ACCEPTANCE OF BLOCKCHAIN TECHNOLOGY BY HIGHER EDUCATION INSTITUTIONS IN THE KINGDOM OF SAUDI ARABIA

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Doctor of Philosophy

ASTON UNIVERSITY

December 2024

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Aston University

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ABSTRACT

The increasing adoption of new technologies in the Higher Education Institutions (HEIs) sector highlights the importance of exploring blockchain acceptance among employees. Adopting blockchain, as an emerging technology, is likely to encounter resistance among employees. This study explores this issue. Specifically, this study aims to determine the drivers and hindrances of blockchain acceptance among employees in the HEIs industry. To address this aim, this study proposes a framework that extends the unified theory of acceptance and use of technology (UTAUT) with individual characteristics. The framework represents factors that explain blockchain acceptance. The identified elements are performance expectancy (PE), effort expectancy (EX), social influence (SI), facilitating conditions (FC), trust, perceived security (SEC) and awareness (AW). The relationships among these factors were examined based on a quantitative approach, where an online questionnaire was employed to collect data from administrative and academic staff working for HEIs in the Kingdom of Saudi Arabia (KSA). Partial Least Squares Structural Equation Model (PLS-SEM) and Multi-group Analysis (MGA) techniques were employed to analyse 394 responses. The findings of this study revealed the direct drivers and hindrances of blockchain acceptance, i.e., PE, FC, SEC and AW. Additionally, this study demonstrated the moderating effects of AW between FC and blockchain acceptance. Furthermore, it determined specific indirect effects of the EX, trust and SEC on blockchain acceptance. Moreover, this research detected significant differences between categories' subsamples and identified the significant factors of blockchain acceptance per subsample. Finally, this research identified where blockchain needs to be adopted most within the HEIs, i.e., financial exchange, certificate management, and students' assessment areas. The HEIs industry in KSA could use these findings to develop concise strategies that encourage the adoption of blockchain. Scholars might also employ the proposed framework to investigate the adoption of blockchain.

Keywords: Technology Adoption, Technology Resistance, Blockchain Acceptance, UTAUT, Awareness, Security, Trust, Behavioural Intention, employees, HEIs.

Acknowledgements

In the name of God, the Most Merciful, the Most Compassionate

First and foremost, I would like to thank my God ‘Allah’ for the countless blessings he has bestowed upon me.

I would like to express my profound gratitude to Dr Luciano Batista. He has guided me toward tangible academic and personal growth and supported me in overcoming all the obstacles I encountered during my PhD. He has constantly delivered assistance when needed, offering invaluable insights and directed me toward achieving this work to the highest standard. I would also like to thank Professor Vladlena Benson for her supervisory role during my PhD. Her valuable insights have enhanced this project considerably.

In addition, I would like to deliver sincere and endless thanks, gratitude, and love to my parents, Abdullah Alhumayzi and Hailah Alkhaldi. They have been providing me endless support. Their relentless care, love and reinforcement they have been delivered to me since the first day of my life. This PhD would not have been conceivable without them.

Moreover, I convey my special, sincere and profound appreciation to my wife, Nora Aboheimed, who has been by my side throughout the whole PhD journey. Living overseas was challenging for her, yet she endured all the difficulties and supported me with love and patience. The presence of Nora beside me during the PhD journey has always been the source of motivation and enhancement of my academic and personal development. More importantly, her presence with me played a core role in completing this thesis. This thesis is as much her as it is mine.

My son, Abdullah, has spent his first days in the UK. His presence with me has been a key motivator for me to develop my personal skills and do my best for him. He brought happiness, joy and additional purpose of life to me. He is the best thing I have ever had. I cannot appreciate his presence with me enough during this journey.

I deliver my profound thanks to my family members for their endless support. In particular, I thank my siblings, Ibrahim, Ghada, Ghaida, Abdulmalik and Areen. Their constant reinforcement, encouraging words and supporting attitudes they have been providing to me have invaluably pushed me to be who I am today. Thank you forever! Special and deep thanks are also delivered to relatives Ibrahim Alhumayzi, Mohammed Ibrahim Alhumayzi, Khalid Alhumayzi, Abdulasalam Alkhaldi, Sultan Alkhaldi and Fares Alkhaldi. Moreover, I convey my appreciation to my aunties, Amena and Maha Alkhaldi, for their support. Finally, I thank my father and mother-in-law, Abdullah Aboheimed and Aljawhara Alsulaiman, for being supportive and by my side in times of need.

My gratitude also extends to Aston University’s staff and PhD students. Special and profound thanks are conveyed to Abdulelah Alshammary, Hassan Alalmai, Husam Bakhaider, Karen Amissah and Simin Yu for their constant support and reinforcement throughout my PhD. I also want to extend my appreciation to Ali Gordjahanbeiglou, Amaka Orji, Badawy Sayed, Daniel Mafulul, Khadijah Mohammed, Mohajer Alowaisi, Mohammed Saharti, Moses Mmadubuko, Santiago Gallego, Shada Almuwallad, Stephen Manders, and Wafa Alosimi, among others, for being as a family for me during the PhD journey. Our one-to-one discussions throughout the PhD have significantly contributed to the advancement of this project.

My appreciation is also extended to Jouf University, which funded this research. I would also like to thank specific employees at Jouf University who assisted in validating this study’s items and supported me during my PhD. Many thanks are delivered to Dr Ahmad Qasmi, Dr Fahad Al-Rashidi, Dr Jamal Alhamlan, Dr Mohammed bin Marzi Al-Huzail, Dr Salah Mortada and Dr Yousef Alshrari, among others.

Last but not least, I would like to thank my closest and lifelong friends. Your ultimate faith and support for me have been the core of my success. Special thanks are delivered to Abdulkarim Aleid, Abdullah Aljunaidl, Abdulaziz Aljunaidl, Anas Alabdulsalam, Fahad Aleid, Huthaifah Aleid, Ibrahim Alhowaish, Mohammed Aleid, Omar Aleid, Omar Alkhuraji, Saleh Aleid and Yazeed Aleid, among others.

Publication

Alhumayzi, M., Batista, L. & Benson, V. (2023) 'Factors Affecting Employees' Acceptance of Blockchain in the Higher Education Institutions', in *Proceedings of the 25th International Conference on Enterprise Information Systems*. [Online]. 2023 SCITEPRESS - Science and Technology Publications. pp. 297–303.

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List of Abbreviations	
ANOVA	**Analysis of Variance**
AI	**Artificial intelligence**
AVE	**Average Variance Extracted**
AW	**Awareness**
BI	**Behavioural Intention**
BL	**Blended Learning**
CB-SEM	**Covariance-based Structural Equation Model**
CVPAT	**Cross-Validated Predictive Ability Test**
DCR	**Deanship of Scientific Research**
DIAR	**Diploma Integrity Authentication Record**
DOI	**Diffusion of Innovation**
ELC	**E-learning Chain**
EX	**Effort Expectancy**
FC	**Facilitating conditions**
FIR	**Fourth Industrial Revolution**
HEIs	**Higher Education Institutions**
HTMT	**Heterotrait-Monotrait**
ICT	**Information Communication Technologies**
IT	**Information Technology**
IS	**Information Systems**
KSA	**Kingdom of Saudi Arabia**
KSU	**King Saud University**
KMI	**Knowledge Media Institute**
LMS	**Learning Management Systems**
MAD	**Median Absolute Deviation**
MANOVA	**Multivariate Analysis of Variance**
M-Learning	**Mobile Learning**
MOOCs	**Massive Open Online Courses**
PLS-SEM	**Partial Least Square Structural Equation Model**
PLS-MGA	**Partial Least Squares Multi-Group Analysis**
RQ	**Research Questions**
SC	**Supply Chain**
SEC	**Perceived Security**
SEM	**Structural Equation Model**
SGE	**Sony Global Education**
SI	**Social Influence**
SPSS	**Statistical Package for the Social Sciences**
TAM	**Technology Acceptance Model**
TOE	**Technology-Organisation-Environment**
TPB	**Theory of Planned Behaviour**
TRA	**Theory of Reasoned Action**
UTAUT	**Unified Theory of Acceptance and Use of Technology**
VIF	**Variance Inflation Factor**

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Chapter 1: Introduction

1.1 Introduction

This introduction chapter begins with an overview of blockchain technology to address its importance. Accordingly, the research problem and motivation are discussed. Subsequently, the study's research questions (RQs) are exhibited, followed by a demonstration of the aim and objectives. Thereafter, the scope of this research is presented, leading to theoretical and practical contributions. This chapter eventually indicates the structure of the present research.

1.2 Overview of Blockchain Technology

Since the inception of the Internet, individuals and institutions globally have been employing its attributes for various purposes. The Internet has facilitated the emergence of innovative technologies, such as blockchain (Chawla et al., 2024; Gottlieb et al., 2024). Blockchain is one of the most disruptive fourth industrial technologies that may affect various industries (Chaka, 2023; Gottlieb et al., 2024; Basdekidou & Papapanagos, 2024). Blockchain's actual benefits have been recognised following the emergence of Bitcoin in 2008 (Nakamoto, 2008; Taylor et al., 2020). It is perceived by scholars to be a game-changing innovation across diverse sectors, including the higher education institutions (HEIs) sector (Gottlieb et al., 2024; El Koshiry et al., 2023). From a broader perspective, blockchain could be described as a distributed ledger that utilises blockchain data structure to record and verify data (Ma et al., 2020).

HEIs may benefit from blockchain by obtaining more secure, immutable and trustworthy blockchain-based systems (Akter et al., 2022; Chittipaka et al., 2023; Bhaskar et al., 2020; Norbu et al., 2024). For instance, the decentralised nature of blockchain may assist in increasing transparency and reducing the possibility of cyberattacks related to different forms of HEIs' data (Rustemi et al., 2024; Chen et al., 2023). To clarify, intermediaries record and manage HEIs' data based on centralised approaches (Kumari & Devi, 2023). HEIs' recording of data (e.g., employees' data) within intermediaries' centralised databases is vulnerable to cyberattacks, which could be reduced by utilising blockchain (Dwivedi & Vig, 2024; Tapscott & Tapscott, 2016). Cyberattacks, data manipulation, and transparency are a few challenges that HEIs encounter and may be reduced by implementing blockchain (See Section 2.2.3).

To take advantage of blockchain capabilities, numerous blockchain-based frameworks and applications have been developed, designed, and proposed to revolutionise the HEIs' departments. These frameworks and platforms aid the certificate management system, ease financial exchange, store and share data, assist the recruiting process, decrease copywriting issues, and increase online assessment transparency (see Section 2.3.3). However, one of the foremost challenges regarding blockchain is its acceptance/resistance among its potential users due to the unfamiliarity of blockchain (El Koshiry et al., 2023; Bhaskar et al., 2020; Chawla et al., 2024; Jang et al., 2024; Erol et al., 2022; Bai et al., 2020). The acceptance issue resulted in recent calls to investigate blockchain adoption from individual aspects (Alshamsi et al., 2022; Delgado-Von-eitzen et al., 2021; El Koshiry et al., 2023; Marengo & Pagano, 2023; Razia, 2023; Loukil et al., 2021). The present study responds to these calls by investigating the blockchain acceptance among HEIs' employees in a developing country.

Therefore, HEIs should reduce some of the persistent challenges associated with the current use of the Internet by adopting blockchain. Careful operational planning is necessary to increase the successful implementation probability of blockchain. One of the main issues is related the employees' acceptance of blockchain implementation in HEIs, which is discussed in further detail in the following section.

1.3 Research Problem

The COVID-19 global pandemic has shifted the position of HEIs to be more accepting of emerging technologies, including blockchain (Sharma & Batth, 2020; Adedoyin & Soykan, 2023). Following the COVID-19 crisis, there has been a notable acceleration in adopting new technologies within the HEI sector (Adedoyin & Soykan, 2023; O'Connor et al., 2023). However, this swift acceleration to adopting new technologies has posed several challenges (Adedoyin & Soykan, 2023). One such is the resistance to using emerging technologies among employees who work in the HEIs industry (Alkaabi et al., 2023; Adedoyin & Soykan, 2023). The resistance issue has led HEIs' scholars and decision-makers to carefully consider employees' acceptance and readiness for new technologies (Adedoyin & Soykan, 2023; Al-Shehri, 2023; Alkaabi et al., 2023; Cramarenco et al., 2023). Recent literature has noted that employees are possibly unwilling to accept the adoption of blockchain (Jang et al., 2024; Erol et al., 2022; Bai et al., 2020). Blockchain resistance or rejection among employees is highly likely to cause failure in its implementation within the HEIs (Dwivedi & Vig, 2024; Venkatesh et al., 2003; Brandon-Jones & Kauppi, 2018; Khechine et al., 2023; Molino et al., 2020). Thus, HEIs need to plan carefully to adopt blockchain by considering blockchain acceptance among employees (Cramarenco et al., 2023).

Therefore, this study examines the factors that drive or restrain blockchain acceptance in HEIs among employees. In other words, it measures the employees' intention to accept using the blockchain in HEIs. Moreover, it investigates through employees' lens the areas that demand blockchain application(s) (e.g., certificate management).

1.4 Research Motivation

The theory-building contribution is the main motivation of this study. The author of this study noted a clear gap where blockchain acceptance of blockchain requires more investigation in the HEIs industry by proposing an extended framework. This gap also responds to the call of literature that has requested the extension of the selected theory of this study (Venkatesh, 2022; Venkatesh et al., 2016; Vorobeva et al., 2023; Xue et al., 2024). Accordingly, this study extends existing theory by adding individual characteristics related to blockchain (see Section 2.6). The proposed theory is expected to identify factors that affect employees' acceptance of blockchain.

This study's context is the Kingdom of Saudi Arabia (KSA). One of the primary motivations for conducting this research is the support of the KSA Government for the adoption of blockchain technology. The KSA Vision 2030 initiative has been a fundamental catalyst for various industries to adopt new technologies (Hussein, 2024; Bendary & Rajadurai, 2024; Sarirete et al., 2022). The Saudi Vision 2030 aims for economic diversification, resulting in heavy investments in adopting emerging technologies, such as blockchain (Bendary & Rajadurai, 2024; Sarirete et al., 2022). The government, through this vision, has been committed toward privatising HEIs, fostering the swift adoption of adopting new technologies (KSA Vision 2030, 2016; Al-Qahtani, 2024). Examples of HEIs that were recently privatised are King Saud University (KSU) and King Abdulaziz University, among others (Al-Qahtani, 2024). Such privatisation enables HEIs in KSA to leverage emerging technologies to enhance services and performance more efficiently (Nadarajah et al., 2012; Williamson & Hogan, 2021). Thus, there is a need for research investigations concerning the embracement of emerging technologies (e.g., blockchain) within HEIs in KSA. This study is one of these contributions that attempt to assist in avoiding the failure of blockchain implementation in HEIs aligned with the Saudi Vision 2030.

Additional motivation concerns blockchain technology's adoption in HEIs. Blockchain technology has yet to be adopted in HEIs located in KSA. To the best of the author's knowledge, only a few HEIs in KSA have adopted blockchain within their systems (Cf. KAUST, 2018; Taibah Valley, 2023). Thus, this study encourages the adoption of blockchain across HEIs in Saudi Arabia.

The following motivation relates to the additional blockchain adoption investigations in the body of knowledge. The adoption of blockchain may assist HEIs in boosting security, diminishing costs, developing the assessments' integrity and facilitating communications among employees (Rani et al., 2024; Alzahrani et al., 2021; Alammary et al., 2019). Nonetheless, the empirical investigation of its adoption is still in the early stages (Alalyan et al., 2023; Alshamsi et al., 2022; Taherdoost, 2022). Thus, this study aspires to contribute to existing knowledge by providing outcomes that assist in increasing the likelihood of successful adoption of blockchain.

Besides the call noted above, this study seeks to address existing gaps. The gaps are associated with the underpinning theory's usage in previous literature. Particularly, the gaps pertain to blockchain adoption across various industries, different technologies' adoption in the HEIs, the participants and the context. A comprehensive discussion related to the gaps is presented in Section 2.6.3.

Following the demonstration of this study's problem and motivation, the next session addresses the RQs of this study.

1.5 Research Questions

This study addresses the aforementioned issue concerning blockchain acceptance among employees. The investigated factors of the present study are related to the proposed theory and extended individual characteristics.

This study's primary RQ is: What factors drive or hinder employees' acceptance of the use of blockchain in HEIs?

The following secondary RQs are formulated to meet the primary RQ of this research:

1. What factors affect the administrative and academic employees' acceptance of the use of blockchain in HEIs?
2. To what extent do various groups of administrative and academic employees differ in relation to the factors that affect blockchain acceptance in HEIs?
3. Which areas within HEIs require the adoption of blockchain applications based on the perception of HEIs' administrative and academic employees?

1.6 Research Aim and Objectives

This research primarily aims to identify factors that influence the acceptance of blockchain among staff who work for HEIs. The factors are related to this study's proposed theory (see Section 2.6).

The following objectives are formulated to address the aim of this study:

1. To develop a comprehensive conceptual model that integrates key elements that may affect blockchain acceptance.
2. To identify the key drivers and barriers that affect the acceptance of blockchain among employees in HEIs.
3. To examine the differences among employees' subgroups based on their characteristics.
4. To determine which areas within HEIs exhibit the greatest need for blockchain adoption based on employees' perceptions.

These objectives will be addressed within the scope of this study, which is presented in the following section.

1.7 Research Scope

This study has boundaries. The following boundaries represent the scope of the present study:

1. This study concentrates on blockchain technology. Other technologies are neglected in this research.
2. This study focuses on blockchain acceptance only. Other adoption dimensions (e.g., the adoption procedures, techniques and regulations, among others) are excluded from this study.
3. The investigated industry in the present research is the HEIs. Other sectors are not part of this study's focus.
4. The participants of this study are administrative and academic employees in HEIs. Other stakeholders within HEIs (e.g., students and external consultants) are excluded from this study. Moreover, employees in other industries are beyond the scope of this research.
5. This research is conducted in KSA only. HEIs' employees from other countries are excluded from the current study.
6. This study develops a model based on an existing theory, enhanced by adding individual characteristics that may affect the acceptance of blockchain among employees.

Other factors from other theories are not part of the present research. Moreover, other individual characteristics that are related to blockchain (e.g., transparency and immutability) are excluded from this paper's scope.

7. This study employs a quantitative approach to address the RQs. It does not conduct an in-depth investigation of blockchain acceptance.

Within the scope of this investigation, theoretical contributions and practical implications are delivered in the following section.

1.8 Contributions

This section discusses the theoretical and practical contributions of this study.

1.8.1 Theoretical Contribution

The primary contribution of this study is the theory-building. This study discusses relevant theories that may contribute to determining the factors that drive or hinder the blockchain acceptance among employees in HEIs. Following the discussion of relevant theories, a single theory is selected and extended with individual characteristics that are related to blockchain. Future authors and scholars seeking to identify the factors that may affect employees' acceptance of blockchain could utilise the proposed framework in this study (See Sections 2.6.4 & 2.6.5). In addition, future research may use the findings of this study as a ground for investigating the heterogeneity of employees, specifically regarding blockchain.

In addition, this study contributes to the existing body of knowledge by delivering results that have been insufficient or never discovered in existing academic journal articles. Moreover, previous research has had contradictory results in relation to the underpinning theory of this study. This study empirically confirms or refutes these relationships, yielding scientific evidence of their significant stance within the scope of the study.

The original and confirmation contributions of this study exist in various aspects. First, this research adds to knowledge and confirms/rejects existing findings related to the blockchain adoption field (regardless of the industry). Additionally, this research confirms or rebuts previous knowledge related to technology adoption (regardless of the blockchain) in the HEI sector. Another originality pertains to this study's participants, as the present study originally explores blockchain adoption from a new perspective, i.e., administrative and academic staff in HEIs. Finally, to the best of the author's knowledge, this study is the first to

investigate blockchain adoption in HEIs in KSA based on the proposed framework. Further details are discussed in Section 2.6.3.

Therefore, scholars, academics, and researchers could use the unique framework presented to empirically investigate blockchain adoption in various industries and contexts.

1.8.2 Practical Contributions

This work enables decision-makers to increase the successful implementation of blockchain in the HEIs, specifically in KSA. Considering its importance, overlooking blockchain technology's acceptance among employees may jeopardise the successful implementation of blockchain in HEIs. To avoid failure embracement of blockchain, this study provides decision-makers with factors that lead to its acceptance among HEIs' employees. These factors are derived from selected theory and the extended individual characteristics. By developing a new framework, this research proposes relationships that may predict employees' acceptance of the use of blockchain in their tasks within the HEIs.

As a result of the proposed framework, this study provides decision-makers with the factors that significantly affect blockchain acceptance among employees. Based on the significant outcomes of these effects, decision-makers determine what factors affect blockchain acceptance among employees. Meanwhile, this study reveals insignificant relationships that could be neglected during the implementation of blockchain. Neglecting these factors yields various benefits to the decision-makers (e.g., cost and time efficiency).

In addition, this study provides decision-makers with findings related to the significant differences in employees' specific differences. The differences were tested in three different ways to measure the difference in the mean of agreement pertained to this study's dependent variables based on Multivariate Analysis of Variance (MANOVA). In addition, differences between categories' (e.g., gender) subsamples (female and male) were provided through the permutation test. Finally, the effect of every proposed relationship in this study's framework was computed based on the bootstrapping MGA.

Furthermore, this study provides decision-makers with the potential areas where blockchain can be adopted to overcome current challenges. The potential areas are determined based on HEIs' academic and administrative employees.

Finally, implications and recommendations are delivered to decision-makers based on this study's findings.

Therefore, the current work provides practicians with results that assist them in adopting blockchain successfully. It also helps decision-makers to know what areas require the adoption of blockchain the most.

1.9 Structure of the Thesis

The sections following the introduction of this PhD are organised as follows:

Chapter two reviews relevant literature related to blockchain adoption. It provides an overview of blockchain, reveals the blockchain applications in education, displays the technology adoption models, discusses the gap and formulates the hypotheses, yielding the conceptual framework of the present study.

Chapter three expresses the research methodology selected for the current PhD research. It justifies the selection of the methodology and approach by identifying the philosophical stance and theoretical perspective. Correspondingly, it exhibits the background of the chosen sample (i.e., workers in HEIs). The objective is to form the process of collecting and analysing data.

Chapter four presents the analysis outcomes and key research findings from the fieldwork. It exhibits the findings of collected data.

Chapter five discusses the results of the data in relation to existing literature.

Chapter six concludes this study. It presents the critical contributions of the PhD research, identifying its limitations and recommendations for future research.

List of References follows the conclusion chapter, aiming to identify all the published materials employed in this thesis.

Appendices are displayed after the reference list to represent significant and relevant materials to some parts of this work. Nonetheless, they are considered to interrupt the flow of the thesis.

Chapter 2: Literature Review

2.1 Introduction

The chapter begins by defining blockchain, discussing its types, exploring its characteristics and presenting its benefits and challenges. Following the overview of blockchain, the HEI sector is discussed in relation with the blockchain technology and the context of the of Saudi Arabia. Subsequently, technology acceptance models are discussed leading to the selection of the unified theory of acceptance and use of technology (UTAUT). This choice is justified and comprehensively discussed leading to carefully adding individual characteristics related to blockchain technology. Moreover, a comprehensive review of extant articles that have empirically investigated blockchain and other technologies in the HEI sector based on UTAUT. This review facilitates a detailed formulation of this study's framework.

2.2 Overview of Blockchain Technology

This section explores the definition of blockchain, its types and characteristics.

Blockchain technology has various definitions in literature. The present study follows Grech and Camilleri's (2017) description of blockchain due to their concentration on the education perspective. The authors describe blockchain as a distributed spreadsheet that facilitates the storage and sharing of data by participants (nodes). Every node preserves a copy of the recorded data, and all participants must approve any entering data. These data could be transactions, contracts, assets, identities, or any other digital form. Moreover, after the updated data are approved, they are changeless, transparent, explorable and accessible to every participant in the network.Thehe accessibility relies on the type of blockchain, as discussed in the following section. Every validated transaction is a new 'block' that is automatically added at the end of a 'chain'. This consensus protocol manages how updated data are launched, confirmed, stored and distributed. Furthermore, the trust system has totally changed within blockchain by relying on the consensus mechanism instead of trusting third-party intermediaries.

There are three main categories for blockchain: public blockchains, consortium blockchains, and private blockchains (Buterin, 2015). According to Beck et al. (2018), these types are based on how the blockchain is implemented and who has access to the data database. In the public blockchain, the authors demonstrate that all the nodes in the network have access and no need for permission from a centralised authority. All the nodes who participate in the public blockchain, particularly in the consensus mechanism, have the

opportunity to be rewarded (Mattke et al., 2019). On the other hand, in the private blockchain, nodes need to be preregistered by a central to access the blockchain network (Beck et al., 2018). In the consortium blockchain, the nodes are 'selected per predefined compliance criteria' (Chong *et al.*, 2019, p.1312). Table 1.0 describes the difference between the public and private blockchains and the accessibility difference according to being permission and permissionless.

Table 1.0 The Difference between Public and Private Blockchain

Blockchain Type	Access to Transaction	Validation
Public (permissioned)	All participants can view and add	Only authorised can confirm
Public (mermissionless)	All participants can view and add	All participants can confirm
Private	Only authorised participants can add and confirm	Not applicable

Table 1.0 retrieved from Beck et al. (2018)

These types of blockchain technology have common characteristics, which are discussed in the following subsection.

Blockchain has attracted researchers' and practitioners' attention to its features. Du et al. (2019) believe that the distributed ledger, consensus protocol, encryption system, smart contracts, and immutability are the most significant Information technology (IT) components of blockchain. Grech and Camilleri (2017) stated that the key characteristics of blockchain are self-sovereignty, trustlessness, transparency, immutability, and disintermediation. Further, Wang et al. (2021) contended a blockchain-based application reflects a more secure, transparent, low transaction cost and an automated system. In addition, being decentralised is one of the main characteristics of blockchain, which authors have agreed on (Grech & Camilleri, 2017; Tapscott & Kaplan, 2019; Tapscott & Tapscott, 2016). Tapscott and Tapscott (2016) stated that the main properties of blockchain include network integrity, distributed power, value as an incentive, security, privacy, rights preserved, disintermediation and inclusion. Further, Swan (2015) pointed out that the main characteristics of blockchain are autonomy, self-sufficiency and decentralisation. Table 2.0 presents the attributes mentioned by the previous authors.

Table 2.0 The main Characteristics and Features of Blockchain

Characteristics/studies	Swan (2015)	Wang et al. (2021)	Du et al. (2019)	Grech and Camilleri (2017)	Tapscott and Tapscott, (2016)
Decentralised	√	×	√	√	√
Trust	√	×	√	√	√
Security	√	√	√		√
Privacy	√		×	√	√
Self-sovereignty and identity	√	×	×	√	√
Immutability	√	×	√	√	√
Integrity	√	√	×	√	√
Disintermediation	√	×	×	√	√
Autonomy	√	×	×	√	√
Right Perception	√	×	×	√	√
Self-sufficiency	√	×	×	×	√
Lower cost	×	√	×	√	√
Inclusion	√	×	×	√	√
value as an incentive	√	×	×	√	√

Based on the table above, it can be argued that the main characteristics of blockchain and smart contracts are decentralisation, trust, security, privacy, self-sovereignty, immutability, integrity, disintermediation, autonomy, right perception, self-sufficiency, lower cost, inclusion and value as incentives.

The employees' perceptions of these or some of the blockchain characteristics can affect the acceptance or resistance of blockchain among employees in HEIs. For instance, HEIs that adopt a blockchain-based application that increases the level of security to record employees' data may increase the level of accepting blockchain. Blockchain, as an encryption-based system, is likely to reduce the cybersecurity attacks and increase the level of data controlling.The perceptions of these characteristics might be hindrances of blockchain adoption in the HEIs industry instead of being drivers. The discussion of blockchain in HEIs is further discussed in the following sections and subsections.

2.3 Blockchain in HEIs

This study concentrates on the adoption of blockchain technology in the HEIs industry. It investigates the factors that cause employees, who work for HEIs in KSA, to accept or reject the adoption of blockchain. Terminologically, the terms ‘adoption’ and ‘acceptance’ have different meanings. The first refers to the implementation of blockchain in an organisation, while the latter represents not rejecting or resisting the technology. However, this study uses the terms acceptance, adoption and use of technology interchangeably, following previous studies (e.g., Raddatz et al., 2021; Venkatesh & Davis, 2000).

In the context of higher education institutions, the term 'institution' embraces various aspects, such as academic and administrative dimensions (Basahel & Basahel, 2018). HEIs main goal should concern providing individuals with competitive skills that benefit the markets (e.g., companies), whereby permanent changes arise constantly and high levels of competence exist, which ultimately benefit the society and the economy in the context of growth and prosperity (Kontzinos et al., 2019).

Blockchain adoption can be observed in various industries, such as supply chain (SC) (e.g., Pieters et al., 2022; Zhang et al., 2023), banking (e.g., Mansoor et al., 2023) and tourism (e.g., Sarnacchiaro et al., 2024), among others. One of the most promising industries is the HEIs; yet, the adoption of is in its early stages (Awaji et al., 2020; Lara et al., 2020; Dwivedi & Vig, 2024).

2.3.1 Blockchain Benefits for HEIs

Blockchain has the potential to be a highly advantageous technology to the HEIs industry. It can, for instance, change the HEIs' relationship between themselves and/or toward the society nodes. Moreover, the characteristics of blockchain, such as security, privacy and trust, enable it to revolutionise the industry considerably (Dwivedi & Vig, 2024). To take advantage of blockchain, multiple projects have been issued, and multiple HEIs have adopted it (Kamišalić et al., 2019).

