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Blockchain technology adoption for sustainable learning

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A B S T R A C T

Sustainable Learning and Education (SLE) is a recent emerging philosophy founded on sustainability principles and in response to the UN announced Sustainable Development Goals (SDGs). Therefore, technologies should be implemented to empower educational institutions to achieve SLE. This study aims to investigate the factors impacting the intentions of using blockchain technology for SLE in Jordanian universities. Accordingly, an extended Technology Acceptance Model (TAM) is proposed where five more factors are integrated. To this end, an extended model was proposed and validated using structural equation modeling based on 407 responses collected using an online survey. The results showed that adopted factors significantly impact blockchain use in SLE. We believe that the study finding would assist decision-makers in building systems for sustainable learning and education for the Jordanian higher educational institutes.

1. Introduction

Sustainable learning and education (SLE) is an emerging philosophy of learning that aims to create and propagate sustainable curricula and methods. SLE is designed to make the learning process retained and transferrable (Hays & Reinders, 2020). The more commonly accepted the necessity of sustainability, the more likely we are to get it (McCullough et al., 2020). According to Ben-Eliyahu (2021), SLE involves ongoing, responsive, and proactive learning. Learners can build their knowledge effectively based on the circumstances changing. In this sense, it is lifelong learning, distinguished by conscious and intentional learning at the moment amid an ongoing low of circumstances and emerging possibilities (Tchamyou, 2020). SLE is inspired by sustainability in design and delivery and involves professional development that continually renews itself in ways that promote sustainable learning. Built on sustainability principles, SLE must be less structured than conventional education and must be operated separately and responsively. This gains learning systems the ability to rapidly adapt and disseminate the learning in complicated and challenging circumstances, which is one of the SLE equation factors (Chen, 2021). The other factors involve equipping learners with the skills and disposition to enable survival and the emergence of a sustainable future. As learners, free resources with decentralized techniques will help deliver and sustain the learning resources. Recent technologies have influenced the learning process and resulted in the development of delivering methods (Raja & Nagasubramani, 2018). For instance, Blockchain Technology (BT) has become an accepted adoption for delivery and learning (Ullah et al., 2021). BT is a creative and innovative technology that provides unique features such as reliability, decentralization, security, and data integrity (Abou Jaoude & George Saade, 2019). Due to its distinct features, BT plays an indispensable role in developing the learning process and improving the traditional education system. In this regard, BT has been effectively adopted by many colleges to manage academic degrees and comprehensive results. The University of Melbourne, for example, started using blockchain in 2017 to issue digital credentials and share students' qualifications with employers or third parties. Massachusetts Institute of Technology issued certifications of the Media Lab on a blockchain network (Alammary et al., 2019).

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However, the possibilities of blockchain go far beyond this matter. One can consider developing a sustainable learning system based on blockchain to co-created and share knowledge even with rapidly changing environments. However, without acceptance of such distinguished technology, i.e., blockchain, discretionary users will seek alternatives to perform inefficiently, negating many, if not all, the presumed benefits of blockchain technology (Binyamin et al., 2017). In this research, we will consider these concerns and present a preliminary study to investigate the adoption of BT for SLE. The study aims to explore and understand the factors that would influence the user's intention to adopt BT for SLE. Formally, the researchers aim to answer the following research question: What are the factors that affect BT adoption for SLE in Jordanian universities? Accordingly, a hypothetical model is developed using the Technology Acceptance Model (TAM) (Hu et al., 2018). The model assesses the influence of five external variables (e.g., Convenience, Facilitating Condition, Effort Expectancy, Cost, and Social Influence) upon the intention to use BT in SLE. To that end, the relationships among the external variables and the belief constructs (e.g., perceived usefulness and ease of use) are determined to influence usage intention (Davis, 1989). In other words, we want to determine if there is a correlation between the belief constructs and external variables.

The rest of this paper is organized as follows. First, the background material and the related works are presented in Section 2. Then, section 3 describes the proposed model, while the research methodology is discussed in Section 4. Next, the obtained results are clarified in Section 5 and discussed in Section 6. Finally, section 7 provides the study conclusion.

