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FACTORS INFLUENCING ADOPTION OF BLOCKCHAIN TECHNOLOGY IN JORDAN: THE PERSPECTIVE OF HEALTHCARE PROFESSIONALS

Ahmad Mousa Altamimi*	Princess Sumaya University for Technology, Amman, Jordan	a.altamimi@psut.edu.jo
Hazem Qattous	Princess Sumaya University for Technology, Amman, Jordan	h.qattous@psut.edu.jo
Duaa Barakat	Princess Sumaya University for Technology, Amman, Jordan	dua20228080@std.psut.edu.jo
Lubna Hazaimeh	Princess Sumaya University for Technology, Amman, Jordan	lub20228060@std.psut.edu.jo

* Corresponding author

ABSTRACT

Aim/Purpose	This paper investigates the user acceptability of blockchain technology in the healthcare sector, with a specific focus on healthcare professionals in Jordan.
Background	The study seeks to identify the factors that affect healthcare professionals' use and acceptance of blockchain technology in Jordan.
Methodology	The study's research framework integrates factors from the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT). A questionnaire was distributed to collect data from 372 healthcare professionals in Jordan, and the results were analyzed using structural equation modeling based on the Partial Least Square (PLS) technique.
Contribution	While only a few previous studies have explored blockchain technology acceptance in the healthcare sector using either the TAM or the UTAUT, this study uniquely integrates elements from both models, offering a novel approach that provides a comprehensive understanding of the factors that influence the acceptance of blockchain technology among healthcare professionals in Jordan. The findings can assist decision-makers in developing strategies to enhance the adoption rate of blockchain technology in the Jordanian healthcare sector.

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Findings The study revealed that usability, convenience, privacy and security, cost, and trust significantly impact the perceived usefulness of blockchain technology. The findings also suggest that healthcare professionals are more likely to have a positive attitude towards blockchain-based healthcare systems if they perceive them as useful and easy to use. Attitude, social influence, and facilitating conditions were found to significantly impact behavioral intention to use.

Recommendations for Practitioners Stakeholders should focus on developing blockchain-based healthcare systems that are easy to use, convenient, efficient, and effort-free.

Recommendations for Researchers Researchers may compare the acceptance of blockchain technology in the healthcare sector with other industries to identify industry-specific factors that may influence adoption. This comparative analysis can contribute to a broader understanding of technology acceptance.

Impact on Society Successful adoption of blockchain technology in the healthcare sector can lead to improved efficiency, enhanced protection of healthcare data, and reduced administrative burdens. This, in turn, can positively impact patient care and lead to cost savings, which contributes to more sustainable and accessible healthcare services.

Future Research Future research may explore integrating blockchain technology with other emerging technologies, such as artificial intelligence and sidechain, to create more comprehensive and innovative healthcare solutions.

Keywords blockchain technology, healthcare, acceptance, TAM, UTAUT

INTRODUCTION

The incorporation of blockchain technology into the healthcare sector has been increasing due to its various benefits and applications that can potentially improve healthcare quality and outcomes (Velmovitsky et al., 2021). Blockchain technology is a decentralized distributed ledger that enables secure, immutable, and transparent record-keeping across a distributed network (Monrat et al., 2019). It consists of a chain of blocks that are linked together using cryptographic hashes. The blockchain architecture provides a high level of security as it ensures that once a block is added, it cannot be altered without changing the subsequent blocks (Guo & Yu, 2022; Zheng et al., 2017).

Massive amounts of health data are being generated, and these data can be used to enhance the accuracy of healthcare decisions and medical diagnoses. Data sharing among healthcare providers through health information systems is essential to improve healthcare outcomes, reduce medical errors, and maintain effective healthcare delivery (Zhang et al., 2018). This is beneficial for patients who visit multiple health providers and require easy and secure access to their medical records. Additionally, it gives physicians the ability to monitor and consult their patients remotely and to be frequently updated on any shared patient medical information. However, storing and recording healthcare information for efficient and secure sharing across health information systems is not easily attainable and is considered a crucial challenge in the healthcare sector (Attaran, 2022). Health information exchange may be considered time-consuming, tedious, and costly due to the slow technological development of medical data management. Also, effective collaboration between healthcare systems is necessary for secure and scalable data sharing (Zhang et al., 2018). However, interoperability issues arise when sharing data between different health providers, as there may be different encryption methods and schema (Dwivedi et al., 2022). Additionally, healthcare records are highly targeted, and several security breaches have been reported. Therefore, advanced security technologies, like blockchain technology, are essential to maintaining data security and patient privacy (Attaran, 2022).

Blockchain technology may be utilized by healthcare providers and patients to store, manage, and access medical records securely and at any time. However, only authorized individuals will be able to access this data. Additionally, blockchain maintains the data integrity by making it immutable and impossible to decipher. This aids in enhancing the accuracy of treatments and diagnosis by ensuring the integrity, reliability, and quality of the data (Attaran, 2022). Blockchain technology can effectively aid in solving interoperability and data-leakage issues due to its decentralization, transparency, and high-security benefits (Han et al., 2022). Additionally, blockchain technology has a significant capability to enhance the Electronic Health Records (EHR) or Electronic Medical Records (EMR) utilized by healthcare institutions. The lack of sufficient security and privacy of EHRs and EMRs can lead to malicious attacks and unauthorized access to sensitive healthcare data and personal health information.

However, it is necessary to ensure that healthcare professionals are willing to use it. Insufficient understanding of how healthcare professionals perceive the implemented technology may lead to a decrease in the technology's success rate (Holden & Karsh, 2010). Therefore, understanding and identifying the factors that may influence healthcare professionals' acceptance of blockchain technology would help enhance the overall intention of usage and the technology's effectiveness in healthcare. The use of technology acceptance models like the Technology Acceptance Model (TAM) (Davis, 1989), and the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003) aid in measuring the acceptance and attitude toward the incorporation of blockchain technology into the healthcare sector.

Due to the importance of studying the healthcare professionals' perception and willingness to use blockchain technology before its implementation into the healthcare sector in Jordan, the objective of this study is to identify the factors that can affect blockchain technology acceptance and usage intention among healthcare professionals through the proposed framework which integrates factors from the TAM and the UTAUT along with additional external factors. This research would significantly aid decision-makers in increasing the intention to adopt and use blockchain-based systems in the Jordanian healthcare sector by addressing the factors found to mostly influence adoption. This will provide the ability to build sustainable and more secure EMR systems. Additionally, this study can be considered significant as no previous study has been conducted to measure the acceptance of blockchain technology among healthcare professionals through the use of an integrated TAM and UTAUT model. The study aims to answer the following research question:

> **RQ:** What are the factors that most influence the acceptance of blockchain technology among healthcare professionals?

To this end, hypotheses were developed based on possible correlations between factors from the proposed framework. A web-based questionnaire was distributed among healthcare professionals in Jordan. The data from the collected responses were analyzed, and the results were presented and discussed.

The rest of this paper is organized as follows. The next section presents the background on blockchain technology and technology acceptance models in healthcare along with the existing works relevant to the study. Then, the research model and development of the hypotheses are introduced. The next sections present the research methodology, analysis, and results. Finally, the discussion and conclusion of the study are stated.