Blockchain can benefit HEIs in various ways. Al Harthy et al. (2019) proposed multiple methods that HEIs can benefit from blockchain technology. They started with the transaction services, which encompasses dealing with credentials, data, and fees. Moreover, they contend that blockchain could increase the security of recording students’ profiles and credentials. Additionally, HEIs could utilise blockchain in human resources activities, such as checking the achievements of employees. Libraries in HEIs, according to the authors, represent another section that might benefit from blockchain by providing digital rights to

literature. Furthermore, blockchain provides a network that supports the publication process (Al Harthy et al., 2019). Moreover, blockchain can enhance the communication level among students, faculty members and employees through its platforms (Alzahrani et al., 2021).

Extant review literature has discussed the benefits of blockchain in relation to the education industry. For instance, Loukil et al. (2021) found that enhancing accountability and transparency, securing and verifying shared proofs, and better controlling data access are the most mentioned features of blockchain literature, respectively. Similarly, Alammary et al. (2019) stated that blockchain has the capability to provide 'significant benefits to education, including high security, low cost, enhancing students' assessments, better control of data access, enhancing accountability and transparency, identity authentication, enhancing trust, improving the efficiency of students' records management, supporting learners' career decisions, and enhancing learners' interactivity' (Alammary *et al.*, 2019, p.11,). Further, Yumna et al. (2019) found that blockchain can benefit the current educational system by decreasing manipulation of academic records, easing verification of students transcripts, reducing administrative load, providing decentralisation, assisting records exchanges among HEIs, enabling traceability, increasing security and developing the payments methods among HEIs and related parties.

Based on its characteristics, blockchain handles cybersecurity differently compared to the traditional systems. Some authors contend that blockchain has become one of the most widely debated topics in the realm of cybersecurity (Lund, 2024; Taylor et al., 2020). In comparison to blockchain, traditional systems store data in a centralised databases, which, if compromised, can lead to significant data losses, particularly for HEIs (Tapscott & Tapscott, 2017). HEIs and employees, particularly in KSA, have been a target for cyberattacks (Sharabi, 2023). For instance, King Saud University, one of the most prestigious universities in KSA, has been hacked by an unidentified hacker (Alqurashi et al., 2020). On the other hand, blockchain offers unique ability to mitigate cybersecurity threats, making it considerably more difficult to be hacked within the cyberspace (Taherdoost, 2023). As a decentralised technology, blockchain reduces the risks associated with a single point of failure, ensuring that HEIs' data are more secure (Ahmed, 2024). Given its immutability, data cannot be altered or deleted. This feature is particularly valuable for HEIs in issuing tamper-proof academic records such as transcripts, diplomas and certificates, thereby safeguarding academic integrity (Ahmed, 2024; Dwivedi & Vig, 2024; Taherdoost, 2023). Furthermore, transparency is a feature of blockchain that can reinforce cybersecurity within HEIs. HEIs' transactions on blockchain can be visible to the public, fostering trust and reducing fraudulent activities (Dwivedi & Vig, 2024; Rodrigues et al., 2022). As an encrypted technology, blockchain advances cryptographic techniques to enhance data security and identity verification (Taylor et al., 2020).

2.3.2 Blockchain Challenges in HEIs

Blockchain is one of the most promising technologies in the fourth industrial technologies (Chaka, 2023; Gottlieb et al., 2024; Basdekidou & Papapanagos, 2024). However, it has several challenges as it is not perfect and cannot solve all the issues (Delgado-Von-eitzen et al., 2021).

The main challenge is the level of awareness (AW) among individuals, specifically, the ultimate users of blockchain (e.g., employees in HEIs) (Hughes et al., 2019; Swan, 2015; Bhaskar et al., 2020; Sarnacchiaro et al., 2024). Blockchain AW among employees might hinder their acceptance of blockchain's implementation, which may lead to a failure to adopt the technology (as discussed in Section 1.3). On the other hand, AW of blockchain among employees can facilitate its adoption significantly (Dwivedi & Vig, 2024). Yet, the effect of AW on blockchain acceptance among HEIs' employees is yet to be empirically investigated. This study will investigate AW's direct effect on blockchain acceptance and its moderating effect between other variables and the behavioural intention (BI) to use blockchain among employees. Detailed exposure of AW is discussed further in upcoming sections.

Another challenge of adopting blockchain is scalability. The scalability issue occurs when a blockchain-based network gets slower and probably more expensive. According to Bhaskar et al. (2020), data within HEIs keeps increasing with more operations and among semesters, which causes a latency of data transactions in the blockchain system. By nature, blockchain holds its transactions in every block, which causes a slow performance to retrieve the stored transactions due to the number of records it receives per second, where the scalability problem emerges (Vukoli´c, 2016; Underwood, 2016).

Moreover, blockchain may not be costly efficient. Although some literature, such as Palas and Bunduchi (2021), noted that blockchain reduces cost, Bhaskar et al. (2020) argue that adopting blockchain could increase the cost risk. They elucidate that by determining the cost of controlling a large amount of data, wasting a significant amount of time and consuming a high portion of computing energy as the main areas where the expenditure occurs. They proceed that the more features blockchain attains, the more expensive it will be.

Security and privacy are controversial issues as they can be considered one of the benefits and challenges of blockchain at the same time (Dwivedi & Vig, 2024). Although they might be considered as one of blockchain's advantages (as mentioned earlier), Bodkhe et al. (2020) stated the potential of blockchain cyberattacks, which might cause information leakage and financial losses. Xu (2016) contend that some of blockchain features, such as being a distributed consensus, might weaken some aspects of cybersecurity. The 51% attack, losing a blockchain account, and having the digital identity stolen, among others, are examples of

potential cybersecurity hacks (Xu, 2016). Privacy is another caveat of blockchain adoption in HEIs. According to Underwood (2016), the issue when a transaction needs to be verified throughout blockchain system is the amount of data that needs to be exposed. The massive data exchanges among Internet users can cause a significant drawback for blockchain in terms of privacy (Bodkhe et al., 2020). Relatedly, privacy might be an issue in blockchain education applications when validating an academic certificate with a third party. According to Underwood (2016), the issue when a transaction needs to be verified throughout blockchain system is the amount of data that needs to be exposed. The massive data exchanges among Internet users can cause a significant drawback for blockchain in terms of privacy (Bodkhe et al., 2020).

In order to foster its advantages and mitigate weaknesses, existing developers, IT specialists and enterprises, among others, have been developing blockchain-based applications to assist in transforming the current system of the HEIs industry.

2.3.3 The Use-cases of Blockchain in Education

Taking advantage of its characteristics and benefits, blockchain-based applications and frameworks have been built to revolutionise the HEIs industry. Blockchain has the potential to enhance the HEI sector in various ways. HEIs are considering the adoption of blockchain to solve various issues (Turkanović et al., 2018; Yu et al., 2023). These potentials and considerations lead this study to present use cases that present or offer blockchain-based services to solve or reduce existing challenges in HEIs.

Previous literature has attempted to review current blockchain-based applications and provide various categorisations of potential areas where they could be implemented. For instance, Loukil et al. (2021) found that recent studies have discussed the blockchain in education from four major dimensions. They found that blockchain can assist HEIs in ‘Certificate/degree verification and revocation, user-centric educational record management, students’ professional ability evaluation, and online learning environment’ (Loukil et al., 2021, p.10). Furthermore, Delgado-Von-eitzen et al. (2021) found that blockchain is applicable in seven areas within the HEIs industry. These areas are 1) certificate issue and academic result management, 2) storing learning trajectory, 3) Performance valuation during the employment process, 4) Competency, 5) sharing and storing data, 6) Rewarding students with tokens and 7) Evaluation of HEIs. In a related contribution, Chen et al. (2023) found that blockchain may assist HEIs in facilitating remote learning, education data mining, data sharing, certificate management, data storing, office management, education of students and crowdfunding. Moreover, Alammary et al. (2019) found twelve categories where blockchain can revolutionise

HEIs. These categories are ‘certificates management, competencies and learning outcomes management, evaluating students’ professional ability, protecting learning objects, securing collaborative learning environment, fees and credits transfer, obtaining digital guardianship consent, competitions management, copyrights management, enhancing students’ interactions in e-learning, examination review, and supporting lifelong learning’ (pp.6-7). In their review, Fedorova and Skobleva (2020), also, discussed four categories where blockchain may play significant roles within the HEIs industry. These categories relate to certificate management, identification solutions, protection of intellectual property, new cooperation methods between students and academics, novel formations of academic passports, financial exchanges, accreditation of HEIs and administration of the educational process. Similarly, El Koshiry et al.,(2023) represented their categorisation of blockchain-based applications in HEIs. Their study resulted in determining credential verification, distributed learning, micro-credential, smart contracts learning analytics, funding and donations, intellectual property, identity management, data sharing and students-record management as the main areas of blockchain within the HEIs industry (El Koshiry et al., 2023). These are the main areas previous authors suggested, based on their review, where blockchain can revolutionise HEIs.

Obviously, the above-mentioned review papers have shown various fields where blockchain may benefit HEIs. However, they do not demonstrate the exact categories. More significantly, these papers present only a few blockchain-based applications and frameworks in detail. These limitations of previous reviews lead this study to explore other blockchain-based applications in more detail and categorise them accordingly.

So, this study investigated current and potential blockchain-based applications that could assist HEIs in various activities. This investigation does not follow any reviewing method because some applications exist in platforms and not in published papers. The aim is to generate options for decision-makers to adopt blockchain where needed.

This study’s investigation of blockchain-based applications resulted in outcomes that differ from the aforementioned studies. This study is unaware of any previous reviews that have investigated and categorised blockchain-based applications for the HEIs as deep as the current study. The found applications are reported and categorised accordingly. Other applications or frameworks might be missing due to the difficulty of tracking every blockchain-based application that can facilitate HEI activities. Therefore, this study provides potential applications that may assist HEIs’ adoption of blockchain.

As a result of this study’s investigation, this study found that blockchain-based applications and frameworks can develop various areas within HEIs. These aspects are 1) certificate management, 2) financial exchanges, 3) storing and sharing data, 4) recruiting, 5)

Copyright, 6) transparency in assessments and 7) multi-purposing projects. The following fields explore these applications in more detail. Within the HEIs, the administrative employees are expected to be the ultimate users from blockchain-based applications and frameworks related to certificate management, financial exchanges, storing and sharing data and recruiting. Meanwhile, the academic employees are expected to be influenced from blockchain-based applications and frameworks related to Copywrite and assessments' development.

2.3.3.1 Credential Authentication and Revocation

Grech and Camilleri (2017) define the credentials as a statement issued from one party (e.g., HEI) and given to another (e.g., student) to certify one or a list of facts to be accurate. The authors stated that certificates must have signatures to prove the stated facts. Certificates have a crucial impact in the social context; however, issuing academic accomplishments among educational institutions remains slow, complex, expensive, and susceptible to fraud (Capece et al., 2020). Certificate management is one of the most noticeable blockchain-based solutions for HEIs (Alammary et al., 2019; Loukil et al., 2021; G. Chen et al., 2018; Gottlieb et al., 2024).

Similar to the findings of previous investigations, this review reveals a considerable number of blockchain-based applications and frameworks related to certificate management. The features of these platforms and frameworks are pertinent to issuing, viewing, validating and sharing academic credentials (Bdiwi et al., 2018). These features can contribute to the educational industry in multiple ways. They may assist in mitigating digital certificate fraud (Alnafrah & Mouselli, 2021; Loukil et al., 2021). Moreover, according to Alnafrah and Mouselli (2021), blockchain can increase the certificates' recording security due to the difficulty of attacking a large number of nodes in the blockchain network. Additionally, the authors claim that the human resources department tasks will be reduced because blockchain applications can assist in generating, verifying, viewing, validating and sharing academic certificates with other HEIs. There are multiple platforms, conceptual frameworks, and/or novel frameworks that provide some or all of the aforementioned features. The expected ultimate users of the following blockchain-based applications are the administrative and academic staff.

For instance, Diploma Integrity Authentication Record (DIAR) is a novel blockchain-based software that is proposed by Rustemi et al. (2024). The application concerns creating and validating the issuance of academic credentials in HEIs. The authors presented DIAR to

solve credential-related issues such as privacy, fraudulent activity and limited capacity of digital services. Similarly, by integrating blockchain and the Internet of Things, Alkhammash et al. (2022) proposed DASC, a complementary framework that assists in managing certificates in HEIs. Their proposed system is meant to assist in issuing, verifying and sharing students' certificates. Through their proposed system, credits, transcripts, badges, skills and course registration can be shared with the HEIs' stakeholders and/or prospective employers. Aiming to address admission forgery among HEIs office workers, Malsa et al. (2021) proposed a blockchain-based framework called CERTbchain. This system stores certificates to enable transparency, increase security and reduce cost, among other features. Further, Docschain is a blockchain-based solution for credential issuance and verification (Rasool et al., 2020). In this system, the verification process does not only support the verification of current credentials. Instead, it enables HEIs to issue new degrees and add them to the Docschain. In other words, it supports all stakeholders in the process of degree issuance and verification for students. Another blockchain-based system is CVSS by Nguyen et al. (2018). They proposed a system that enables issuing digitised certificates in HEIs to solve counterfeiting-related concerns. Its competitive advantage is related to its built system on smart contract architecture. Also, according to the authors, this system ensures privacy and transparency for all parties. Furthermore, Ranosys Technologies (2019) introduced a digital degree system called Opencerts that integrates blockchain and facial recognition. This integration of these two technologies leads to a more secure system. Their system, according to the author, is built on a mobile phone where students can acquire their credentials without visiting the HEIs. Students request the degree, and the facial recognition embedded in the system verifies the diploma recipient.

Other fully developed platforms and applications are available to enhance HEIs' certificate management. For instance, ElearnChain is a blockchain-based practical project presented by An and Chen (2021). They embedded features such as traceability, immutability and decentralisation to generate their project. Their projects store educational records of e-learning and share them with potential employers. The competitive advantage of this application is taking into consideration the privacy and auditability of e-learning (An & Chen, 2021). The Massachusetts Institute of Technology (MIT) Media lab presented one of the first projects of storing credentials, called Digital Academic Credentials. It enables HEIs to issue, display and verify certificates based on the Bitcoin blockchain mechanism (Lab, 2016). This project led to the operation of Blockcerts. Through this project, students can use the platform-based blockchain to share, receive, tamperproof and verify digitalised certificates using their Blockcerts Wallet (Agustin et al., 2020). Blockcerts facilitates collaboration among users and Learning Machine—a Cambridge-based Software Company (Oyelere et al., 2020). Similarly,

Kolvenbach et al. (2018) presented a platform that is capable of issuing, observing, validating and sharing certificates. It is a platform-based blockchain that enables HEIs to store their student's certificates within their system. Moreover, Certchain is a user-friendly platform-based public blockchain that aims to securely store, search, monitor, and share students' diplomas (J. Chen et al., 2018). Another platform that aims to reduce certificate counterfeiting is the Unicert. It is based on the blockchain-based Unicorn database (Huynh et al., 2018). Further, Educhain is a blockchain-based system that enables the issuance, exchange and verification of certificates securely (Liu et al., 2021). This platform is one of the full-scale platforms and it has been adopted by many universities such as Khalifa University in the United Arab Emirates. RecordSkeepers is another application that enables issuing and recording data in different industries such as SC and education. In the latter, it enables the issuing, storing and verifying certificates. It provides features such as transparency, immutability, disintermediation and collaboration while processing the previous stages (issuance, storing and verifying) (RecordsKeeper, 2018). In the same context, the University of Maribor, through Turkanović et al. (2018), introduced a blockchain-based platform EduCTX. The University of Maribor aimed to enable its users to manage, assign and present any type of digital certificates (Turkanović et al., 2018). Similarly, Xu et al. (2017) introduced Educational Certificate Blockchain (ECBC) to enhance the security and trust of the certificate management. The developers of ECBC took the user's privacy protection into careful consideration (Xu et al., 2017). Another platform is Cerberus, proposed by Tariq et al. (2019) based on smart contracts. This platform aims to reduce the counterfeit of certificates within the HEI industry. The developers also provide features like verifying the grades of students, ensuring the privacy of the data and providing selective disclosure of data (Tariq et al., 2019). In a similar approach, Arenas and Fernandez (2018) presented their CredenceLedger platform based on a permissioned blockchain to store and verify certificates for students. In a similar context, Rooksby and Dimitrov (2017) proposed a system for recording students' grades. Gradbase offers its services based on blockchain, which involves verifying students' academic qualifications to accelerate the recruiting process (Colle et al., 2018). Moreover, ZebiEdu is a platform established mainly to store certificates and verify them by a higher education institution. Thereafter, the result will be shared with the potential employer using a QR code (Zebi, 2019). Additionally, BCdiploma is a platform based on blockchain whereby certificates, badges and micro-certificates can be stored in this platform and shared in all formats (Bcdiploma, 2021).

The aforementioned applications, including the following areas' systems and platforms are summarised in Appendix A, Table A1. Also, the Table presents the competitive advantages (additional features) that each framework or application provides while others might not provide them.

2.3.3.2 Financial Exchanges

Blockchain has the potential to ease the transactions between students and institutions through blockchain cryptocurrencies (e.g., Bitcoin). Many universities have accepted tuition fees with cryptocurrencies, such as Bitcoin (see Section 2.3.1.7). This ultimate users of this section are expected to be the administrative employees.

2.3.3.3 Storing and Sharing Data

Within the HEIs industry, blockchain 'could store and exchange things of value and where we could trust each other without powerful intermediaries' (D. Tapscott & Tapscott, 2017, p.12). Loukil et al. (2021) contend that universities can exploit the disintermediation feature of blockchain to transfer information. The authors noted that HEIs could reduce costs by minimising the reliance on intermediaries. The expected beneficiaries of blcockahin-based apps within this section are expected to be the administrative and academic employees at the same time.

In storing data, Sharples and Domingue (2016) proposed a model for storing educational records aiming to enhance the reputation management of HEIs. Similarly, Curmi and Inguanez (2019) offered a framework for the HEIs to store their data. Furthermore, Edgecoin is a blockchain system that enables storing educational data, including, but not limited to, online courses and credentials (Guustaaf et al., 2021).

On the other hand, existing blockchain-based platforms were developed or proposed to enable HEIs to share educational data. For instance, EduCoin is a blockchain-based system that rewards employees and students for sharing their skills, certificates and other data (Nair et al., 2019). Likewise, the Academic Blockchain framework was proposed to enable a transparent and secure method of sharing academic transcripts and learners' achievements (Kumaresh, 2020).

2.3.3.4 Recruiting

Acquiring human resources within HEIs is essential for generating a competitive advantage and accomplishing institutions' goals (Syed & Kramar, 2017). Checking the credibility of employment requests is not an easy quest for HEIs as it might cost time and financial losses (Ark, 2018). Blockchain-based platforms and frameworks exist to assist in enhancing the Human Resource departments in relation to HEIs. The expected ultimate users of this category within the HEIs are the administrative employees.

For instance, Kuvshinov et al. (2018) introduced a project based on a public blockchain. The proposed project issues and generates verified personal profiles for students. It assists in creating their digital CV during their educational career, supported by Disciplina in terms of authentication (Kuvshinov et al., 2018). In addition, Chen (2018) presented the blockchainbased EchoLink. In this platform, the information can be entered only by trusted institutions like authorised HEIs. The HEIs can store individuals' certificates, skills and information in an immutable manner. For example, students' grades, transcripts, and certificates could be stored in this remotely secure and variable blockchain system. Moreover, users can utilise their profiles for the recruiting procedure. Specifically, EchoLink provides students with a complete profile that could be provided to potential employees. In another blockchain-based platform, Chrono.Tech is proposed to accelerate the recruitment and payment procedures of HEIs (The Chronobank Team, 2016). Similarly, APII is a blockchain-based UK platform that verifies the potential employees who apply for jobs within HEIs (APII, 2016).

2.3.3.5 Copyright

Blockchain can keep the original copy of the initiator (e.g., the original author), who may protect their rights more effectively (Tapscott & Tapscott, 2016; Cai, 2020). This section focuses on the applications and platforms that aid researchers from the faculty members in HEIs in KSA. The expected beneficiaries of this category are the academics.

For that, Binded (2017) proposed a blockchain-based system that serves copyright issues for authors. In addition, Bernstein is a blockchain-based platform that provides an encrypted vault that enables authors and instructors to record their outcomes and publications (Bernstein, 2021). In addition, Inayatulloh et al. (2023) proposed a framework that assists in solving the plagiarism issue in HEIs. They contended that the plagiarism issue has not been solved, yet their proposed blockchain-based framework can solve this issue. Plagiarism, according to the authors, can be solved by using blockchain due to its traceability feature. Indeed, authors, academics, reviewers and institutions can trace the research and publications in real time (Inayatulloh et al., 2023). Furthermore, Gipp et al. (2017) offered a system related to secure and integrity submissions based on blockchain called CryptSubmit. Once a manuscript is submitted, the system automatically generates a decentralised and tamperproof timestamp for it. It enables academics and researchers to independently verify the time they submit their manuscript that is submitted to a journal or a conference. Further, it creates timestamps for feedback received by peer reviewers of the journal or conference to enhance the traceability of innovative ideas. Also, Pozi et al. (2018) proposed a blockchain-

based model that gauges the contribution rate of scientific papers' authors for external parties. Pozi and others argue that the authors of a journal paper recognise the contributions of their co-authors; however, the readers do not. Thus, they proposed a blockchain-based framework that evaluates the contributions of all authors in a scholarly paper. Finally, Another copywrite-related that is based on blockchain is a system introduced by Andi et al. (2019). The authors' aim is to prevent plagiarism by building a blockchain-based application without the need for reliance on middlemen. In the event of plagiarism, blockchain will report the violation. Security, immutability and trust are the main features of their proposed application. In this case, scholarly articles are alleged to be protected through this application (Andi et al., 2019).

2.3.3.6 Assessments

HEIs are aware of the importance of evaluating students and assessing them fairly. However, Shen and Xiao (2018) stated that the current methods of evaluating students are not transparent, unfair, and can be easily tampered with, especially in online venues. Thus, multiple blockchain-based applications and frameworks have been proposed to mitigate such issues. The expected ultimate users of blockchain-based applications within this category are expected to be the academics.

Various platforms and conceptual frameworks based on blockchain can increase the transparency of educational assessments in HEIs. Shen and Xiao (2018) proposed a blockchain-based platform that permits public to verify learners' answers. In addition, Bore et al. (2017) produced a conceptual framework suggesting a blockchain-enabled School Information Hub (SIH) and tested the framework on Kenya's school system, as a case study. Further, Sahonero-Alvarez (2019) proposed an automated-marking system to assess students and reward them with digital badges without the interference of instructors. Tentea and Ionescu (2019) also delivered a blockchain-based showcase that may enhance the integrity of online assessments. Similarly, Jain et al. (2021) developed an application based on blockchain and smart contracts to evolve the online examination system. Mitchell et al. (2019) established a decentralised blockchain application that facilitates examination reviews (i.e., dAppER). Their solution starts from the production of exams to the release of the outcomes. They suggest that blockchain might be used to facilitate a secure way of deploying the exams by keeping immutable records of the exams on blockchain. This system, also, enables the development of paper exams by more than one person (e.g., module leader, internal moderator and external examiner at the same time). Furthermore, Zheng (2021) proposed a blockchain-based e-Portfolio evaluation system. The proposed system assesses the

educational and teaching process. The aim is to enhance the current e-Portfolio evaluations, i.e., privacy safeguard, data sharing and traceability of data.

In addition, Luo et al. (2024) integrated blockchain and Artificial Intelligence (AI) to propose BC4LLM. Their purpose is to enable the AI large language model (LLM) by employing blockchain. LLM helps individuals and organisations create content. However, they suffer from significant issues, including security and privacy, among others. To reduce such challenges, Luo et al. (2024) proposed the blockchain-enabled LLM to improve education in multiple facets. For instance, chatbots (e.g., ChatGPT) can assist academics and admission offices in analysing students' performance and grades. However, reporting students' records in AI chatbots may cause a series of privacy breaches, as the students will be targeted by third-party organisations who will obtain their data scores. BC4LLM, according to Luo and others, can address such leakage of data by leveraging blockchain.

2.3.3.7 Multipurpose Case Uses

Some blockchain-based frameworks and platforms serve more than one of the aforementioned areas. The expected beneficiaries of the following blockchain-based applications are both academic and administrative staff.

Based on the IBM system powered by the Hyperledger blockchain system, Sony Global Education (SGE) team (2017) proposed a blockchain-based system that assists in authenticating, storing and managing educational records, called the SGE. This project enables HEIs to record and analyse their data with the help of AI. Further, Ocheja et al. (2018) proposed their prototype system based on blockchain, where distributed learning platforms can connect and keep persistent records of learners' education activities. Their platform is based on smart contracts. Kanan et al. (2019) proposed another multi-featured platform based on blockchain called SmartCert. Its main purpose is to store all types of data. It enabled all the departments of Al-Zaytoonah University to issue all sorts of documents safely and share them with other parties. Examples of these data include financial documents, official documents and digital academic credentials (Kanan et al., 2019). However, this application may suffer from security issues due to its followed approach in programming (Saleh et al., 2020). According to Sharma and Batth (2020), Teachmeplease is another platform that provides distance sessions to various learning groups. The authors state that this platform is based on private and public blockchains. Its private blockchain stores the educational data, while its public blockchain sends these data to invited parties (e.g., potential employers) (Sharma & Batth, 2020). A recent blockchain-based software is one that increases the privacy of disabled students to keep their students' needs protected (Xu, 2024). Moreover, EduCrypto is a blockchain-based system that

provides several advantages and was introduced by Badlani et al. (2022). It is a data management system that enables security, integrity and immutability of HEIs-related data. The system not only enables HEIs to store, retrieve and authenticate their documents but also simplifies the process of examination and transcript issuance (Badlani et al., 2022). Finally, Lizcano et al. (2020) introduced a blockchain-based model to attain various advantages. They claimed that their proposed blockchain-based approach reduces the gap between students' training and the market needs. The reduction occurs by enabling students to verify the acquisition of competent knowledge and allow HEIs to attain fair assessment of their teaching approaches in accordance with the fast-changing labour market. Further, their approach simplifies the recruitment process for students. This occurs by facilitating students to share their blockchain-based credentials with employers. Employers will receive authentic credentials without being worried about credential forgery. The final advantage is students' accessibility to digital curricula that benefit labour market (Lizcano et al., 2020).

In summary, Appendix A, Table A2 demonstrates the above-mentioned applications and frameworks that could transform the HEIs.

2.3.3.8 HEIs Adopting Blockchain

Several HEIs worldwide have adopted blockchain within the previous proposed categories to take advantage of its security, privacy immutability and traceability features.

In the UK, a number of institutions have adopted blockchain for different purposes. University College London, for instance, has adopted blockchain to enhance the security and transparency of data management, particularly in storing and managing research data and other sensitive information (El Koshiry et al., 2023). The Knowledge Media Institute (KMI), part of the Open University (OU), has implemented a blockchain system to award digital badges to users who complete OU courses (Arndt, 2019). Additionally, KMI incorporated features like storing certificates and enhancing the web reputation of OU by leveraging blockchain (Saleh et al., 2020; Jirgensons & Kapenieks, 2018). Moreover, the University of Southampton has adopted blockchain to issue and store credentials (Fedorova P. & Skobleva I., 2020). Also, Woolf Of University has implemented blockchain to enhance certificate management, digital identity solutions, tuition payment processes, and other educational activities (Fedorova P. & Skobleva I., 2020).

In the United States, MIT has implemented blockchain to issue and store secure, verifiable digital certificates (Lab, 2016). Moreover, Fedorova and Skobleva. (2020) reported several other US universities that have integrated blockchain for various applications. They noted that the University of New Hampshire have adopted blockchain to generate and store

certificates and diplomas. King's College has utilised blockchain to receive tuition fees with crypto currencies. The University of California has implemented blockchain to issue and store credentials and diplomas. In addition, Stanford University has explored the adoption of blockchain to secure data sharing, manage digital identity and secure credential issuance (El Koshiry et al., 2023).

In Russia, Fedorova and Skobleva. (2020) found that Synergy University issues and stores certificates based on the blockchain system. This institution also has employed a blockchain-based application to foster cooperation between learners and lecturers. Further, the Penza State University in Russia has adopted blockchain for issuing and storing academic certificates.

In Greece, Aristotle University of Thessaloniki, Athens University of Economics and Business, and Democritus University of Thrace have all adopted blockchain for certificate management and digital identification solutions. Meanwhile, in China, Zhejiang University, Shenzhen University, Chinese Academy of Sciences have adopted blockchain to enhance the protection of intellectual property (Fedorova P. & Skobleva I., 2020)

In Saudi Arabia, two universities have adopted blockchain to issue certificates. These HEIs are King Abdullah University of Science and Technology (KAUST) and Taibah University (KAUST, 2018; Taibah Valley, 2023).

Other universities worldwide have also adopted blockchain for various factors. In Australian, the University of Melbourne has implemented blockchain to enhance data security, facilitate data sharing, issue certificates, and strengthen digital identity management (El Koshiry et al., 2023). According to Fedorova and Skobleva. (2020), the Malta College of Arts Science and Technology, located in Malta, has implemented blockchain to issue and store credentials. In the United Arab Emirates, the University of Dubai has integrated blockchain technology, while in Bahrain, the University of Bahrain has done the same. Further examples include Central New Mexico Community College in Mexico and Ngee Ann Polytechnic in Singapore, both of which use blockchain for issuing and storing credentials and diplomas (Fedorova P. & Skobleva I., 2020). Similarly, University of Nicosia has been utilising blockchain to issue, store and validate certificate (Chaka, 2023; Sharples & Domingue, 2016; Grather et al., 2018).

Other universities in Canada, Brazil and Indonesia, among others have implemented blockchain technology. Appendix J provides a summary of the HEIs that have adopted blockchain technology. Additionally, it categorises these HEIs by country, illustrating the global adoption of blockchain in higher education.

2.4 HEI sector in KSA

This study is conducted in KSA. This section discusses the need of blockchain in the HEIs located in KSA.