2. Background Material and Related work

BT is an emerging technology that has grown in prominence in recent years for financial services. For example, BT was the underlying technology of Bitcoin (Lim et al., 2021). Over the recent years, BT has received significant attention from industry to academia. Furthermore, it was widely accepted in various domains such as the supply chain, communication, government, and education (Ahmad et al., 2021). However, most literature focused on the opportunities and challenges of implementing BT (Zheng et al., 2018). Few of them have focused on studying the adoption of BT in education applications (Ullah et al., 2021) nor for SLE. To the best of our knowledge, no one has investigated the intention to use BT for SLE in developing economies like Jordan. Thus, this research will be one of the initial studies to investigate the adoption of BT for SLE.

Before discussing the proposed model, it is essential to discuss some main topics related to this research. Accordingly, the following subsection introduces blockchain technology, the main features that distinguish BT from other technologies, the applications of BT in education, and the Technology Acceptance Model (TAM) and its main factors.

2.1 Blockchain Technology (BT)

BT is a distributed ledger that can record information in a structure called Blocks represented as a Merkle tree. Each block is linked to the one before it using a cryptographic hash (Zheng et al., 2018). By design, blockchain is resistant to modification due to its values (the previous block's hash value and the timestamp). As a result, a block cannot be changed once data is recorded without modifying all subsequent blocks (Ichikawa et al., 2017). Moreover, BT is not managed by centralized authority; a peer-to-peer network typically governs it with communication and validation protocols. So, BT is considered secure and exemplifies a distributed, decentralized computing system (Baker El-Ebiary et al., 2021).

2.2 Blockchain Features

BT has many distinguishing features. Below, we briefly describe the main ones.

Digital identity through encryption: The blockchain provides a secure digital identity for the participant by defining two keys. First, a public key forms the identity of a particular participant, and it is public to everyone. Second, a private key is confidential and secured for the owner. It allows validating incoming and outgoing transactions (Risius & Spohrer, 2017).

Cryptographic Hash: It links blocks in a blockchain. It is an equal-size string calculated using a Hash Algorithm (e.g., SHA-256) based on the block content. The hash value is placed in the next block, so the two blocks are linked together. Moreover, it is impossible to reverse engineer the hash value to determine the corresponding input. Therefore, any change in a block content (no matter how) will always generate a different hash value. (Khezr et al., 2019).

Merkle Tree: It makes blockchain sensitive to tampering. Pointers link blocks together. Each pointer comprises the block header hash of the preceding block. So, any change with the underlying information in a particular block will spread over the entire tree and distort the Merkle Root. Consequently, the block header hash will be affected, altering the subsequent block (Atlam et al., 2018).

Consensus Protocol: Before adding a new block to an existing chain, the protocol consensus must be satisfied to ensure that all the chain participants agree upon the new block. Some involved methods include voting to meet some pre-set consistent criterion or solve a mathematical problem like Bitcoin. So, no one must be able to take ownership or claim owning information (Vujičić et al., 2018).

Decentralized and Trustworthy: Usually, the centralized approach is adapted to settle the educational platforms where all the information is stored in a central server. BT changes this assumption using a decentralized network to formulate the chain where anyone can participate and conduct a transaction. The elegance of blockchain is that it stores the same information on all participants' nodes. So, reliability and authority are both ensured here. Furthermore, blockchain is designed to be immutable where blocks already stored on the chain or will be added to the chain cannot be erased or modified as they have been validated by many participants of the chain (Kaur et al., 2020).

2.3 Blockchain in Education

Recently, many universities and educational institutes have applied blockchain into their educational systems to support students' transcripts and certificates management, secure their archives, or verify the accuracy of the information provided by the candidates. For instance, Nicosia university stored the whole transcript in a blockchain (Bellini et al., 2020). As a result, these documents can be delivered anytime, anywhere, and users can quickly share them with potential employers. In fact, using blockchain contributes to reducing degree fraud, where it is used to grant and manage students' degrees and avoid human interception. Here, the stored data are matched, checked, and validated with users' IDs by many chain participants, so reliability and authority are both ensured (Skiba, Editor, 2017).