LITERATURE REVIEW

BLOCKCHAIN TECHNOLOGY

Blockchain technology is a decentralized digital database of transactions maintained by a network of computers and provides autonomous and secure data storage (Morkunas et al., 2019). It ensures integrity, immutability, and transparency by utilizing cryptographic protocols like digital signatures and hash functions (Guo & Yu, 2022). Each block contains a unique code called a hash that links it to the previous block, creating an immutable record of all transactions. The consensus mechanisms and the distributed networks of the blockchain make it fault-tolerant and immune to single-point attacks. This technology can be used in several fields like digital cryptocurrency, finance, and healthcare as it provides a more secure, reliable, and efficient data storage environment (Liu et al., 2023). Due to its decentralization, blockchain transactions are performed without requiring a trusted central authority. This enables user validation, storage, and synchronization of data while ensuring maintenance of data integrity and reliability (Ali et al., 2021).

Blockchain Technology Use in Healthcare

The use of blockchain technology in healthcare has been increasing due to its several potential applications and benefits to the healthcare sector (Hölbl et al., 2018). Large amounts of healthcare data are being generated rapidly and continuously. The protection of the privacy and security of healthcare data is a major concern due to the constant data exchange and sharing process that occurs between healthcare providers and patients. Therefore, blockchain technology can be beneficial for storing medical data as it maintains data integrity through authentication and consensus mechanisms. The accuracy of diagnosis has the potential to be improved through the use of blockchain technology that encrypts data, making it immutable and impossible to decipher once added to the chain (Attaran, 2022). Blockchain technology aids in enhancing storage and interoperability along with maintaining data integrity and restricting access to only authorized individuals when implemented in healthcare settings (Haleem et al., 2021). The privacy of each user is secured through the use of a unique identifier that allows only authorized individuals to access the data, keeping it secure while also making it possible to share with chosen individuals or healthcare providers (Attaran, 2022). Blockchain technology can be used to improve the security and accurate management of EHRs due to its decentralization (Hölbl et al., 2018). The adoption of blockchain technology can reduce the costs associated with administrative processes. It also addresses data transparency, immutability, and traceability issues, thus highly improving healthcare data management systems (Capece & Lorenzi, 2020; Yaqoob et al., 2022). The traceability, integrity, security, and non-repudiation solutions have the potential to transform healthcare and can be applied to EHRs along with other uses, such as fraud detection, telemedicine, and clinical trials (McGhin et al., 2019). It addresses healthcare billing inaccuracies and frauds through the use of decentralized records and smart contracts that control the verification process. Blockchain technology can also help health insurance companies by providing transparent information about the transactions and maintaining the data from being tampered (Attaran, 2022).

Related Work

In exploring the adoption of blockchain technology in healthcare, only a few studies have utilized the Technology Acceptance Model (TAM) or the Unified Theory of Acceptance and Use of Technology (UTAUT) as theoretical frameworks to identify factors influencing intention to use. Table 1 provides a summary of the related studies conducted on this matter.

Kumar and Jain (2023) utilized TAM to investigate factors influencing the adoption intention of blockchain in e-health/medical records. Their findings revealed positive correlations between (1) perceived ease of use and perceived usefulness, (2) perceived usefulness and adoption intention, (3) perceived ease of use and trust, (4) trust and perceived usefulness, (5) perceived security and privacy (PSP) and trust, and (6) perceived security and privacy (PSP) and perceived usefulness. Similarly, Altalhi and Basiouni (2022) applied TAM to assess the attitude and acceptance of blockchain technology among Canadian pharmaceutical companies. Their study demonstrated positive correlations between perceived usefulness and attitude towards use, perceived ease of use and attitude towards use, attitude towards use and intention to use, as well as intention to use and actual usage of blockchain technology. Additionally, Shaukat et al. (2023) proposed a framework that integrates four technology acceptance models, including the TAM and UTAUT. The study investigated the factors influencing the acceptance of blockchain in telemedicine. Perceived usefulness, trust, and perceived ease of use were found to have a significant impact on behavioral intention to use the blockchain.

Baltruschat et al. (2023) utilized an extended UTAUT model to investigate user acceptance of blockchain technology for EHR data sharing. Their study highlighted positive relationships between performance expectancy, social influence, and perceived trust with behavioral intention, as well as correlations between incentives and facilitating conditions, perceived security and trust, and self-efficacy and effort expectancy. Furthermore, Dbesan et al. (2023) proposed a framework that utilizes factors from the UTAUT 2 to investigate their influence on behavioral intention to adopt the blockchain technology in healthcare. The findings of this study indicate a positive correlation between behavioral intention and the following: performance expectancy, effort expectancy, social influence, and facilitating conditions. Trust was also found to impact behavioral intention mediated by level of knowledge sharing.

These studies highlight the importance of factors such as perceived usefulness, perceived ease of use, trust, security, and social influence in shaping the adoption of blockchain technology in healthcare contexts.

Table 1. Related work summary

Study	Aim	Model	Findings
Kumar and Jain (2023)	Investigate factors influencing the adoption intention of blockchain in e-health/medical records	TAM	Positive correlation between: (1) Perceived ease of use and perceived usefulness (2) Perceived usefulness and adoption intention (3) Perceived ease of use and trust (4) Trust and perceived usefulness (5) Perceived security and privacy (PSP) and trust (6) Perceived security and privacy (PSP) and perceived usefulness
Altalhi and Basiouni (2022)	Assess the attitude and acceptance of blockchain technology among Canadian pharmaceutical companies	TAM	Positive correlation between: (1) Perceived usefulness and attitude towards use (2) Perceived ease of use and attitude towards use (3) Attitude towards use and intention to use (4) Intention to use and actual usage of blockchain technology
Shaukat et al. (2023)	Investigates the factors influencing behavioral intention to adopt blockchain technology in telemedicine.	• TAM • UTAUT • Technology organization environment model (TOE) Theory of planned behavior (TPB)	Behavioral intention was positively influenced by: (1) Perceived usefulness (2) Trust (3) Perceived ease of use

Study	Aim	Model	Findings
Baltruschat et al. (2023)	Investigate user acceptance of blockchain technology for EHR data sharing	UTAUT	Behavioral intention positively influenced by: (1) Performance expectancy (2) Social influence (3) Perceived trust Positive correlation between: (1) Incentives and facilitating conditions (2) Perceived security and trust (3) Self-efficacy and effort expectancy
Dbesan et al. (2023)	Investigate the factors that influence the behavioral intention to adopt the knowledge sharing driven blockchain technology in healthcare.	UTAUT 2	Behavioral intention was positively influenced by: (1) Performance expectancy (2) Effort expectancy (3) Social influence (4) Facilitation conditions (5) Trust (mediated through knowledge sharing)

RESEARCH MODEL AND HYPOTHESES DEVELOPMENT

TECHNOLOGY ACCEPTANCE MODEL IN HEALTHCARE

With the advancements in healthcare technology and the benefits that it could provide to the healthcare sector, it is crucial to ensure that healthcare professionals fully utilize such technologies when implemented into healthcare settings (Rouidi, Elouadi, & Hamdoune, 2022). It is important to understand the factors that can affect the healthcare technologies' use and the correlation between these factors and the users' willingness to use such technology (AlQudah et al., 2021). This aids in identifying the reasons behind technology acceptance and how to successfully implement it into healthcare professionals' workflows (van der Ham et al., 2020). The TAM and the UTAUT models can be applied to assess and predict the acceptance of healthcare technology (Rouidi, Elouadi, Hamdoune, Choujtani, & Chati, 2022).

The TAM is a theoretical framework that was developed by Davis (1989) for measuring user adoption and attitude towards technology usage. The two primary factors of this model are perceived usefulness and perceived ease of use. Perceived usefulness refers to how much a user believes that the technology will be helpful for their task, while perceived ease of use indicates the simplicity of its usage. These two factors are linked, and both have a significant impact on attitude towards using technology, which then determines behavioral intention to use, as illustrated in Figure 1.

