has consolidated the literature on the ethical and legal aspects of the use of health monitoring wearable devices (HMWDs) in a healthcare environment. The authors conducted a scoping review and narrative synthesis using the PubMed, EBSCO, and legal periodical databases (May 2023 and March 2024) [8]. The study revealed the existence of several complex ethical issues, such as lack of informed consent, data ownership uncertainty, and lack of adequate legal provisions from HMWDs. Results indicate that law and theory must provide a foundation for these devices and that there is a need for specific legal frameworks and meaningful involvement of patients and the public to facilitate their regulation in clinical and institutional settings.

The goal was to explore the ethical dilemmas of using AI-powered wearable technology and to propose a realistic governance model based on responsible AI principles. The author conducted a systematic analysis of the risks at the data collection, data preprocessing, modelling, and deployment levels of devices including Apple Watch, Oura, and Fitbit [9]. The study identified the lack of embedded auditability and transparency mechanisms as a risk to AI-powered wearables in terms of enabling surveillance, discriminatory profiling, and algorithmic bias. Results have created a data-driven, structured framework that designates accountability for developers, manufacturers, users, and regulatory agencies to maintain ethical standards throughout the entire AI and health data lifecycle.

The goal was to critically evaluate the reasons behind the fact that wearable devices are not interchangeable in clinical practice and to outline the technical skills needed for successful clinical integration [10]. The authors conducted a narrative evidence synthesis search of MEDLINE/PubMed and Embase from January 2019 to August 2025, as well as a search of clinical trial registries and FDA/CE regulatory summaries. The study found that the difference in sensor configuration, connectivity

protocols, and validation contexts that can be used is clinically useful and safe for patients. The findings showed that the following competencies are crucial for the safe and effective use of wearables in healthcare institutions: context-driven device selection, good interoperability standards, ethical governance, and sufficient IT infrastructure.

Past research examined the landscape of current cost-effectiveness studies of wearable health technologies for a wide range of clinical settings [11]. The authors conducted a systematic review of literature using PubMed, EMBASE/MEDLINE, Google Scholar, and CINAHL, which yielded 10 articles from 2012 to 2023, and included different types of devices including seizure devices, cardioverter defibrillators, and continuous glucose monitors in various settings. Cost-effectiveness was calculated in terms of quality-adjusted life years (QALY) and incremental cost-effectiveness ratios (ICERs). The results showed that when appropriately targeted, wearable technologies can be cost-effective, which reinforces the need for having strong value-for-money (VfM) audit systems in use for the procurement of health products and services.

The aim of past research was to create a map of the evidence regarding the use of wearables by healthcare workers, with special emphasis on the effects of these devices on their occupational health, organizational resilience, and economic outcomes [11]. The authors conducted a scoping review by searching the following databases for articles from inception until July 2025: PubMed, Scopus, Web of Science, Embase, and CINAHL, using the Arksey and O'Malley framework and PRISMA-ScR guidelines. Staff safety and reduced workload were found to be improved by wearables, resulting in cost savings of between €54 and €90 per patient due to reduced nursing time. It was brought to light that some of the key factors that facilitate the realization of value for money in the adoption of wearables in healthcare are user-centered design, leadership support, effective staff training, and appropriate use of IT infrastructure.

The objective was to examine the current literature on remote health monitoring in non-hospital environments with wearable technology and to identify risk patterns based on the type of device and the clinical condition [12]. The authors conducted a scoping review search in the CINAHL, Scopus, Embase, and MEDLINE databases up to August 2024, encompassing 80 eligible studies classified into two groups: intended to monitor diseases and to identify new diseases. Chronic disease monitoring was the most prevalent category (85% of studies), and the highest prevalence was for neurodegenerative and cardiovascular diseases. Results showed that the quality of evidence was of concern, with only 8% of studies being randomized controlled trials, which could be used to inform risk-stratified audit planning for decisions on the deployment of wearable health monitoring systems.