2.4.1 HEIs in KSA

Education is one of the most important sectors that the government of Saudi Arabia plans to improve, particularly in the Saudi Vision 2030. This improvement of education involves the HEI sector substantially. The crown prince of the Kingdom of Saudi Arabia, Prince Mohammed bin Salman, presented the Saudi Vision 2030 in 2016. In its booklet, the Government (2016), planned to invest in the education sector to improve the skills of its citizens, refine the current model of teaching, and increase the quality of instructors and HIE's leaders. The government of Saudi Arabia built its vision on three main themes, and one of the themes aims to achieve a thriving economy that links the education system and markets' needs. To achieve that, the government announced its commitment to close the gap between HEIs' outcomes and the labour market. The government plans to enable students to track their records (e.g., transcripts) from the commencement of their studies until the completion of their educational journey, including the higher-education studies (Government 2016). Blockchain may play a critical role in this plan (see Section 2.3.1). Furthermore, in this vision booklet, the government intends to remove all the obstacles that prevent investors from investing in HEIs. In other words, the government's vision is to transfer the HEIs from public to private ones. The government, within its vision, seeks to shift its role from a service provider to be a monitor.

2.4.2 Blockchain Implementation in HEIs in KSA

As mentioned above, the Saudi government aims to privatise HEIs and adopt emergent technologies. According to Vision 2030 of the Saudi Government, HEIs should overcome existing challenges by adopting new technologies such as blockchain (KSA Vision 2030, 2016). Blockchain technology may change the HEIs' relationships among themselves and/or toward the society members. HEIs in KSA face challenges that can be significantly mitigated or solved by adopting blockchain. These challenge include, but not limited, to cyberattacks and high financial costs.

Tapscott and Tapscott (2017) stated that universities depend on intermediaries' centralised databases to record individuals' data and issue transactions, among other services. Although the authors see that these institutions usually perform well while implementing these tasks, some drawbacks still exist. One of the major concerns in the current

system implemented by HEIs is their reliability on centralised servers to store HEIs' data. The authors stated that centralised databases are more vulnerable to cyberattacks. An example of a cyberattack is one that attacked KSU. KSU is one of the most prestigious universities in KSA. Yet, an unidentified hacker was able to access a database of 812 users and share their information in public (Elnaim & Al-Lami, 2017). To minimise cyberattacked issues related to centralised systems, Tapscott and Tapscott (2017) believe that blockchain is the solution HEIs need. Elements such as 'Collective self-interest, hard-coded into this new native digital medium for value' (P.12) would guarantee safe, secure and reliable exchanges in the online education system (Tapscott & Tapscott, 2017). Therefore, KSA's HEIs may benefit from blockchain in reducing cyberattacks and minimising financial costs accordingly. Thefeatures and characteristics of blockchain mentioned in Sections 2.2.3 and 2.3.3 may assist in reducing or addressing other challenges in HEIs.

Based on the importance of blockchain technology adoption in HEIs and particularly in KSA, it is significant to discuss technology adoption in more detail.

2.5 Technology Adoption Theories in Research

This section discusses relevant theories and models.

2.5.1 Technology Acceptance

For a long period of time, multiple theories have examined the acceptance of various technologies from organisational or/and individual perspectives. In this study, technology acceptance indicates how individuals' perceptions influence their behavioural intention to utilise a technology (Molino et al., 2020). This section explores relevant theories that regard technology acceptance (Oliveira & Martins, 2010), specifically for blockchain (Alshamsi et al., 2022; Al-Ashmori et al., 2022). Relevant theories within the information system discipline include the technology acceptance model (TAM) by Davis (1985), theory of planned behaviour (TPB) by Ajzen & Fishbein (1980), UTAUT by Venkatesh et al. (2003), diffusion of innovation (DOI) by Rogers (1983) and the technology-organisation-environment (TOE) framework by Tornatzky and Fleischer (1990) (Oliveira & Martins, 2010; Taherdoost, 2022). All these theories and models concern individuals' acceptance, except the DOI and TOE, as they pertain to the institutional level (Oliveira & Martins, 2010). Furthermore, Alshamsi et al. (2022) and Al-Ashmori et al. (2022) have found TAM and UTAUT to be the most suitable and used models for blockchain adoption. The theory of reasoned actions (TRA) will be discussed in this section as well due to its importance as it is deemed to be the underpinning theory of multiple theories,

i.e., TPB, TAM and UTAUT (Davis, 1985; Venkatesh et al., 2003; Ajzen, 1985). Hence, this section discusses the aforementioned theories in addition to TRA due to their relevance to this study. These models are presented chronologically (based on the date of the model's introduction).

2.5.2 Diffusion of Innovations

In 1962, Rogers introduced the DOI theory from a sociological stance (Kapoor et al., 2014; Alkhwaldi & Kamala, 2017). Broadly, this theory concentrates on comprehending factors that lead to technology adoption and then changing a specific social structure and context (Vargo et al., 2020). Rogers (2003) defines diffusion 'as the process by which an innovation is communicated through certain channels over time among the members of a social system' (p.11). From this definition, he identifies four main elements of diffusion, namely, innovation, communication channels, time and social system.

Rogers (2003) refers to the technology-decision process as the stages where individuals or decision-makers who represent a certain institution shift from acquiring initial knowledge of a technology to performing a particular attitude toward the technology to making a decision to adopt or reject the technology. This process consists of five phases: Knowledge, persuasion, decision, implementation and confirmation. In addition, Rogers (2003) proposes five attributes of technologies to decrease the uncertainty about innovation. These attributes are 1) relative advantage, 2) compatibility, 3) complexity, 4) trialability and 5) observability.

In their use of DOI, Lin et al. (2021) highlighted three constructs of Rogers' theory, i.e., complexity, compatibility and relative advantage. Thereafter, the authors titled them as the significant predictors of adopting a technology. They aimed to explore the impact of privacy concerns, trust and hazard perceptions on individuals' preparedness to adopt a tracing application from the government that is built to manage the Covid-19 pandemic in Australia. The authors found that relative advantage, compatibility, trusting beliefs do increase the intention of using the government's app. Furthermore, privacy concerns do reduce the trusting beliefs and boost the risk beliefs. They also found that trusting beliefs decrease risk beliefs (Lin et al., 2021).

DOI is not implemented in the present study. Although the DOI has been used in recent studies (e.g., Lin et al. 2021), it is not suitable for advanced technologies and most likely does not stand alone in the current time (Hsu et al., 2006). Taherdoost (2018) emphasised that DOI concentrates more on technological characteristics, organisational attributes and

environmental faces and obtains less power in predicting outcomes related to individuals. Therefore, DOI is disregarded in this study.

2.5.3 Theory of Reasoned Action

TRA is drawn from social and psychological stances and is deemed one of the most impactful theories of individual behaviour (Venkatesh et al., 2003). According to Davis (1985), the debut of this model was in 1967 by Martian Fishbein. Later on, it was developed and refined by Fishbein and Ajzen in 1975. The core constructs of this model are attitude toward behaviour and subjective norms, which lead to BI (see Figure 1.0).

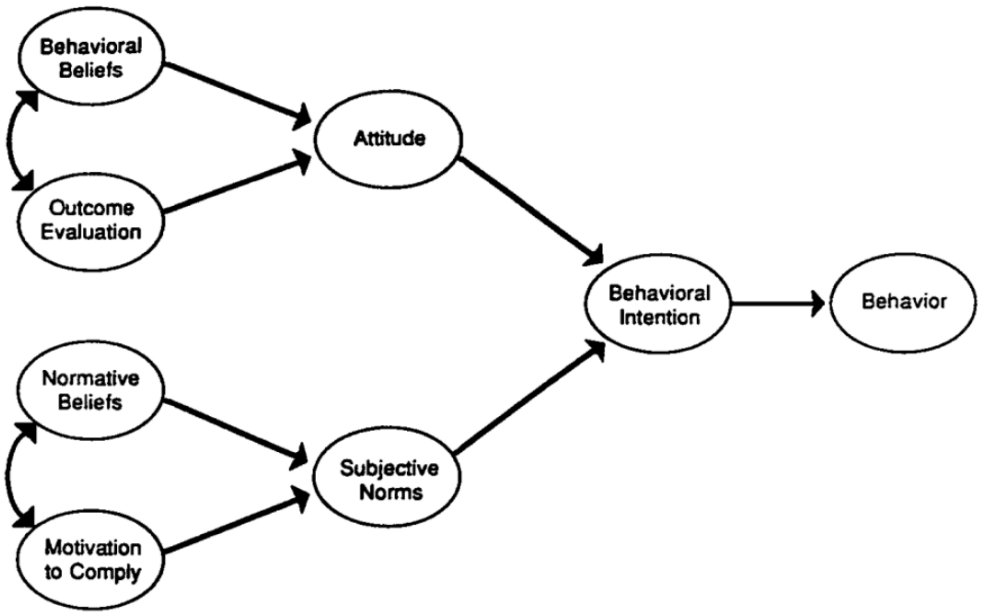

Figure 1.0 Theory of Reasoned Action (Fishbein & Ajzen, 1975)

It is not an easy task to find recent high-ranking studies that utilise TRA theory solely, and it occurs probably due to two factors. Firstly, studies typically utilise the new version of TRA, namely, the TPB (Hansen et al., 2018). Additionally, Wu (2012) mentions that scholars have been utilising reformed theories based on TRA determinants, such as TPB and TAM. Due to being potentially invalid for blockchain and in this time, TRA is not implemented in this study.

2.5.4 Theory of Planned Behaviour

Since Ajzen (1985) developed his theory, TPB has been one of the most frequently cited theories to predict users' behaviour (Ajzen, 2011). The theory extended TRA by adding

perceived behavioural control. TPB predictors were combined with the perceived usefulness from TAM to offer a hybrid framework for UTAUT (Venkatesh et al., 2003). As illustrated in the following section, UTAUT is the selected model of this study. The intention is assumed to be the central determinant of one's behaviour in TPB (Ajzen & Fishbein, 1980; Ajzen, 1991). The latent variables in TPB are attitude toward the behaviour, subjective norms, perceived behavioural control, intention and behaviour (see Figure 2.0).

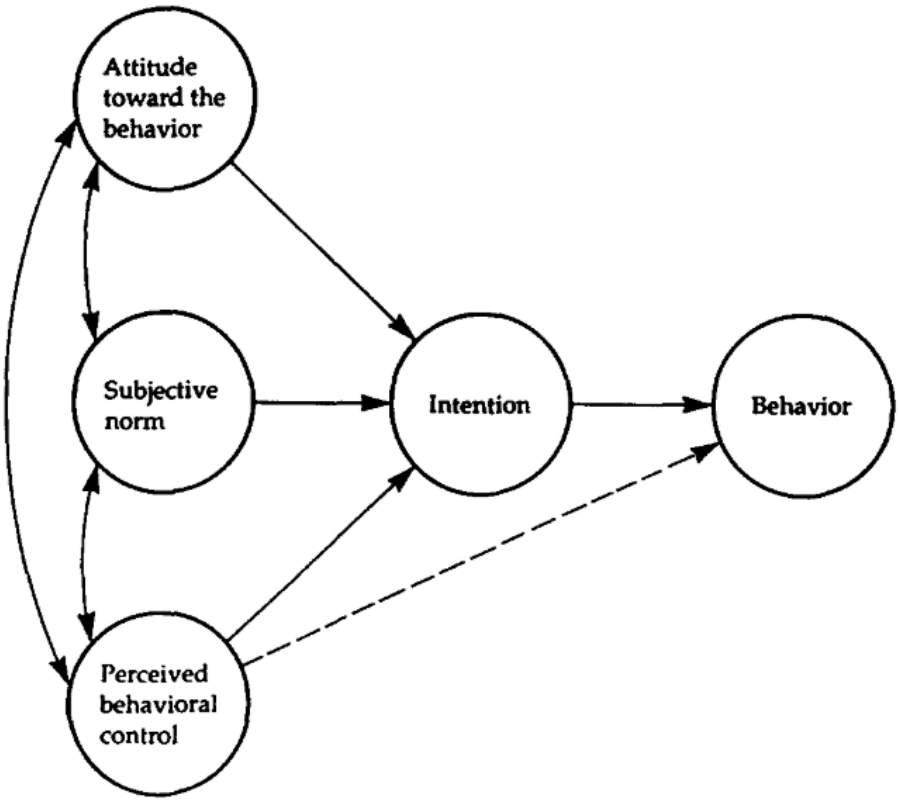

Figure 2.0 Theory of Planned Behaviour (Ajzen, 1991)

Foth (2016) employed the TPB. The author tested the TBPs' determinants, i.e., attitude, subjective norms and perceived behavioural control, to measure the employees' intention to adhere to the data protection regulations. They surveyed hospital employees to determine the most critical factors determining their intention to adhere to the data protection regulations. Their outcomes revealed that attitude, subjective norms and perceived behavioural control significantly influence employees' intention to comply with the data protection's regulations. They also found a significant difference between genders in their compliance with the regulations.

TPB was not selected as the base theory of this study because it ignores significant individual factors that may significantly affect employees' acceptance of blockchain. These

factors, for instance, include Performance Expectancy (PE), Effort Expectancy (EX) and Facilitating Conditions (FC), among others. Moreover, the attitude toward the behaviour of using blockchain (the investigated technology of this study) is not of interest in this study, as blockchain is still not accessible for most employees in HEIs in KSA. Therefore, TPB is disregarded in this study.

2.5.5 Technology Acceptance Model

Davis (1985) introduced TAM to accomplish two aims. The first aim is to increase the comprehension of the user's acceptance. The second aim is to provide a theoretical methodology that practically tests the user acceptance of a technology. In other words, their methodology aimed to provide the technology designers and executers the ability to assess the new system before it is formally carried out (Davis, 1985). According to Davis (1989), TAM is based on two main constructs, i.e., perceived usefulness and perceived ease of use (Figure 3.0).

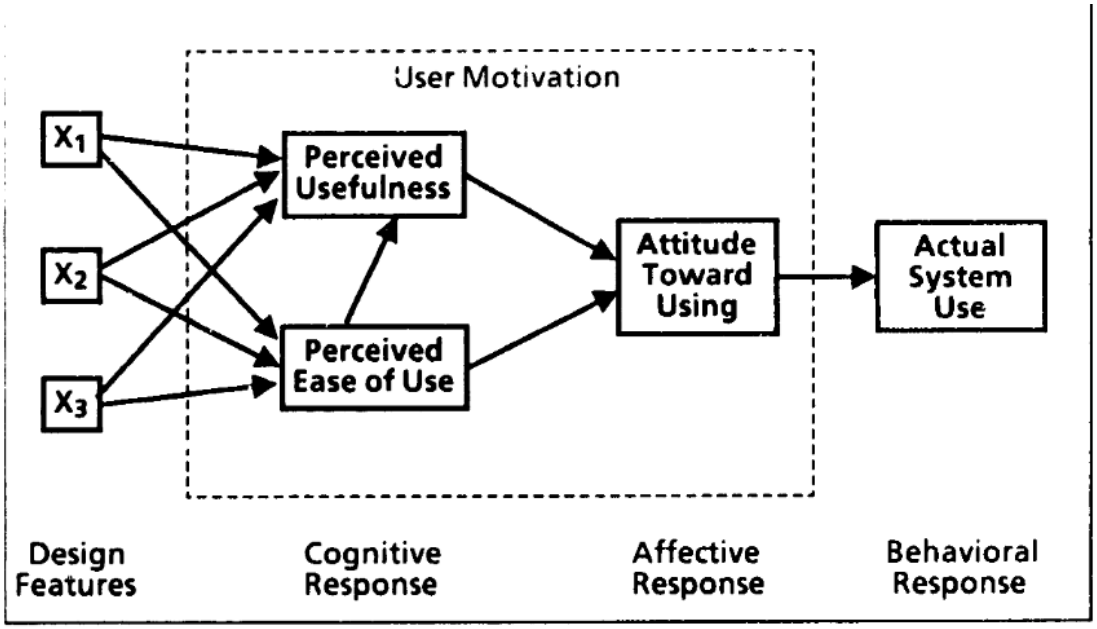

Figure 3.0 Technology Acceptance Model (Davis, 1985)

Numerous recent papers have built their models based on TAM (e.g., De Guinea et al., 2014; Lowry et al., 2013; Brandon-Jones & Kauppi, 2018). By selecting Brandon-Jones and Kauppi (2018) study as an example, this study used TAM as a cognitive mechanism. Based on that, the authors examined the role of employees' user perception of diverse viewpoints of e-procurement. The authors extended the TAM framework by examining five variables, namely, processing, content, usability, training and professionalism. This study conducted a survey that included 139 employers who utilise e-procurement at a university located in the

Netherlands. Their result found that there is a significant relationship between the variables mentioned above and TAM antecedents. Moreover, they uncovered that the processing and usability variables have a more significant impact than the professionalism on TAM antecedents.

Regardless its importance and applicability, TAM is not implemented in this study. TAM has been investigated a lot in blockchain and HEIs literature and other theories require more investigation (Alshamsi et al., 2022; Taherdoost, 2022; Xue, 2024). For instance, Alshamsi et al. (2022) suggest using UTAUT instead of TAM to investigate blockchain. Moreover, TAM has less coefficient of determination than UTAUT, yielding to the implementation of UTAUT in this study rather than TAM (Venkatesh et al., 2003). TAM is one of the used theories to develop UTAUT, yielding the latter to potentially develop a more comprehensive relationship related to blockchain adoption. Therefore, this study disregards the use of TAM to apply the UTAUT.

2.5.6 Technology-Organisation-Environment

Tornatzky and Fleischer introduced the TOE framework in 1990. They identified three main organisational elements that describe an institution's behaviour while intending to adopt a new technology. The elements consist of technological, organisational and environmental contexts, which are applicable on a firm level (see Figure 4.0) (Tornatzky & Fleischer, 1990; Oliveira & Martins, 2010).

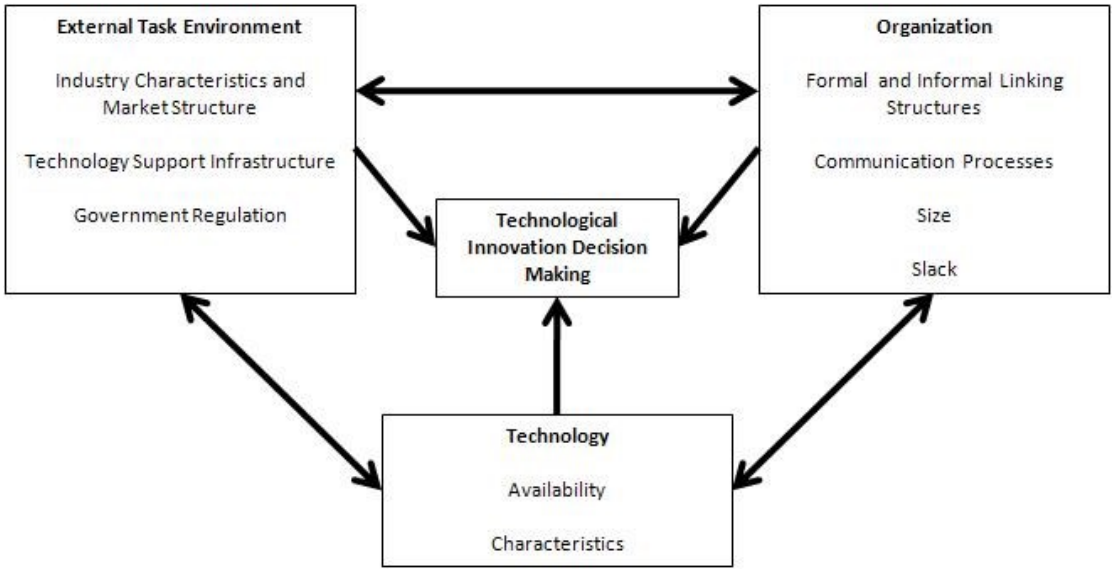

Figure 4.0 Technology-Organisation-Environment Framework (Tornatzky & Fleischer, 1990)

Multiple studies have based their models on TOE, which is considered one of the most utilised frameworks in literature, especially for the organisational level (Oliveira & Martins,

2010; Clohessy et al., 2020). For instance, Picoto et al. (2014) examined the value of mobile technologies for firms. The authors integrated TOE, DOI and Resource-based theories to build their conceptual model. The models assess the post-adoption phases to determine the usability and value of mobile technologies for organisations. The model consists of technological factors, organisational factors and environmental factors. The determinants of the technological factors are relative advantage, compatibility, and complexity. Organisational factors include technology competence, technology integration, and managerial obstacles. The environmental factors are competitive pressure, partner pressure, and mobile environment. This authors' methodology follows a mixed-method approach. They conducted interviews to assess mobile technology usage in organisations, and then 180 organisations, based on Portuguese, were utilised to test the conceptual model. Their outcomes detect that 'relative advantage, technology competence, technology integration, managerial obstacles, competitive pressure, partner pressure and mobile environment are significant antecedents of m-business usage' (Picoto et al., 2014, p.580).

TOE is not used in this study due to its ignorance of the individual characteristics, which are the main focus of this study.

2.5.7 Unified Theory of Acceptance and Use of Technology

Aiming to unify the view toward technology user acceptance, Venkatesh (et al., 2003) proposed UTAUT. The authors identified ‘PE, EX, Social Influence (SI) and FC’ (p.447) as the constructs that are directly associated with individuals’ acceptance and utilisation behaviour (see Figure 5.0).

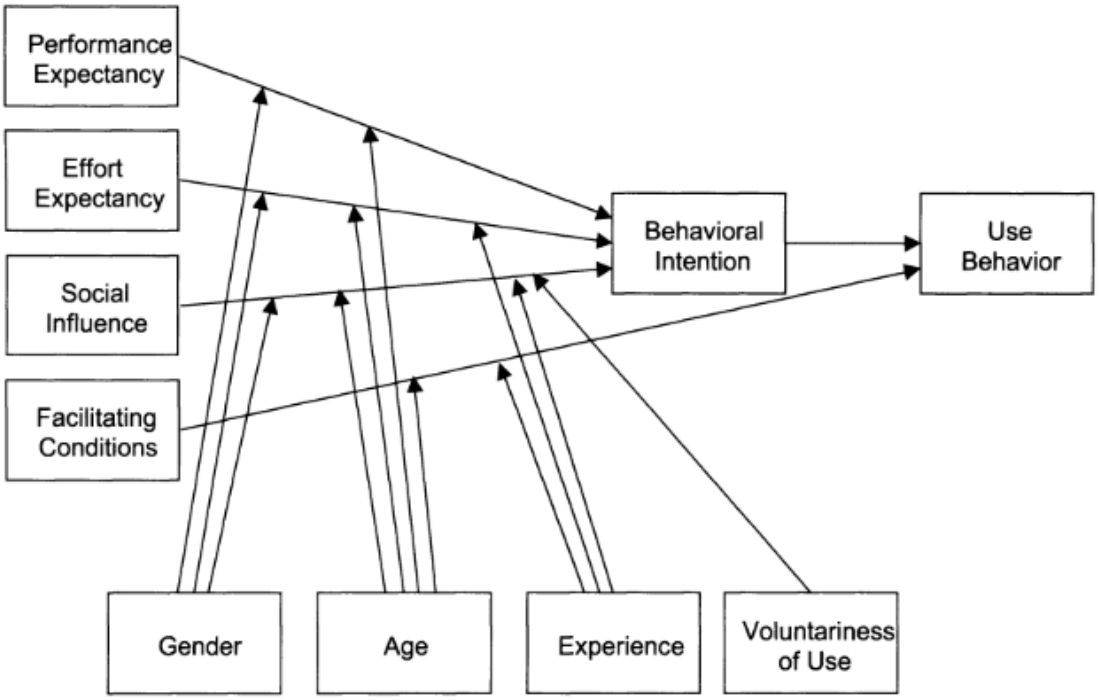

Figure 5.0 Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003)

Measuring technology acceptance by employing UTAUT as the underpinning theory has been utilised in various sources (e.g., Niehaves & Plattfaut, 2014; Warkentin et al., 2017). For instance, Niehaves and Plattfaut (2014) aimed to identify the factors that influence elderly users' behaviour to use Internet. The authors built their framework based on the UTAUT and other three models. Their primary constructs are attitudinal beliefs, normative beliefs, and control beliefs. The attitudinal beliefs consist of applications for personal use, utility for children, utility for work-related use, application for fun and status gains. The normative beliefs construct contains influences from friends and family, secondary sources' influences, and workplace referents. Lastly, control beliefs covers fear of technological advances, cutting-off cost, perceived ease of use, and self-efficacy. The authors' findings confirm significant relationships among all proposed constructs. Additionally, they show that people aged 65≥ are more resistant to Internet use. Moreover, the authors found that UTAUT and the Model of Adoption of Technology in Houseland can interpret more than 70% of the differences in intention to adopt the Internet.

Among all the existing technology acceptance models that the author is aware of, UTAUT is the most appropriate model to investigate blockchain acceptance among administrative and academic staff in the HEIs in KSA. Further discussion in Section 2.6.1 to justify the selection of UTAUT in the present study.

In summary, Table 3.0 represents the above-mentioned theories and frameworks and their antecedents.

Table 3.0 Existing Theoretical Frameworks

Theory/framework	Author(s)	Antecedents	Authors(s)
DOI	Rogers (2003)	Relative advantage, compatibility, complexity, triability and observability	Lin et al. (2021)
TRA	Fishbein and Ajzen (1975)	Attitude toward behaviour and subjective norm.	Wu (2012)
TPB	Ajzen (1985)	Attitude toward behaviour, subjective norm, perceived behavioural control and actual behaviour.	Foth (2016)
TAM	Davis (1985)	Perceived usefulness, perceived ease of use, attitude toward using and actual use.	De Guinea et al., (2014); Lowry et al., (2013); Brandon-Jones and Kauppi, (2018)
TOE	Tornatzky and Fleischer (1990)	Organisational, Technological, Environmental factors.	Oliveira and Martins, (2010); Clohessy et al., (2020); Picoto et al. (2014)
UTAUT	Venkatesh et al. (2003)	PE, EX, SI and FC	Warkentin et al. (2017); Niehaves and Plattfaut (2014)

Table 3.0 described the above-mentioned theoretical models and their authors. Among these models, the underlying model for this study is the UTAUT.

2.6 Theoretical Lens

This section explains and justifies the development of the conceptual framework of the current study. The previous section (2.5) critically discussed significant previous technology acceptance frameworks. Accordingly, this section discusses the selection of this study's underpinning theory (i.e., UTAUT). It also presents and justifies the determinants that extend

UTAUT. Consequently, the hypotheses are carefully developed and then proposed in this section. The phases of developing a new conceptual model are as follows:

Phase one: Justifying the selection of the UTAUT model.

Phase two: Determining the added variables to the UTAUT.

Phase three: Hypotheses development.

2.6.1 Justifying the Selection of UTAUT

The first factor in choosing UTAUT is the high variance on the dependent variable. As noted above, this study proposes a conceptual framework based on UTAUT, which was initially introduced by Venkatesh et al. (2003). In UTAUT, the authors (Venkatesh et al., 2003) established the fundamental antecedents based on eight technology acceptance models established before the UTAUT. The authors' empirical investigation demonstrated substantial evidence of the validity of UTAUT. The variance of the UTAUT antecedents on BI in Venkatesh and others' study was the highest. While the UTAUT had a 70% variance on BI, the remaining models' variance ranged between 17-53% in the behavioural intention to use technologies (Venkatesh et al., 2003). These models include social cognitive theory, innovation diffusion theory, model of PC utilisation, TPB and TAM (Venkatesh et al., 2003). Hence, the higher variance is the first reason for selecting UTAUT as the underpinning theoretical model in this study.

Moreover, UTAUT is more appropriate for investigating new technologies at different times (Venkatesh, 2022; Venkatesh et al., 2016). UTAUT is more suitable for this advanced era as it could boost framework development more efficiently (Kaushik & Verma, 2020). Besides, earlier studies have selected the UTAUT as the foundation model in their investigation of blockchain in various sectors (e.g., Sarnacchiaro et al., 2024) and the HEI sector for other technologies (e.g., Shah et al., 2024). Further review is represented in Section 2.6.3.

There are other factors contributed to the selection of UTAUT in this study. These factors were stated in Venkatesh et al.'s (2016) paper. The authors found scholarly articles that have applied UTAUT to investigate various types of technology users (e.g., employees, students, customers, and others). Specifically for employees, UTAUT is a more suitable framework for studies that consider workplace situations (Sneesl et al., 2022). Indeed, UTAUT assists in attaining a more comprehensive understanding of the factors that affect their acceptance of blockchain among employees (Queiroz & Fosso Wamba, 2019). Thus, the present study investigates administrative and academic employees in HEIs where the UTAUT

choice is more rational. Furthermore, Venkatesh et al. (2016) found that previous studies had utilised the UTAUT in different industries, such as HEIs and healthcare. This finding indicates the applicability of UTAUT to the targeted industry of this study (i.e., HEIs). Indeed, Xue et al. (2024) recommended using UTAUT, particularly for HEIs settings, as it is a functional theory to predict technology adoption in HEIs. Moreover, UTAUT assists in investigating various periods of adoption, which is an additional supportive perspective for selecting UTAUT, as it could be applied before, during and after the adoption of a particular technology (e.g., blockchain) (Venkatesh et al., 2016). Ultimately, the UTAUT has been implemented in various contexts, including KSA (e.g., Al-Mamary, 2022), which reflects the identical context of the present study.

Thus, the selection of UTAUT is mainly due to its coverage of this study's dimensions. UTAUT is suitable for investigating blockchain, employees, prior adoption conditions and the country (KSA). Therefore, this study uses UTAUT as the base model of the proposed framework.