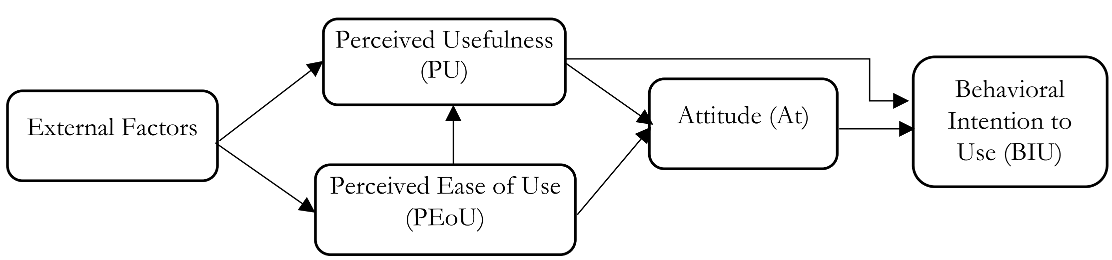

Figure 1. The original TAM model (Davis, 1989)

The TAM has emerged as an effective method for understanding the reasons and factors that may influence the healthcare professionals' acceptance and attitude toward the implementation and use of technology in the healthcare field. The widespread adoption of TAM is due to its ability to assess the perceived usefulness of these technologies, which has been identified as the primary predictor of their acceptance. This highlights the importance of considering how well a technology addresses current healthcare challenges, meets user needs, and provides tangible benefits in determining its level of adoption within this sector (Nguyen et al., 2020).

The TAM model may be helpful in identifying the factors that may influence the attitude and behavior of healthcare professionals when it comes to the acceptance of blockchain technology implementation in healthcare. This aids in increasing the adoption rate and use of blockchain-based healthcare systems as these factors would be taken into consideration before the implementation of this technology. The TAM model has been used in several studies to measure the factors that may affect acceptance of the blockchain in several industries (Chaveesuk et al., 2020; Giri & Manohar, 2023; Sciarelli et al., 2022; Shrestha & Vassileva, 2019). However, only a very limited number of studies have used TAM models to measure the acceptance of blockchain in healthcare (Altalhi & Basiouni, 2022; Kumar & Jain, 2023; Shaukat et al., 2023).

The UTAUT is another commonly used model to measure technology acceptance in healthcare (Dash & Sahoo, 2022; Kim et al., 2015). It integrates elements from eight technology acceptance models (Venkatesh et al., 2003). The UTAUT has four main constructs (performance expectancy, effort expectancy, social influence, and facilitating conditions) that are believed to be direct determinants of user acceptance and have an influence on behavioral intention to use technology (Venkatesh et al., 2003), as illustrated in Figure 2.

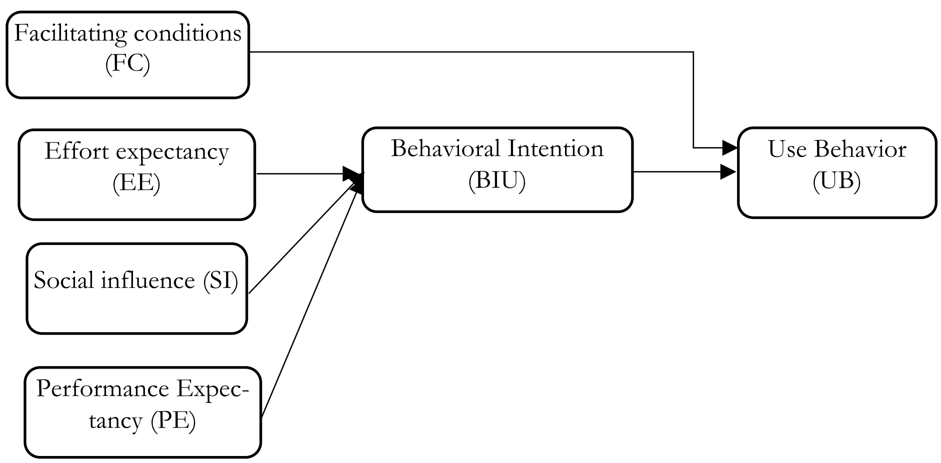

Figure 2. The UTAUT Model (Venkatesh et al., 2003)

Previous studies have adapted the UTAUT model to measure user acceptance and the attitude of users towards blockchain technology (Jameel & Alheety, 2022; Sharma et al., 2023; Surarityothin et al., 2022). However, only a few studies have utilized it to measure blockchain technology acceptance in healthcare (Baltruschat et al., 2023; Dbesan et al., 2023).

The proposed framework used in this study is an extended version of the TAM integrated with three factors from the original UTAUT to measure the acceptance and attitude of healthcare professionals towards the use of the blockchain technology in healthcare settings. The constructs from the original TAM model (perceived usefulness, perceived ease of use, attitude, and behavioral intention to use) were included along with the following additional constructs: usability, convenience, perceived privacy and security, cost, and perceived trust. These additional factors were incorporated to investigate their influence and to provide a more comprehensive inclusion of the factors that may affect blockchain technology in this study. Perceived privacy and security and perceived trust were included based on the positive results from Kumar and Jain (2023), a blockchain-based study. However, usability, convenience, and cost were included based on other technology studies (Brandon-Jones & Kauppi, 2018; Chang et al., 2012; Ozbek et al., 2015; Wang et al., 2022). Three factors from the UTAUT model (effort expectancy, social influence, and facilitating conditions) were also included, as depicted in Figure 3. Performance expectancy was not included due to being considered similar to perceived usefulness (Venkatesh et al., 2003). In this study, behavioral intention to use refers to the healthcare professionals' intention or willingness to use blockchain-based healthcare systems.

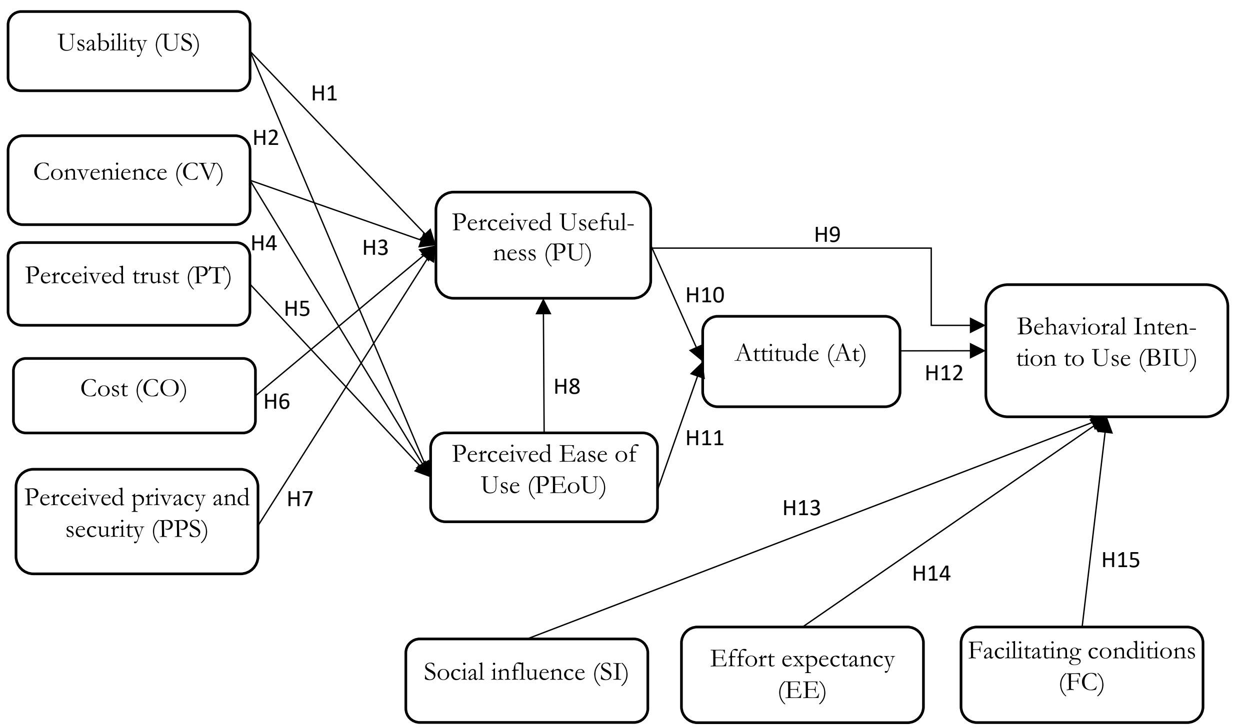

Figure 3. The research model

The following hypotheses were formulated to be tested in this study:

H1: Usability has a significant impact on perceived usefulness.