Blockchain was also used for developing innovative learning platforms (Lizcano et al., 2020). For example, the Education Ecosystem platform is a remarkable project that allows academicians and learners to share their ideas and access study materials. Furthermore, users who contribute can earn internal tokens, which can later be traded (Awaji et al., 2020). In addition to educational applications, BT provides services to secure archives, ensuring that data cannot be changed. It also delivers accurate information to human resources. As a result, recruiters' workload and time will be significantly reduced, as blockchain facilitates many functions like the possibility of automating agreements and payment (Azzi et al., 2019). Moreover, developing a sustainable management system was also considered by blockchain developers, where resources used in the practices are optimized in such a way that will benefit current generations and future generations (Pincheira et al., 2021).

2.4 Technology Acceptance Model (TAM)

Davis et al. (1989) adapted TAM from TRA to predict users' acceptance of information technology. They introduced two essential constructs, perceived usefulness, and ease-of-use, to measure the technological perspective. Davis posits that the most crucial determinant of the user's behavioral intention and actual usage is the attitude, a combination of perceived usefulness and ease of use. The causal relationships among these constructs have been validated empirically in many user acceptance studies (Al-Husamiyah & Al-Bashayreh, 2022; D. Almajali et al., 2021; D. A. Almajali et al., 2021; Jimenez et al., 2021; Zaineldeen et al., 2020). Therefore, TAM attempted to provide a basis to study the effects of external variables on user behavior by identifying some essential variables as the determinants of computer acceptance, as exhibited in Fig. 1.

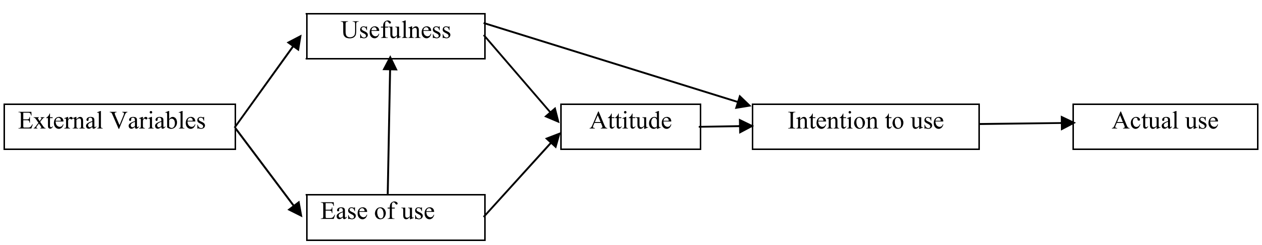

Fig. 1. Original TAM Model (Davis, 1989)

3. Research Methodology

This study examines various factors that would affect the acceptance of BT in SLE from a conceptual viewpoint instead of a specific service. To this end, the reasoning procedure for hypothesis development and evaluation is utilized here. It comprises four stages: building up the model, detailing testable hypotheses, gathering data, and lastly, testing the hypotheses (Yang et al., 2017). Thus, a framework that suitably explains the acceptance behavior on a conceptual level is first built. Here, the TAM model is adopted as the theoretical foundation of our research model. Besides the four main factors of TAM, which are Perceived Ease of Use (PEOU), Perceived Usefulness (PU), Attitude (ATT), and Behavioral Intention to Use (BI). Our model is extended with five additional factors, which are Perceived Convenience (PCV), Perceived Facilitating Condition (PFC), Perceived Effort Expectancy (PEE), Perceived Cost (PC), and Perceived Social Influence (PSI).

Two independent experts validated the developed survey instrument to ensure its validity and relevance to collect the required data. The survey instrument is divided into two sections: The first section contains sociodemographic questions and a screening question about BT awareness. The screening question is used to minimize the biases. Participants who have no idea about BT are excluded from the study. The second section contains open-ended questions that examine the intention to use BT for SLE. All the survey questions have been evaluated on a 5-point Likert scale; 1 indicates strongly disagree, while 5 strongly agree (Croasmun & Ostrom, 2011).