2.6.2 Discussing the Selected Variables

UTAUT is a model that enables the investigation of acceptance toward a specific technology among a group of individuals. Nonetheless, it needs to be extended to test users' perceptions of a technology's characteristics, such as blockchain (Venkatesh, 2022). In other words, UTAUT initially did not involve the investigation of perceptions related to a particular technology (e.g., security of blockchain) (Norbu et al., 2024). For instance, the blockchain is proposed to be a more secure technology (Dwivedi & Vig, 2024). However, it is unclear whether security of blockchain affects its acceptance among employees. Fortunately, characteristics like security can extend UTAUT (Venkatesh, 2022). According to Venkatesh (2022) 'one of the most fruitful and important avenues leveraging UTAUT as a theoretical basis is to examine antecedents/determinants that are tailored to the particular technology' (p.647). Thus, it can be observed that the perception of the effect of specific characteristics of blockchain technology can extend UTAUT. In other words, privacy, security, trust and awareness are not considered in UTAUT; yet, it can extend it (Norbu et al., 2024; Venkatesh, 2022). Accordingly, there is a need to consider adding individual constructs that are related to blockchain, whereby the perceptions of employees toward these constructs may affect their acceptance of blockchain. Thus, with the endorsement of UTAUT, the perception of blockchain characteristics, i.e., privacy, SEC and trust along with AW will be investigated with the UTAUT's initial constructs in this study.

In more detail, by leveraging UTAUT in this study, the individual perceptions of blockchain features (privacy, security and trust along with AW) are added to UTAUT to determine individual drivers and hindrances among HEIs' employees in KSA. Previous theories, such as TOE, have included technology characteristics in their original model (see 2.6.5), which underpins investigating the effect of individual characteristics relevant to blockchain to investigate the intention of using blockchain. Further, previous empirical studies have employed individual characteristics that are related to a specific technology within their modified models, especially to measure the intention to use a technology (e.g., Sari et al., 2019; Wang et al., 2016; Mansoor et al., 2023). Thus, investigating the individual characteristics related to a specific technology to determine individuals' acceptance of that technology is significant. Therefore, this study employs the individual attributes related to blockchain to extend the UTAUT model.

The individual perceptions of blockchain characteristics are added to UTAUT in this study in three main phases. In phase one, the elements of blockchain have been selected based on the agreement of previous sources that have been applied widely in relevant articles that are relevant to this study (see Table 2.0). Phase two affirms that these characteristics partially or entirely exist in the current use cases of blockchain in the education industry (see 2.2.1). Previous reviewing papers were utilised in phase three to confirm the selected features and test the relationship between the determined attributes and blockchain acceptance (Loukil et al., 2021; Alammary et al., 2019; Ocheja et al., 2022; Arndt, 2018; Xue et al., 2024). These three phases lead to the selection of security, privacy, trust and AW as additional factors that lead to blockchain acceptance among HEIs' employees.

Based on Venkatesh et al. (2016), UTAUT could be extended in three main ways, which are as follows:

1. *New Exogenous Mechanisms* reflect the effects of external determinants on the UTAUT's exogenous constructs (i.e., PE, EX, SI, and FC). For instance, Neufeld et al. (2007) surveyed 209 employees in seven firms which were significantly involved in adopting technologies. They found that charismatic leadership was positively associated with 'increased PE, EX, SI and facilitating condition perceptions of users' (Neufeld et al., 2007, p.494).

2. *New Endogenous Mechanisms* reflect the effect of new determinants on two endogenous variables, which are part of the UTAUT. The two variables are BI and use behaviour. Also, this method reflects the enrichment of the PE, EX, SI, and FC (New Exogenous determinants) in addition to the new endogenous determinants. For instance, Venkatesh et al. (2008) examined a new factor, i.e., the behavioural expectation on technology

utilisation. Likewise, Eckhardt et al. (2009) added five new constructs, which stem from the source of influence, to enrich the SI construct (from UTAUT). These five new constructs examined whether the colleagues were from the same section, operating section, IT section, customers and superiors.

3. *New Moderating Mechanisms* reflect new moderating determinants added to the UTAUT constructs. These mechanisms include the moderation of newly added connections. For instance, Venkatesh et al. (2008) examined the moderating role of experience on the impact of FC on BI.

4. *New outcome mechanisms* reflect new constructs added beyond the technology use to examine a new result. For instance, individual performance construct could be added after the actual technology usage.

The following Figure illustrates the four previous types of UTAUT extensions in previous studies.

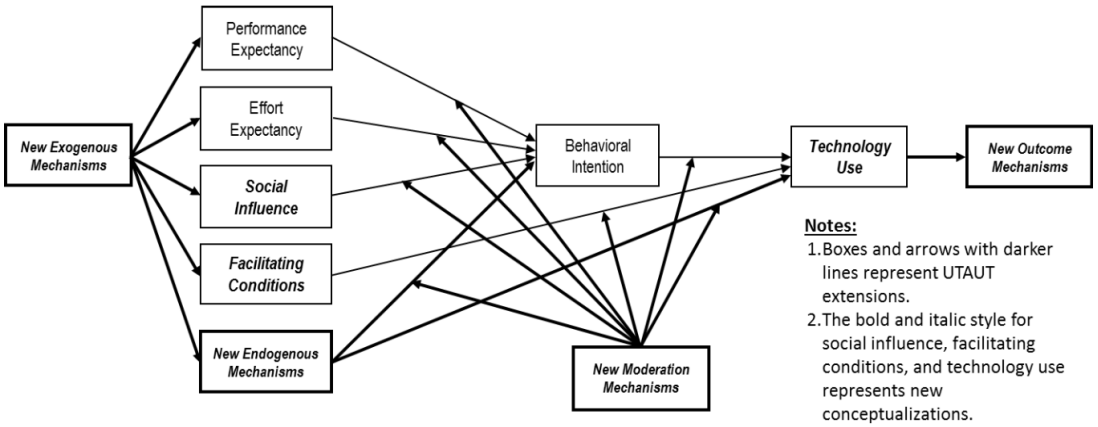

Figure 6.0 Methods to Extend UTAUT (Venkatesh et al., 2016)

Based on Figure 6.0 by Venkatesh et al. (2016), new Exogenous, new Endogenous and new Moderating mechanisms are formulated in this study to build determinants derived from the characteristics of blockchain. Also, following the previous Figure leads to modifying UTAUT's main exogenous variables by correlating them with exogenous variables (i.e., SEC and trust). This modification alters some UTAUT variables to be endogenous and exogenous variables at the same time. For instance, PE is an exogenous variable hypothesised to affect employees' BI to use blockchain. Meanwhile, it is an endogenous variable as it is hypothesised to be affected by other variables in this study's proposed framework. This example applies to EX.

In more detail, this study investigates the alignment between individual perceptions related to blockchain and UTAUT antecedents. Precisely, the perceptions of blockchain-related factors (i.e., privacy, security, trust and AW) are predicted to relate directly to UTAUT

antecedents (i.e., PE, EX and/or BI). Meanwhile, UTAUT antecedents (PE, EX, SI and FC) are expected to directly influence employees' acceptance of blockchain. The proposed relationships are expected to create implicit single and multiple mediation. For instance, paths involving PE and EX are expected to mediate the trust and SEC effects on blockchain acceptance. Trust is also anticipated to function as an exogenous and endogenous variable. Trust will be an endogenous variable, as it is assumed to be affected by the security-privacy factor. This endogenous role is expected to create single and multiple implicit mediation paths of trust between the security-privacy variable and BI. The mediating effects are further explored in following sections. The main point is that PE, EX, and trust are treated as endogenous and exogenous variables at the same time (Venkatesh et al., 2016; Lee, 2023; Kumari et al., 2023).

This study does not correlate the individual characteristics related to blockchain (i.e., privacy, security and trust) with the FC and SI due to the illogical correlations between the individual characteristics and these two variables. For instance, it is unclear how trust will be directly affecting social influence, which in turn, might affect the behavioural intention. Similar ambiguous relationships in previous literature regarding the direct affect of trust on facilitating condition, which in turn, presumed (based on UTAUT) to directly affect the behavioural intention. Therefore, the mediating relationship for SI and FC betweeb trust and behavioural intention is unclear. This example applies to the direct effect of SEC on SI and FC. Moreover, no solid theoretical background has been found to develop new hypotheses for these relations. Thus, no correlations are anticipated between added SEC and trust with FC and SI In other words, FC and SI do not mediate the relationships between SEC and trust.

Concerning its role, AW has been established as an exogenous and moderator variable at the same time because blockchain is still considered an emerging technology. AW of blockchain is still in its infancy stages among the public in KSA (Mansoor et al., 2023; Zhang et al., 2023; Adaryani et al., 2024). This study examines AW as an exogenous factor that influences BI directly. Further, it examines AW as a moderating factor against UTAUT determinants. One construct's dual role (exogenous and moderating roles) has been applied previously in the adoption field (e.g., Yang, 2017). Thus, AW is investigated as an exogenous and moderating role in this study.

The proposed framework of this study does not utilise the UTAUT moderators (i.e., gender, age, experience and voluntariness of use), which were proposed in the original model, similar to previous studies (e.g., Yogesh K Dwivedi et al., 2017; Queiroz & Fosso Wamba, 2019). However, this study's framework tested their effects pertinent to the proposed relationships per subgroup separately through Multi-Group Analysis (MGA) approaches (see

Section 3.5.2). A justification for the exclusion of UTAUT explained by Dwivedi et al. (2019). The authors suggested that the UTAUT moderators should be reconsidered, suggesting removing them. They claimed that these moderators are not widely accepted in previous studies. In other words, the previous studies typically neglect the original moderators of UTAUT. A similar Observation was conducted by Venkatesh et al. (2012) when he proposed UTAUT2. This study follows these studies by removing the original moderators of UTAUT. A common potential reason for dropping the UTAUT moderators from further investigations is the possibility of no variation in the moderators for the adoption context (Dwivedi et al., 2019; Alazab et al, 2021). This presumption of the potential of the lack of variance in behavioural intention to adopt blockchain is another reason for the omission of these moderators. Therefore, this study removes UTAUT original moderators.

In addition, AW does not moderate security and trust due to the lack of theoretical background supporting AW as a moderating variable between security and trust and BI. Thus, the lack of theoretical development leads to neglecting the possibility of these relations (Hair et al., 2021; Hair et al., 2022). Finally, the usage behaviour construct is disregarded in this study because blockchain technology is not widely implemented in Saudi HEIs (Nguyen et al., 2023). Therefore, the only implemented moderator is AW, while the UTAUT initial moderators are analysed differently as categorical variables through MGA.

In summary, the designated factors for the current study are PE, EX, SI and FC (derived from UTAUT). Moreover, security-privacy, AW and trust determinants are selected due to their association with the characteristics of blockchain. The constructs of these studies are divided into exogenous, endogenous and/or moderating variables. As one function, FC, security-privacy and SI factors are exogenous variables. The BI to use blockchain is an endogenous variable only. However, PE, EX, and trust are exogenous and endogenous variables at the same time (implying a mediating effect). Another dual role concerns AW. In addition to its exogenous role, AW moderates the correlation between UTAUT antecedents and intention to use blockchain. Succinctly, privacy-security, FC and SI (as exogenous variables), PE, EX and trust (as an endogenous and exogenous variable) and AW (as exogenous and moderating variables) are the main variables to test the acceptance of blockchain among HEIs' employees in Saudi Arabia (For more clarification, see Figure 6.0). These variables are reviewed in previous studies in the following section.

2.6.3 Review of UTAUT in Research

This section reviews existing studies whereby UTAUT was the underlying model in the blockchain and HEIs, separately. The other models are disregarded from this review since no

other framework covers all the UTAUT constructs and involves additional constructs. In other words, this review is related exclusively in UTAUT, which led to discussing the following literature after introducing UTAUT. UTAUT's unique set of antecedents implies that investigating UTAUT's constructs yields unique findings that cannot be found when applying other models. Hence, gaps within the UTAUT model are inevitably gaps in other models. Therefore, this review focuses only on studies that employed UTAUT as their underlying construct. Also, the security, trust and AW, as additional individual characteristics, are reviewed in relation to UTAUT in this section.

The following sections and subsections contain studies that have employed UTAUT to investigate blockchain adoption in various industries (not only HEIs) (See Appendix B, Table B1). Further, the following sections involve journal articles that have used the UTAUT in the HEI sector to investigate different technologies (not only blockchain) (See Appendix B, Table B2). Subsequently, a review of studies is presented based on the participants who are related to the HEIs industry (e.g., administrative staff and academics). Finally, a review of studies that were conducted in KSA based on UTAUT and in the HEI sector is presented in the following section.

The aim of this review is to highlight the gaps that will be addressed in this study. The gaps will be demonstrated at the end of each main section based on statistics that were drawn from the reported articles. A summary of the articles' findings is added in the appendices. For instance, blockchain adoption, regardless of the industry is reported in Appendix B, Table B3, technology adoption in HEIs regardless of the technology can be observed in Appendix B, Table B4, the findings related to participants are exhibited in Appendix B, Table B5, and papers were conducted in KSA are summarised in Appendix B, Table B6. Based on these reported findings, the statistics are exhibited at the bottom of every subsection to identify the gaps.

Therefore, the following subsections discuss the studies that have used UTAUT to primarily investigate blockchain in various industries, various technologies in the HEIs, related participants and the KSA context. Subsequently, this study identifies the covered gaps.

2.6.3.1 Blockchain Technology in Various Industries

2.6.3.1.1 Supply Chain

In the SC discipline, multiple studies have found significant relationships when employing UTAUT. For instance, some have uncovered significant and positive relationships between PE and BI to use blockchain in SC management (Kabir et al., 2021; Pieters et al., 2022; A. Sharma et al., 2023; Mukherjee et al., 2023; Adaryani et al., 2024; Queiroz & Fosso

Wamba, 2019; Alazab et al., 2021; Nguyen et al., 2023). Additionally, a considerable number of the found studies reported EX to significantly and positively affect the acceptance of the use of blockchain (Kabir et al., 2021; Zhang et al., 2023; Vijh et al., 2023; Adaryani et al., 2024; Queiroz et al., 2021; Alazab et al., 2021). Some of the discovered studies revealed that SI significantly and positively influences blockchain acceptance (Pieters et al., 2022; Zhang et al., 2023; A. Sharma et al., 2023; Adaryani et al., 2024; Queiroz et al., 2021; Alazab et al., 2021). Queiroz and Fosso Wamba (2019) found SI to significantly impact BI to use blockchain in India only. Concerning the FC, as part of the original UTAUT, some of the studies within SC realm have demonstrated that FC significantly affects the BI to use blockchain (Kabir et al., 2021; Pieters et al., 2022; Zhang et al., 2023; A. Sharma et al., 2023; Queiroz et al., 2021; Alazab et al., 2021), other scholarly literature has not found significant impact (Figueiredo et al., 2023; Adaryani et al., 2024; Nguyen et al., 2023). Oppose to SI, Queiroz and Fosso Wamba (2019) found FC to significantly affect blockchain acceptance in the USA only. Some studies in the SC industry added trust to UTAUT, yielding a variety of results. Some scholars have found trust to significantly influence the behaviour intention to use blockchain (Kabir et al., 2021; Queiroz et al., 2021; Latif & Zakaria, 2020).

However, other studies have recognised some of the above-mentioned relationships as insignificantly impacting blockchain intention to use blockchain in the SC sector. PE was discovered to be insignificantly related to the BI to use blockchain among few studies (Queiroz et al., 2021; Figueiredo et al., 2023; Zhang et al., 2023; Wong, Tan et al., 2020). In addition, other studies in the SC sector have found insignificant results of EX on the behaviour to use blockchain (Wong, Tan et al., 2020; Figueiredo et al., 2023; Pieters et al., 2022; Nguyen et al., 2023). Some of the discovered studies revealed that SI significantly and positively influences blockchain acceptance (Pieters et al., 2022; Zhang et al., 2023; A. Sharma et al., 2023; Adaryani et al., 2024; Queiroz et al., 2021; Alazab et al., 2021). In addition, extant studies reported SI to insignificantly impact the blockchain acceptance (Wong, Tan et al., 2020; Figueiredo et al., 2023; Kabir et al., 2021; Nguyen et al., 2023). Queiroz and Fosso Wamba (2019) found SI to insignificantly affect BI to utilise blockchain in the USA only. Queiroz and Fosso Wamba (2019) found FC to be insignificantly affecting blockchain acceptance in India. Few journal articles empirically tested the impact of trust on BI to use blockchain in the SC sector, finding an insignificant impact. (Zhang et al., 2023; Wong, Leong, et al., 2020)

Therefore, studies in the SC sector have various findings as a result of implementing UTAUT antecedents and BI.

2.6.3.1.2 Accounting and Finance

Extant studies have examined BI to use blockchain by applying UTAUT in accounting and financial-related settings. Combining them in the same category is due to their complementary rule in HEIs' financial procedures and outcomes (e.g., profitability) (Morshed, 2020).

Some studies have found various results regarding the effect of PE on the BI to use blockchain. A considerable number of these studies have found PE to be significantly related to blockchain acceptance (Mansoor et al., 2023; Kumari et al., 2023; Jena, 2024; Abu Afifa et al., 2023; Jena, 2022; Ferri et al., 2021; Sham et al., 2023; Mokthar & Sapuan, 2023). Moreover, two studies have investigated the relationship between EX and PE, and both find a significant and direct effect between the two constructs (Kumari et al., 2023; Abu Afifa et al., 2023). Furthermore, several journal articles concerning financial and accounting sectors have found EX to significantly affect blockchain acceptance (Mansoor et al., 2023; Abu Afifa et al., 2023; Ferri et al., 2021; Bakri et al., 2023; NAZIM et al., 2021; Sham et al., 2023). Additionally, existing studies in relevant disciplines have represented SI to be significantly influencing BI to use blockchain (Kumari et al., 2023; Abu Afifa et al., 2023; NAZIM et al., 2021; Ferri et al., 2021; Sham et al., 2023; Mokthar & Sapuan, 2023). Another UTAUT construct is the FC, which was found in some studies to significantly and positively affect blockchain acceptance (Mansoor et al., 2023; Jena, 2024, 2022; NAZIM et al., 2021; Mokthar & Sapuan, 2023). Trust has been found to be significantly related to the BI to use blockchain. This significance exists in all the found literature (Mansoor et al., 2023; Kumari et al., 2023; Jena, 2024; Abu Afifa et al., 2023). Similarly, Abu Afifa et al. (2023) found trust to significantly and positively affect the PE and EX. Additionally, Kumari et al. (2023) found AW to significantly moderate the relationship between PE and BI.

In comparison, other demonstrated insignificant relationships between UTAUT constructs and blockchain adoption in financial-related settings. For instance, a couple of studies acquired an insignificant effect of PE on blockchain adoption (Bakri et al., 2023; NAZIM et al., 2021). Other studies highlighted EX to have an insignificant impact on behavioural acceptance in the relevant fields (Kumari et al., 2023; Mokthar & Sapuan, 2023). Moreover, two journal articles have found SI to have an insignificant impact on BI to use blockchain in the same sector (Mansoor et al., 2023; Bakri et al., 2023). Regarding its effect, FC was concluded in previous avenues to have an insignificant impact on BI (Kumari et al., 2023; Bakri et al., 2023; Abu Afifa et al., 2023; Jena, 2022; Sham et al., 2023).

Therefore, studies in the finance and accounting-related sectors have various results regarding UTAUT construct, excluding trust. Trust has been collectively agreed to be significantly affecting the intention to use blockchain in the finance and accounting themes.

2.6.3.1.3 Few Studies in Various Disciplines

This subsection regards a single or a couple of scholarly article(s) conducted in a single sector using UTAUT as their underlying model. These disciplines include Gamification (Vorobeva et al., 2023), Human Resource Management (Vijh et al., 2023), e-commerce platforms (Jain et al., 2022), small and medium-sized enterprises (SMEs) (Khazaei, 2020), public sector (Latif & Zakaria, 2020), big data (Abdullah Sani et al., 2021), healthcare (Altamimi et al., 2024), tourism (Sarnacchiaro et al., 2024; Chang et al., 2022) and media (Y. Wang et al., 2023; Pham & Thi Nguyet, 2023).

Regarding the relationship between PE and BI to use blockchain, some of these studies have found a significant relationship between the two latent variables (Jain et al., 2022; Khazaei, 2020; Latif & Zakaria, 2020; Abdullah Sani et al., 2021; G. Wang et al., 2023; Sarnacchiaro et al., 2024; Chang et al., 2022). A cluster of scholars has found the EX to significantly impact the BI to use blockchain (Vorobeva et al., 2023; Vijh et al., 2023; G. Wang et al., 2023; Pham & Thi Nguyet, 2023; Sarnacchiaro et al., 2024; Chang et al., 2022). In addition, some of the detected studies have highlighted SI to significantly influence the BI to use blockchain in various industries (Khazaei, 2020; Latif & Zakaria, 2020; Vorobeva et al., 2023; Vijh et al., 2023; Altamimi et al., 2024; Sarnacchiaro et al., 2024). Regarding FC, several studies have found it to be significantly affecting the BI to use blockchain (Pham & Thi Nguyet, 2023; Vijh et al., 2023; Jain et al., 2022; Altamimi et al., 2024; Sarnacchiaro et al., 2024; Chang et al., 2022). Moreover, trust has been demonstrated to significantly affect the BI to use blockchain (Vorobeva et al., 2023; Khazaei, 2020; Latif & Zakaria, 2020; Abdullah Sani et al., 2021; Sarnacchiaro et al., 2024). Relatedly, trust in the tourism industry has been found to significantly affect the PE (Sarnacchiaro et al., 2024; Chang et al., 2022) and EX (Chang et al., 2022). Regarding security, Chang et al. (2022) and Sarnacchiaro et al. (2024) have found it to significantly affect the PE of blockchain in the tourism industry. Besides, it has been found in the tourism sector that security significantly impacts trust in blockchain use (Sarnacchiaro et al., 2024). Likewise, security was found to be significantly influencing EX directly (Chang et al., 2022). Security has also been found to significantly affect the BI use of blockchain technology in SMEs and tourism areas (Khazaei, 2020; Chang et al., 2022).

In comparison, other studies have presented the effect of PE on BI as insignificant (Vorobeva et al., 2023; Vijh et al., 2023; Pham & Thi Nguyet, 2023). Similarly, a group of scholars has obtained an insignificant result between EX and BI (Jain et al., 2022; Khazaei,

2020; Latif & Zakaria, 2020; Altamimi et al., 2024). Moreover, two found studies have revealed an insignificant relationship between SI and BI (Jain et al., 2022; Chang et al., 2022). Likewise, two studies have found FC to be indirectly related to BI to utilise blockchain (Vorobeva et al., 2023; Latif & Zakaria, 2020). Moreover, trust has been found to be insignificantly related to BI in one study. Finally, according to Khazaei (2020), AW of blockchain is insignificantly related to BI in SMEs.

Hence, UTAUT constructs have had varied results in terms of their significant relationships with BI. Moreover, few studies have investigated trust, security and AW.

2.6.3.1.4 Multiple Industries for Each Study

Finally, two studies were found to investigate multiple industries in a single study by employing UTAUT as their underpinning theory. In exploring various Italian firms, Caldarelli et al. (2020) found PE, EX, SI and FC to significantly influence the blockchain acceptance. Lee (2023) investigated only one direct relationship of UTAUT constructs on BI to use blockchain technology, i.e., PE on BI. The other relationships were mediated by opportunity recognition. The author found blockchain acceptance to be significantly and directly affected by PE. Also, they found that the BI to use blockchain was indirectly affected by SI, EX and FC (mediated by opportunity recognition). Therefore, besides the little and general evidence, the two studies have similar results, yielding a direct-significant effect of PE on BI to use blockchain among various industries.

2.6.3.1.5 Research Gap of Blockchain Adoption in Various industries

Thirty-seven scholarly studies, in total, have been found to investigate the adoption of blockchain technology in various industries based on UTAUT as their underlying theory (See Appendix B, Table B3).

In their examination of UTAUT's main antecedents, 33-35 studies have hypothesised the effects of PE, EX, SI and FC on BI to use blockchain in various industries. This range is because some factors are dropped in some studies. This justification applies to the following ranges. Seven-teen studies have added trust to examine BI based on UTAUT.

In addition, 23-26 studies have found BI to be significantly impacted by PE, SI, FC, EX, and trust among various industries. Moreover, twelve studies have reported significant effect of trust on BI. Moreover, the findings revealed that PE has the highest significant rate (74.29%). In contrast, the lowest significant rate was related to the effect of EX on BI to utilise blockchain. The significant rates of SI, FC, trust and EX are 73.52%, 72.73% and 70.59, respectively, reflecting roughly close results.

In comparison, the effects of 1) EX on PE, 2) trust on PE, 3) trust on EX, 4) security on BI, 5) security on PE, 6) security on trust and 7) security on EX have been hypothesised in the same studies between 1-3 times only in extant studies. All the results have revealed significant findings in all these relationships.

Finally, one study only found a direct impact of AW on BI to use blockchain in relation to UTAUT. The study's findings yielded an insignificant relationship between AW and BI. Also, one study found AW to moderate the relationship between PE and BI to use blockchain.

As a result, this research proposes seventeen relationships. These relationships basically discuss UTAUT antecedents and individual characteristics related to blockchain technology that might affect blockchain acceptance. Only five of the seventeen relations have been investigated in extant studies more than three times. These five relationships concern the effects of PE, EX, SI, FC and trust on BI. The other 12 relationships proposed in this study have been investigated 0-3 times, producing an area of improvement to investigate the BI to use blockchain.

In addition, the other relationships that have been investigated more than three times have represented various results. For instance, EX has been found to affect blockchain adoption by only 65.71%. In other words, there is a potential for an insignificant impact of approximately 34%. This example, along with the other variables, opens a considerable possibility that significant results in previous studies to be insignificant results in the present study.

Therefore, this study contributes to the blockchain adoption area by investigating relationships that require more evidence. As these new relationships are expected to significantly shape academic and administrative employees' perceptions of blockchain adoption, they are examined in this study. In addition, this study will confirm or reject the contradictory results of UTAUT that have been investigated heavily in existing scholarly investigations.

2.6.3.2 Various Technologies within HEIs

This subsection reflects existing studies that have discussed the UTAUT constructs with various technologies in the HEI sector. Despite the inclusion of reviewing its characteristics, the blockchain technology is separate from this reviewing scope, as it is focused on the technology adoption in HEIs but not on a specific technology. This investigation is mainly derived from Xue et al. (2024). Nonetheless, other papers that are not part of their inclusion and exclusion criteria have been further investigated and included in this review.

Therefore, this review includes all the papers reported in Xue and others' (2024) article and additional scholarly articles for this research. The studies are classified based on the investigated technology. For instance, mobile learning technology is investigated independently in this review. Yet, it is acknowledged that there is an apparent overlap in the literature regarding various technologies such as Information Communication Technologies (ICT), Learning Management Systems (LMS), and e-learning. This study relies on the category of the paper itself. For instance, some papers consider e-learning to be part of LMS (e.g., Shah et al., 2024) or vice versa (e.g., Zacharis & Nikolopoulou, 2022), whereas others consider it under the ICT (e.g., Yakubu & Dasuki, 2019). The current research categorises these scholarly journal articles based on the paper's choice. The discussion starts with ICT followed by LMS, mobile learning, games, blended learning, AI and ends with other rarely investigated technologies.

2.6.3.2.1 ICT in General

Starting with its definition, ICT refers to various batches of technologies, including but not limited to the Internet, intranets, and other technologies (Gupta et al., 2008). Numerous studies have utilised UTAUT to investigate the BI to use ICT in HEIs.

Abnormally, all related studies have collectively demonstrated PE to have a significant impact on the BI to use ICT. The other UTAUT's constructs differ, as the results vary between significant and insignificant effects on BI to use ICT. For instance, several investigations have revealed insignificant effects of EX on BI (Rotar, 2023; Vasuthevan et al., 2024; Arif et al., 2018; Zacharis & Nikolopoulou, 2022). Similarly, SI was revealed to have insignificant correlation to BI in other avenues (Chen & Hwang, 2019; Yakubu & Dasuki, 2019). Finally, some studies have discovered that the FC to be irrelevant to ICT adoption (Rotar, 2023; Vasuthevan et al., 2024).

Therefore, all the studies have had mixed results besides PE. The latter variable has been collectively revealed to obtain a significant impact on BI to use ICT.

2.6.3.2.2 IC-related Technologies

This part reviews scholarly articles that have empirically implemented UTAUT to investigate precise ICTs in HEIs. This incorporates specific technologies that are asserted within the same articles to be under the umbrella of ICT. These technologies include Massive Open Online Courses (MOOCs), social media, and podcast learning in HEIs due to their relationship under the umbrella of ICT (Ma et al., 2022). To confirm, these technologies were not part of the ICT part due to being specific technologies, while the previous part was related to ICT in a general sense.

Starting with its impact, PE has been revealed to significantly affect the BI to use ICT-related technologies(Al-Rahmi et al., 2022; Kazemian & Grant, 2023; Edumadze et al., 2023; Lakhal et al., 2013; Mohan et al., 2020; Meet et al., 2022; Rahman et al., 2021; Tseng et al., 2022; Fianu et al., 2020; Giannakos & Vlamos, 2013; Durak, 2019). Relatedly, Hsu (2023) demonstrated PE to be significantly affecting BI in the existence the moderating effect, whereas this effect is insignificant without the moderating effect. Also, Lin et al. (2013) showed the effect of PE on BI to be significant among students. In addition, EX in the same context has been significantly related to BI (Al-Rahmi et al., 2022; Edumadze et al., 2023; Giannakos & Vlamos, 2013; Hsu, 2023; Lin et al., 2013; Rahman et al., 2021; Durak, 2019). Kazemian and Grant (2023) uncovered a significant sway of EX on BI in terms of contributive use. Concerning SI, multiple studies have revealed it to significantly affect BI to use MOOC, podcasting or social media technologies (Al-Rahmi et al., 2022; Edumadze et al., 2023; Hsu, 2023; Rahman et al., 2021; Tseng et al., 2022; Durak, 2019). In relevance, Kazemian and Grant (2023) determined SI to significantly affect BI in the consumptive use. Concerning FC, numerous studies have uncovered that it is significantly related to BI (Edumadze et al., 2023; Khechine et al., 2020; Lakhal et al., 2013; Meet et al., 2022; Rahman et al., 2021; Tseng et al., 2022; Durak, 2019).