Usability in this study refers to how easy and efficient it is for healthcare professionals to interact with the blockchain-based healthcare system (Yen & Bakken, 2012). Perceived usefulness refers to the degree to which healthcare professionals believe that using the blockchain-based healthcare system will enhance their job performance (Davis, 1989). In Brandon-Jones and Kauppi's (2018) study, usability of an e-procurement system was found to positively correlate with its perceived usefulness. Therefore, in H1, we investigate whether this also applies to blockchain-based healthcare systems.

H2: Usability has a significant impact on perceived ease of use.

Perceived ease of use is defined as the degree to which healthcare professionals believe that using the blockchain-based healthcare system would be free of effort (Davis, 1989). Usability was found to directly impact perceived ease of use of an e-system (Brandon-Jones & Kauppi, 2018). Accordingly, H2 investigates whether this also applies to blockchain technology. It hypothesizes that if healthcare professionals perceive the blockchain-based healthcare system to be of high usability, they are more likely to find its use free of effort.

H3: Convenience has a significant impact on perceived usefulness.

Convenience refers to the degree to which healthcare professionals perceive that they can access the blockchain-based healthcare system in an effective and timely manner (Wang et al., 2022). Due to the absence of information on the influence of convenience on adoption, H3 hypothesizes that if the blockchain-based healthcare system is perceived as convenient by healthcare professionals, they are more likely to find it useful.

H4: Convenience has a significant impact on perceived ease of use.

In Chang et al.'s (2012) study, a positive relationship was found between perceived ease of use and convenience of the English mobile learning system. This may also be applicable to blockchain-based technology. Thus, H4 hypothesizes that if the blockchain-based healthcare system is perceived as convenient, healthcare professionals will more likely believe that using it would be free of effort.

H5: Perceived trust has a significant impact on perceived ease of use.

Perceived trust is how healthcare professionals perceive the trustworthiness of blockchain technology. In Kumar and Jain's (2023) study, the results have shown a significant positive correlation between perceived ease of use and trust. H5 studies whether the healthcare professionals' perceived trust in the blockchain-based healthcare system has an impact on its perceived ease of use.

H6: Cost has a significant impact on perceived usefulness.

In Ozbek et al.'s (2015) study, the results showed that cost has a positive effect on the perceived usefulness of online reservation websites. This may also be investigated in the case of blockchain technology. Therefore, H6 hypothesizes that the higher the costs of the implementation and staff training, the less likely it is for healthcare professionals to be willing to adopt the blockchain-based healthcare system.

H7: Perceived privacy and security have a significant impact on perceived usefulness.

Perceived privacy and security refer to how healthcare professionals perceive the effectiveness of blockchain technology in protecting and maintaining the confidentiality of sensitive healthcare data and personal health information. The users' perceived usefulness of the blockchain healthcare system was found to be strongly influenced by perceived security and privacy (Kumar & Jain, 2023). H7 studies if the healthcare professionals' perceived privacy and security of the blockchain-based healthcare system have a significant impact on its perceived usefulness.

H8: Perceived ease of use has a significant impact on perceived usefulness.

Kumar and Jain (2023) found a positive correlation between perceived ease of use and perceived usefulness. H8 studies whether the healthcare professionals' perceived ease of use of the blockchain-based healthcare system has a positive impact on its perceived usefulness making it more likely for healthcare professionals to be willing to adopt this technology.

H9: Perceived usefulness has a significant impact on behavioral intention to use.

Behavioral intention to use refers to the healthcare professionals' intention or willingness to use blockchain-based healthcare systems (Venkatesh et al., 2003). Shaukat et al. (2023) have found that perceived usefulness positively influences the behavioral intention to adopt blockchain technology. Accordingly, H9 hypothesizes that if healthcare professionals perceive using blockchain technology in healthcare is useful, they are more likely to be willing to use it.

H10: Perceived usefulness has a significant impact on attitude.

Attitude refers to the healthcare professionals' overall evaluation, positive or negative, about using blockchain technology. According to Davis (1985), perceived usefulness has a direct effect on attitude. The study by Sciarelli et al. (2022) shows a positive impact of perceived usefulness on the attitude towards blockchain adoption. Therefore, H10 was proposed to identify whether the healthcare professionals' perceived usefulness of the blockchain-based healthcare system will be positively correlated with their attitude towards it.

H11: Perceived ease of use has a significant impact on attitude.

Davis (1985) indicates that perceived ease of use has a direct effect on attitude. The results from Ahmed et al.'s (2023) study show that perceived ease of use has a positive impact on the attitude towards blockchain use. H11 hypothesizes that the perceived ease of use of the blockchain-based healthcare system will have a positive impact on the healthcare professionals' attitude towards it.

H12: Attitude has a significant impact on behavioral intention to use.

In the study by Sciarelli et al. (2022), attitude was found to have a significant impact on behavioral intention to use the blockchain technology. Accordingly, H12 hypothesizes that if healthcare professionals have a positive attitude toward blockchain technology, this would result in an increased behavioral intention to use the blockchain-based healthcare system.

H13: Social influence has a significant impact on behavioral intention to use.

Social influence is defined as the extent to which healthcare professionals perceive that important others believe that they should use the blockchain-based healthcare system (Venkatesh et al., 2003). Baltruschat et al. (2023) found a positive impact of social influence on the behavioral intention to use the blockchain. H13 studies whether social influence will have an impact on healthcare professionals' behavioral intention to use blockchain technology.

H14: Effort expectancy has a significant impact on behavioral intention to use.

Effort expectancy is defined by Venkatesh et al. (2003, p. 450) as "the degree of ease associated with the use of the system." In Dbesan et al.'s (2023) study, effort expectancy was found to have a positive impact on behavioral intention to adopt blockchain technology in healthcare. Therefore, H14 studies whether effort expectancy will significantly impact healthcare professionals' behavioral intention to use the blockchain-based healthcare system.

H15: Facilitating conditions have a significant impact on behavioral intention to use.

Facilitating conditions is defined by Venkatesh et al. (2003) as "the degree to which an individual believes that an organizational and technical infrastructure exists to support the use of the system." In the original UTAUT model, facilitating conditions have a direct significant effect on use behavior as shown in Figure 2. However, the study by Dbesan et al. (2023) found a positive correlation between facilitating conditions and behavioral intention to use. Accordingly, H15 studies the impact of facilitating conditions on healthcare professionals' behavioral intention to use the blockchain-based healthcare system.

METHODOLOGY

A web-based questionnaire was used to collect responses from 372 healthcare professionals from several healthcare facilities in Jordan. The collected data were statistically analyzed using the Structural Equation Model (SEM). The results are then presented and studied to identify the impact of the adopted factors on the acceptance level of the blockchain-based healthcare system among healthcare professionals.