The survey was distributed to 407 participants to evaluate the proposed model, fulfilling the sample requirements as suggested by (Willis et al., 2016). However, only completed responses were considered for the final analysis using the Structural Equation Modeling (SEM), based on the Partial Least Square approach. According to Dutot et al. (2018), his approach is suitable for studies where the sample size is small to medium.

3. Research Framework

Our research model extends the TAM model with five new factors. These factors are discussed next, along with their measurements.

3.1 Factors and Measurements

In this study, four main factors of TAM are considered, which are Perceived Usefulness (PU), Perceived Ease of Use (PEOU), Attitude (ATT), and Behavioral Intention to Use (BI) (Davis, 1989). These factors consist of measurement items, as illustrated in Table 1. For example, the PU factor consists of 6 measurement items, the PEOU factor consists of 6 measurement items, the ATT factor consists of only 3 measurement items, and the BI factor consists of 3 measurement items. The measurements are coded by utilizing starting letters that name the factors, trailed by the numbering. In addition to these four factors, five additional factors are added to the proposed model, which is: Perceived Convenience (PCV) (Yoon & Kim, 2007), Perceived Cost (PC) (Tornatzky & Klein, 1982), and Perceived Effort Expectancy (PEE) (Venkatesh et al., 2003). Each of which has 3 measurement items. While Perceived Facilitating Conditions (PFC) and Perceived Social Influence (PSI) (Venkatesh et al., 2003) have 4 measurement items, as shown in Table 1.

Table 1
Measurements of Factors

Perceived Usefulness (PU)	
The use of blockchain technology would allow me to complete my tasks quickly.	PU1
The use of blockchain technology would make my tasks easier to do.	PU2
The use of blockchain technology is worthwhile.	PU3
The use of blockchain technology is generally advantageous.	PU4
The use of blockchain technology would simplify my job.	PU5
The use of blockchain technology would seem to support my job.	PU6
Perceived Ease of Use (PEOU)	
It would not be easy for me to learn blockchain technology.	PEOU1
I do not have to overthink when interacting with blockchain technology.	PEOU2
The use of blockchain technology in completing my tasks is easy.	PEOU3
I would find blockchain technology seems to offer flexible interaction.	PEOU4
I can easily master the use of blockchain technology.	PEOU5
I would find blockchain technology would appear easy to use.	PEOU6
Attitude (ATT)	
Blockchain technology usage is a good idea.	ATT1
I would generally have positive feelings towards blockchain technology.	ATT2
Choosing to use blockchain technology over other services is wise.	ATT3
Behavioral Intention to Use (BI)	
I intend to use blockchain technology.	BI1
I predict that I will use blockchain technology.	BI2
I plan to use blockchain technology.	BI3
Perceived Convenience (PCV):	
Blockchain technology is convenient because I can use them at any time.	PCV1
Blockchain technology is convenient because I can use them in any place.	PCV2
Blockchain technology is convenient because they are not complicated.	PCV3
Perceived Cost Items (PC):	
Using blockchain technology is expensive overall.	PC1
Installing and operating blockchain technology is a burden to me.	PC2
There is a financial barrier to maintaining and repairing blockchain technology.	PC3
Perceived Effort Expectancy (PEE):	
I expect that it will be easy for me to become skillful at using blockchain technology in a short time	PEE1
I expect to find blockchain technology easy to use.	PEE2
Learning to use blockchain technology is easy for me.	PEE3
My interaction with blockchain technology would be clear and understandable for performing tasks.	PEE4
Perceived Facilitating Conditions (PFC):	
I have the needed resources necessary to use blockchain technology.	PFC1
I have the knowledge necessary to use blockchain technology.	PFC2
Technical staff in my university is available for assistance with blockchain technology difficulties.	PFC3
I think that blockchain technology fits well with the way I work.	PFC4
Perceived Social Influence (PSI):	
Co-workers who influence my behavior think that I should use blockchain technology	PSI1
Co-workers who are important to me think that I should use blockchain technology	PSI2
The management of the university has helped promote the use of blockchain technology	PSI3
In general, my university has supported the use of blockchain technology	PSI4

3.2 Research Model

This work utilizes theories testing, which shows the idea of relationships. So, one can gauge the qualities of connections among factors. The proposed model is illustrated in Figure 2, which is utilized to check the speculations and distinguish the relations amongst the tested components.