Nevertheless, other studies have found some of UTAUT antecedents' effects on BI to be insignificant. Beginning with PE, existing research has reported this relationship to be insignificantly connected to behaviour intention (Altalhi, 2021; Khechine et al., 2020). Relatedly, Hsu (2023) highlighted PE to be insignificantly impacting BI without the moderating effect. Also, Lin et al. (2013) found the effect of PE on BI to be insignificant among academics. In addition, several studies have attained insignificant findings on the relationship between EX and BI (Altalhi, 2021; Fianu et al., 2020; Lakhal et al., 2013; Meet et al., 2022; Mohan et al., 2020; Tseng et al., 2022). In relevance, Kazemian and Grant (2023) showed that the EX is insignificantly related to BI in consumptive use. In addition, multiple studies have revealed SI to insignificantly affect BI (Altalhi, 2021; Giannakos & Vlamos, 2013; Khechine et al., 2020; Meet et al., 2022; Mohan et al., 2020). Relatedly, Kazemian and Grant (2023) reported SI to be insignificant in the contributive use. Finally, few studies have attained insignificant results in the relationship between FC and BI (Kazemian & Grant, 2023; Altalhi, 2021; Mohan et al., 2020).

Therefore, MOOCs, social media and podcast studies in the HEIs industry have shown diverse results aligned with UTAUT implementation.

2.6.3.2.3 LMS

In addition, multiple studies have utilised UTAUT as their overarching theory to investigate LMS technologies. LMS is a “server-based or cloud-based software programme containing information about users, course and content which provides a place to learn and teach without depending on the time and space boundaries” (Sharma & Vatta, 2013, p.1). This part comprises papers that partially or fully used the UTAUT as the underpinning theory to investigate the adoption of LMS technologies. Examples of LMS include Blackboard, ClassStart, XRM and Google Classroom (Kumar & Bervell, 2019; Thongsri et al., 2019). Also, this part excludes other relevant technologies such as mobile learning, massive open online courses (MOOCs), social media, and others, as they will be discussed independently following this part.

Starting with the PE, most of the located research has found it to significantly affect the BI to use LMS-related technologies (Zhou et al., 2022; García-Murillo et al., 2023; Bayaga & du Plessis, 2024; Shah et al., 2024; Abdekhoda et al., 2022; Ahmed et al., 2021; Ain et al., 2016; Alghamdi et al., 2022; AL-Nuaimi et al., 2022; Alotumi, 2022; Almaiah & Alyoussef, 2019; Dečman, 2015; El-Masri & Tarhini, 2017; Khechine et al., 2023; Kumar & Bervell, 2019; Malanga et al., 2022; Almagrashi et al., 2023; Oluwajana & Adeshola, 2021; Prasetyo et al., 2021; Qendraj et al., 2022; Raza et al., 2021; Tandon et al., 2022; Thongsri et al., 2019; Zhang & Yu, 2022; Abbad, 2021). Furthermore, the significant effect of EX on PE was significantly associated by Buabeng-Andoh and Baah (2020) in LMS among students. Regarding the effect of EX on BI to use LMS, multiple studies have found this relationship significant (Zhou et al., 2022; García-Murillo et al., 2023; Abdekhoda et al., 2022; Ahmed et al., 2021; Alghamdi et al., 2022; AL-Nuaimi et al., 2022; Almaiah & Alyoussef, 2019; Bervell & Umar, 2017; Maleševic et al., 2021; Mujalli et al., 2022; Oluwajana & Adeshola, 2021; Raza et al., 2021; Tandon et al., 2022; Xu et al., 2022; Zhang & Yu, 2022; Abbad, 2021). Relatedly, El-Masri and Tarhini (2017) stated that the EX significantly affects BI in Qatar but not the USA. Additionally, some studies have found SI to significantly affect BI to use LMS (Zhou et al., 2022; Bayaga & du Plessis, 2024; Abdekhoda et al., 2022; Ullah et al., 2021; Ain et al., 2016; Alghamdi et al., 2022; Dečman, 2015; Khechine et al., 2023; Lin & Lin, 2019; Mujalli et al., 2022; Qendraj et al., 2022; Raza et al., 2021; Thongsri et al., 2019; Xu et al., 2022; Zhang & Yu, 2022). In relevance, AL-Nuaimi et al. (2022) discovered SI to be significantly related to BI among students. Moreover, El-Masri and Tarhini (2017) highlighted that SI significantly affects BI in Qatar but not the USA. Besides, FC have been revealed to a significant driver of BI to use LMS in multiple studies (García-Murillo et al., 2023; Bayaga & du Plessis, 2024; Abdekhoda et al., 2022; Ahmed et al., 2021; Alghamdi et al., 2022; Almaiah & Alyoussef, 2019; Bervell & Umar, 2017; Khechine et al., 2023; Malanga et al., 2022; Oluwajana & Adeshola, 2021; Tandon et al., 2022; Zhang &

Yu, 2022). Relatedly, El-Masri and Tarhini (2017) found this relationship significant among USA participants but not among Qatari participants.

On the other hand, some of the UTAUT-related constructs have been found to be insignificantly related to BI to use LMS. Few studies have revealed the PE to be insignificantly affecting BI (Bervell & Arkorful, 2020; Bervell et al., 2022; Lin & Lai, 2019; Maleševic et al., 2021; Xu et al., 2022). A considerable amount of research, in addition, has demonstrated EX to have no impact on BI to use LMS (Bayaga & du Plessis, 2024; Alammary et al., 2022; Ain et al., 2016; Alotumi, 2022; Bervell et al., 2022; Dečman, 2015; Khechine et al., 2023; Kumar & Bervell, 2019; Lin & Lin, 2019; Malanga et al., 2022; Prasetyo et al., 2021; Thongsri et al., 2019). Relatively, El-Masri and Tarhini (2017) revealed that the EX significantly affect BI in the USA but not Qatar. Additionally, a considerable number of studies have revealed SI to insignificantly affect BI (García-Murillo et al., 2023; Alotumi, 2022; Almaiah & Alyoussef, 2019; Bervell & Umar, 2017; Bervell et al., 2022; Kumar & Bervell, 2019; Maleševic et al., 2021; Oluwajana & Adeshola, 2021; Prasetyo et al., 2021; Tandon et al., 2022; Abbad, 2021). Relatedly, AL-Nuaimi et al. (2022) demonstrated that SI is insignificantly related to BI among academics. Moreover, El-Masri and Tarhini (2017) stressed that SI insignificantly affects BI in the USA but not in Qatar. Meanwhile, other set of studies have found this relationship insignificant (Zhou et al., 2022; Ain et al., 2016; Alammary et al., 2022; AL-Nuaimi et al., 2022; Alotumi, 2022; Kumar & Bervell, 2019; Maleševic et al., 2021; Mujalli et al., 2022; Raza et al., 2021; Prasetyo et al., 2021; Xu et al., 2022; Buabeng-Andoh & Baah, 2020). El-Masri and Tarhini (2017) revealed this relationship between FC and BI to be insignificant in Qatar and not the USA. Finally, Alammary et al. (2022) investigated the direct impact of AW on BI among academics and found an insignificant relationship.

Therefore, previous studies have proven the possibility of having various significant impacts of UTAUT constructs on the BI to use LMS technologies.

2.6.3.2.4 Mobile Learning Technologies

Other empirical studies have investigated the effects of UTAUT constructs on BI to use Mobile Learning (M-learning). M-learning refers to a way of learning where academics and students access learning-related information through mobile technology (Almulla, 2024; Ullah et al., 2021). This review highlights what previous empirical studies have revealed in their findings based on the use of UTAUT as their underpinning theory.

To begin with significant effects, PE has been heavily and significantly linked to the BI (Parhamnia, 2022; Abu-Al-Aish & Love, 2013; Alasmari & Zhang, 2019; Al-Azawei & Alowayr, 2020; Alowayr & Al-Azawei, 2021; Alghazi et al., 2021; Almaiah et al., 2019; Ameri et al., 2020; Arain et al., 2019; Chao, 2019; Hu et al., 2020; Huan et al., 2015; Kaisara et al., 2022; Kolil &

Achuthan, 2023; Li et al., 2023; Lutfi et al., 2022; Sabah, 2016; Sabri et al., 2022; Salem & Elshaer, 2023; Shukla, 2021; Sidik & Syafar, 2020; Sitar-Taut & Mican, 2021; Sultana, 2020; Sung et al., 2015; Daniali et al., 2022; Almulla, 2024; Hoi, 2020; Nikolopoulou et al., 2020; Nassuora, 2013; Al-Hujran et al., 2014; Lawrence, 2016). In addition, one study investigated the effect of EX on PE in relation to the mobile acceptance in HEIs, obtaining a significant effect (Sung et al., 2015). Similar to the heavy investigation of PE, the majority of studies have recovered significant relationships between the EX and BI related to M-learning (Parhamnia, 2022; Abu-Al-Aish & Love, 2013; Alasmari & Zhang, 2019; Al-Azawei & Alowayr, 2020; Alghazi et al., 2021; Almaiah et al., 2019; Kaisara et al., 2022; Lutfi et al., 2022; Sabri et al., 2022; Salem & Elshaer, 2023; Shukla, 2021; Sidik & Syafar, 2020; Sultana, 2020; Al-Adwan et al., 2018; Daniali et al., 2022; Chao & Chen, 2023; Nassuora, 2013; Al-Hujran et al., 2014; Lawrence, 2016). Along the same lines, Chao (2019) determined a significant relationship between the EX and BI with the inclusion of interaction effect. Furthermore, multiple research publications have ascertained that SI is significantly correlated to the BI to utilise M-learning in the HEIs industry (Parhamnia, 2022; Alasmari & Zhang, 2019; Ameri et al., 2020; Briz-Ponce et al., 2017; Kaisara et al., 2022; Kolil & Achuthan, 2023; Li et al., 2023; Moorthy et al., 2019; Sabah, 2016; Sabri et al., 2022; Salem & Elshaer, 2023; Shukla, 2021; Al-Adwan et al., 2018; Daniali et al., 2022; Almulla, 2024; Chao & Chen, 2023; Hoi, 2020; Nikolopoulou et al., 2020; Al-Hujran et al., 2014). This variable has been found to differ in various contexts and participant groups. For instance, Al-Azawei and Alowayr (2020) noted that SI is significantly associated to BI to use M-learning in Saudi Arabia but not in Iraq. Also, AL-Nuaimi et al. (2022) pinpointed this variable to be significant in relation to students but not academics in the HEIs realm. In addition, scholarly papers have found FC to be a significant predictor of BI to utilise M-learning (Parhamnia, 2022; Alowayr & Al-Azawei, 2021; Almaiah et al., 2019; García Botero et al., 2018; Hu et al., 2020; Li et al., 2023; Lutfi et al., 2022; Sabri et al., 2022; Salem & Elshaer, 2023; Shukla, 2021; Sitar-Taut & Mican, 2021; Chao & Chen, 2023; Hoi, 2020; Lawrence, 2016). In this context, Kolil and Achuthan (2023) encountered a significant sway of FC on BI related to M-learning usage among academics (group 2). Regarding trust, few studies have come across its significant relationship with BI to utilise M-learning (Parhamnia, 2022; Al-Azawei & Alowayr, 2020; Chao, 2019). Concerning their correlation, one study examined the role of security on trust revealing a significant relationship (Almaiah et al., 2019). In relation to AW, Sabah (2016) and Salem and Elshaer (2023) investigated its effect on BI revealing a significant effect. Sabah named AW of mobile technology as M-learning services.

Another set of studies that has had insignificant relationships between UTAUT constructs and BI to use M-learning. Beginning with PE, few academic papers have identified this relationship to be insignificant (García Botero et al., 2018; Moorthy et al., 2019). Moreover,

EX was recognised to have an insignificant or negative effect on BI (Al-Azawei & Alowayr, 2020; Ameri et al., 2020; Arain et al., 2019; García Botero et al., 2018; Hu et al., 2020; Huan et al., 2015; Kolil & Achuthan, 2023; Li et al., 2023; Hoi, 2020). Relatedly, Chao (2019) came across an insignificant linkage between the EX and BI with the moderator's main effect. In addition, some journal contributions have encountered insignificant relationships between the SI and blockchain adoption (Alowayr & Al-Azawei, 2021; Almaiah et al., 2019; Arain et al., 2019; García Botero et al., 2018; Hu et al., 2020; Huan et al., 2015; Lutfi et al., 2022; Sultana, 2020; Nassuora, 2013; Lawrence, 2016). Analogously, Al-Azawei and Alowayr (2020) came across an insignificant association between SI and BI to use M-learning in in Iraq but not Saudi Arabia. Correspondingly, AL-Nuaimi et al. (2022) located SI to be insignificantly influencing BI with students but not academics. Concerning its impact within the HEI sector, FC has been demonstrated in peer-reviewed publications to be insignificantly correlated to BI (AL-Nuaimi et al., 2022; Ameri et al., 2020; Kaisara et al., 2022; Huan et al., 2015; Moorthy et al., 2019; Sultana, 2020; Zacharis & Nikolopoulou, 2022; Nassuora, 2013; Al-Hujran et al., 2014). In connection, Kolil and Achuthan (2023) confronted an insignificant impact of FC on BI concerning M-learning use among school teachers (group 1).

Therefore, extant studies have revealed diverse findings regarding the impact of UTAUT constructs on BI concerning M-learning in the HEI sector.

2.6.3.2.5 Games in HEIs

Games in HEIs have been investigated in HEIs based on the UTAUT. In this review, games refers to the application of animation and storytelling approaches (Suki & Suki, 2017), digital games (Udeozor et al., 2023) and business simulation games (Wang et al., 2020) in the learning procedures in HEIs.

Few academic papers have investigated the acceptance of games' use, based on UTAUT as their underpinning framework, in the HEIs. Suki and Suki (2017) found PE and EX to have a significant impact on the BI to apply animation and storytelling. However, two of the found studies have revealed that PE and EX have an insignificant impact on the BI to use games in HEIs (Udeozor et al., 2023; Wang et al., 2020). Regarding SI, it was collectively found to be insignificantly affecting the adoption of games in HEIs among students in all the found studies (Udeozor et al., 2023; Wang et al., 2020; Suki & Suki, 2017). Furthermore, FC was found to be significantly affecting the use of business-simulation games and animation and storytelling approaches in HEIs among students (Wang et al., 2020; Suki & Suki, 2017). Nevertheless, Udeozor et al. (2023) found this impact insignificantly related to the BI to utilise digital games in HEIs among students.

2.6.3.2.6 Blended Learning in HEIs

Few academic journal contributions have been discerned to utilise UTAUT to investigate the BI to utilise blended learning (BL). BL is basically the integration of traditional in-person and remote learning by operating pedagogical strategies tailored to foster students with various learning styles (Ghazal et al., 2018; Anthony et al., 2023).

Four studies have investigated the adoption of blended learning by implementing UTAUT. All the located journal articles have found performance and EX to significantly influence the BI to use blended learning (Prasad et al., 2018; Azizi et al., 2020; Anthony et al., 2023). Notably, one study did not examine these effects (Zhang et al., 2022). Moreover, three of the discovered studies have revealed SI to have a significant impact on BI (Azizi et al., 2020; Anthony et al., 2023; Zhang et al., 2022). In comparison, Prasad et al. (2018) found SI to have an insignificant influence on BI to adopt blended learning among students. Additionally, two articles have found the effect of FC on BI to use blended learning to be significant (Anthony et al., 2023; Zhang et al., 2022). Further, Anthony et al. (2023) found AW to strongly affect the blended learning acceptance among academics.

Therefore, the drivers and hindrances of BI to use games might vary, as shown in previous studies.

2.6.3.2.7 Artificial Intelligence

AI has been examined in a few recent papers within the HEIs realm based on UTAUT as their main theory.

All the detected studies examining the effect of AI's PE on BI have found it to be significant (Cao et al., 2021; Sobaih et al., 2024; Bouteraa et al., 2024). Related to the investigation of EX's impact on the BI to use AI in HEIs, two studies have revealed this relationship to be significant (Cao et al., 2021; Sobaih et al., 2024). However, one study highlighted that this effect is insignificant (Bouteraa et al., 2024). Moreover, SI was found to be investigated only in two scholarly articles, yielding a significant impact as a result of both of them (Sobaih et al., 2024; Bouteraa et al., 2024). Meanwhile, FC was found to be significantly affecting BI to use AI in Chatterjee's and Bhattacharjee's (2020) investigation. However, it was insignificantly affecting BI in other studies (Cao et al., 2021; Sobaih et al., 2024).

Therefore, besides the little evidence, AI use in HEIs has distinguishable results related to UTAUT constructs.

2.6.3.2.8 Other Technologies

Finally, other technologies have been found to be rarely (a single or couple of times) investigated in the existing literature by implementing UTAUT in the HEIs industry. These technologies include the use of paperless technologies (Tatlı et al., 2024), big-data (Azam & Ahmad, 2024), PowerPoint (Chávez Herting et al., 2023), augmented reality (Faqih & Jaradat, 2021), Haptic Virtual Simulator (González Bravo et al., 2020), Student Response (JazzQuiz) (Li et al., 2022), Computer-based assessment (Lin & Lai, 2019), Virtual Reality (Noble et al., 2022), Open Educational Resources (Mtebe & Raisamo, 2014), accentuating (Toh et al., 2023), Cloud, CourseWiki (Yueh et al., 2015), geospatial technologies (Cascante-Campos, 2023), Electronic Textbooks (Hung et al., 2018), Facebook (Moghavvemi et al., 2017) and Podcast Aggregator (Martins et al., 2020).

A set of academic articles has found PE to significantly influence the BI to use a portion of the aforementioned technologies (Faqih & Jaradat, 2021; González Bravo et al., 2020; Lin & Lai, 2019; Noble et al., 2022; Yadegaridehkordi et al., 2018; Cascante-Campos, 2023; Hung et al., 2018; Moghavvemi et al., 2017; Tatlı et al., 2024; Azam & Ahmad, 2024). Martins et al. (2020) have ascertained a significant effect of PE on BI to use podcast aggregators in Accounting among students who conduct Financial Statements' Structure model. Additionally, one study investigated the effect of BI on the PE of cloud-based technology among students, rendering a significant relationship (Yadegaridehkordi et al., 2018). Other studies have found EX to have a significant impact on BI (Tatlı et al., 2024; Azam & Ahmad, 2024; Li et al., 2022; Noble et al., 2022; Mtebe & Raisamo, 2014; Yadegaridehkordi et al., 2018; Cascante-Campos, 2023). Furthermore, SI has been discovered to have a significant sway on the BI to use some of the previously mentioned scholarly literature (Tatlı et al., 2024; Azam & Ahmad, 2024; Lin & Lai, 2019; Noble et al., 2022; Yadegaridehkordi et al., 2018). Relatedly, Cascante-Campos (2023) indicated that SI has a significant effect on the BI to use Desk GIS technology. Moreover, Hung et al. (2018) uncovered that SI significantly affects the BI to use e-textbooks among inexperienced students but not experienced learners. FC has been revealed in some academic papers as a significant driver of BI (Azam & Ahmad, 2024; Chávez Herting et al., 2023; Hung et al., 2018).

Another group of publications has come across insignificant findings concerning the relationship between PE and BI to use the technologies mentioned in this subheading (Chávez Herting et al., 2023; Mtebe & Raisamo, 2014; Li et al., 2022; Toh et al., 2023; Yueh et al., 2015). Martins et al. (2020) come upon the same result with students who conduct Financial Statement course. In addition, some journal papers have revealed insignificant results of EX on BI (Chávez Herting et al., 2023; González Bravo et al., 2020; Lin & Lai, 2019; Toh et al., 2023; Yueh et al., 2015; Hung et al., 2018; Moghavvemi et al., 2017; Martins et al., 2020).

Similarly, SI was identified to insignificantly affect BI in other empirical studies (Chávez Herting et al., 2023; González Bravo et al., 2020; Mtebe & Raisamo, 2014; Li et al., 2022). Relatedly, Cascante-Campos (2023) revealed that SI has an insignificant influence on the BI to utilise digital gloves, GPS, Remote sensing and Web-based GIS (geospatial technologies). Moreover, Hung et al. (2018) disclose that SI is insignificantly affecting the BI to use e-textbooks among experienced students. In addition, research articles have not met a significant relationship between FC and BI (Mtebe & Raisamo, 2014; Toh et al., 2023; Yadegaridehkordi et al., 2018; Yueh et al., 2015).

Therefore, various technologies in HEIs have yielded various results in relation to UTAUT's constructs.

2.6.3.2.7 Research Gap of Technology Adoption in HEIs

A total of 139 scholarly positions of literature have been found investigating various technologies in the HEIs based on UTAUT as their underlying theory (See Appendix B, Table B4). Most of the papers (between 92 and 131 papers) have hypothesised the effects of PE, EX, SI and FC on the BI to use various technologies in the HEI sector. These relationships have been investigated in an array of previous scientific literature. The results of these relationships have determined various results in previously published papers. While a plethora of scholarly articles have demonstrated significant results, a high volume of other studies has displayed insignificant findings. For instance, out of 92 studies, 43.48% of them have found FC to insignificantly affect blockchain acceptance. The exact illustration applies to the other UTAUT relationships that have been hypothesised in previous studies.

To compare, only one to six papers out of these 139 empirical papers have hypothesised the effect of EX on PE, trust on BI, security on BI, security on trust and AW on BI. All these relationships were found significant. Besides, one study out of six papers found AW to have an insignificant effect on BI to use various technologies in HEIs. Furthermore, no studies, to the best of the author's knowledge, have investigated the impact of trust on PE, trust on EX, security on PE, security on EX and the moderating rule of AW between UTAUT antecedents and BI.

Therefore, the present study reveals two primary gaps in the extant literature that could be covered. The first gap pertains to the various results between UTAUT main constructs (i.e., PE, EX, SI and FC). This gap exists due to the diverse outcomes, where some of the research publications have revealed significant results and others come across insignificant findings. The second gap concerns this study's proposed relationships (See Section 2.6.5), whereby most of these relationships are neglected or slightly investigated in previous academic papers. The majority of the relationships in this study's proposed framework have not been sufficiently

covered in previous studies. In detail, this study proposes 17 relationships, 13 of which have been investigated six times or less in the HEIs' related academic articles. Eight relationships out of the 17 have never been investigated. Given that these relationships are anticipated to greatly influence academic and administrative employees' perceptions on blockchain adoption, they are investigated in this study. Therefore, the various results and the minor or lack of evidence concerning the most proposed relationships in this study reveal the gaps related to the HEIs industry.

2.6.3.3 Blockchain and HEIs

The previous discussions concerned the assessment of UTAUT in relation to blockchain technology in various industries. The following subsections concentrate on the HEIs, whereby the UTAUT antecedents had the potential to affect the BI to use miscellaneous technologies in the HEIs. This section concerns the integration of the previous two sections, where studies have operated the UTAUT to investigate what variables affect the BI to use blockchain in the HEIs industry. This review yields in finding three studies.

2.6.3.3.1 Review of Extant Studies of Blockchain and HEIs

Few studies have employed UTAUT variables to investigate the effects of UTAUT antecedents on the BI to use blockchain in the HEI sector only. One of the studies investigated HEIs with other industry firms (i.e., Lee et al., 2019).

As a UTAUT construct, PE has been found to significantly influence BI to use blockchain in the HEIs (Alomari & Abdullah, 2023; Al-Riyami et al., 2023). Furthermore, two publications that have determined EX to have a significant impact on BI to use blockchain (Alomari & Abdullah, 2023; Al-Riyami et al., 2023). Moreover, SI has been discovered to significantly impact BI to use blockchain in HEIs (Alomari & Abdullah, 2023; Al-Riyami et al., 2023). In addition, Al-Riyami et al.'s (2023) study showed a significant effect of FC on BI to use blockchain in HEIs. Furthermore, security was revealed to be significantly and positively influencing BI to use blockchain among students in the HEI sector (Alomari & Abdullah, 2023). In relevance, security was found to significantly influence the trust of blockchain in HEIs with other industries (Lee et al., 2019). Finally, AW had a significant impact on the BI to use a blockchain-based cryptocurrency in HEIs among students (Alomari & Abdullah, 2023).

In contrast, Lee et al. (2019) found an insignificant relationship between EX and BI. Moreover, Alomari and Abdullah (2023) revealed an insignificant impact of FC on BI. Further, trust was found to have an insignificant impact on BI to use blockchain in HEIs and other industries (Lee et al., 2019).

Therefore, to the best of the authors' knowledge, there is little evidence in current research about what factors affect blockchain acceptance in HEIs. Within the little evidence results, different outcomes have been observed in relation to the use of UTAUT constructs' effect on BI to utilise blockchain in HEIs.

2.6.3.3.2 Research Gap of Blockchain Adoption in HEIs

This review found three studies that have employed UTAUT to investigate the variables that affect the intention to use blockchain in the HEIs industry (Lee et al., 2019; Al-Riyami et al., 2023; Alomari & Abdullah, 2023). Although these articles employed UTAUT as their underpinning theory, they have central differences from the current research.

In comparison with these three academic publications, the current study differs in multiple aspects. The primary difference is that the present study investigates eight more relationships than those investigated in the three studies. The previous three scientific publications have not investigated eight connections between independent and dependent latent variables (See Sections 2.6.4 & 2.6.5). Thus, the present research contributes to covering existing gaps by examining new relationships that no previous studies have investigated. These relationships relate to blockchain adoption in HEIs.

Additionally, these studies vary in the nature of their investigation. For instance, Al-Riyami et al. (2023) investigated the fourth industrial revolution in general. Although blockchain is a fourth industrial revolution technology, it includes other technologies such as AI, big data, Internet of Things, among others (Schwab, 2017). Al-Riyami et al. (2023) extended their focus beyond blockchain technology to include additional technologies in the fourth industrial revolution field. In contrast, blockchain is the primary concentration of the present study. Thus, the present study is different from Al-Riyami and others' investigation in terms of the scope of the study.

Moreover, Alomari and Abdullah (2023) investigated the acceptance of cryptocurrency; they ignored the acceptance of other applications that are based on blockchain (e.g., certificate management). This study covers the acceptance of blockchain in a more general sense.

Similarly, Lee et al. (2019) differ from the present study in terms of participants and context. Lee and others surveyed students and faculty of midsize universities, while the present study neither investigated students nor distinguished the university's size. Moreover, Lee et al. (2019) collected data from other industries involving collected data from IT professionals and participants from other industries. This diversity of sectors and participants may affect the results. The current study concentrates only on HEIs and their staff.

Therefore, this study uniquely contributes to the existing knowledge in developing new relationships related to UTAUT, specifically in the context of blockchain technology adoption in the HEI sector. These new relationships are expected to strongly impact the behavioural intention academic and administrative employees in HEIs toward blockchain adoption. Accordingly, they are examined in this study.

2.6.3.4 UTAUT among Academic and Administrative Staff in HEIs

Subsequent to reviewing the use of UTAUT with blockchain technology and in the HEIs, it is crucial to investigate the gap in the previous literature in relation to the participants. The present study investigates the blockchain acceptance among administrative and academic staff in HEIs. This investigation will lead (as will be demonstrated in the methodology chapter) to collect data from administrative and academic staff in HEIs. So, this part discusses the effect of UTAUT antecedents and individual characteristics related to blockchain on the acceptance of various technologies among academics and office employees, separately. Following that, there will be a discussion of investigating what factors influence one of these groups in integration with other groups. An example is a paper that investigates academics and administrative employees collectively (e.g., Tatlı et al., 2024). Scholarly articles that concentrated on students only are disregarded in this review, as the main focus is on HEIs' administrative and academic staff.

2.6.3.4.1 Administrative Staff in HEIs

This discussion begins with administrative employees only, who carry out office tasks in HEIs' various departments and facilities. Some studies have employed UTAUT to investigate their acceptance of various technologies. As an antecedent of UTAUT, PE has been found to significantly affect administrative staff's BI to use various technologies (Azam & Ahmad, 2024; Bayaga & du Plessis, 2024). Furthermore, an existing study identified EX to significantly lead employees to accept big-data use in HEIs' libraries (Azam & Ahmad, 2024). Furthermore, the found studies have collectively uncovered significant effects of SI and FC on the BI to use LMS and big-data in libraries (Bayaga & du Plessis, 2024; Azam & Ahmad, 2024).

On the other hand, EX was determined to insignificantly influence BI to use LMS tertiary among administrative staff. (Bayaga & du Plessis, 2024).

2.6.3.4.2 Academics in HEIs

A group of studies have employed the UTAUT antecedents to investigate the academics' acceptance of various technologies. This category includes studies that

investigated academics alone or separated from other groups. For instance, AL-Nuaimi et al. (2022) separated the academics' results from students'.