QUESTIONNAIRE

A web-based questionnaire was prepared using Google Forms. The question items for each of the 12 factors were constructed and used to measure the intention to use blockchain technology in healthcare. Among these factors, five were external variables adopted from previous studies. Table 2 shows the external variables used in this research, with some literature reviewed citing these variables. It is essential to explicitly state that all the external factors were adopted from existing sources without any modification reflecting the constructs as originally developed in the cited works. This approach ensures the preservation of the integrity and conceptualization of each factor, aligning with the methodologies established in the referenced studies. For a more comprehensive understanding of the measurement items associated with each construct, Table 3 provides a detailed description of the measurement items for each construct.

Table 2. External variables with the references

Variable	Reference
Usability (US)	Brandon-Jones and Kauppi (2018)
Convenience (CV)	Wang et al. (2022)
Perceived trust (PT)	Baltruschat et al. (2023); Kumar and Jain (2023)
Cost (CO)	Tung et al. (2008); Ozbek et al. (2015)
Perceived privacy and security (PPS)	Baltruschat et al. (2023); Kumar and Jain (2023)

The questions were graded on a 5-point Likert scale where (1) = strongly disagree, (2) = disagree, (3) = neutral, (4) = agree, and (5) = strongly agree. The questionnaire was tested by 10 participants to collect their feedback and ensure the questions' clarity. The estimated time to complete the questionnaire was around 10 minutes. Participants were initially required to answer whether they have knowledge of the concept of blockchain technology. Therefore, all participants who were not familiar with blockchain technology were excluded from the study.

Table 3. Measurement items description for each construct

Variables	Construct Items		Source
Perceived usefulness	PU1	The healthcare system's performance could be improved using blockchain technology	Davis (1989); Kumar and Jain (2023)
	PU2	Using blockchain technology would reduce the time it takes for the system process to be completed	
	PU3	The use of blockchain technology would improve the efficiency of the healthcare system	
	PU4	B-BHS will make my job easier	
	PU5	B-BHS increases my productivity	
	PU6	Overall, B-BHS is useful in healthcare settings	
Perceived ease of use	PEoU1	The properties of B-BHS are simple to use	Davis (1989); Kumar and Jain (2023)
	PEoU2	The blockchain concept is simple to grasp and put into healthcare practice	
	PEoU3	It is simple to learn how to use B-BHS	
	PEoU4	Interacting with B-BHS is flexible	
Attitude	At1	I believe that B-BHS will improve the healthcare outcomes	Davis (1989)
	At2	I am willing to use and support the implementation of B-BHS	
	At3	I have a positive attitude towards using B-BHS in general	
Behavioral intention to use	BIU1	I would use a B-BHS to share and store healthcare data and personal health information	Baltruschat et al. (2023); Davis (1989) Venkatesh et al. (2003)
	BIU2	I plan to use a B-BHS to share and store healthcare data and personal health information	
	BIU3	I prefer to use a B-BHS over other traditional solution	

Variables	Construct Items		Source
Usability	US1	Interacting with B-BHS is easy and efficient	Brandon-Jones and Kauppi (2018)
	US2	B-BHS is easy to access	
	US3	B-BHS is easy to navigate	
Convenience	CV1	Using B-BHS is convenient because it is time efficient	Wang et al. (2022)
	CV2	B-BHS is convenient because it will reduce the workload	
	CV3	B-BHS is convenient because it is not complicated	
Perceived privacy and security	PPS1	I believe that B-BHS is secure	Baltruschat et al. (2023); Kumar and Jain (2023)
	PPS2	Using B-BHS to share healthcare data increases the data security and privacy	
	PPS3	B-BHS is safe to use	
Cost	CO1	The implementation of B-BHS is expensive	Tung et al. (2008)
	CO2	Training the staff on use of B-BHS will require additional costs	
	CO3	Buying and maintaining B-BHS is a financial burden	
Perceived trust	PT1	B-BHS is trustworthy	Baltruschat et al. (2023); Kumar and Jain (2023)
	PT2	I believe that a B-BHS is reliable	
	PT3	Transparency is a feature of B-BHS	
Effort expectancy	EE1	Learning how to share data with a B-BHS would be easy	Venkatesh et al. (2012)
	EE2	Sharing data on a B-BHS is clear and understandable	
	EE3	Overall, a B-BHS is easy to use	
Social influence	SI1	I will be more willing to use B-BHS if other healthcare professionals and colleagues are using it	Baltruschat et al. (2023)
	SI2	I will be more willing to use B-BHS if my superiors are adopting it	
	SI3	Other healthcare professionals and colleagues will be expecting me to use B-BHS	
Facilitating conditions	FC1	I have the necessary knowledge to use a B-BHS	Baltruschat et al. (2023)
	FC2	I have the necessary resources and training to use a B-BHS	
	FC3	I believe that healthcare institutions are technologically able to implement and use a B-BHS	

B-BHS = Blockchain-based healthcare system

DATA COLLECTION

The web-based questionnaire was distributed using multiple channels to enhance reach and participation diversity (see Appendix). Jordanian healthcare professionals were approached directly in different healthcare facilities like hospitals, pharmacies, laboratories, and medical clinics. The questionnaire was distributed among Jordanian-based healthcare online groups through social media platforms. Prior to engaging in the survey, participants were provided with clear information about the research objectives, confidentiality measures, and the voluntary nature of their participation. The privacy of the participants was protected throughout the study, and only the researchers had access to the collected data. Additionally, responses were anonymized to ensure that no personally identifiable information was collected or linked to individual responses.

Research population

The targeted research population for this study comprised Jordanian healthcare professionals actively engaged in diverse healthcare facilities, including hospitals, pharmacies, laboratories, and medical clinics. The inclusion criteria encompassed individuals directly involved in healthcare services and decision-making related to the implementation of technology, specifically blockchain, in their professional capacities. Initially, the questionnaire was sent to many health providers. The healthcare professionals that were targeted included pharmacists, physicians, therapists, nurses, and laboratory and radiology technicians. A total sample of 372 participants answered the questionnaire. The demographic distribution of the participants reflects a gender balance within the sample. Of the 372 participants, 197 (53%) were males, while 170 (47%) were females. This gender balance was sought to minimize potential biases associated with a skewed participant composition.

Specialization considerations

There was no question asking about their specialization. The decision to omit this aspect from the survey was intentional, aiming to maintain a broad focus on the general perceptions and intentions related to blockchain adoption among healthcare professionals. This approach aimed to capture the diversity of experiences and perspectives related to the intention to use blockchain technology in different healthcare settings and our belief that Blockchain technology can serve different specializations.

Sampling strategy

A stratified random sampling approach was employed to ensure a representative and diverse participant pool. Stratification was based on the type of healthcare facility, aiming to capture insights from professionals across various sectors within the healthcare domain. This approach facilitated a comprehensive understanding of the intention to use blockchain technology in different healthcare settings.

Survey distribution

The web-based questionnaire was distributed to hospitals, pharmacies, laboratories, and medical clinics. Additionally, the survey was shared within Jordanian-based healthcare online groups on popular social media platforms, including Facebook, WhatsApp, LinkedIn, Instagram, and email. Leveraging these platforms broadened the geographical scope and ensured a more inclusive representation of the target population.

Data collection timeline

The process of collecting data from 372 participants spanned four months, commencing in August 2023 and concluding in November 2023. This timeline was chosen to accommodate the dynamic schedules of healthcare professionals and maximize participation. The extended duration also allowed for a robust collection of responses, ensuring a comprehensive dataset for the analysis.