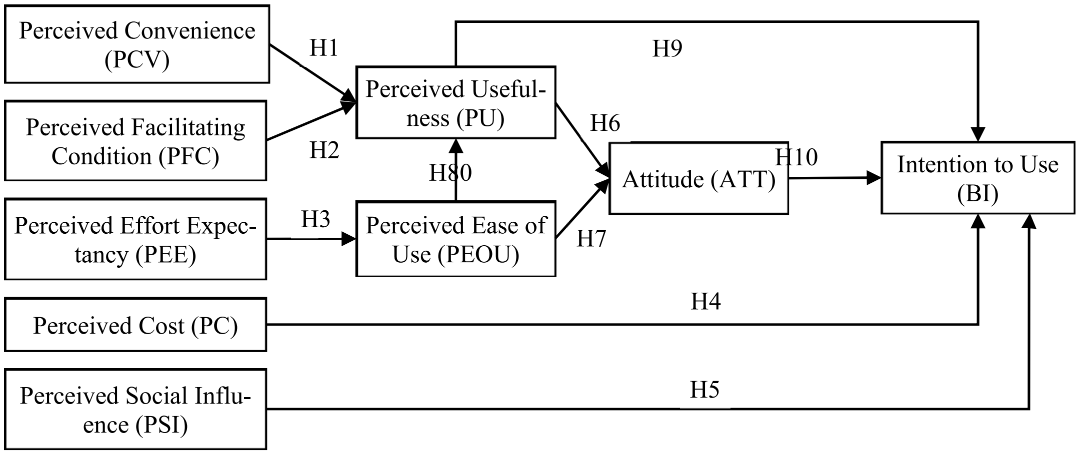

Fig. 2. Research Model

3.3 Research Hypotheses

Having defined the required factors, it is crucial to build up relations with them in the research model, in which this should be possible by planning hypotheses. Table 2 records the used hypotheses in clarifying the relationships among the factors, while the hypotheses are mapped with the model in Fig. 2.

Table 2
Research Hypotheses

	Hypotheses
H1	PCV has a direct effect on PU.
H2	PFC has a direct effect on PU.
H3	PEE has a direct effect on PEOU.
H4	PC has a direct effect on BI.
H5	PSI has a direct effect on BI.
H6	PU has a direct effect on ATT.
H7	PEOU has a direct effect on ATT.
H8	PEOU has a direct effect on PU.
H9	PU has a direct effect on BI.
H10	ATT has a direct effect on BI.

3.4 Questionnaire Design

The questionnaire is designed based on the factors and measurement items listed in Table 1. It utilizes a five-point scale with anchors ranging from "strongly disagree" to "strongly agree." The interval scale is used because it allows for specific mathematical operations on the data collected from respondents. Also, the Lakers' rating scale is used because it is designed to examine how strongly subjects agree or disagree with statements (Hair, 2007).

3.5 Data Analysis

Analyses of the collected data were performed statistically using Structural Equation Modeling (SEM), based on the Partial Least Square (PLS) approach. This approach should be able to determine and examine the overall model as one unit. It could also examine models with multiple independent factors, even if there are correlations between unbiased and extraordinary dependent factors. Furthermore, the goodness of the path coefficients to be examined and the hypotheses' testing to be executed using a suitable approach based on the shape of the collected data.

4. Results and Discussion

After analyzing the data using the IBM SPSS Statistics tool, descriptive statistics and frequencies were calculated to understand the collected data. Moreover, the appropriate degree of reliability regarding each construct was identified by calculating Cronbach's Alpha.

4.1 Reliability Analysis

Reliability is used to examine consistency, which indicates that the research procedure can be replicated while the same results should be obtained (Elliott et al., 2020). To this end, the alpha values were utilized with the limit of 0.7. Here, alpha values are calculated to determine if the factors are stable to be used as a scale (Chan & Idris, 2017). Table 3 shows that all factors have scores greater than 0.7, indicating their suitability for use as a scale.