Starting with PE, a considerable number of research articles have found academics to accept the use of technology if they believe that technology assists in their work (Rotar, 2023; García-Murillo et al., 2023; Kazemian & Grant, 2023; Anthony et al., 2023; Abdekhoda et al., 2022; Cascante-Campos, 2023; Hu et al., 2020; Al-Riyami et al., 2023; Salem & Elshaer, 2023; Tseng et al., 2022; Aziz et al., 2022; AL-Nuaimi et al., 2022). Additionally, EX has been found in literature to significantly affect the acceptance of various technologies among academics (García-Murillo et al., 2023; Anthony et al., 2023; Mbazu et al., 2024; Abdekhoda et al., 2022; Bervell & Umar, 2017; Cascante-Campos, 2023; Mtebe & Raisamo, 2014; Al-Riyami et al., 2023; Salem & Elshaer, 2023; Aziz et al., 2022; AL-Nuaimi et al., 2022; Lin et al., 2013). Relatedly, as mentioned earlier, Kazemian and Grant (2023) found that EX significantly affects the BI to use social networks among academics concerning contributive use. In addition, SI has been found to significantly impact the BI to use distinct technologies among academics in HEIs (Anthony et al., 2023; Mbazu et al., 2024; Abdekhoda et al., 2022; Salem & Elshaer, 2023; Tseng et al., 2022; Aziz et al., 2022). In relevance, Kazemian and Grant (2023) noted that academics' BI to use social networks is significantly affected in the case of contributive use. Plus, Cascante-Campos (2023) found SI to significantly affect the BI to use various geospatial-related technologies among academics. In addition, FC has been found in existing studies to significantly affect academics' BI to use various technologies in HEIs (García-Murillo et al., 2023; Anthony et al., 2023; Mbazu et al., 2024; Abdekhoda et al., 2022; Bervell & Umar, 2017; Chávez Herting et al., 2023; Bervell & Arkorful, 2020; Al-Riyami et al., 2023; Salem & Elshaer, 2023; Tseng et al., 2022; Aziz et al., 2022). Relatedly, Hu et al. (2020) found FC to have a significant effect only on the existence of moderators. Finally, AW was significantly found to affect BI among academics (Salem & Elshaer, 2023; Anthony et al., 2023).

In comparison, other empirical findings have found the PE to have an insignificant influence on the BI to use various technologies in HES among academics (Toh et al., 2023; Bervell & Umar, 2017; Chávez Herting et al., 2023; Mtebe & Raisamo, 2014; Lin et al., 2013). Meanwhile, the EX has been found in other literature to insignificantly affect BI to utilise diverse technologies (Rotar, 2023; Alammary et al., 2022; Chávez Herting et al., 2023; Hu et al., 2020; Kolil & Achuthan, 2023; Toh et al., 2023; Tseng et al., 2022). In parallel, Kazemian and Grant (2023), discerned insignificant results of EX among academics on BI concerning consumptive use. Furthermore, other studies have detected different results yielding an insignificant impact of SI on BI (Toh et al., 2023; Mtebe & Raisamo, 2014; Hu et al., 2020; Chávez Herting et al., 2023; Bervell & Umar, 2017; García-Murillo et al., 2023; AL-Nuaimi et al., 2022). In relevance, Kazemian and Grant (2023) documented that academics' BI is not significantly impacted by

SI in the case of consumptive use. Also, Cascante-Campos (2023) revealed that SI is insignificantly affecting BI among academics regarding the usage of Desk GIS. Additionally, other studies have found this relationship insignificant among academics (Mtebe & Raisamo, 2014; Rotar, 2023; Kazemian & Grant, 2023; Toh et al., 2023; Alammary et al., 2022; AL-Nuaimi et al., 2022). Finally, Alammary et al. (2022) demonstrated that AW does not impact academics' BI to use e-learning.

Therefore, investigating various technologies among academics reveals an array of results in previous scientific papers relevant to the UTAUT variables. Also, there is a clear gap in literature related to administrative and academic staff in relation to blockchain and UTUAT. This study bridges this gap.

2.6.3.4.3 Various Stakeholders

The last category relates to studies that integrate the academics and administrative participants together, as part of the HEI sector, or with other groups of participants (e.g., students). These studies examine UTAUT constructs' effect on the BI to use various technologies. For instance, some of these studies have investigated the intention of various technologies among academics, administrative and students collectively based on UTAUT (Chatterjee & Bhattacharjee, 2020; Nikou & Aavakare, 2021; Sultana, 2020). Other studies have investigated academics and students at the same time (Rahman et al., 2021; Obienu & Amadin, 2021; Wan et al., 2012; Mujalli et al., 2022). Furthermore, some journal articles have examined HEIs stakeholders with external parties such as IT professionals (Lee et al., 2019) from other industries or schools' teachers (Kolil & Achuthan, 2023). Also, Tatlı et al. (2024) investigated the intention to use paperless technologies among academics and administrative staff based on UTAUT. The latter study is the only study that investigated academics and administrative staff personnel together. This study is not related to this blockchain. By illustrating this integrating relationship, the following narrative discusses the results of the integration of these various groups of participants.

Commencing with the effect of PE on BI among HEIs stakeholders, existing investigations have found this relationship significant (Tatlı et al., 2024; Mujalli et al., 2022; Nikou & Aavakare, 2021; Rahman et al., 2021; Sultana, 2020). Furthermore, other studies have represented the impact of EX on BI as significant (Tatlı et al., 2024; Mujalli et al., 2022; Nikou & Aavakare, 2021; Rahman et al., 2021; Sultana, 2020). Additionally, SI has been found to be significantly correlated to BI to use different HEIs-related technologies (Tatlı et al., 2024; Mujalli et al., 2022; Kolil & Achuthan, 2023; Wan et al., 2012; Obienu & Amadin, 2021; Rahman et al., 2021). Similarly, FC has been found to significantly and directly influence the acceptance of various technologies among HEIs' stakeholders (Rahman et al., 2021; Chatterjee &

Bhattacharjee, 2020). Relatedly, Kolil and Achuthan (2023) demonstrated that the FC was a significant driver of blockchain acceptance among academics and teachers who have used virtual labs only during Covid-19. Finally, AW was significantly affecting the BI to adopt recycling attitudes and behaviour among students and academics (Wan et al., 2012).

In comparison, other scholarly publications have revealed all or some of the aforementioned relationships to be insignificant. For instance, Lee et al. (2019) came across an insignificant correlation between EX and BI. Moreover, Sultana (2020) observed SI to be insignificantly related to the acceptance of mobile-cloud learning systems among students, academics and office workers. Other scientific findings have revealed an insignificant impact of FC on BI among students and academics (Mujalli et al., 2022) along with administrative workers (Sultana, 2020). Relatedly, Kolil and Achuthan (2023) demonstrated that the FC was insignificantly related to BI to use virtual labs among academics and teachers who were familiar with virtual labs before the Covid-19 pandemic.

2.6.3.4.4 Research Gap Related to Participants

A total of 41 academic papers were retrieved where administrative staff and academics were partially or entirely involved based on UTAUT (See Appendix B, Table B5). This investigation involves various technologies in the HEI sector. Other sectors are disregarded in this investigation due to the inability to find studies that have investigated academic and administrative workers outside the HEIs field. Therefore, this study concentrates on the HEI sector.

The findings demonstrate that the most investigated effects relate to the influence of PE, EX, SI and FC on BI. These relationships have been hypothesised between 29 to 37 times in previous studies. Some studies do not cover all the UTAUT factors, making them to be hypothesised 29 times while other factors were hypothesised up to 37 times.

Among these hypotheses, PE, EX, SI and FC have been found significant in the range of 17-28 scholarly articles. This 17-28 range of articles refers to the fact that some factors were significantly proven while others were found insignificant. For instance, PE has the highest significance rate, with 84.85% of these articles. EX, SI and FC count for 66.57%, 66.67% and 58.62%, respectively.

In addition, four studies only investigated the influence of AW on BI, delivering significant results in all of them. Further, one study investigated the impact of trust on BI, and another one investigated the influence of security on trust. This evidence yields room for significant contributions, which is covered in the present study (See 2.6.5).

Therefore, two dimensions might be derived from this review. First, it is widely applicable and validated in literature to adopt more than one segment of the stakeholders in relation to the HEIs industry. For instance, the present study will investigate two groups of employees in HEIs, i.e., academic and administrative employees. Second, there are obvious gaps in investigating the effect of blockchain acceptance based on UTAUT among administrative and academic staff. The first gap relates to inconsistent results in the previous studies. The second gap concerns the neglected relationships that may affect the blockchain acceptance in HEIs among academic and administrative employees. The third gap pertains to the investigation of blockchain acceptance among administrative and academic workers, which has never been conducted in previous research.

Therefore, the current study contributes to covering these gaps, representing a standpoint where it is, based on the author's knowledge, the first study investigating the administrative and academic staff regarding blockchain acceptance in the HEIs based on UTAUT. This gap is significant to address. Indeed, considering academic and administrative employees' perceptions gives a more complete view of blockchain adoption in HEIs. Also, overlooked factors affecting blockchain adoption could offer key insights for research and practicians to investigate and adopt blockchain.

2.6.3.5 Review of UTAUT in KSA

The current study aims to investigate the adoption of blockchain in the HEI sector in the KSA. So, the context of the study is KSA, whereby the data of the present study will be collected. In this stage, this research investigates studies that have conducted their examination in the HEIs within KSA in connection to UTAUT for various technologies. Remarkably, only one study was found to investigate blockchain in KSA, and it was related to the HEI sector (i.e., Alomari & Abdullah, 2023).

2.6.3.5.1 UTAUT in Saudi Context

In the Saudi context of the HEI sector, previous studies have utilised UTAUT to examine what factors affect the BI to use various technologies.

Starting with the PE, it was a significant predictor of BI to use various technologies of the HEIs in KSA in almost all the found empirical studies that implemented UTAUT as their underlying theory (Abbad, 2021; Al-Azawei & Alowayr, 2020; Alowayr & Al-Azawei, 2021; Alghamdi et al., 2022; Alghazi et al., 2021; Almaiah & Alyoussef, 2019; Lutfi et al., 2022; Mujalli et al., 2022; Salem & Elshaer, 2023; Alomari & Abdullah, 2023; Sobaih et al., 2024; Alhramelah & Alshahrani, 2020; Nassuora, 2013; Al-Hujran et al., 2014; Lawrence, 2016). In addition, EX has been revealed to significantly influence the BI to use different technologies in KSA (Abbad,

2021; Alasmari & Zhang, 2019; Alowayr & Al-Azawei, 2021; Alghamdi et al., 2022; Alghazi et al., 2021; Almaiah & Alyoussef, 2019; Lutfi et al., 2022; Mujalli et al., 2022; Salem & Elshaer, 2023; Alomari & Abdullah, 2023; Sobaih et al., 2024; Alhramelah & Alshahrani, 2020; Nassuora, 2013; Al-Hujran et al., 2014; Lawrence, 2016). Furthermore, SI has been detected in extant scholarly literature to significantly drive the BI to use various technologies in KSA within the HEI sector (Al-Hujran et al., 2014; Almulla, 2024; Sobaih et al., 2024; Alomari & Abdullah, 2023; Salem & Elshaer, 2023; Mujalli et al., 2022; Alghamdi et al., 2022; Al-Azawei & Alowayr, 2020; Alasmari & Zhang, 2019). Concerning FC, it has been found in literature that has been conducted in KSA to have a significant impact on the BI to use various technologies in the HEI sector (Alasmari & Zhang, 2019; Al-Azawei & Alowayr, 2020; Alghamdi et al., 2022; Mujalli et al., 2022; Salem & Elshaer, 2023; Lawrence, 2016). Additionally, one investigation stated that security and BI have a significant relationship (Alomari & Abdullah, 2023). Likewise, two research publications have examined the impact of AW on BI, displaying a significant impact between the two variables in KSA (Alomari & Abdullah, 2023; Salem & Elshaer, 2023).

However, one study conducted in KSA revealed that PE was an insignificant driver of BI to utilise diverse technologies (i.e., Altalhi, 2021). Moreover, other journal articles have found insignificant effects of EX on the BI in the KSA context (Alammary et al., 2022; Al-Azawei & Alowayr, 2020; Altalhi, 2021). In addition, numerous scholarly papers have found SI to have no impact on BI in the context of KSA for HEI sector (Abbad, 2021; Alowayr & Al-Azawei, 2021; Alghazi et al., 2021; Altalhi, 2021; Almaiah & Alyoussef, 2019; Lutfi et al., 2022; Alhramelah & Alshahrani, 2020; Nassuora, 2013; Lawrence, 2016). Similarly, FC has been found in research to have an insignificant influence on the BI to use various technologies in KSA (Al-Hujran et al., 2014; Nassuora, 2013; Sobaih et al., 2024; Mujalli et al., 2022; Altalhi, 2021; Alammary et al., 2022). Finally, Alammary et al. (2022) found AW to have an insignificant influence on BI.

2.6.3.5.2 Research Gap Related to KSA

Nineteen journal articles have been found examining the technology adoption in HEIs that are located in KSA (See Appendix B, Table B6). The impact of PE, EX, SI and FC on BI have been hypothesised between 14 to 18 times. The significant effect of performance and EX on BI have been revealed in 15 studies. The significant impacts of SI and FC on BI have been reported in seven to nine papers. Therefore, there are no consent results pertaining to the impact of UTAUT constructs on the BI. This study will confirm or reject the influence of UTAUT antecedents on blockchain acceptance in HEIs in KSA.

Furthermore, two of these three articles have found AW to predict BI to use various technologies in KSA. Furthermore, trust and security were found to significantly affect BI to

use technologies in HEIs in two different studies. Also, this study adds ten more relationships that previous scholars have not investigated in KSA concerning UTAUT.

Finally, only one study was related to blockchain in KSA; however, it concentrates on cryptocurrency only (i.e., Alomari & Abdullah, 2023).

Therefore, this study covers three contextual gaps. First, there are diverse results in previous studies pertaining to the UTAUT constructs, which will be addressed in this study. Second, there is little or possibly lack of investigation related to this study's proposed relationships in KSA (See Sections 2.6.4 & 2.6.5). So, this study contributes to finding new factors that may affect blockchain adoption in HEIs in KSA that have not been investigated in the current literature. Finally, this study, to the best of the author's knowledge, is the first study to investigate the factors that affect blockchain acceptance in HEIs in KSA based on UTAUT.

Subsequent to conducting a literature review related to the proposed framework's constructs of this study, the following section discusses the hypotheses' development.

2.6.4 Hypotheses Development

Following the identifies gaps reported above, this section formulates hypotheses to investigate what factors affect blockchain acceptance among administrative and academic employees in HEIs in KSA. As stated in previous sections, the hypotheses development is based on UTAUT determinants and added individual characteristics. The UTAUT latent variables are PE, EX, SI, FC and BI. The added determinants are trust, Sec and AW.

2.6.4.1 Performance Expectancy

Performance expectance is essential in accepting or rejecting an emerging technology among employees in HEIs. In their initial proposal of UTAUT, Venkatesh et al. (2003) stated that the root of the PE factor was derived from previous constructs, i.e., perceived usefulness (Davis, 1989), extrinsic motivation (Davis, 1989), job-fit (Thompson et al., 1991), relative advantage (Gary et al., & Izak, 1991) and outcome expectations (Compeau & Higgins, 1995). Further, Venkatesh et al. (2003) referred to PE as the extent to which technology users are confident that utilising a technology such as blockchain will assist in improving their job performance. This definition is applied to the current study.

This study assumes that PE is a significant and positive driver of blockchain acceptance in HEIs among administrative and academic staff. This relationship refers to the

assumption that the higher administrative and academic staff perceive blockchain will enhance their job performance, the higher their intention to use it will be.

Blockchain may increase the job performance of administrative staff and academics working for HEIs. Multiple use cases of blockchain could enhance employees' performance while conducting their tasks in HEIs. For instance, Alharthi et al. (2019) asserted that the human resource staff in HEIs could benefit from checking their accomplishments through blockchain. Additional departments demonstrated by the author to attain benefits from blockchain features are the library and research sections, where digital rights can be validated and confirmed (Hoy, 2017). On the other hand, academics may leverage blockchain to store and share their data (e.g., research and course materials), secure their intellectual property, and enhance their evaluation procedures of students (see Section 2.3.3) (Truscholar, 2021; Bucea-Manea-Ţoniş et al., 2021). Therefore, this study suggests that blockchain's PE significantly and positively affects BI.

PE has been applied within the blockchain domain in previous scholarly studies. They have found that PE positively and significantly affects the intention to adopt blockchain in various settings (Alazab et al., 2021; Abu Afifa et al., 2023; Queiroz et al., 2021; Shahzad et al., 2024; Mokthar & Sapuan, 2023; Lee, 2023; Mansoor et al., 2023; Sham et al., 2023). For instance, Mansoor et al. (2023) found the PE to significantly and positively influence the BI to use blockchain-based remittance services in Pakistani's bank industry. Regarding HEIs, PE has been found to strongly sway technology adoption of diverse systems (Chao & Chen, 2023; Xue et al., 2024). Tatlı et al. (2024), for instance, found PE to significantly and positively affect the intention to use paperless technologies among academic and administrative staff.

Therefore, this study proposes the following hypothesis:

H1. PE has a significant and positive impact on the BI to use blockchain among HEIs' employees in KSA.

2.6.4.2 Effort Expectancy

EX is a significant variable in determining the acceptance of blockchain technology among HEI's employees. This determinant was developed based on the integration of previous constructs, i.e., perceived ease of use (Davis, 1989), complexity (Thompson et al., 1991) and ease of use (Gary & Izak, 1991). In their study, Venkatesh et al. (2003) defined EX 'as the degree of ease associated with the use of the system' (p.450). This definition is adopted in the present study. Not only blockchain's acceptance but also EX can potentially affect the PE of blockchain.

EX might influence PE and BI variables. In relation to PE, EX has the potential to affect the PE of blockchain technology. This effect implies that the more employees believe that blockchain-based applications are easier to use, the more they believe that these applications will evolve their job performance. As it was previously hypothesised to affect blockchain directly (H1), PE is anticipated to mediate the relationship between EX and BI (Hair et al., 2022).

Additionally, employees' acceptance of a certain technology is more likely to increase if they acknowledge that it is easier to operate (Thompson et al., 1991; Alazab et al., 2021). Thus, this study proposes that if employees find the utilisation of blockchain in the HEIs diminishes their effort to implement their tasks and is not complex, they will accept the use of blockchain applications.

Blockchain may reduce the EX among employees in HEIs in various ways. Some of blockchain's features may make administrative and academic staff's work less complex. For administrative employees, an example of reducing effort while conducting their tasks may relate to automating academic credentials. This feature may reduce administrative employees' need for multiple verification of students' records. Further, leveraging blockchain-based smart contracts may automate tasks like student enrolment, tuition fees and contracting management, significantly reducing EX (Truscholar, 2021). For academics, blockchain may afford easier ways to secure and share research data. Therefore, blockchain EX is anticipated to affect PE and BI significantly.

Previous studies have found that EX positively and significantly affects the intention to adopt blockchain in fields other than HEIs (Alazab et al., 2021; Abu Afifa et al., 2023; Pham & Thi Nguyet, 2023). Additionally, previous literature has found EX to significantly and positively affect PE in blockchain and HEIs-related studies (Kumari et al., 2023; Yadegaridehkordi et al., 2018). Relatedly, Baptista and Oliveira (2016) found that EX significantly impacts the PE of an emerging technology in their meta-analysis investigation. Therefore, this study proposes the following hypothesis:

H2A. EX has a significant and positive impact on BI to use blockchain among HEIs' employees in KSA.

H2B. EX has a significant and positive impact on PE in adopting blockchain among HEIs' employees in KSA.

2.6.4.3 Social Influence

SI is a considerable variable in accepting or rejecting an emerging technology. The foundation of this construct was built based on previous models, i.e., subjective norm (Davis, 1989; Ajzen, 1991; Taylor & P. A. Todd, 1995; Taylor & P. Todd, 1995), social factors (Thompson et al., 1991) and image (Gary & Izak, 1991). According to Venkatesh et al. (2003), SI is the extent to which a user (e.g., employees) perceives that significant others believe the user should utilise the new technology. The important others may include their colleagues', friends', and/or family members' beliefs in relation to the use of blockchain technology (Alazab et al., 2021; Queiroz & Fosso Wamba, 2019). Venkatesh and others' definitions are applied in the present study.

SI is expected to be a significant predictor of employees' intention to use blockchain. This suggestion implies that the more HEIs office workers and academics in HEIs perceive their important people believe that they should use blockchain, the more they accept its usage. For instance, the security level of blockchain may increase the perception of employees that their colleagues believe they should use blockchain. This increased perception is anticipated to increase BI to use blockchain technology.

To attain a deeper understanding of SI, individual perceptions of blockchain features (e.g., security, privacy, and trust) are assumed to increase the acceptance of blockchain in HEIs-related environments. The related environment here refers to employees' important others, such as colleagues, friends and family members. Their increased belief regarding blockchain use is anticipated to increase the employees' perception that these important ones believe in using blockchain. Therefore, SI is anticipated to significantly and positively affect blockchain acceptance within the HEI systems.

Recent studies of blockchain and HEIs have found SI to positively and significantly affect blockchain acceptance. Concerning blockchain, literature has found a positive and significant correlation between SI and the intention to use blockchain applications in various fields (Abu Afifa et al., 2023; Ferri et al., 2021; Khazaei, 2020). Within the HEIs industry, SI has been found to affect the BI to use various technologies besides blockchain (Azam & Ahmad, 2024; Mbazu et al., 2024; Bayaga & du Plessis, 2024; Tatlı et al., 2024).

Hence, this study proposes the following hypothesis:

H3. SI has a significant and positive impact on the BI to use blockchain among HEIs' employees in KSA.

2.6.4.4 Facilitating Conditions

FC is an essential predictor of employees' intention to accept or reject the use of blockchain in HEIs in Saudi Arabia. Although Venkatesh et al. (2003) derived this determinant from previous models, i.e., perceived behavioural control (Ajzen, 1991; Taylor & P. A. Todd, 1995; Taylor & P. Todd, 1995), FC (Thompson et al., 1991) and compatibility (Gary & Izak, 1991). Based on these constructs, Venkatesh et al. (2003) defined FC 'as the degree to which an individual believes that an organisational and technical infrastructure exists to support the use of the system' (p.453). This definition is applied to this study in relation to blockchain.

To interpret this definition, this study anticipates FC to significantly and positively affect blockchain adoption. This anticipation implies that the more employees perceive the organisational and technological infrastructure (e.g., internet, desktops and IT support) to be supporting blockchain, the more they accept using it with their work (Alazab et al., 2021; Queiroz & Fosso Wamba, 2019). In KSA, for example, most faculty members have access to the Internet to teach, communicate and research (Al-Shawi & Al-Wabil, 2019), which might increase their feeling of having a better infrastructure. The feeling of better blockchain support is anticipated to increase blockchain acceptance among administrative and academic staff in HEIs in KSA.

Prior literature investigating blockchain has found FC to significantly and positively impact the BI among various sectors (Alazab et al., 2021; Pham & Thi Nguyet, 2023; Jena, 2022).FC impact on BI was not part of the original UTAUT but added in UTAUT2 and applied in previous studies (Venkatesh et al., 2003, 2012). On the other hand, previous literature within the HEIs realm has found FC to significantly and positively affect technology adoption among employees (García-Murillo et al., 2023; Anthony et al., 2023; Mbazu et al., 2024; Bayaga & du Plessis, 2024). Thus, this study formulates the following hypothesis:

H4. FC has a significant and positive impact on the BI to use blockchain among HEIs' employees in KSA.

2.6.4.5 Trust

Due to its relation to blockchain in the education industry (Mayer & Davis, 1999), this study adapts Grech and Camilleri's (2017) definition of trust. Grech and Camilleri define trust as the risk judgment between two or more individuals, institutions or countries. The lower the risk judgment, the higher the trust, and the more the risk judgement of blockchain, the less trust is. To be more specific, trust, in this study, is related to the judgment of employees that

blockchain is capable of operating consistently in situations where risky consequences are less likely to occur (Mcknight et al., 2011; Salem & Ali, 2019; Lee et al., 2019). This definition is adopted in this study.

Trusting blockchain is a necessary factor to investigate in order to facilitate its adoption in HEI settings. Essentially, trust has been considered one of the most significant factors within the technology acceptance context (Wu et al., 2011; Queiroz & Fosso Wamba, 2019; Alazab et al., 2021; Salem & Ali, 2019; Jarvenpaa et al., 2000; Wong, Tan et al., 2020; Marengo & Pagano, 2023; Norbu et al., 2024; Mondego, 2018). Trust between users and a particular technology affects the users' intention to utilise the technology (Alazab et al., 2021; Dhagarra et al., 2020; Latif & Zakaria, 2020; Enaizan et al., 2020; Leong Tang et al., 2021; Francisco & Swanson, 2018). Further, trust significantly pertains to blockchain and higher education shareholders, such as employees (Rodrigues et al., 2022). Hence, it is argued that increased trust in blockchain can drive its acceptance among HEIs' employees (Almaiah et al., 2019; Alazab et al., 2021). The significance of trust leads to the proposal that trust may significantly influence users' BI to use blockchain directly. In addition, this study expects trust to directly influence PE and EX.

Indeed, not only BI but trust might also act as an exogenous factor that impacts other UTAUT antecedents (i.e., PE and EX). Regarding trust and PE, it is likely that the first significantly affects the latter among employees. The rationale behind this assumption is that trusting blockchain technology would lead employees to believe blockchain will benefit their job performance. If employees perceive blockchain as more trustworthy, they are more likely to believe it will enhance their job performance. Thus, trust is anticipated to significantly and positively affect PE. As PE was hypothesised (H1) to have a direct relationship with BI, and trust is expected to have a direct relationship with PE, this study establishes an implicit mediation relationship of PE between trust and BI (Hair et al., 2022).

Furthermore, trust in blockchain within the HEIs context is assumed to significantly and positively influence the expected effort to use blockchain. To illustrate, increased trust in blockchain technology increases the expectancy that blockchain requires less effort to use. In other words, the more HEIs' employees perceive blockchain technology as a trustworthy technology, the more they expect it to be easier to use (Thatcher et al., 2011). To interpret, if employees perceive blockchain as a riskier technology that may hinder them from accomplishing their tasks, they will perceive it as more complex and challenging to use. Thus, trusting blockchain-based applications is proposed to significantly and positively impact employees' EX of blockchain in HEIs. As trust is expected to have a direct relationship with

EX, and it was previously hypothesised to affect blockchain directly (H2a), EX is anticipated to mediate the relationship between EX and BI implicitly (Hair et al., 2022).

Previous studies have found trust to significantly and positively affect UTAUT antecedents and BI to use blockchain within the HEIs industry. Within the blockchain, trusting blockchain has been found in extant studies to significantly and positively influence BI in various sectors, such as SC (Kabir et al., 2021), gamification (Vorobeva et al., 2023), banking (Mansoor et al., 2023; Jena, 2022), among others. Furthermore, trust has been found in existing literature to significantly affect PE in various sectors, including tourism (Sarnacchiaro et al., 2024; Chang et al., 2022) and accounting (Abu Afifa et al., 2023), among others. Finally, Abo Afifa et al. (2023) uncovered a significant effect of trusting blockchain on EX among accountants. On the other hand, trusting various technologies has been found in literature that concerns the HEIs industry to significantly and positively affect BI (Parhamnia, 2022; Al-Azawei & Alowayr, 2020; Chao, 2019).

H5A. Trust has a positive and significant impact on the BI to use blockchain among HEIs' employees in KSA.

H5B. Trust has a positive and significant impact on PE, which was hypothesised to affect BI to use blockchain among HEIs' employees in KSA.

H5C. Trust has a positive and significant impact on the EX, which was hypothesised to affect BI to use blockchain among HEIs' employees in KSA.

2.6.4.6 Perceived Security

SEC is a critical determinant that is considered one of the most significant blockchain characteristics (Rodrigues et al., 2022; Razia, 2023; Aslam et al., 2021; Chittipaka et al., 2023). This study integrates the privacy and security factors, yielding the privacy-security factor due to the parallel conceptions between the two factors (Razia, 2023). The security-privacy factor (i.e., SEC) refers to the employees' perception of safeguarding against security breaches, threats and data control within the blockchain technology application (Salisbury et al., 2001). This definition is implemented in this study.

SEC, including privacy aspects (e.g., data control), is a significant factor to be investigated, especially within the HEIs industry. This industry usually incorporates a massive amount of data within its system, including students, administrative staff and academics' personal information (Dwivedi & Vig, 2024). Employees' perception or feeling of acquiring higher security protection while utilising blockchain technology drives them to feel safer against cybersecurity attacks and breaches, which might cause personal data leakage or

financial losses (Khazaei, 2020). Hence, employees may need to be confident that utilising blockchain applications increases their SEC while conducting their tasks.

This significance leads to the perception that SEC is essential to influencing employees' intention to use blockchain in HEIs. In other words, SEC may have a significant and positive impact on the BI of blockchain. To interpret this relationship, the perception of employees regarding blockchain's protection against cybersecurity attacks, threats and data leakage (SEC) is probably a significant factor of blockchain acceptance (BI) among administrative and academic staff who work for HEIs in KSA. In addition, SEC is expected to significantly and positively impact PE, trust and EX of blockchain.

Indeed, the SEC is tightly associated with PE, trust and EX. First, this study proposes that employees' perception of blockchain's security can shape their belief that blockchain usage will enhance their job performance (PE). Additionally, this study suggests that SEC can potentially affect the trust in blockchain technology. This correlation indicates that if employees perceive blockchain as a secure technology, they are more likely to judge it as a less risky technology (trust). Finally, SEC is suggested to have a significant relationship with EX. In other words, the more blockchain is perceived as more secure and provides more privacy, the more employees expect it to be easier to use.

SEC is expected to directly affect 1) PE, 2) trust and 3) EX. These three variables were hypothesised to directly affect blockchain acceptance (see H1, H2a and H5a). Hence, the three variables are expected to mediate the relationship between SEC and BI (Hair et al., 2022). In other words, SEC is expected to affect blockchain acceptance through PE, trust and EX. These expected indirect effects of SEC and BI might be single or serial (Zhao et al., 2010; Hair et al., 2021; Nitzl et al., 2016; Hair et al., 2022). An example of a single-indirect connection is the effect of SEC on BI through PE. The serial-indirect example might occur when SEC significantly affects trust, which may significantly affect PE, which is expected to directly affect blockchain acceptance. These mediating relationships are implicitly and considerably investigated in this study.