Analysis and Results

The formulated hypotheses were evaluated with the survey data collected from 372 Jordanian healthcare professionals. SPSS and AMOS tools were utilized to statistically analyze the collected data using the structured equation modeling (PLS-SEM) technique.

Reliability Analysis

Cronbach's Alpha values are presented in Table 4. All variables had values between 0.752 and 0.899 which is above the stated criterion of 0.7 (Hair et al., 2017). This indicates that the scale items are consistent with each other.

Confirmatory Factor Analysis

Assessment of normality

The skewness and kurtosis results are presented in Table 4. For the data to be classified as normally distributed, the kurtosis and skewness values for factors should be between -3 and 3 (Aburumman et al., 2023). The collected data is normally distributed as the kurtosis values are between -1.056 and 1.762, and the skewness values are between -0.537 and 0.703.

Table 4. Reliability analysis of the variables

Variables	Mean	Standard Deviation	Skewness	Kurtosis	Cronbach's Alpha
Social Influence	3.1024	1.06076	-0.112	-0.813	0.825
Usability	3.0898	0.95469	-0.103	-0.835	0.769
Convenience	3.1608	1.05162	-0.229	-0.881	0.818
Facilitating conditions	3.2345	1.01540	0.036	-0.917	0.786
Perceived trust	3.1024	0.74837	0.044	-0.363	0.752
Cost	2.9245	0.97675	0.033	-0.698	0.809
Perceived privacy and security	2.3019	0.71444	0.703	1.762	0.803
Effort expectancy	3.1024	0.92398	0.157	-0.742	0.753
Perceived usefulness	2.8823	0.82167	0.120	-0.364	0.87
Perceived ease of use	3.3598	1.02118	-0.537	-0.285	0.899
Attitude	2.8446	1.06660	0.103	-0.786	0.799
Behavioral intention to use	2.5714	1.18723	0.177	-1.056	0.868

Factor loadings (FL)

As shown in Table 5, all factor loading values were greater than or equal to 0.5, indicating its significance (Hair et al., 2010). Therefore, all questions were considered in this study. Table 5 also presents the p-values, which appear to be less than 0.001, indicating significance.

Table 5. Confirmatory factor analysis results

Latent variables	Indicator	Factor loading	Factor loading squared	P-value
AT	AT1	0.772	0.595984	-
	AT2	0.705	0.497025	<0.001
	AT3	0.788	0.620944	<0.001
BIU	BIU1	0.857	0.734449	-
	BIU2	0.873	0.762129	<0.001
	BIU3	0.754	0.568516	<0.001
CO	CO1	0.758	0.574564	<0.001
	CO2	0.605	0.366025	<0.001
	CO3	0.849	0.720801	-
CV	CV1	0.744	0.553536	<0.001
	CV2	0.752	0.565504	<0.001
	CV3	0.794	0.630436	-

Latent variables	Indicator	Factor loading	Factor loading squared	P-value
EE	EE1	0.677	0.458329	<0.001
	EE2	0.682	0.465124	<0.001
	EE3	0.767	0.588289	-
FC	FC1	0.706	0.498436	<0.001
	FC2	0.834	0.695556	<0.001
	FC3	0.687	0.471969	-
PEoU	PEoU1	0.851	0.724201	-
	PEoU2	0.831	0.690561	<0.001
	PEoU3	0.914	0.835396	<0.001
	PEoU4	0.814	0.662596	<0.001
PPS	PPS1	0.845	0.714025	-
	PPS2	0.708	0.501264	<0.001
	PPS3	0.728	0.529984	<0.001
PT	PT1	0.6	0.414736	-
	PT2	0.644	0.762129	<0.001
	PT3	0.873	0.335241	<0.001
PU	PU1	0.579	0.335241	-
	PU2	0.746	0.556516	<0.001
	PU3	0.806	0.649636	<0.001
	PU4	0.559	0.312481	<0.001
	PU5	0.838	0.702244	<0.001
	PU6	0.808	0.652864	<0.001
SI	SI1	0.721	0.702244	-
	SI2	0.856	0.652864	<0.001
	SI3	0.771	0.519841	<0.001
US	US1	0.741	0.732736	<0.001
	US2	0.702	0.594441	<0.001
	US3	0.735	0.549081	-

Construct Validity

To test the construct validity, both the convergent validity (CV) and discriminate validity (DV) were measured. Composite Reliability (CR) and the Average Variance Extracted (AVE) are used to evaluate the convergent validity. The results displayed in Table 6 show that all CR and AVE values are greater than 0.7 and 0.5, respectively, confirming good convergent validity of the variables in this study (Fornell & Larcker, 1981; Hair et al., 2017). As shown in Table 6, the square roots of AVEs appear to be higher than the correlations among constructs, confirming discriminant validity among all variables in this study (Fornell & Larcker, 1981; Hair et al., 2017).

Table 6. Validity analysis results

	CR	AVE	SI	US	CV	EE	CO	PPS	FC	PT	PU	PEoU	At	BIU
SI	0.831	0.625	**0.785**											
US	0.808	0.625	-0.431***	**0.726**										
CV	0.807	0.583	0.687***	-0.741***	**0.764**									
EE	0.752	0.504	-0.694***	0.321***	-0.524***	**0.71**								
CO	0.785	0.554	0.636***	-0.485***	0.743***	-0.551***	**0.744**							
PPS	0.806	0.582	-0.475***	0.300***	-0.514***	0.230***	-0.519***	**0.763**						
FC	0.788	0.555	-0.052	0.115†	0.009	0.013	0.178**	-0.163*	**0.745**					
PT	0.754	0.512	0.094	-0.213**	0.283***	-0.034	0.076	-0.112†	-0.067	**0.716**				
PU	0.871	0.535	0.093	-0.274***	0.191**	0.022	0.041	0.002	-0.091	0.675***	**0.731**			
PEoU	0.914	0.728	0.529***	-0.633***	0.752***	-0.365***	0.579***	-0.439***	-0.073	0.240***	0.073	**0.853**		
At	0.8	0.571	0.663***	-0.405***	0.546***	-0.569***	0.482***	-0.368***	-0.192**	0.193**	0.251***	0.487***	**0.756**	
BIU	0.868	0.688	0.707***	-0.526***	0.694***	-0.576***	0.667***	-0.471***	-0.007	0.197**	0.157**	0.593***	0.696***	**0.83**

Note: Boldfaced values in diagonal lines are the square root of AVE of each latent variable; otherwise, the correlation coefficient between the latent variable and the other latent variables. * p <0.05; ** p<0.01; *** p<0.001

Model Fit Values for the Measurement Model

The chi-squared/degree of freedom value is 2.313, which is considered acceptable as it is within the specified range of 2 < chi-squared/degree of freedom ≤ 3 (Schermelleh-Engels et al., 2003).

The Goodness of Fit Index (GFI) in this study is 0.837, which is a reasonable fit according to Doll et al. (1994).

The Comparative Fit Index (CFI in this study is 0.895, which is very close to the recommended good fit value of >0.9 by Hair et al. (2010).

The Normed Fit Index NFI value is found to be 0.831, which is considered to be acceptable (NFI ≥ 0.8) according to Akkus (2019).

The Root Mean Squared Error of Approximation (RMSEA) value is 0.06, which is considered to be acceptable and within the range of 0.05 < RMSEA ≤ 0.08 (Sánchez & Hueros, 2010; Schermelleh-Engels et al., 2003).

Thus, an acceptable model fit was achieved according to the results obtained from the model fit analysis.