Table 3
Internal Consistency of the Used Questionnaire

FACTOR	NO. OF QUESTIONS	CRONBACH'S ALPHA
BEHAVIORAL INTENTION TO USE	3	0.972
PERCEIVED USEFULNESS	6	0.767
PERCEIVED EASE OF USE	6	0.867
ATTITUDE	3	0.936
PERCEIVED FACILITATING CONDITION	4	0.76
PERCEIVED COST	3	0.919
PERCEIVED EFFORT EXPECTANCY	4	0.805
PERCEIVED CONVENIENCE	3	0.838
PERCEIVED SOCIAL INFLUENCE	4	0.735
ALL FACTORS	**36**	**0.869**

4.2 Normality Testing

Kurtosis was utilized to determine the distribution normality with the threshold between -1.96 and 1.96 (Corrado & Su, 1996). The positive values of Kurtosis indicate a peak, while the negative values indicate flat distributions compared to the normal distribution (Joanes & Gill, 1998). As shown in Table 4, all the obtained values are within the threshold, which indicates that the distribution is asymmetrical for a given factor.

Table 4
Normality of the Dataset

Factor		*Skewness*	*Kurtosis*
Behavioral Intention to Use	BI1	0.262	-1.332
	BI2	0.322	-1.193
	BI3	0.265	-1.325
Perceived Usefulness	PU1	0.02	-0.508
	PU2	0.275	-0.558
	PU3	0.164	-0.722
	PU4	0.233	-0.742
	PU5	0.079	-0.072
	PU6	-0.034	-0.216
Perceived Ease of Use	PEOU1	0.115	-0.899
	PEOU2	0.077	-0.906
	PEOU3	0.126	-0.917
	PEOU4	0.168	-1.096
	PEOU5	0.144	-0.453
	PEOU6	0.084	-0.605
Attitude	ATT1	-0.315	-0.875
	ATT2	-0.12	-1.001
	ATT3	-0.125	-1.098
Perceived Facilitating Condition	PFC1	-0.368	-0.796
	PFC2	-0.569	-1.049
	PFC3	-0.473	-1.047
	PFC4	-0.151	-1.022
Perceived Cost	PC1	-0.333	-0.793
	PC2	-0.689	-0.669
	PC3	-0.431	-0.921
Perceived Effort Expectancy	PEE1	-0.073	-0.815
	PEE2	0.092	-0.905
	PEE3	-0.154	-0.811
	PEE4	0.056	-1.181
Perceived Convenience	PCV1	-0.159	-0.888
	PCV2	-0.242	-0.959
	PCV3	-0.113	-1.261
Perceived Social Influence	PSI1	-0.333	-0.78
	PSI2	-0.688	-0.651
	PSI3	-0.438	-0.9
	PSI4	-0.135	-0.807

Moreover, the Skewness values were also calculated to determine if the values are normal univariate distribution. Table 4 demonstrates the skewness values. The obtained values are accepted (between -0.5 and 0.5) (George & Mallery, 2019), which indicates that these values are acceptable and reflects a high degree of normality.

4.3 Convergent Validity

After the factor analysis and test the normality and reliability of the factors. We turned our focus to determine the Convergent Validity (Carlson & Herdman, 2012). Here, we calculated the factor loading to measure the variable's level related to a given factor. Table 5 shows the obtained results. As one can note, the corresponding value for every factor exceeds the accepted threshold value of 0.60, which is a minimum requirement to pass (Henseler et al., 2016).