The goal was to explore the underlying issues and challenges of unsustainable procurement of medical devices in LMIC settings, where many of the purchased devices are unused, which means that the public healthcare funds are being wasted [13]. The authors mapped the feedback loops and the failures in governance throughout the procurement cycle using a systems thinking approach with causal loop diagram (CLD) modeling. Core drivers identified in the study included the inadequate selection of vendors, inadequate governance of contracts, inadequate planning for a contract's lifecycle, and transparency problems related to corruption. Results have created an in-depth leverage-point model to connect the procurement reform to better governance indicators such as transparency, bureaucratic quality, and accountability, which is directly applicable to vendor and contract management auditing of healthcare technology systems.

Although internal audits have been explored in the academic literature, with every study specifically focusing on compliance requirements, technical governance, economic value, risk profiles, and procurement governance of WHMS, a gap still exists in the literature: no study has looked into the internal audit function as a comprehensive, multidimensional analysis of the cost-effectiveness of WHMS within a developing-economy healthcare context. While there are studies on a single dimension (regulatory compliance, technical competency (VfM), risk-based auditing, and vendor governance), none of them combines these capabilities into a unified approach to audit and empirically evaluates their combined impact on WHMS cost-effectiveness assessment. It is especially pronounced in the Jordanian healthcare system, where digital health transformation is progressing and has not been defined in relation to national standards for technology auditing. Therefore, the present study aims to investigate the ability of the internal audit capabilities (technical competency, risk-based auditing, compliance auditing, VfM assessment, and vendor and contract management) in predicting the cost-effectiveness of WHMS in healthcare institutions in Jordan.

From the above argument, it can be said that the current study is based on the following research question:

How can aspects of internal audit, including technical competency, risk-based auditing, compliance & regulatory auditing, VfM, vendor and contract management assess the cost-effectiveness of wearable health monitoring systems in Jordan?

2 LITERATURE REVIEW

2.1 Wearable health monitoring systems

Wearable health monitoring systems are a converging biomedical engineering, information technology, and digital health field that has started to dramatically transform the ways physiological data are gathered, sent, and analyzed in various healthcare settings [14].

There are two well-known definitions that locate the construct in the academic literature. Firstly, WHMSs are considered to be the new generation of healthcare, and they allow for the real-time unobtrusive monitoring of patients' physiological parameters using several biosensors on and within the body [Gu]. Second, from an engineering point of view, WHMS is known as an effective enabler of real-time physiological measurement in healthcare, eldercare, sports, and occupational safety [15].

The physiological parameters that are usually recorded by a WHMS are heart rate, blood oxygen saturation, blood pressure, body temperature, ECG signals, and physical activity parameters [16]. These are collected via several different types of sensors and communicated wirelessly to either central platforms or mobile applications where they are analyzed and given to the clinician for decision support. In Jordan, WHMS implementation fits in with the national agenda for digital health transformation, where remote monitoring, as an efficient and scalable option, is perceived as vital to enhance healthcare access, quality, and operational efficiency in both the public and private sectors [17–18].

2.2 Cost-effectiveness of WHMS

Today, WHMS have been a revolutionary development in healthcare delivery, and their worth is more than their price tag. These technologies need to be evaluated from a multifaceted perspective, including clinical, resource use, and long-term

resource-saving perspectives [19]. The basic tenet of their economic value is the concept of prevention. WHMS can provide continuous monitoring of the condition of the individual and can indicate early signs of deteriorating health status and can be utilized to identify that before a person becomes severely unwell and requires costly emergency treatment or long hospital stays. This proactive surveillance model is a paradigm change for healthcare spending, from costly and reactive treatment to more cost-effective and preventative management [20].

Wearable health monitoring systems can also alleviate the strain on overburdened healthcare facilities from a resource allocation viewpoint, as it allows the remote monitoring of patients. Clinicians can care for more patients with less staff or resources and make the most of their resources and skilled medical personnel. This is particularly relevant in low-resource environments in healthcare where efficiency plays a crucial role [21].