Hypothesized Structural Model

The p-value and the path coefficient results for the suggested relationships between the variables are displayed in Table 7. H2, H5, H9, and H14 have p-values greater than 0.05 indicating no statistical significance; therefore, they were rejected. On the other hand, H1, H6, H7, and H15 are supported due to their statistical significance, as their p-values are less than 0.05. H3, H4, H8, H10, H11, H12, and H13 are also supported with p-values less than 0.001. Figure 4 presents the final model after the SEM analysis.

Table 7. Results for the hypothesized relationships

Hypothesis	Path			Path coefficient	P-value	Decision
H1	PU	<---	US	1.397	**0.01**	**Supported**
H2	PEoU	<---	US	-0.064	0.568	Rejected
H3	PU	<---	CV	2.799	**<0.001**	**Supported**
H4	PEoU	<---	CV	0.765	**<0.001**	**Supported**
H5	PEoU	<---	PT	-0.001	0.992	Rejected
H6	PU	<---	CO	-1.402	**0.001**	**Supported**
H7	PU	<---	PPS	0.431	**0.045**	**Supported**
H8	PU	<---	PEoU	-0.199	**<0.001**	**Supported**
H9	BIU	<---	PU	0.039	0.662	Rejected
H10	At	<---	PU	0.355	**<0.001**	**Supported**
H11	At	<---	PEoU	0.539	**<0.001**	**Supported**
H12	BIU	<---	At	0.521	**<0.001**	**Supported**
H13	BIU	<---	SI	0.678	**<0.001**	**Supported**
H14	BIU	<---	EE	-0.098	0.321	Rejected
H15	BIU	<---	FC	0.136	**0.038**	**Supported**

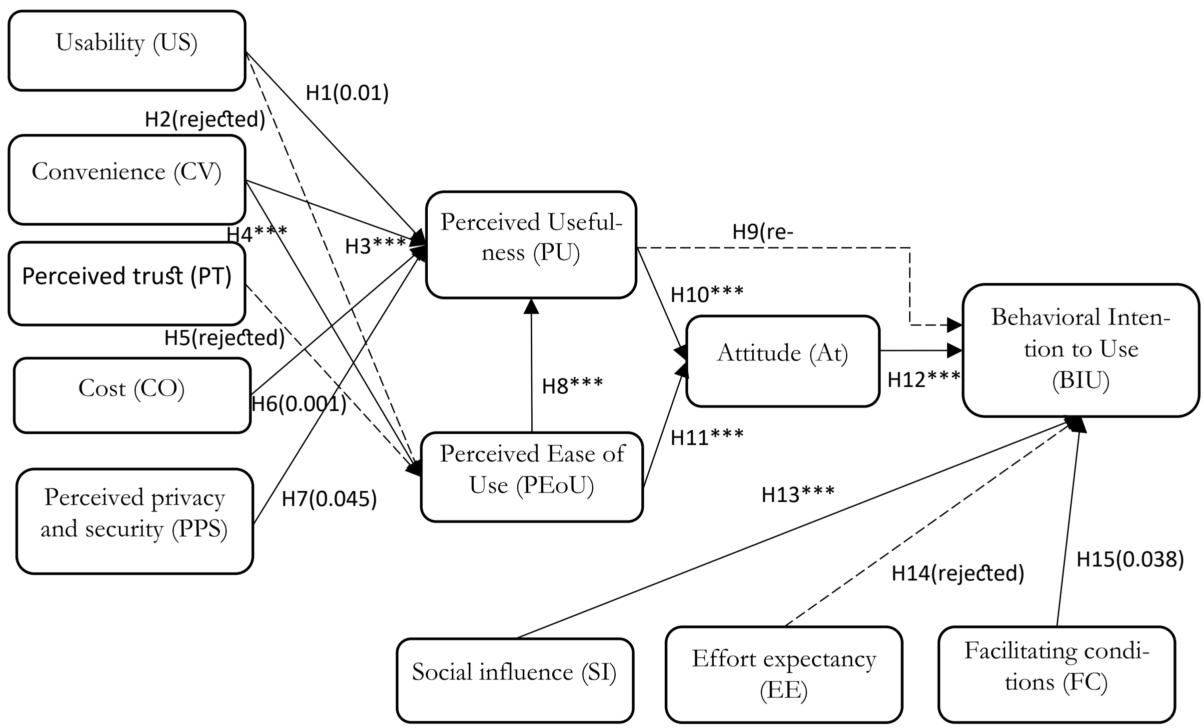

Figure 4. Final hypotheses model

Note: Numbers in parentheses represent p-values; p-value < 0.001 = ***
Solid arrow = supported hypothesis; dashed arrow = rejected hypothesis

DISCUSSION

In this research, the acceptance of blockchain-based healthcare systems among Jordanian healthcare professionals was examined. Only a limited number of previous studies were performed to evaluate the acceptance of blockchain technology in healthcare using technology acceptance models. In addition, no research has specifically focused on healthcare professionals in Jordan. This encouraged exploring the factors that may influence the acceptance of blockchain technology in Jordanian healthcare using an extended integrated TAM and UTAUT model.

Based on the factors included in this model, 15 hypotheses were formulated to predict correlations between the constructs. The results show that 11 hypotheses were supported, while four were rejected.

H1 was supported, confirming that healthcare professionals are more likely to perceive the blockchain-based healthcare system as useful if they believe in its usability, conforming with Brandon-Jones and Kauppi (2018). Additionally, convenience was found to have a significant impact on PU (H3), indicating that healthcare professionals are more likely to find blockchain-based healthcare systems useful if they are perceived to be convenient. H6 was also supported as the cost was found to significantly impact the PU, similar to the study by Ozbek et al. (2015). This means that it is less likely for healthcare professionals to be willing to adopt the blockchain-based healthcare system if its implementation leads to higher costs and expenses. Conforming with Kumar and Jain (2023), both H7 and H8 were supported; thus, ensuring that the blockchain-based healthcare system is highly usable, convenient, cost-effective, secure, and easy to use would enhance its perceived usefulness.

As in Sciarelli et al. (2022), the results from the analysis support H10, which confirms a positive correlation between perceived usefulness and attitude. Also, H11 was supported as perceived ease of use was found to have a positive impact on attitude, similar to the results from Ahmed et al. (2023). Thus, an easy-to-use and efficient blockchain-based healthcare system may help healthcare professionals obtain a positive attitude toward its use.

Similar to the results from Sciarelli et al. (2022), H12 was supported, indicating that behavioral intention to use the blockchain-based healthcare system would increase if the healthcare professionals had a positive attitude towards it. Social influence was also found to have a positive impact on behavioral intention to use, supporting H13 and conforming with Baltruschat et al. (2023). This confirms that healthcare professionals are more willing to use the blockchain-based healthcare system if other healthcare professionals or important colleagues are using it. Additionally, H15 was supported, indicating that facilitating conditions have a positive impact on behavioral intention to use, similar to Dbesan et al.'s (2023) study. Thus, encouraging superiors and leaders in healthcare facilities to adopt the blockchain-based healthcare system may provide support in influencing its use among other healthcare professionals. Also, ensuring that the necessary resources, technology, and training are available can help in increasing the intention to use the blockchain-based healthcare system.

H4 was supported confirming that convenience has a significant impact on perceived ease of use as in Chang et al. (2012). This means that healthcare professionals will more likely believe that using the blockchain-based healthcare system would be free of effort if they perceive its convenience.

H2 was rejected as usability was found to have no significant impact on perceived ease of use, contrary to Brandon-Jones and Kauppi (2018). Unlike Kumar and Jain's (2023) study, H5 was rejected as the results showed no significant correlation between perceived trust and perceived ease of use.