Prior studies have reported that SEC has significant connections with UTAUT antecedents. Concerning blockchain investigation, the SEC of blockchain has been discovered in previous studies to significantly and positively influence the BI to use blockchain. This result has been found in various settings, including SMEs (Khazaei, 2020) and the HEIs industry (Alomari & Abdullah, 2023). Alomari and Abdullah (2023) examined cryptocurrency usage among students in the HEI sector. Moreover, recent scholars have found SEC to significantly and positively affect PE in various sectors, such as tourism (Sarnacchiaro et al., 2024; Chang et al., 2022). Studies investigating blockchain have also uncovered a significant

and positive relationship between SEC and trust in HEIs, tourism and other industries (Lee et al., 2019; Sarnacchiaro et al., 2024). Finally, Chang (2022) found a significant and positive relationship between the SEC of blockchain and EX concerning the tourism industry.

H6A. SEC of blockchain has a significant and positive impact on the BI to use blockchain among HEIs' employees in KSA.

H6B. SEC of blockchain has a significant and positive impact on the PE, which was hypothesised to affect BI to use blockchain among HEIs' employees in KSA.

H6C. SEC of blockchain has a significant positive impact on trust, which was hypothesised to affect BI to use blockchain among HEIs' employees in KSA.

H6D. SEC of blockchain has a significant and positive impact on the EX, which was hypothesised to affect BI to use blockchain among HEIs' employees in KSA.

2.6.4.7 Awareness

AW is a critical factor in determining the acceptance or rejection of blockchain technology among employees who work in HEIs. *AW* is defined as 'user's knowledge about the capabilities of a technology, its features, potential use, and cost and benefits' (Rogers, 1995, p.372). This definition is applied to this study.

AW of blockchain is anticipated to be a necessary factor for its adoption. Regarding blockchain technology and its applications, AW among individuals is still in an early stage, particularly in KSA (Mansoor et al., 2023; Zhang et al., 2023; Adaryani et al., 2024). In case of insufficient AW of blockchain, employees are anticipated to resist its adoption (Yaqub et al., 2013). Indeed, some researchers found that a lack of AW causes slow adoption of various technologies among employees (Khazaei & Khazaei, 2016; Khazaei, 2020). Thus, AW is anticipated to significantly influence blockchain acceptance among administrative and academic employees within the KSA HEIs industry.

Not only is it expected to impact the BI directly, but AW may moderate the relationships between UTAUT determinants and BI. AW is expected to significantly alter the relationships between UTAUT antecedents (i.e., PE, EX, SI and facilitating condition) and the BI to use blockchain. This anticipation of significant change between the UTAUT antecedents and blockchain acceptance is related to the nature of UTAUT antecedents. UTAUT antecedents are related more to the individuals' perception and beliefs toward a system. So, the AW of a system's capabilities and features is expected to significantly impact the relationship between these perceptions and the acceptance of that system. With PE, for instance, the more AW of

blockchain, the more AW affects the relationship between the perception that blockchain will enhance their job performance (PE) and BI. Similarly, the more employees are aware of blockchain's capabilities (AW), the more the relationship between EX and BI is affected. These two examples apply to SI and FC. Therefore, AW is expected to be a significant moderating variable between UTAUT antecedents and BI to use blockchain.

So, this study expects AW to be an exogenous and moderating variable at the same time. Playing a dual role is typical in academia, as previous studies have investigated diverse constructs as exogenous and moderating variables. For instance, Hamdani (2019) examined the impact of experience on the perceived usefulness and as a moderator between subjective norms and behaviour of use. Therefore, it is necessary to investigate AW's direct effect on BI and its moderating direct effect between UTAUT antecedents and BI.

Starting with its predicting role, AW of blockchain is more likely to have a significant and positive influence on blockchain technology adoption among HEIs' employees in KSA. It could be alleged that employees' lower AW of blockchain technology is considered one of the most significant barriers to adopting blockchain (Sadhya & Sadhya, 2018). Flowingly, the higher AW of blockchain is considered one of the most significant drivers of blockchain adoption among administrative and academic staff in HEIs (Abubakar et al., 2013). Hence, this study argues that the more employees are aware of blockchain, the more they accept blockchain. To interpret this relationship as pertinent to this study, the more administrative employees and faculty members know about blockchain presence, features, effort to use, and utility, the more likely they will accept its use. Therefore, AW is likely to have a significant and positive effect on BI.

In addition, AW is likely to have a significant moderating effect between UTAUT antecedents and BI. Initially, this study proposes that AW of blockchain significantly moderates the relationship between PE and BI. This moderation effect indicates that employees' knowledge about blockchain's capabilities, characteristics, benefits, ease of use and cost (AW) significantly influences the relationship between employees' perception that blockchain enhances their job performance (PE) and their acceptance of blockchain (BI). Likewise, AW is anticipated to significantly influence the relationship between the degree of blockchain easiness to use (EX) and blockchain acceptance. Similarly, the relationship between the extent of employees' perception that important ones believe they should use blockchain (SI) and BI would be significantly affected based on their AW of blockchain. Finally, the correlation between the perception of employees regarding the extent of the HEIs' organisational and technical support following the adoption of blockchain (facilitating condition) would be significantly affected by the AW of blockchain.

Recent studies have found AW to significantly and positively affect technology's acceptance concerning the HEIs industry. Regarding HEIs, Anthony et al. (2023) found AW to significantly and positively affect academics' acceptance of blended learning. In addition, AW has been found to significantly moderate the relationship between PE and BI to use blockchain technology (Kumari et al., 2023). More generally, previous studies found AW to significantly affect BI to adopt various technologies in diverse sectors (Charbaji & Mikdashi, 2003; Rehman et al., 2012; Bu et al., 2021; Mensah & Khan, 2024; Dinev & Hu, 2007a). Relatedly, it is not uncommon in previous studies to add independent variables as moderators (Shin, 2009; Zendehdel & Paim, 2015). For instance, Wu et al. (2008) employed education construct as a moderator in the UTAUT model. Besides, previous studies have found AW to have a significant impact as a moderation role between BI and UTAUT's constructs (Daniali et al., 2022; Omar & Ala'a, 2011; Kumari et al., 2023; Al-Azizi et al., 2018). Therefore, the following is hypothesised:

H7A AW of blockchain has a positive and significant impact on the BI to use blockchain among HEIs' employees in KSA.

H7B AW of blockchain significantly moderates the correlation between performance expectations and the intention to adopt blockchain.

H7C AW of blockchain significantly moderates the correlation between effort expectations and the intention to adopt blockchain among HEIs' employees in KSA.

H7D AW of blockchain significantly moderates the correlation between SI and the intention to adopt blockchain among HEIs' employees in KSA.

H7E AW of blockchain significantly moderates the correlation between FC and the intention to adopt blockchain among HEIs' employees in KSA.

2.6.4.8 Behavioural Intention

BI to use a technology is a central antecedent in previous theories concerning technology acceptance, such as UTAUT, TAM and TPB (see Section 2.5). According to Fishbein and Ajzen (1975), BI is defined as the users' goal or purpose in carrying out the behaviour. In the present study, BI indicates employees' acceptance of the utilisation of blockchain applications in HEIs in KSA. In other words, the employees' intention to accept blockchain technology's usage (or continued usage) within their HEIs tasks.

2.6.5 The Proposed Framework

Following the previous discussion, Figure 7.0 demonstrates this study's proposed conceptual model. The model reflects the proposed hypotheses conceptually. The antecedents of UTAUT are highlighted in the orange boxes. Meanwhile, the additional constructs in this study are represented in blue boxes. The hypotheses are illustrated along the paths by connecting independent and dependent variables. For instance, H1 in the figure represents the hypothesis concerning the potential influence of PE on BI. This example applies on the other paths and hypotheses within the model.

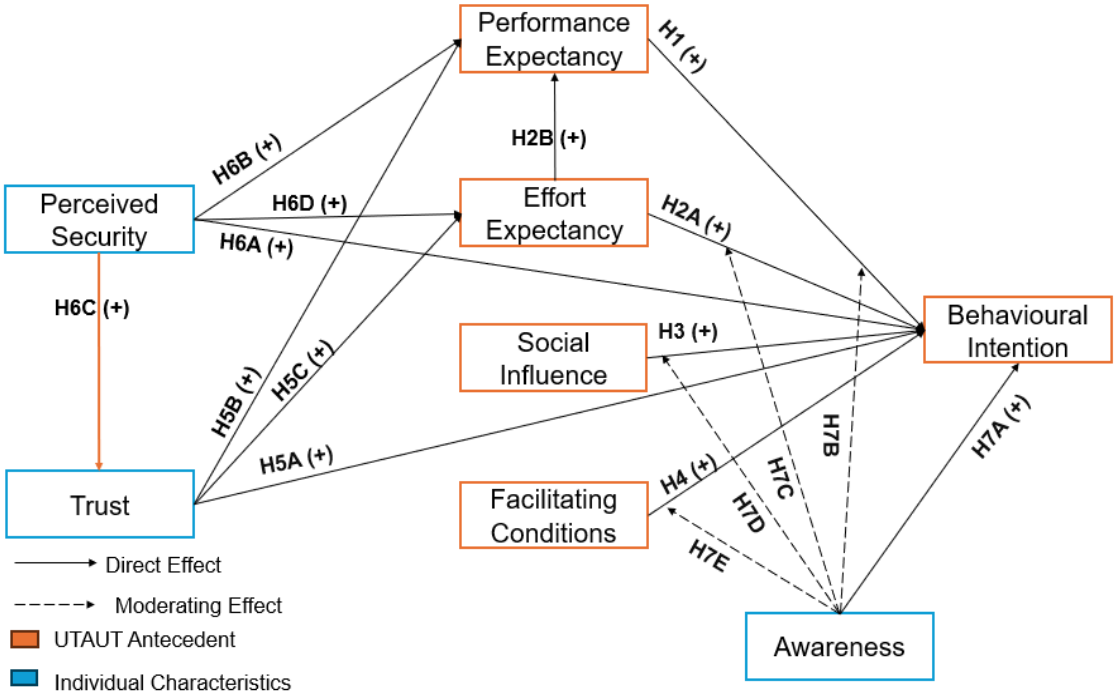

Figure 7.0 The Proposed Conceptual Framework

2.7 Conclusion

This chapter mainly discusses three areas, i.e., blockchain technology, the HEI sector, and the proposed framework.

Starting with blockchain technology, this chapter began with defining blockchain and describing its types. To link blockchain with HEIs, this chapter went through the importance of blockchain for HEIs. Also, this chapter represented how blockchain may benefit HEIs and what challenges may occur with implementing blockchain technology in HEIs. This chapter has carefully aggregated and presented Blockchain-based applications and frameworks, considering the aforementioned benefits and challenges. The use cases of blockchain in

education resulted in figuring out that blockchain might mainly be adopted blockchain in five areas. These areas relate to credential management, financial management, recording and sharing data, recruiting, copywriting and assessments. Next, KSA, as the context of this study, was discussed in relation to blockchain in HEIs. Specifically, this chapter involved the reason behind selecting Saudi Arabia as the context for implementing blockchain and why HEIs in KSA particularly need the adoption of blockchain technology.

Subsequently, technology adoption was introduced by listing existing relevant theories. This presentation ended up choosing UTAUT as the underpinning theory of the present study. From a theoretical lens, UTAUT selection was justified, resulting in specifying areas of improvement related to UTAUT. This area of improvement was related to the lack of technological aspects that affect BI. For this primary reason and based on the road map by Venkatesh et al. (2016), UTAUT was extended by adding individual characteristics related to blockchain. This enhancement mainly proposed the constructs that were investigated in this study.

The constructs of this study were reviewed across previous academic journals to determine the gaps in the present study. The review was related to blockchain technology, HEI sector, participants and context. Each element was reviewed separately. For instance, the empirical findings of blockchain adoption were reviewed across various industries (not only HEIs). Meanwhile, HEIs industry was reviewed concerning diverse technologies (not only blockchain). In addition, academic and administrative staff, as the participants of the present study, were reviewed in relation to UTAUT and individual characteristics. Finally, the blockchain and other technologies' adoption in HEIs was discussed in KSA. Each element represents a gap this study addresses.

Based on this review and the identified gaps, hypotheses were developed to demonstrate the direct and indirect relationships between this study's constructs. These relationships were exhibited in the proposed conceptual framework.

In light of the proposed conceptual framework, the following chapter discusses the employed methodology to collect and analyse data related to the framework.

Chapter 3: Research Methodology

3.1 Introduction

The current chapter deliberates the research methodological approaches used in the present research to collect data and test the proposed framework and hypotheses. This chapter mainly incorporates research philosophy, research design, data collection and data analysis.

3.2 Research Philosophy

Philosophical assumptions should be identified during research conduction. Research philosophy indicates ‘a system of beliefs and assumptions about the development of knowledge’ (Saunders et al., 2019, p.130). Determining the philosophical assumptions assists in justifying the selection of the suitable research method (e.g., qualitative, quantitative or mixed methods) (Creswell & Creswell, 2018). According to Bell et al. (2019), philosophy enables researchers to investigate the underlying assumptions about reality. The authors remarked that philosophy in social science concerns three spheres- ontology, epistemology and research strategy. Bell and others describe it as individuals’ perceptions of the best way to conduct research based on ontological and epistemological assumptions (Bell et al., 2019).

3.2.1 Ontological Considerations

Ontology discusses ‘assumptions about the nature of reality’ (Saunders et al., 2019, p.133). Bell et al. (2019) stated that ontological assumptions assist in determining what the subject that researchers attempt to understand is. Further, it assists in determining how reality can be attained. Bell and others argue that comprehending the researcher’s ontological assumptions leads to a more effective design of the research study.

Objectivism has a noteworthy influence on ontological and epistemological assumptions (Bell et al., 2019; Saunders et al., 2019). Objectivism reflects the standing philosophical position of this study. Bell et al. (2019) emphasised that objectivism suggests the existence of social phenomena as external facts regardless of our awareness of their existence. In other words, these phenomena have objective realities that are out of researchers’ scope. Ontologically, realism reflects the extreme form of objectivism, whereby social actors (e.g., HEI’s employees) ‘independently of how we think of them, label them, or even of our awareness of them’ (Saunders et al., 2019, p.135). Also, Saunders et al. (2019)

highlighted that objectivists, in their realism-ontological stance, believe in the existence of only actual social reality. Objectivism is adopted as the ontological assumption of this study. By implementing the objectivism-ontological stance in the present research, HEIs' employees in KSA are considered social entities that act independently from the researcher's thoughts, assumptions, and so on (Saunders et al., 2019). The ontological assumptions in the present research contain four assumptions pertaining to HEIs, employees and factors that affect the adoption of blockchain among employees. Firstly, this study assumes that all HEI objects obtain their rules and regulations regardless of the researcher's awareness. Moreover, the targeted employees have tasks to conduct within these HEIs. Further, there are individual and technological factors that drive employees to accept or reject the adoption of new technologies, such as blockchain technology, in HEIs. Finally, employees are presumed to be the ultimate users in the case of adopting the blockchain technology application within the HEIs.

In more detail, this study assumes the existence of physical or regulative objects in Saudi HEIs, which includes employees who are current or prospective users of blockchain technology. Moreover, it assumes that blockchain-based applications have some mutual characteristics that might lead employees to accept or reject blockchain adoption within the HEIs context. In case of rejection, the adoption process in HEIs is highly likely to fail. These assumptions have been backed by previous theories, previous literature's arguments and findings, and individual renowned authors' stances (e.g., Venkatesh, 2003). The mutual characteristics of blockchain-based applications, for instance, have been determined based on industrial and academic renowned authors in the field of blockchain (see 2.1.2). Likewise, the individual factors that lead HEIs' employees in KSA to accept or reject the adoption of blockchain have been mainly derived from UTAUT constructs. Hence, the ontological stance in this study is that the individual characteristics that might lead to accepting or rejecting blockchain adoption within HEIs do exist and, thereby, will be investigated in the present study.

3.2.2 Epistemological Consideration

Epistemology in social science refers to assumptions about knowledge (Saunders et al., 2019, p.133). Bell et al. (2019) observed that the epistemological stance follows the logic of the ontological position. The authors stated that the epistemological position stems from our understanding of how researchers can attain knowledge of that reality.

In the present research, the objectivist stance is associated with epistemological considerations. Saunders et al. (2019) stated that the epistemological assumptions concern how knowledge can be attained. Also, the authors determined that objectivists attain their

assumptions from natural scientists. Thus, building on previous scholars in the field (e.g., Venkatesh et al., 2003), knowledge could be attained from the HEIs' employees by direct or indirect observation (Bell et al., 2019). The observation procedure of this study's data is without any type of interference. Meanwhile, the indirect observation is neglected in the present study. A concrete research design and techniques are employed in the current research to contribute to the body of knowledge.

The positivism paradigm is followed in the current study as the epistemological stance (Bell et al., 2019). Saunders et al. (2019) indicated that positivism entails researching perceptible social reality to uncover generalisable spottings. The authors asserted that the positivist position indicates the importance of what is given. To clairfy, Saunders and others reported that positivists strictly design an empirical method to yield unbiased and uninfluenced data. In the present study, there is no influence concerning the collection or analysis procedures/approaches of the gathered data in any way. Further, this study aims to generalise the findings on the population of HEIs' employees in KSA. Hence, positivism is the pursued stance in the current research. The following section justifies the selection of the positivist position in more detail.

3.2.3 Research Paradigm

The philosophical worldviews are designated in some studies as paradigms (Creswell & Creswell, 2018), which create an intersecting relationship between paradigms and philosophical assumptions. Paradigm may reflect more practical stances as it explicitly identifies the phenomenon that should be studied in a particular subject, how to study it and how to interpret the results (Bryman, 2016). Indeed, it enables the researcher to be more concrete about his philosophical assumptions (Bell et al., 2019). As shown in the previous section, the present research embraces the positivism paradigm as an epistemological position. This approach was determined based on the following factors, as suggested by John W. Creswell and Creswell (2018):

***Deductive approach**:* Previous studies emphasise that the positivist paradigm is associated with the deductive approach (Saunders et al., 2019; Sekaran & Bougie, 2019; Bell et al., 2019; Creswell & Creswell, 2018). *Deductive reasoning* is the predominant strategy that supports the connection between theory and research (Bryman, 2016). According to Bell et al. (2019), researchers deduce their hypotheses based on their theoretical considerations. Accordingly, the authors suggest that researchers should specify the data collection method related to the developed hypotheses. Following the data collection, researchers should present their findings, hypotheses; results (confirmed or rejected) and end up revising their

theory (Bell et al., 2019). Figure 8.0 represents the process of deduction followed in the present research based on Bell et al.'s suggestion.

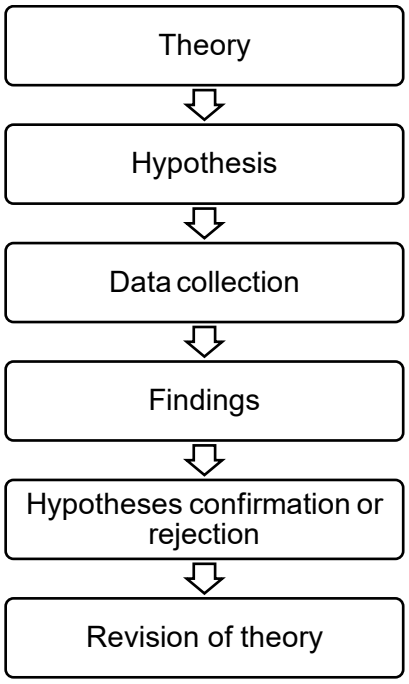

Figure 8.0 Progress of Deduction Derived from Bell et al. (2019)

In applying the above Figure, the present study builds a conceptual framework based on UTAUT, additional individual characteristics and AW as a moderator. Based on the theoretical considerations that were justified in more detail previously in the present study, hypotheses will be deduced and empirically tested. The data-collection approach and the analysis of the current study will be determined in the methodology chapter. After obtaining the required data, the findings will be presented in the following chapter; the hypotheses will be confirmed or rejected. Finally, the conceptual framework will be revised accordingly, if needed.

***Quantitative research**:* By building on ontological and epistemological assumptions and the research strategy (i.e., deductive), the methodological choice could be quantitative, qualitative or mixed methods (Saunders et al., 2019). Quantitative research is usually associated with the deductive approach (Bell et al., 2019). The research design in the present research is quantitative research, which is commonly related to positivists' assumptions (Creswell & Creswell, 2018). Typically, positivists employ quantitative research to test objective hypotheses by investigating the relationship between dependent and independent variables. Researchers are perceived as positivists if they use statistics and hypothesis testing (Myers, 2019). Additionally, previous studies have based their investigations on UTAUT have conducted quantitative research (e.g., Alazab et al., 2021; Dwivedi et al., 2017; Queiroz &

Fosso Wamba, 2019). Further, previous studies investigating employees' acceptance of a technology have utilised a quantitative approach (e.g., Ayaz & Yanartaş, 2020; Magni et al., 2021; Queiroz & Fosso Wamba, 2019). Similarly, previous studies have employed a quantitative approach while applying a UTAUT in investigating employees' adoption of a technology within the education realm (e.g., Sarabadani et al., 2017). Therefore, this study selects the quantitative approach based on the ontological and epistemological positions, methodological position and following relevant previous studies. In other words, this study explores the research problem of the present research by implementing a quantitative approach to collect data from administrative staff and faculty members who work in HEIs in KSA. Thus, this research applies positivism as the research paradigm, which leads to the methodological choice of quantitative research.

Cause and effect law: According to Sekaran and Bougie (2019), positivists view scientific research as the way to acquire truth. Indeed, they believe that there is objective truth in the world. Sekaran and Bougie articulated that controlling and foreseeing this truth is how positivists understand the world. The world works by the mechanism of cause and effect. In the present study, the research problem of employees' actual use of blockchain is caused by independent variables. Hence, the constructs that affect the employees' utilisation of blockchain technology applications are empirically explored.

Statistics: In analysing quantitative data, positivists usually utilise complex statistical techniques and instruments (Sekaran & Bougie, 2019; Creswell & Creswell, 2018). In the current study, the Structural Equation Modelling (SEM) statistical technique will be utilised to examine the developed framework and test the hypotheses.

The research paradigm is employed in this study to connect the above-mentioned philosophical stances with the following research design. In other words, the following section fosters the discussion of the philosophical stances and research paradigm.

3.3 Research Design

After justifying the positivist research paradigm, this section concerns the research design. Bell et al. (2019) described research design as 'a framework for generating evidence that is suited both to a certain set of criteria and to the RQ that is being addressed' (p.44). Bell et al. (2019) noted that research design is the execution guideline of the selected strategy in specific research (e.g., qualitative or quantitative). In other words, Sekaran and Bougie (2019) observed that research design assists in empirically collecting, measuring and analysing data developed to answer the RQs. Sekaran and Bougie remarked that research design involves

research strategy and cross-sectional studies as the main elements. Therefore, this section discusses the selection of quantitative approach and cross-sectional studies as a further step toward addressing the RQs.

3.3.1 Quantitative Approach

Quantitative methods is a distinct research strategy (Bryman, 2016). By expanding the aforementioned research paradigm, this study's research design adopts the quantitative approach. This section discusses the angle of selecting the quantitative approach in alignment with the research paradigm. The quantitative approach was described by Bryman (2016) as a process that involves:

- Gathering of numerical data.
- A deductive viewpoint of the correlation between theory and research.
- A tendency for a natural science approach (particularly for positivism).
- An objectivist concept of social reality.

Align with the research paradigm (see 3.2.3), and as recommended by Bryman (2016), the current study selects quantitative research for the following factors:

Quantitative theory: UTAUT derived from Venkatesh et al. (2003) basically underpins the current model. Previous studies that have based their studies on UTAUT have conducted quantitative research (e.g., Alazab et al., 2021; Dwivedi et al., 2017; Queiroz & Fosso Wamba, 2019). Moreover, previous studies investigating employees' acceptance of a technology have utilised a quantitative approach (e.g., Ayaz & Yanartaş, 2020; Magni et al., 2021; Queiroz & Fosso Wamba, 2019). Further, some previous studies have conducted a quantitative approach while applying UTAUT in investigating employees' adoption of a technology within the education realm (e.g., Sarabadani et al., 2017). Other justifications of this selection were discussed in the previous section- quantitative research.

Positivist paradigm: This component elaborates on the solid linkage between the positivist stance and the quantitative approach by justifying the selection of the quantitative approach through the positivist approach. In other words, the current research applies the positivism paradigm, which is more associated with the quantitative approach (Bryman, 2016). According to Saunders et al. (2019), employing the positivism paradigm in research should reflect being neutral in collecting and analysing data to avoid a personal impact on the findings. The authors contended that the neutral position is plausible because quantitative data collection requires measuring and using quantifiable data. The researcher of the present study attempts to detach himself from the research and data, aiming for a lack of personal influence

on the findings. Hence, the positivism paradigm leads to the selection of a quantitative approach, in addition to the selection of a quantitative approach in previous studies, as mentioned in the previous section (3.2).

Deductive approach: The present study framework primarily stems from the UTAUT framework and blockchain main characteristics, which direct the development of the research hypotheses. Thus, the current study benefits from the deductive approach, which is linked to quantitative studies (Saunders et al., 2019; Bryman, 2016).

Research aim: Quantitative is the most appropriate approach for a researcher who aims to determine factors that might affect an outcome (Creswell & Creswell, 2018). The current research aims to determine the factors that affect academics and administrative staff utilisation of blockchain technologies in HEIs in KSA. Hence, a quantitative strategy is implemented.

3.3.2 Cross-sectional Designs

Cross-sectional is the second element of research design. Sekaran and Bougie (2019) stated that cross-sectional data are only collected once; it could be over a certain period of days, weeks or months. For instance, the collecting time of the present study takes approximately four months, from 20 May 2023 to 09 September 2023. The purpose of cross-sectional studies, as mentioned by Sekaran and Bougie, is to answer the RQs. The authors assert that cross-sectional design is the most dominant in literature due to financial cost limitations, time restrictions and the needed effort. Additionally, this study aims to generalise the findings, which has a solid linkage with using a cross-sectional design (Bell et al., 2019). Therefore, this study employs the cross-sectional design as the data are collected once and over a specific period of months.

3.4 Data Collection

In the present study, a sample of current administrative and academic employees who work for HEIs in Saudi Arabia will be surveyed to determine the factors that lead them to accept or reject the adoption of blockchain-based applications. To collect the data using a solid technique, the following sections discuss the survey method, the targeted population, sampling techniques and procedures, questionnaire items development, pilot testing and ethical considerations.

3.4.1 Survey Method

A survey is one of the most commonly employed tools in collecting data involving people (Sekaran & Bougie, 2019). It is defined as 'a system for collecting information from or about people to describe, compare, or explain their knowledge, attitude, and behaviour' (Fink, 2003, p.1). As an outcome, surveys produce a 'quantitative description of trends, attitudes, and opinions of a population, or tests for associations among variables of a population, by studying a sample of that population' (Creswell & Creswell, 2018, p.147). Creswell and Creswell (2018) suggest that RQs that aim to address the relationship between variables should consider employing a survey design. This suggestion applies to the present research as it investigates the variables that might impact the acceptance of blockchain among HEIs' academics and administrative employees in KSA.

Surveys can be collected face-to-face, electronically, by telephone, or by mail (Sekaran & Bougie, 2019). According to Sekaran and Bougie (2019), 'online questionnaires are usually created as 'Web forms' with a database to store the answers and statistical software to provide statistical analysis' (p.144). Web surveys are performed by asking prospective participants to access a website where the questionnaire can be viewed and completed (Bryman, 2016). Sekaran and Bougie (2019) assert that online survey tools such as Google Forms make collecting data online more convenient. Although an online survey, as an instrument, is unsuitable for all studies (Sue & Ritter, 2012), it is a valuable tool due to its advantages in saving time and financial costs (Wright, 2005). Employing a web survey tool is particularly beneficial for the present research because the prospective respondents are distributed in different geographical areas (Sekaran & Bougie, 2019; Sue & Ritter, 2012).

The present study employs an online questionnaire tool method to collect data from academic and administrative staff who work for HEIs in KSA for various reasons. According to Sekaran and Bougie (2019), this tool decreases the financial and time costs compared to other tools, such as interviewing. The authors noted that questionnaires could be administrated personally or online. They suggest conducting the survey personally if the questionnaire is restricted to one local area, which does not apply to the current study. Sekaran and Bougie (2015) recommend employing online questionnaires when 1) it is challenging to reach the targeted sample personally and 2) the participants are dispersed across a wide geographical area. These two factors apply to the present study, as it is challenging to reach the targeted participants personally and participants are distributed in a wide geographical area of Saudi Arabia. In addition, online surveys could be implemented through tools such as Google Forms, Qualtrics and other platforms (Creswell & Creswell, 2018). In the present study, the online survey will be mainly adopted by employing Google Forms due to free accessibility, ease of

use, security and permanent saving of the data. To highlight, the data will be secured by Google and will not be removed after a specific period of time. Accordingly, the questionnaire will be sent to Jouf University for dissemination (see Section 3.4.4).

Therefore, this study addresses the RQs by employing an online survey tool (Google Forms) to collect data from administrative staff and faculty members in HEIs to determine the enablers and inhibitors of blockchain acceptance. The development of this survey is discussed in section 3.4.5.

3.4.2 Population Identification

Population is the whole number of units from which the sample is extracted (Bryman, 2016; Bell et al., 2019; Hair et al., 2016). The 'units' terminology involves humans, cities, firms, regions and so forth (Bryman, 2016; Bell et al., 2019).

The total number of participants, where the sample is derived for this study, is determined. Derived from the Ministry Of Education (2015), to the best of the author's knowledge, the most recent statistics of the targeted respondents demonstrate that the entire teaching staff in Saudi HEIs are around 77,000. Moreover, the same statistical report indicates that the administrative and technical staff are approximately 76,600. Although not targeted in the current study, technical staff are not distinguished from the administrative staff in the Ministry of Education's (2015) report. Hence, including the technical staff, the targeted population comprises approximately 150,000 administrative and teaching staff who work for HEIs in KSA. The technical staff are excluded from the current study because the investigated blockchain applications do not clearly show a direct impact on their job tasks.