They are also cost-effective because they are involved in chronic disease management. There are a number of conditions that need long-term monitoring, such as diabetes, blood pressure (hypertension), and heart disease. Monitoring the evolution of the disease and compliance to the treatment process with digital health platforms and by the patient itself are low-impact tools that can reduce the need for face-to-face consultation and the indirect costs of the patients (e.g., transportation, lost productivity) [22]. Moreover, WHMS creates large volumes of data, which can be used to support evidence-based clinical decision-making. This can also support reducing the total expenditures of the health system by decreasing unnecessary tests and procedures and duplicate tests [19].

2.3 Internal audit and WHMS

The adoption of new and increasingly complicated digital health technologies in the hospitals is now a major concern for the organization to integrate into the rigorous assurance process and is now a critical field of healthcare governance where WHMS are playing a key role. Internal audits' role is evolving beyond a financial and operational audit and is now a component of patients' monitoring processes, hospital operational procedures, and technology-specific procedures [23].

Regulatory changes, the legacy of digital transformation, and new cyber risks pose growing and increasingly complicated challenges for organizations as they work to protect operations, meet regulatory requirements, enhance financial and IT controls, and manage evolving risks [24]. The role of internal audit is essential to help protect operations, stay compliant with regulations, boost financial and IT controls, and handle emerging risks, as the healthcare sector adjusts to long-term effects of digital transformation, regulatory shifts, and new cyber threats. In this context, WHMS deployments add a unique set of audit challenges across technical infrastructure, regulatory compliance, data governance, financial stewardship, and third-party relationships [25]. But the traditional audit methods are no longer sufficient to cope with the dynamic and complex risks of large-scale digital health technologies, and internal auditors must have the technical expertise to handle the risks and challenges. Healthcare environments are a challenging environment to implement WHMS, as well as internal auditors should have a multidisciplinary approach, which includes not only biomedical device standards but also data protection regulations, procurement governance, and cost-effectiveness assessment frameworks [14].

In a world of growing cybersecurity threats, financial accuracy, and operational efficiencies, internal audits must abide by many external rules and regulations, seek compliance in a networked, sensor-driven health technology system, and prove

increasingly challenging. As a result, internal audit is one of the significant institutional instruments that can ensure that the WHMS within healthcare institutions is operational and lawful, sustainable and economical, and well managed [26]. The five major ways that the internal audit capabilities are elaborated on below relate to WHMS contexts.

2.4 Technical competency

Technical competency is the basic aptitude that internal auditors assess to determine the integrity, security, and reliability of technology-based systems such as WHMS. As far as wearable health technologies are concerned, technical competence relates to the capacity of an auditor to evaluate the interoperability of devices, the security of data transmission, the validation of software, and the connection with hospital information technology. Internal auditors need to have technical expertise in IT risk management, continuous monitoring, and advanced analysis of data because traditional audit methods that focus on periodic, sample-based auditing and retrospective analysis are becoming inadequate to oversee the dynamic and complex risks that organizations face today [26].

2.5 Risk-based auditing

Risk-based auditing (RBA) is a robust and systematic approach to allocating internal audit resources based on the degree of risk involved with specific organizational processes, systems, or assets. In WHMS applications, RBA prioritizes high-risk failure scenarios—such as exposure to data breaches, failure of devices, and unauthorized access to protected health information. In the context of WHMS auditing, risk-based approaches are especially relevant because of the constant stream of data generated by such devices and the implications that misread or tampered physiological data will have in clinical settings [27].

2.6 Compliance and regulatory auditing

Compliance and regulatory auditing within WHMS are the systematic process of ensuring that the implemented devices, data handling, and procedures meet the relevant regulatory, national health, and clinical safety requirements. If digital health technologies are used in clinical situations, they should be compliant with the clinical risk management requirements set by the applicable regulations. This includes requirements for assessing and mitigating risks arising from the design and use of the technology, and healthcare organizations should not purchase or deploy digital health technology without the appropriate clinical risk management assurance [28].