Although Shaukat et al. (2023) found that perceived usefulness positively influences behavioral intention to use, H9 was rejected as there was no significant correlation between them. In Dbesan et al.'s (2023) study, effort expectancy directly affected the behavior intention to use blockchain technology in healthcare. However, conforming with Baltruschat et al. (2023), no correlation was found between effort expectancy and behavioral intention to use. Therefore, H14 was rejected.

Based on these results, the study reveals that usability, convenience, privacy and security, cost, and trust significantly impact the perceived usefulness of blockchain technology among Jordanian healthcare professionals. The findings also suggest that healthcare professionals are more likely to have a positive attitude towards blockchain-based healthcare systems if they perceive them as useful and easy to use. Additionally, attitude, social influence, and facilitating conditions were found to significantly impact behavioral intention to use.

CONCLUSION

The blockchain-based healthcare system has the potential to vastly improve the healthcare quality in Jordan. To ensure effectiveness, it is important to understand the concerns of healthcare professionals and the factors that would influence the usage of such technology in healthcare settings. The research integrates the TAM and UTAUT models to provide a comprehensive understanding of the factors that influence the acceptance of blockchain technology among healthcare professionals in Jordan. This study helped identify the factors that should be addressed to increase the overall intention to use the blockchain-based healthcare system in Jordan. Stakeholders should focus on developing blockchain-based healthcare systems that are easy to use, convenient, efficient, and effort-free. Successful adoption of blockchain technology in the healthcare sector can lead to improved efficiency, enhanced protection of healthcare data, and reduced administrative burdens. This, in turn, can positively impact patient care and lead to cost savings, which contributes to more sustainable and accessible healthcare services.

Although the study collected data from 372 healthcare professionals, this may not be enough to fully represent the entire population of healthcare professionals in Jordan, affecting the generalizability of the findings. The collected data relied on self-reported responses from participants, which may introduce the possibility of bias and act as a limitation in this study. Additionally, there may be other relevant factors influencing the acceptance of blockchain technology in the healthcare sector that were not considered in this study.

Future research should focus on exploring the integration of blockchain technology with other emerging technologies, such as artificial intelligence and sidechain, to create more comprehensive and innovative healthcare solutions. Additional factors may also be explored to provide a more comprehensive understanding. Additionally, researchers may conduct a comparative analysis of blockchain technology acceptance between the healthcare sector and other industries to identify industry-specific factors that may influence adoption. This can contribute to a broader understanding of technology acceptance across different sectors.

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APPENDIX

Online Survey Form

Section 1	**Yes**	**No**
Are you familiar with the concept of blockchain technology?		
Are you currently employed as a healthcare professional directly involved in providing healthcare services or making technology implementation decisions across various healthcare facilities, including hospitals, pharmacies, laboratories, and medical clinics?		
Gender:	Female	Male

Section 2			**Strongly agree**	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
Perceived usefulness	PU1	The healthcare system's performance could be improved using blockchain technology					
	PU2	Using blockchain technology would reduce the time it takes for the system process to be completed					
	PU3	The use of blockchain technology would					

Section 2			Strongly agree	Agree	Neutral	Disagree	Strongly disagree
		improve the efficiency of the healthcare system					
	PU4	B-BHS will make my job easier					
	PU5	B-BHS increases my productivity					
	PU6	Overall, B-BHS is useful in healthcare settings					
Perceived ease of use	PEoU1	The properties of B-BHS are simple to use					
	PEoU2	The blockchain concept is simple to grasp and put into healthcare practice					
	PEoU3	It is simple to learn how to use B-BHS					
	PEoU4	Interacting with B-BHS is flexible					
Attitude	At1	I believe that B-BHS will improve the healthcare outcomes					
	At2	I am willing to use and support the implementation of B-BHS					
	At3	I have a positive attitude towards using B-BHS in general					
Behavioral intention to use	BIU1	I would use a B-BHS to share and store healthcare data and personal health information					
	BIU2	I plan to use a B-BHS to share and store healthcare data and personal health information					
	BIU3	I prefer to use a B-BHS over other traditional solution					
Usability	US1	Interacting with B-BHS is easy and efficient					
	US2	B-BHS is easy to access					
	US3	B-BHS is easy to navigate					
Convenience	CV1	Using B-BHS is convenient because it is time efficient					
	CV2	B-BHS is convenient because it will reduce the workload					

Section 2			Strongly agree	Agree	Neutral	Disagree	Strongly disagree
	CV3	B-BHS is convenient because it is not complicated					
Perceived privacy and security	PPS1	I believe that B-BHS is secure					
	PPS2	Using B-BHS to share healthcare data increases the data security and privacy					
	PPS3	B-BHS is safe to use					
Cost	CO1	The implementation of B-BHS is expensive					
	CO2	Training the staff on use of B-BHS will require additional costs					
	CO3	Buying and maintaining B-BHS is a financial burden					
Perceived trust	PT1	B-BHS is trustworthy					
	PT2	I believe that a B-BHS is reliable					
	PT3	Transparency is a feature of B-BHS					
Effort expectancy	EE1	Learning how to share data with a B-BHS would be easy					
	EE2	Sharing data on a B-BHS is clear and understandable					
	EE3	Overall, a B-BHS is easy to use					
Social influence	SI1	I will be more willing to use B-BHS if other healthcare professionals and colleagues are using it					
	SI2	I will be more willing to use B-BHS if my superiors are adopting it					
	SI3	Other healthcare professionals and colleagues will be expecting me to use B-BHS					
Facilitating conditions	FC1	I have the necessary knowledge to use a B-BHS					
	FC2	I have the necessary resources and training to use a B-BHS					

Section 2			Strongly agree	Agree	Neutral	Disagree	Strongly disagree
	FC3	I believe that healthcare institutions are technologically able to implement and use a B-BHS					

AUTHORS

Ahmad Mousa Altamimi received his Ph.D. degree with distinction from Concordia University, Canada, in 2014. He is currently an associate professor with the Software Engineering Department at Princess Sumaya University for Technology. His research interests are Technology Adoption, Bioinformatics, and Cybersecurity, with over 45 refereed publications, including journal papers, conference papers, book chapters, and books. During his career, Dr. Altamimi received numerous awards and fellowships and served as a program and steering committee member for several international conferences.

Dr. Hazem Qattous is currently an Assistant Professor in the Department of Software Engineering at Princess Sumya University for Technology (PSUT). He obtained his BSc from the Department of Computer Science at the Applied Science Private University (ASU) in 2004. Dr. Hazem attained his MSc in Software Engineering at the University of the West of England (UWE) in Bristol, UK. His Ph.D. was in the field of Meta-CASE tools and programming by example from Glasgow University in 2011 with full sponsorship. He worked as an Assistant and Associate Professor at ASU for 9 years. During this period, he was the head of the Computer Science Department for 2 years and worked as a Vice Dean for 1 year.

Duaa Barakat earned her Bachelor of Pharmacy degree from Ajman University and is currently pursuing a master's degree in health information technology at Princess Sumaya University for Technology. With a solid foundation in pharmacy and ongoing studies in health information technology, she is dedicated to enhancing healthcare delivery through the integration of technology and data-driven approaches. Her academic background and practical experience position her as a valuable contributor to the advancement of healthcare informatics.

Lubna Hazaimeh holds a B.Sc. in Occupational Therapy from Jordan University of Science and Technology and is currently pursuing a master's degree in health information technology at Princess Sumaya University for Technology. With a background in occupational therapy and ongoing studies in health information technology, she is deeply committed to leveraging technology to enhance patient care and optimize healthcare delivery. Her interdisciplinary expertise equips her to address complex challenges at the intersection of healthcare and technology, making her a valuable asset in advancing healthcare informatics.