Table 5
Factor Loading

Factor		*PU*	*PEOU*	*ATT*	*PCV*	*PFC*	*PC*	*PEE*	*PSI*	*ITU*
Perceived Usefulness	PU1	.678								
	PU2	.593								
	PU3	.774								
	PU4	.665								
	PU5	.905								
	PU6	.906								
Perceived Ease of Use	PEOU1		.787							
	PEOU2		.835							
	PEOU3		.848							
	PEOU4		.843							
	PEOU5		.809							
	PEOU6		.828							
Attitude	ATT1			.823						
	ATT2			.884						
	ATT3			.862						
Perceived Convenience	PCV1				.702					
	PCV2				.817					
	PCV3				.792					
Perceived Facilitating Condition	PFC1					.812				
	PFC2					.808				
	PFC3					.892				
	PFC4					.617				
Perceived Cost	PC1						.773			
	PC2						.696			
	PC3						.797			
Perceived Effort Expectancy	PEE1							.730		
	PEE2							.839		
	PEE3							.815		
	PEE4							.713		
Perceived Social Influence	PSI1								.866	
	PSI2								.790	
	PSI3								.882	
	PSI4								.668	
Behavioral Intention to Use	ITU1									.756
	ITU2									.773
	ITU3									.655

Also, the Average Variance and the Composite Reliability values were calculated for every factor. As shown in Table 6, the obtained values were accepted where the average variance extracted above the recommended level of 0.5 (Leguina, 2015) and the composite reliability values above 0.70 (Fornell & Larcker, 1981).

Table 6
Convergent Validity

Factor	No. of Questions	Average Variance Extracted (> 0.50)	Composite Reliability (> 0.70)
Intention To Use	3	0.5327	0.7729
Perceived Usefulness	6	0.5821	0.8907
Ease Of Use	6	0.6811	0.9276
Attitude	3	0.7339	0.8921
Perceived Facilitating Condition	4	0.6221	0.8663
Perceived Cost	3	0.5724	0.8001
Perceived Effort Expectancy	4	0.6024	0.8578
Perceived Convenience	3	0.5959	0.8150
Perceived Social Influence	4	0.6496	0.88

Ultimately, Table 7 shows the results of KMO and Bartlett's Tests, including Chi-Square, which is utilized to determine if the responses given are suitable for structure detection and must have a value greater than 0.5 (Base, n.d.). The obtained result is between 0.7 and 0.8 (greater than 0.5), and therefore they are considered acceptable. Furthermore, the value of Chi-Square (9387.583) is greater than the tabulated value at the degrees of freedom of 528, equal to 124.342 at $\alpha \leq 0.05$, indicating that the data is suitable for analysis. In addition, Bartlett's Test of Sphericity is significant (0.000 less than 0.05), which means that the correlation matrix is not an identity matrix.

Table 7
KMO and Bartlett's Tests

Kaiser-Meyer-Olkin Measure of Adequacy		0.829
Bartlett's Test of Sphericity	Approx. Chi-Square	9387.583
	Degree of Freedom	528
	Sig.	0.000

5. Hypotheses Results and Discussion

The hypotheses were tested and analyzed to determine the intention to use BT for SLE. Table 8 illustrates the hypothesis status and the significance levels for the adopted variables. According to Churchill and Gilbert (2006), the significant (P) value level is acceptable if less than 0.01. The results clarified that the factors have significant P coefficients at $p < 0.01$. Therefore, as shown in Table 8, all the hypotheses are confirmed and supported by the statistical analysis.

Table 8
Hypothesis Status

	Hypothesis			P	Hypothesis Status
H1	Perceived Convenience	→	Perceived Usefulness	***	Supported
H2	Perceived Facilitating Condition	→	Perceived Usefulness	0.009	Supported
H3	Perceived Effort Expectancy	→	Ease of Use	***	Supported
H4	Perceived Cost	→	Intention to Use	***	Supported
H5	Perceived Social Influence	→	Intention to Use	0.003	Supported
H6	Ease of Use	→	Perceived Usefulness	***	Supported
H7	Ease of Use	→	Attitude	***	Supported
H8	Perceived Usefulness	→	Attitude	***	Supported
H9	Perceived Usefulness	→	Intention to Use	***	Supported
H10	Attitude	→	Intention to Use	***	Supported

The relationship between factors is displayed in Fig. 3 (extended from Fig. 2) by showing the P-value for each external factor to the intention to use BI.