2.7 Value-for-money

Value for Money Auditing ensures that the expenditure of an organization on goods and services provides optimum value in terms of economy, efficiency, and effectiveness. VfM auditing for WHMS installments focuses on the connection between the monetary investment in a wearable health technology and the clinical,

operational, and patient outcome advantages it creates that are worth that cost. As it is a constrained fiscal environment, internal auditors that carry out VfM assessments of WHMS need to consider the total cost of ownership (TCO)–such as procurement, implementation, maintenance, training, and data management costs as well as evidence of clinical effectiveness and return on investment [27].

2.8 Vendor and contract management

Vendor and contract management auditing reviews the mechanisms that enable healthcare organizations to control and manage third-party vendors of WHMS technologies, as well as to hold them accountable. The integrity of vendor relationships is an operational and patient safety issue with wearable health devices due to the complexity and sensitivity of this market. There are many external vendors that are relied upon by many healthcare organizations, and the risk of third-party risks can cause organizations to miss their goals or hurt their brand image, meaning it is also essential to regularly audit vendors and have cybersecurity compliance questionnaires for them [28].

3 RESEARCH METHODOLOGY

We have adopted in the current study the quantitative approach as the main methodology. It was best suited to collect primary data from a larger sample size and generalize results after analysis. The main tool was a questionnaire that was built by researchers through the aid of previous studies [1, 3, 5, 27, 28]. The population of the study consisted of internal auditors in Jordan within healthcare sectors. A convenient sample of 388 individuals was adopted to be the main sample of the study. SPSS was used to screen and analyze collected data. The relationship between variables was highlighted in the following Figure 1.

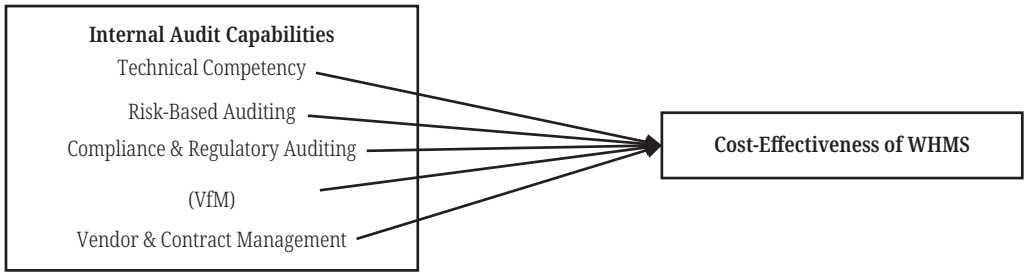


Fig. 1. Conceptual framework [1, 3, 5, 27, 28]

4 RESULTS

4.1 Demographics

Demographics taken into consideration included gender, qualifications, and experiences. Through calculating percentage and frequencies, it was noticed that 75.5% of respondents were males. Regarding educational qualifications, analysis indicated that 49% of respondents held a BA degree in a related academic field, while 54.6% of respondents had experience in the field that ranged between 12 and 17 years.

4.2 Questionnaire results

Table 1 shows the mean and standard deviation of the variables asked about in the questionnaire based on the answers that were given by the respondents. Analysis showed that all respondents had a positive view of the variables asked about in the questionnaire because they all scored higher than the mean of the scale 3.00 and were statistically positive.

It was the Cronbach's alpha that the researcher used to figure out how reliable the study was. The alpha value given to each variable in the next table is an excellent number because it is higher than the minimum percentage of 0.70.

Table 1. Questionnaire analysis

	$\bar{x}$	σ	α
Technical Competency	3.9263	.78199	0.868
Risk-Based Auditing	4.1392	.80143	0.92
Compliance and Regulatory Auditing	4.1263	.81525	0.942
Value-for-money	4.1773	.77460	0.921
Vendor and Contract Management	4.0418	.76270	0.89
Cost-Effectiveness of Wearable Health Monitoring Systems	4.1402	.94715	0.946

4.3 Hypotheses testing

Table 2 indicates the multiple regression as it is used to test the main hypothesis. The finding, r = 0.679, shows that the independent and dependent variables are strongly and positively related. On top of that, the independent variables explain 46.1 percent of the variation in the dependent variable. The F value = 65.298 is significant at the 0.05 level, which means that internal audit capabilities are able to assess cost-effectiveness of wearable health monitoring systems.

Table 2. Hypotheses testing

			Standardized Coefficients	t	Sig.	r	R^2
	B	Std. Error	Beta				
(Constant)	.180	.223		.808	.420	.679	.461
Technical Competency	.276	.059	.228	4.663	.000		
Risk-Based Auditing	.159	.074	.135	2.139	.033		
Compliance & Regulatory Auditing	.173	.069	.149	2.507	.013		
(VfM)	.191	.082	.156	2.324	.021		
Vendor and Contract Management	.175	.072	.141	2.428	.016		

Based on Table 2 and launching from values of r and R^2, it can be said that:

Technical competency is able to assess cost-effectiveness of wearable health monitoring systems. Risk-based auditing is able to assess cost-effectiveness of wearable health monitoring systems. Compliance and Regulatory Auditing is able to assess cost-effectiveness of wearable health monitoring systems. VfM is able to assess cost-effectiveness of wearable health monitoring systems. Vendor and Contract Management is able to assess cost-effectiveness of wearable health monitoring systems.

5 DISCUSSION

The purpose of this study is to understand the internal audit capabilities and its capacity to evaluate the cost-effectiveness of WHMS in Jordan's healthcare industry, namely Technical competency, Risk-Based Auditing, Compliance and Regulatory Auditing (VfM) and Vendor and Contract Management. Based on quantitative data obtained from 388 internal auditors, the results offer good empirical evidence for the main idea that a multidimensional internal audit framework can be used to meaningfully measure WHMS cost-effectiveness in the context of a developing economy.

The descriptive analysis showed consistently positive perceptions with mean values ranging from 3.93 to 4.18 on a five-point Likert scale, and all the means were above the 3.00 neutral threshold. The highest mean was obtained for VfM ($\bar{x} = 4.18$), followed closely by Risk Based Auditing ($\bar{x} = 4.14$) and cost-effectiveness of WHMS itself ($\bar{x} = 4.14$), as compared to Technical Competency, which registered the lowest mean ($\bar{x} = 3.93$), indicating that although auditors are positive about technical skills, this aspect may require the most developmental attention. The reliability coefficients (Cronbach's alpha) ranged from 0.868 to 0.946, well above the generally accepted 0.70 value, which verified the internal consistency and measurement quality of the instrument.

The multiple regression analysis showed that the five dimensions of internal audit together account for 46.1% of the variance in the assessment of the WHMS cost-effectiveness ($R^2 = 0.461$), with an overall correlation coefficient of $r = 0.679$. The model was found to be statistically significant at the 0.05 level (F-test significant), and the t-value for each individual dimension was significant, thus supporting all five sub-hypotheses. Technical competency was the highest single predictor ($\beta = 0.228$, $t = 4.663$, $p < 0.001$), followed by (VfM) ($\beta = 0.156$), Compliance & Regulatory Auditing ($\beta = 0.149$), Vendor and Contract Management ($\beta = 0.141$), and Risk-Based Auditing ($\beta = 0.135$).

The findings are similar to and build upon some strands of previous research. This emphasizes the importance of technical competency, as highlighted by [10], who found that selecting the appropriate device in the context of the targeted study, adhering to interoperability standards, and ensuring adequate IT infrastructure are essential for the safe and effective use of wearables in healthcare institutions. [12] also found portable and mobile biomedical devices (MBD) are an important part of modern healthcare. Likewise, previous research highlighted how traditional auditing approaches are inadequate to address dynamic risks of digital health technologies, and the many empirical findings in this article support that technical auditor capability is the most critical factor in this present model [1].