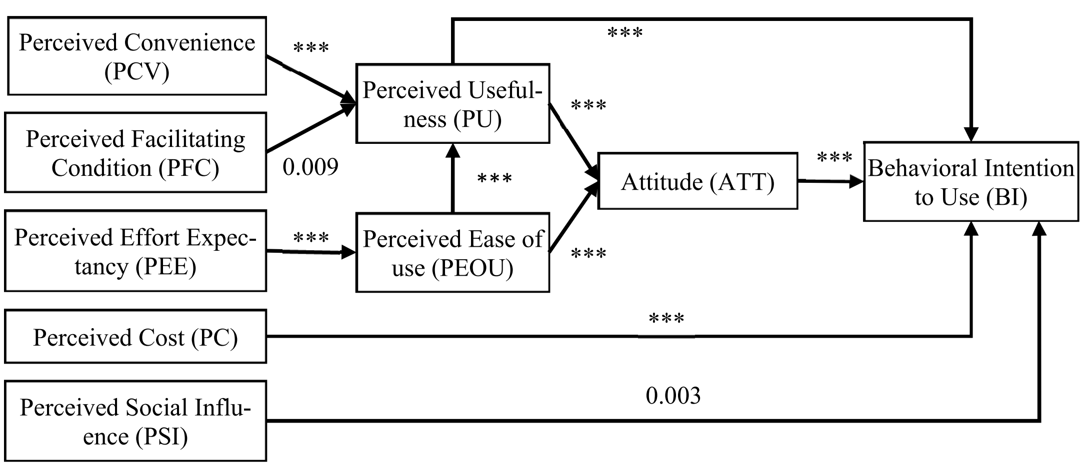

Fig. 3. Hypothesis results

It can be shown that PCV and PFC directly affected PU (H1 and H2) with $p<0.01$ and $p<0.009$, respectively, which is consistent with previous user acceptance studies (Almajali, 2021; Baki et al., 2018; Cheng, 2015; Teo, 2011) Results also confirmed that PEE positively affected PEOU (H3) with p<0.01, which was consistent with previous studies (Razak et al., 2017; Sair & Danish, 2018). Moreover, the findings revealed that PC had a direct positive effect on BI (H4), which was confirmed previously by Kavitha (2021), Singh and Sinha (2020). PSI has also had the same positive effect on BI (H5) in the same vein. Previous studies were stressed such significance (Al-Emran et al., 2020; Raza et al., 2021). Regarding PEOU, the results revealed that PEOU positively affects both (PU) (H6), which was consistent with the previous studies (Alamri et al., 2020; Kamble et al., 2018; Nuryyev et al., 2020), and ATT (H7), which was also confirmed with the previous studies (Du Mont & Network, 2002; Russell et al., 2013). In turn, PU shows significant values on ATT (H8) and BI (H9), as seen in Figure 3, which was confirmed by the previous studies (Chen & Aklikokou, 2020; Davis et al., 1989; Eveleth & Stone, 2020; Sugihartono et al., 2020). Ultimately, The significance of ATT on BI was also revealed by our study and was confirmed by Al-Rahmi et al. (2020), and Hew et al. (2020). It is worth mentioning that few empirical studies on the application of BT for learning have been conducted so far. According to our knowledge, no one has investigated the intention to use BT for sustainable learning and education, especially in developing economies like Jordan. This study can be considered an initial idea for future researchers to analyze BT adoption using TAM deeply. The statistically validated model constructs derived from the integration of traditional theories have significant influence, and the finding suggests that their advertising strategies need to concentrate on the potential of BT in higher education.

6. Conclusion

This study empirically assesses the intention to use blockchain technology in sustainable learning in Jordan universities. To this end, an extended model based upon the TAM model was built with nine factors. The proposed model is then validated using a questionnaire designed specifically for this research. In order to ensure that our model can be generalized, the survey is being distributed over 407 samples of participants, which is calculated using Cochran's Sample Formula. SPSS v25.0 and AMOS v23.0 have been utilized to test the proposed model and the corresponding hypotheses to obtain detailed results.

All the testing results agreed to the normality and validity of the data set. Moreover, the discriminant validity is also tested between the factors, which agreed that our model also sufficed. Finally, to test the research's hypotheses, the p-value is used to determine the significance of the results. Results showed that the external adopted factors have significant P coefficients at p<0.01, while the variable experience with BT positively affects the intention to use for SLE.

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