The importance of risk based auditing is emphasized by the ongoing data streams produced by WHMS and the clinical consequences of misread and tampered physiological data, which is the same as what was proposed in past studies [12].

This dimension was found to be a significant predictor of cost-effectiveness assessment, lending support to the positioning of risk-stratified planning as an audit methodology appropriate for WHMS deployment.

Past studies have found that the primary compliance challenges for wearable health IoT deployments were related to security misconfiguration, authentication problems, and inadequate access controls [7], while other studies emphasized the need for robust legal frameworks and concrete regulatory bases for the clinical application of health monitoring devices [8]. In the present study, the empirical evidence supports these normative recommendations by showing that the capability of compliance auditing directly impacts the cost-effectiveness assessment in a real-world organizational context.

The high coefficient of the VfM dimension is in line with systematic reviews by [2] indicating that wearable devices can be cost-effective when targeted correctly and by [11], who found the importance of applying the 5Q Model in hospitals to achieve customer satisfaction. [27] previous point about the importance of thinking about WHMS stewardship from a total cost of ownership perspective.

Lastly, the importance of VCM resonates with [13], who, through a systems-thinking lens of medical device procurement in low- and middle-income countries (LMICs), highlight wasted public healthcare expenditure stemming from inadequate vendor selection, poor contract governance, and transparency failures—a theme well suited to Jordan's developing digital health procurement environment.

6 CONCLUSION

This study is an empirical novelty that combines five dimensions of the internal audit related to the cost-effectiveness of WHMS in a single predictive model, while no study has been able to do that so far. The results have direct practical applications to the Jordanian healthcare institutions through the following recommendations:

- Technical training for auditors should be conducted.
- The principles and procedures of conducting a risk-based audit should be institutionalized.
- The principles and structures of the governance of the vendors should be improved.
- The principles of VfM assessment should be incorporated in the procurement process.

Longitudinal studies and studies in other MENA settings could be conducted in the future to validate and refine these findings.

7 REFERENCES

[1] F. Mohd Razali, N. Sulaiman, D. I. Abdul Manan, and J. Said, "Sustainability of audit profession in digital technology era: The role of competencies and digital technology capabilities to detect fraud risk," *Sage Open*, vol. 15, no. 1, 2025. https://doi.org/10.1177/21582440241304974

[2] G. D. De Sario Velasquez *et al.*, "Economic perspective of the use of wearables in health care: A systematic review," *Mayo Clinic Proceedings: Digital Health*, vol. 2, no. 3, pp. 299–317, 2024. https://doi.org/10.1016/j.mcpdig.2024.05.003

[3] S. A. Hazaea, C. Cai, E. M. Al-Matari, M. A. Al-Bukhrani, and H. G. Chong, "Mapping the literature trends of internal auditing in the United States: A systematic review and directions for future research," *Sage Open*, vol. 15, no. 1, 2025. https://doi.org/10.1177/21582440251318071

[4] M. Al Khaldy, A. Shaheen, W. Alzyadat, and A. Alhroob, "The impact of smartwatches on health and lifestyle: A study on Jordanian society," *International Journal of Online and Biomedical Engineering (iJOE)*, vol. 21, no. 9, pp. 138–152, 2025. https://doi.org/10.3991/ijoe.v21i09.54723

[5] M. Hasan and M. O. Faruq, "AI-augmented risk detection in cybersecurity compliance: A GRC-based evaluation in healthcare and financial systems," *ASRC Procedia: Global Perspectives in Science and Scholarship*, vol. 1, no. 1, pp. 313–342, 2025. https://doi.org/10.63125/49gs6175

[6] V. Rattanawiboomsom and S. R. Talpur, "Enhancing health monitoring and active aging in the elderly population: A study on wearable technology and technology-assisted care," *International Journal of Online and Biomedical Engineering (iJOE)*, vol. 19, no. 11, pp. 173–186, 2023. https://doi.org/10.3991/ijoe.v19i11.41929

[7] V. A. Sheetal and J. S. Nayak, "Wearable health IOT devices: A vision on compliance, security and feature directions," *International Journal of Safety and Security Engineering*, vol. 16, no. 2, pp. 307–326, 2026. https://doi.org/10.18280/ijsse.160206

[8] E. Capulli *et al.*, "Ethical and legal implications of health monitoring wearable devices: A scoping review," *Social Science & Medicine*, vol. 370, Art. no. 117685, 2025. https://doi.org/10.1016/j.socscimed.2025.117685

[9] P. Radanliev, "Privacy, ethics, transparency, and accountability in AI systems for wearable devices," *Front. Digit. Health*, vol. 7, Art. no. 1431246, 2025. https://doi.org/10.3389/fdgth.2025.1431246

[10] E. G. Bignami *et al.*, "Wearable devices in healthcare beyond the one-size-fits all paradigm," *Sensors*, vol. 25, no. 20, Art. no. 6472, 2025. https://doi.org/10.3390/s25206472

[11] B. S. Ajarmah, T. N. Hashem, and R. J. Swies, "The effect of 5Q model on patient's satisfaction in military hospitals in Jordan," *International Journal of Productivity and Quality Management*, vol. 20, no. 3, Art. no. 273, 2017. https://doi.org/10.1504/ijpqm.2017.082634

[12] T. Hashem and M. Teunissen, "Understanding the role of portable medical devices in the healthcare system: A systematic literature review," *International Journal of Online and Biomedical Engineering (iJOE)*, vol. 22, no. 6, pp. 39–53, 2026. https://doi.org/10.3991/ijoe.v22i06.61525

[13] V. Di Virgilio, M. S. Maldonado, A. B. Saindon, and L. Astolfi, "Enhancing sustainability of medical devices procurement in low- and middle-income countries," *International Journal of Sustainable Engineering*, vol. 18, no. 1, Art. no. 2547595, 2025. https://doi.org/10.1080/19397038.2025.2547595

[14] T. Tamura, "Advanced wearable sensors technologies for healthcare monitoring," *Sensors*, vol. 25, no. 2, Art. no. 322, 2025. https://doi.org/10.3390/s25020322

[15] F. Kurul *et al.*, "Wearable sensors for health monitoring: Current applications, trends, and future directions," *Biosensors and Bioelectronics: X*, vol. 28, Art. no. 100727, 2026. https://doi.org/10.1016/j.biosx.2025.100727

[16] S. Song, M. Zhang, X. Gong, S. Shi, J. Fang, and X. Wang, "Advances in wearable sensors for health management: From advanced materials to intelligent systems," *Advanced Functional Materials*, vol. 36, no. 11, Art. no. e18767, 2025. https://doi.org/10.1002/adfm.202518767

[17] A. Nazir *et al.*, "Wearable technology and its potential role in cardiovascular health monitoring and disease management," *Health Science Reports*, vol. 8, no. 11, Art. no. e71486, 2025. https://doi.org/10.1002/hsr2.71486

[18] W. Y. Leong, "Sustainable wearable health monitoring using energy-harvesting and biodegradable electronics," *Eng. Proc.*, vol. 12, Art. no. 12, 2026. https://doi.org/10.3390/engproc2026129012

[19] S. P. Gavan, K. Payne, W. G. Dixon, S. N. Van Der Veer, A. C. T. Tam, and N. Bansback, "Active remote monitoring of long-term conditions with mobile devices: A systematic review of cost-effectiveness analyses," *npj Digital Medicine*, vol. 8, no. 1, Art. no. 625, 2025. https://doi.org/10.1038/s41746-025-01898-3

[20] R. Kenny *et al.*, "Algorithm-based remote monitoring of heart failure risk data in people with cardiac implantable electronic devices: A systematic review and cost-effectiveness analysis," *Health Technology Assessment*, vol. 29, no. 50, pp. 1–160, 2025. https://doi.org/10.3310/ppoh2916

[21] S. Bjorvig, E. Breivik, J. Piera-Jiménez, and C. Carrion, "Economic evaluation methodologies of remote patient monitoring for chronic conditions: Scoping review," *Journal of Medical Internet Research*, vol. 27, Art. no. e71565, 2025. https://doi.org/10.2196/71565

[22] T. Hashem, "The role of digital health platforms in shaping consumer behavior," *International Journal of Science and Research Archive*, vol. 14, no. 2, pp. 1109–1117, 2025. https://doi.org/10.30574/ijsra.2025.14.2.0481

[23] Z. Baharom, "Theoretical and practical insights into digital technologies in internal auditing: A bibliometric analysis of trends and future directions (1980–2024)," *Discover Data*, vol. 3, no. 1, Art. no. 41, 2025. https://doi.org/10.1007/s44248-025-00081-z

[24] Y. Oskrochi, E. Roy-Highley, K. Grimes, and S. Shah, "Digital health technology compliance with clinical safety standards in the national health service in England: National cross-sectional study," *Journal of Medical Internet Research*, vol. 27, Art. no. e80076, 2025. https://doi.org/10.2196/80076

[25] M. M. Ozcelik, I. Kok, and S. Ozdemir, "A survey on internet of medical things (IOMT): Enabling technologies, security and explainability issues, challenges, and future directions," *Expert Systems*, vol. 42, no. 5, Art. no. e70010, 2025. https://doi.org/10.1111/exsy.70010

[26] J. A. Holgado-Terriza, P. Pico-Valencia, and Z. Liang, "Wearable devices and new frontiers in smart health monitoring," *Sensors*, vol. 26, no. 7, Art. no. 2097, 2026. https://doi.org/10.3390/s26072097

[27] L. Zhang, C. Bullen, and J. Chen, "Digital health innovations to catalyze the transition to value-based health care," *JMIR Medical Informatics*, vol. 13, Art. no. e57385, 2025. https://doi.org/10.2196/57385

[28] P. Bharadwaj *et al.*, "Unlocking the value: Quantifying the return on investment of hospital artificial intelligence," *Journal of the American College of Radiology: JACR*, vol. 21, no. 10, pp. 1677–1685, 2024. https://doi.org/10.1016/j.jacr.2024.02.034

8 AUTHORS

Mohammed Idris is a Professor of Accounting and the Dean of the Faculty of Business at the Applied Science Private University in Jordan. He earned his PhD from the University of Gloucestershire, UK. His research interests include earnings management, corporate governance, financial markets, and accounting education (E-mail: m.idris@asu.edu.jo).

Ahnaf Ali Alsmady, PhD, CPA, is a faculty member in the Department of Accounting at the College of Business Administration, University of Tabuk, Saudi Arabia. He earned his PhD in Accounting from Universiti Kebangsaan Malaysia (UKM) and has more than 16 years of academic, research, and professional experience in accounting, auditing, corporate governance, sustainability, financial reporting, and risk management (E-mail: aalsmadi@ut.edu.sa).

Osama Abdel Latif Mahd is an Associate Professor and full-time accounting academic for Qatar University and the president of the board of directors for the Scientific Accounting Association in Qatar. Osama joined Qatar University in 2016 and served at multiple universities, such as Applied Science Private University in Jordan (E-mail: almansour80@qu.edu.qa).

Dinara Kassymova is the Head of the Department of Information and Communication Technologies and an Associate Professor at ALT University, Kazakhstan. She holds a PhD in Information Systems and has more than two decades of experience in higher education and research. Her academic and research interests include big data analytics, artificial intelligence, intelligent transportation systems, cloud computing, and information technologies (E-mail: d.kassymova@alt.edu.kz).