In characterising the population, the targeted population consists of administrative and academic staff who work for HEIs in KSA. More importantly, they must be current or potential users of blockchain applications in case of having blockchain implemented in the system of HEIs they work for. HEIs in KSA consist of public universities (28), private universities, institutions and colleges (42), which equals 71 HEIs in total (Ministry Of Education, 2022a, 2022b). The author of this project will attempt to send the survey to all the administrative employees who work for the 71 HEIs in KSA. However, sending the survey does not reflect that the aim is to receive answers from all the targeted samples, as the targeted number of respondents is 384 or more, as discussed in Section 3.4.4. It is possible that, due to technical or administrative obstacles, some HEIs do not receive the survey and have it distributed among their employees. Indeed, it is also possible that due to administrative and/or technical considerations, the survey may not reach to some HEIs' employees. For instance, employees

who have difficulties in accessing the internet during the period of disseminating the survey may find it challenging to participate in the survey. These are difficult-to-avoid limitations of using an online survey tool (Bryman, 2016). Nevertheless, the followed online dissemination method had many advantages, including getting faster responses, eliminating geographical limitations, lowering costs and obtaining better data accuracy (Bryman, 2016). In the present study, a sample of current administrative and academic employees who work for HEIs in Saudi Arabia will be surveyed to determine the factors that lead them to accept or reject the adoption of blockchain-based applications. To conduct the survey using a solid technique, the following two section discusses scientifically justified sampling techniques and procedures.

3.4.3 Sampling Techniques

Sampling is described as 'the segment of the population that is selected for investigation' (Bell et al., 2019. p.188). Sampling aims to 'find information, and reach a conclusion, representative of some larger population' (K. Punch, 2014, p.284)**.** One might contend that surveying the whole population (census) is the only practical approach to accomplish the purpose of a research paper (Punch, 2014). However, the census approach is a highly resource-intensive task (Andrews et al., 2003) and frequently beyond the capability of a typical researcher (Punch, 2014). Moreover, surveying the entire population can cause high financial costs and slow data collection. Gathering information from a representative sample can overcome these issues by decreasing financial expenses and speeding up data collection (Punch, 2014).

Quantitative research researchers should typically sample their population (Bryman, 2016). According to Sue and Ritter (2012), sampling a population diverges into probability and nonprobability techniques. The authors define *probability samples* as 'the probability of each participant's inclusion can be computed' (p.36). Further, this method is suggested for researchers to select a representative sample, as its findings are generalisable (Hair et al., 2016). Sue and Ritter (2012) stated that probability sampling could be for closed or open populations. Sue and Ritter classified closed populations into simple random, systematic, cluster and stratified, while the open populations were classified into intercept and prerecruited panels. Table 4.0 reflects potential sampling techniques a researcher might adopt.

Table 4.0 Sampling Methods and Techniques

Methods	Techniques	Definitions
Probability Sampling Method (For Closed Population)	Simple random	Every individual/unit in the population has an opportunity to participate in the study.
	Systematic sampling	The researcher starts randomly with an element from a sample list and selects every n^{th} element of that population.
	Stratified sampling	It consists of two stages: 1. Dividing the population into strata (subgroups); 2. Selecting either a simple random or systematic sample for each subgroup (e.g., age).
	Cluster sampling	It refers to pre-existing group in a specific population (e.g., classes in a school). It involves the following set of procedures: • Dividing the target population into clusters; • Drawing or selecting a random sample of clusters; • From the selected clusters, including in the sample, which entails all or part of the selected clusters' elements.
	Multistage cluster	Involving more than one stage within the cluster sampling.

Probability Sampling Method (For Open Population)	Intercept sampling	Inviting participants to be involved in a survey by using online pop-up windows.
	Prerecruited panel	Using various tools (e.g., e-mail solicitation) to recruit a group of survey participants
Nonprobability Sampling (For Closed Population)	Convenience sampling	'Non-systematic approach to recruiting respondents that allows potential participants to self-select into the sample' (Sue & Ritter, 2012, p.44)
	Volunteer opt-in panel	Based on gathering a group of individuals who have volunteered to be involved in upcoming surveys.
	Snowball	Begins with identifying a participant, who refers to someone else, and the second participants suggest a new participant, and so on.

Retrieved from Bryman (2016); Creswell and Creswell (2018); Sekaran and Bougie (2019) and; Sue and Ritter (2012).

The previous Table shows the difference between probability and non-probability sampling methods, whereby every method includes different types. The probability method includes simple random, systematic random, stratified sampling, cluster sampling and multi-stage sampling. On the other hand, the non-probability sampling involves intercept sampling, prerecruited panel, convenience sampling, volunteer opt-in panel and snowballing. The Table also briefly describes each type of probability and non-probability method. According to Hair et al. (2020), the probability sampling method is implemented in quantitative research, whereas the non-probability sampling method is implemented in qualitative research. The authors recommended careful consideration in selecting the sampling design, which will be highlighted in the following section.

3.4.4 The Sampling Procedure

Determining the suitable sampling method and sampling technique is significant in ensuring the accuracy of the findings. The determination procedure depends on multiple factors, including but not limited to the research aim, previous studies, the nature of the research and the time and financial costs (Hair et al., 2016). Simple random sampling deals with giving every prospective participant the opportunity to participate in a study. Bryman (2016, p.176) stated that 'with random sampling, each unit of the population has an equal probability of inclusion in the sample'. S*imple random sampling* is described as 'a straightforward method of sampling that assigns each element of the target population an equal probability of being selected' (Hair et al., 2020, p. 185). Based on the descriptions of Bryman (2016) and Hair et al. (2020) of random sampling along with following previous studies of blockchain adoption (e.g., Malik et al., 2021; Kamble et al., 2019), it could be argued that the present study's most suitable probability sampling technique is the simple random sample.

The present research attempts to generate a representative sample to generalise the findings. According to Hair et al. (2020), obtaining a representative sample requires following a set of explicit procedures. Thus, the following stages represented in Figure 9.0, as derived from Hair et al. (2020), reflect the suggested procedures to develop a representative sample.

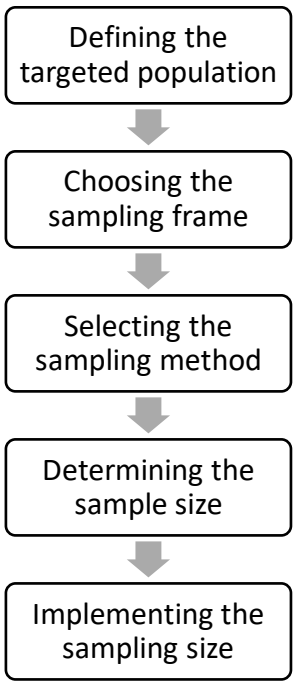

Figure 9.0 Representative Sample Procedure Derived from Hair et al., (2020, p.181)

Defining the targeted population: The targeted population of the present study are employees who work for HEIs in KSA. This section represents the inclusion and exclusion characteristics of HEIs in Saudi Arabia and the targeted employees.

Regarding the HEI sector, this study does not distinguish between public universities, private universities and colleges because they involve the targeted participants (employees) with similar characteristics. In other words, any institution that provides undergraduate or postgraduate programmes defined as higher education in Saudi Arabia is included in the present study. These programmes involve bachelor, diploma, master and PhD degrees in any field. On the other hand, institutions that only deliver training courses and do not end up awarding beneficiaries with undergraduate or postgraduate degrees are not part of the targeted HEIs. To be more precise, the mutually accepted HEIs' characteristics in this study are mainly represented in the (1) type (teaching undergraduates' students and/or above educational levels), (2) age (involving employees of different ages), (3) gender (employing different genders), (4) have faculty members and administrative staff within its official system and (5) have a system that has a potential implementation of blockchain applications (e.g., Internet).

In terms of the targeted units, the targeted employees involve administrative employees who work for an HEI in Saudi Arabia. The survey of the present study is aimed to be delivered to administrative employees who provide office services that might be affected by blockchain applications. For example, employees who provide services related to certificate management, human resources, finance, students' assessment and other students' services departments are part of the potential respondents in this study. The other targeted group are the academics who work for HEIs. The academic participants represent employees who mainly teach students and/or conduct research as part of their roles in the HEIs. They must be current or potential users of blockchain-based applications.

Employees who work for HEIs outside Saudi Arabia are excluded from this study. Also, employees who work in HEIs but are from external organisations, such as lawyers and consultants, are excluded from the targeted population. Further, technicians who work for HEIs and all employees who are neither current nor potential users of blockchain-based applications are excluded from the targeted population.

Selecting the sampling frame: Hair et al. (2020, p.183) defined the sampling frame as a 'comprehensive list of the elements from which the sample is drawn'. In other words, it is a list of all prospective respondents from which the sample will be randomly selected (Bryman, 2016). In the present research, accessing the employees' data without obtaining prior permission from each HEI could be considered by some or all HEIs in KSA as violating the

privacy law, which ultimately may harm the researcher and/or the participants. On the other hand, obtaining the regulative consent from each of the 71 HEIs in KSA is seriously challenging. It requires unaffordable time and effort by the researcher. Hence, this study did not obtain a list of employees due to privacy and administrative and regulative reasons.

Moreover, this study attempts to obtain anonymous responses from participants based on the ethical agreement between the researcher and Aston University Research Integrity and Ethics Committee. Acquiring a list of the participants may cause ethical concerns and raise questions of possible harm to the participants (see Section 3.4.7). Rather than acquiring a list of participants, the survey will be disseminated among the targeted respondents by a method that is argued to be more random and reliable.

This study attempts to address issues of not obtaining a list of the participants at hand and of attaining anonymous responses. This occurs by reaching the employees through a third party, i.e., Jouf University. Jouf University is located in KSA and is able to contact the participants anonymously without the author's involvement. The author of the present research is a lecturer at Jouf University, Saudi Arabia. This position enables him to distribute the questionnaire through Jouf University. To highlight, the researcher of the present study will contact the Deanship of Scientific Research (DCR) at Jouf University and ask them to disseminate the developed survey on his behalf to the targeted participants of the present study. Jouf University's DCR, hypothetically, can reach almost all the employees of the 71 HEIs. This is a substantial advantage that the researcher is taking, which makes the selection of the participants more random than selecting the participants from a sampling frame. The followed disseminating method is approved by DCR at Jouf University in Saudi Arabia and the ethical committee of Aston University, UK (see 3.4.7).

Choosing the Sampling Method: As discussed above, the selected sampling method is the probability sampling, and implementing the simple-random sampling technique. Hair et al. (2020) noted that selecting the sampling method should be mainly based on the nature of the study, the aim of the study, the time of the survey and the available budget. The authors divided the sampling methods into probability and nonprobability. Considering the nature and the aim of this study regarding the determination of factors that drive employees to accept or resist the adoption or the continuation of adopting blockchain in Saudi HEIs, the most suitable way is the probability-simple-random sampling technique. Further, the limited time and budget of the current PhD project significantly affect the selection of the simple random sampling. The researcher had four months to collect the data with a limited budget, which hindered him from disseminating the survey in various regions in Saudi Arabia.

It could be argued that the followed sampling approach does not affect the finances and time as Jouf University's DCR assists in disseminating the survey to the targeted participants for free. In response, the researcher has limited time (maximum four months) to receive the surveys. Respondents who filled out the survey after the determined time have been disregarded due to establishing the data analysis procedures. Besides, the researcher's limited budget hinders him from confirming the delivery of every survey to every employee in different regions in Saudi Arabia.

In the followed sampling method, the researcher follows a specific method for disseminating the survey among the targeted participants, which is through Jouf University's DCR (see Selecting the sampling frame). One may claim that the followed method is the Census method because all participants are expected to receive the survey. However, it is not confirmed that all participants have viewed, received or had the opportunity to participate in the survey. Some participants may not receive the survey for technical and administrative issues. For instance, some prospective participants may not have access to the Internet, while others may not have access to their HEI's systems (e.g., organisation's email) during the dissemination period. Similarly, some HEIs may not receive the survey due to technical issues, so they cannot disseminate it among their employees. It is also possible that some employees were on holiday, which may hinder them from receiving the survey. Such situations may hinder employees from receiving the survey, meaning that the online survey cannot be confirmed to reach all the prospective participants. Therefore, it does not reflect the Census sampling method.

Accordingly, it is confirmed that every participant has been given the same opportunity to participate in the survey by attempting to reach all possible employees randomly without determination or selection. This attempt aligns with the definition of the simple random sampling. Hence, the simple random sampling is selected in the current study considering the nature, the aim and the available time and budget (Hair et al., 2020). Therefore, it is alleged to be more random than previous and suggested random techniques in existing literature.

Determining the Sampling Size: Determining the adequate sample size is important prior to the data-collection phase to obtain a representative sample. According to Sekaran and Bougie (2019), sampling technique and sample size are critical for researchers who seek to generalise their sample. The authors argue that if a sample size is inadequate for the required standard of accuracy and confidence, researchers cannot accomplish their research objectives. As Sekaran and Bougie associated the sample size with the accuracy and confidence of one's research, the sample size is discussed carefully in this subsection.

Following Hair et al.'s (2020) suggestion, the current research aims to attain a 95% confidence level and no more than 5% margin of error. Likewise, Bryman (2016) suggested that the 95% confidence level reflects the possibility of generalising the result to the whole population. Indeed, Bryman (2016) stated that the increase in sample size is likely to reduce the sampling error. Hence, the present study aims for a representative sample size by obtaining 95 per cent or more of the confidence degree.

Research demonstrates various rules of thumb associated with determining the sample size. Choosing the appropriate and suitable sample size for one's study is challenging because there is no single solid rule to follow. However, determining sample size in this study is conducted based on the previously suggested rules related to the sampling method (i.e., random probability sampling) and the multivariate analysis technique. Rules related to the probability sampling include but are not limited to sample-to-item ratio, sample-to-variable ratio and ten-times rule (Memon et al., 2020). In addition, the multivariate analysis technique for the present study is the Partial Least Square Structural Equation Model (PLS-SEM). Following this affects the determination of the sample size (see 3.5). In other words, scholars have suggested different sample size methods associated with PLS-SEM, such as power tables by Cohen (1992, 1988) and Hair et al. (2021) and G*power software (Memon et al., 2020; Hair et al., 2021; Faul et al., 2009).

In the sample-to-item ratio approach, the number of items is the fundamental factor in determining the sample size (Memon et al., 2020). Previous studies have suggested the ratio to be greater than the ten-to-one ratio (e.g., ten observations for each item) (Sue & Ritter, 2012). Accordingly, the number of items is 27, implying that there is a need for at least 270 participants in this study.

Concerning the sample-to-variable ratio approach, the main factor is the independent variable (Memon et al., 2020). A researcher may apply of five-to-one, ten-to-one, fifteen-to-one or twenty-to-one ratio, the more the better (Nunnally, 1978; Hair et al., 2019). This study's framework involves seven independent variables (SEC, trust, PE, EX, SI, FC and AW). Therefore, the minimum required sample size is 140 with computing the twenty-to-one ratio.

Moreover, one of the most used and well-known criteria is the Krejcie and Morgan Table (Memon et al., 2020; Krejcie & Morgan, 1970). Memon et al. (2020) recommend using this Table for a simple random technique. Considering its popularity and following this recommendation, the sample size of this study takes Krejcie and Morgan's Table into considerable account. Krejcie and Morgan suggested that with a population of more than 100,000, the sample size should be 384 respondents. Following this suggestion, the appropriate sample size for this study is 384 participants.

Related to multivariate technique (e.g., PLS-SEM), a commonly used method is the 10-times rule by Barclay et al. (1995) (Memon et al., 2020). This rule suggests that the sample size should be ten times more than the estimated structural paths directly pointed to a specific latent variable in the structural model (Hair et al., 2022). In the present study's model, for instance, seven arrows are directed to the BI construct as the largest number of paths at a single latent variable. Hence, the total number of participants should be at least 70. Although this approach has been criticised by previous scholars (e.g., Hair et al., 2022; Marcoulides & Chin, 2013), it has been widely accepted in literature that applied PLS-SEM (Memon et al., 2020). Hence, based on the ten-times-rule, the minimum required sample size of this study is 70 observations.

It is recommended to employ the statistical power values of the statistical paths to determine the sample size (Hair et al., 2021; Kock & Hadaya, 2018). Statistical power refers to 'statistic's ability to correctly reject the null hypothesis when it is false' (Burns, 2008, p.244). The acceptable level of statistical power in social science research is 80 percent or more (Hair et al., 2022; Cohen, 1988; Memon et al., 2020). The power statistical assessment could be conducted through Cohen's (1992, 1988) recommendation, G*power tool by Faul et al. (2009) and Hair and others' (2021, 2022) minimum path coefficient Table.

The discussion of statistical methods that pertain to PLS-SEM begins with Cohen's (1992) guideline. It is employed to measure the sample size. By calculating the obtained numbers with the Cohen's related equations, the minimum sample size must be at least 76 respondents (Cohen, 1992).

Furthermore, statistical methods such as G*power could be applied to determine the sample size (Hair et al., 2021; Memon et al., 2020). Following Memon and others' (2020) steps, the G*power tool is utilised to determine the sample size of this study. This tool suggests at least 98 participants for the present tool.

However, the previous two methods to determine the sample size might propose too small number of participants (Kock & Hadaya, 2018). This note yields the proposal of the inverse square root method by Kock and Hadaya (2018), which was criticised and developed later by Hair et al. (2021). Hair and others' method is followed in this study to determine the sample size. Hair et al. (2021) mainly built their recommendation to determine the sample size based on the expected range of the minimum path coefficients and various significance levels. The minimum path coefficients must be related to the least significant finding. For instance, in the present study, the minimum path coefficient for a significant relationship between latent variables is 20.3% between the FC and BI (see 4.5.2.5). Following Hair et al. (2021), the minimum sample size in this case must be at least 155.

To conclude, previous discussion presented different methods to determine the minimum requested sample size for this study. Appendix K summarises these methods and the suggested minimum sample size. Based on the aforementioned methods, the highest suggested number of participants is 384. Although it was based on previous scholarly suggestions, low number of participants (e.g., 70) might be considered too low even with implementing the PLS-SEM approach (Brysbaert, 2019; Kock & Hadaya, 2018). The present study attempts to obtain no less than 384 participants, as this number is the most conservative and safe stance among the above-mentioned authors. It is safe because the more participants a study obtains, the more the sample size is likely to become more representative (Bryman, 2016). Thus, the present study obtains 394 observations in total.

3.4.5 Questionnaire Design

In designing the online questionnaire, this study follows Creswell's and Creswell's (2018) guidelines in relation to instrument (e.g., survey) development. This study's survey is associated with the proposed conceptual framework (See Figure 7.0). Creswell and Creswell suggest that instrumentation procedures encompass naming the questionnaire instruments, establishing the validity of the instrument's scores, demonstrating the reliabilities' scores, developing sample items, content of the instrument, pilot testing and administrating the survey. These phases are followed in this study.

***Naming the questionnaire instruments utilised in the study*:** This element is related to the suitability of the selected instrument to one's research (Creswell & Creswell, 2018). In the present research, the outcome variable is related to BI to use blockchain technology among employees. Following previous studies in the same field that have employed UTAUT (e.g., Doney & Cannon, 1997; Venkatesh et al., 2003; Pavlou, 2003; Jarvenpaa et al., 2000; Salisbury et al., 2001; Featherman & Pavlou, 2003; Misra et al., 2022; Kumar et al., 2023), the most suitable instrument is the Seven-point Likert scale based on employed items (see Appendices C and D) (Creswell & Creswell, 2018). The seven-point Likert scale assists in minimising the social reliability bias (Obienu & Amadin, 2021).

Validity of the instruments' scores: Creswell and Creswell (2018) suggest deriving the validity scores acquired from previous relevant studies that have employed the scales the researcher intends to use. The authors claim that the validity scores aid in recognising whether the selected scale is appropriate for their survey. In this study's survey, the research uses scales that have been mostly validated in prior studies. The UTAUT instrument-based items have been validated by Venkatesh et al. (2003). The trust items have been retrieved from Doney and Cannon (1997), and then validated by Jarvenpaa et al. (2000) and Pavlou (2003).

The security scales have been validated by Salisbury et al. (2001) and Featherman and Pavlou (2003). Similarly, blockchain-related studies have validated the use of a seven-point Likert scale ranging from strongly disagree (1) to strongly agree (7) (e.g., Wong et al., 2020). Hence, the questionnaire-based items instrument is validated by previous studies.

Regardless of the validation of previous studies, this study slightly modifies the validated items. This modification may reflect the need for additional validation. Therefore, face validity is conducted to confirm whether the items' concepts are delivered clearly (see 3.4.6.1).

***Reliability of scores*:** Creswell and Creswell (2018) referred to reliability as a scale's consistency or reproducibility. In the present study, the performed structure of reliability is the multi-item scale, leading to the selection of internal consistency. Creswell and Creswell consider internal consistency the most significant type of multi-item scale. The internal consistency of a scale is calculated by Cronbach's alpha value (α), which ranges between zero and one. The authors also state that the optimal value of a scale should range between .7 and .9. In the present study, the UTAUT internal consistency reliability ranged between .8 and .9 (Venkatesh et al., 2003). The trust factor scale's reliability averaged .9 in Pavlou's (2003) study. Further, the security's Cronbach's alpha average was found to range between .77 and .93 (Salisbury et al., 2001; Featherman & Pavlou, 2003). Hence, all the scale items of the current study ranged between .7 and .93, as reported in previous studies (Venkatesh et al., 2003; Pavlou, 2003; Featherman & Pavlou, 2003).

Nonetheless, this study conducts further reliability tests because the items have been modified to fit the blockchain technology (see Table 5.0). Also, the face validity test may cause additional adjustments to the items, which may influence the reported reliability tests that were reported in previous studies. Hence, a pilot study is executed whereby a new reliability test is conducted to confirm carefully considered reliability score that suits the present study and the targeted population (see 3.4.6.2).

Sample items: Creswell and Creswell (2018) suggest including the sample items in a Table to enable the readers to observe the actual utilised scales. Table 5.0 covers all the items used in the current study. This Table reflects the initial constructs before the face validity and pilot testing.

Content of the Questionnaire: Creswell and Creswell (2018) suggest that a study generally indicates the content section in the survey. Hence, this study's questionnaire mainly contains a cover letter, profiling questions, items and a confirmation message about completing the survey. Moreover, the current study follows a continuous scale, i.e., strongly disagree (1) to strongly agree (7), including the 'neutral' response (4).

In more detail, after the introduction page, the questionnaire includes questions that obtain basic personal and demographical characteristics, which enrich the results but do not lead to recognising the respondents' identities. The personal questions include whether the participant is a Saudi citizen or not to determine whether there is a difference between Saudi and non-Saudi participants in terms of accepting the use of blockchain. In addition, other profile questions include gender, age, job type (administrative employee or academic), experience and the HEI's name. These questions are derived because they support the study's practical contribution, namely, helping decision-makers minimise the failure of blockchain adoption. For instance, if the difference is significant between genders, age groups, and so on, decision-makers may take specific actions based on whether the blockchain users or prospective users are part of a particular group. That also applies to the HEIs' names, which will be encoded based on the regions of Saudi Arabia. For instance, Jouf University is in the Jouf region, which may significantly differ from the responses from another region (e.g., Riyadh). This example applies to all HEIs in different regions in Saudi Arabia.

In addition, participants will face a question in the survey about whether they use a blockchain-based application in their role at the HEI in KSA. Based on their answer (Yes or No), they will be directed to a suitable set of questions. If they are blockchain users, they will have to go through a direct set of questions. If participants are non-users of blockchain, they would be put in a scenario where they consider using blockchain applications in the future within their work. Based on this consideration, they will face the same questions that the users face but with different wording. For instance, while current users see the Trust1 "I find the blockchain applications useful in my job", the non-users encounter the same question as "I would find the blockchain applications useful in my job". This difference is because the blockchain user is likely to have acquired some knowledge of blockchain usage. At the same time, the non-users are potentially future users of blockchain without previous actual usage. However, the trust and security items are presented in the exact words for user and non-user groups. This similarity is because these two variables (trust and security) measure the perceptions of both groups (users and non-users) rather than the usage or expectation of usage, which are related to the UTAUT constructs.

***Administrating the survey**:* The present study disseminates the survey among participants with the assistance of Jouf University, which can reach the targeted audience more conveniently, randomly and reliably. For more detail, see 3.4.4.

Table 5.0 Constructs and Items of This Study

Construct	Original items	Code	Modified items	Source(s)
Trust	'This Web retailer is trustworthy'.	Trust1	Blockchain technology applications are trustworthy.	Jarvenpaa et al., (2000); Pavlou, (2003), p. 132
	'This Web retailer is one that keeps promises and commitments'.	Trust2	Blockchain technology applications help HEIs to keep their promises and commitments.	
	'I trust this Web retailer because they keep my best interests in mind'.	Trust3	I trust Blockchain technology applications at HEIs because they keep my best interests in mind.	
Security	'I would feel secure sending sensitive information across the World Wide Web'.	Sec1	I would feel secure providing sensitive information into a blockchain application.	Featherman and Pavlou, (2003), p. 471; Salisbury et al. (2001), p. 169
	'The World Wide Web is a secure means through which to send sensitive information'.	Sec2	Blockchain applications are a secure means through which to provide sensitive information	
	'I would feel totally safe providing sensitive information about myself over the World Wide Web'.	Sec3	I would feel totally safe providing sensitive information about myself over a blockchain application.	

	'Overall, the World Wide Web is a safe place to transmit sensitive information'.	Sec4	Overall, blockchain applications are a safe place to provide sensitive information.	
	'Internet hackers (criminals) might take control of my checking account if I used an XXXXX'.	Sec5	Internet hackers (criminals) might take control of my checking account if I used a blockchain application.	
UTAUT Constructs				
PE	'I would find the system useful in my job'.	PE1	I would find the blockchain applications useful in my job.	Venkatesh et al., (2003), p. 460
	'Using the system enables me to accomplish tasks more quickly'.	PE2	Using the blockchain applications enables me to accomplish tasks more quickly.	

	‘Using the system increases my productivity’.	PE3	Using the blockchain applications increases my productivity.	
	‘If I use the system, I will increase chances of getting a raise.	PE4	If I use the blockchain applications, I will increase chances of getting a raise.	
EX	‘My interaction with the system would be clear and understandable’.	EX1	My interaction with the blockchain applications would be clear and understandable.	Venkatesh et al., (2003, p. 460
	‘It would be easy for me to become skilful at using the system’.	EX2	It would be easy for me to become skilful at using the blockchain applications.	
	‘I would find the system easy to use’.	EX3	I would find the blockchain applications easy to use.	
	‘Learning to operate the system is easy for me’.	EX4	Learning to operate the blockchain applications is easy for me.	

SI	'People who influence my behaviour think that I should use the system'.	SI1	People who influence my behaviour think that I should use the blockchain applications.	Venkatesh et al., (2003), p. 46
	'People who are important to me think that I should use the system'.	SI2	People who are important to me think that I should use the blockchain applications.	
	'The senior management of this business has been helpful in the use of the system'.	SI3	The senior management of this business has been helpful in the use of the blockchain applications.	
FC	'I have the resources necessary to use the system'.	FC1	I have the resources necessary to use the blockchain applications.	Venkatesh et al., (2003), p. 46
	'I have the knowledge necessary to use the system'.	FC2	I have the knowledge necessary to use the blockchain applications.	
	'The system is not compatible with other systems I use'.	FC3	The blockchain applications are not compatible with other systems I use.	
	'A specific person (or group) is available for assistance with system difficulties'.	FC4	A specific person (or group) is available for assistance with blockchain applications difficulties.	

BI to use the system	'I intend to use the system in the next <n>months'.	BI1	I intend to use the blockchain applications in the next <n>months.	Venkatesh et al., (2003), p. 46
	'I predict I would use the system in the next <n>months'.	BI2	I predict I would use the blockchain applications in the next <n>months.	
	'I plan to use the system in the next <n>months'.	BI3	I plan to use the blockchain applications in the next <n>months.	
AW	'I follow news and developments about the spyware technology.	Aw1	I follow news and developments about the blockchain technology.	Dinev and Hu, (2007), p. 407
	'I discuss with friends and people around me security issues of Internet'.	Aw2	I discuss with friends and people around me about blockchain technology.	

	‘I read about the problems of malicious software intruding Internet users’ computers’.	Aw3	I read about the benefits and issues of blockchain technology.	
	‘I seek advice on computer web sites or magazines about blockahin applications’.	Aw4	I seek advice on computer web sites or magazines about blockahin applications.	
	‘I am aware of the spyware problems and consequences’.	Aw5	I am aware of the blockchain technology use benefits, problems and consequence.	
What do you think the most needed areas of improvement that could be enhanced by	Not Applicable	Area1	Credential Authentication and Revocation.	NA
		Area2	Financial exchanges between	
		Area3	Students and higher education institutions.	
		Area4	Online Learning Venues.	

applying blockchain technology?		Area5	Recruiting
		Area6	Copyright
		Area7	Assessments
		Area8	I do not Know
		Area9	All of the above

The previous Table includes the items used in the current study's questionnaire. The original items are totally derived from previous studies (i.e., Dinev & Hu, 2007; Featherman & Pavlou, 2003; Jarvenpaa et al., 2000; Salisbury et al., 2001; Venkatesh et al., 2003). The above Table shows the original items from the previous studies. These items have been modified to fit within the current study to be associated with the blockchain-based applications. However, the final question in the questionnaire was developed entirely by the author of the present research, aiming to answer one of the RQs and achieve one of the main objectives. This question concerns the areas of improvement that could be enhanced by implementing blockchain applications and software. The given answers to the last questions are derived from the literature of the current study by aggregating all possible blockchain applications that might develop HEIs. The previous Table reflects the initial development of the survey, which would be objected to experts' review from the targeted population (face validity) and reliability test, as discussed in the following section.

3.4.6 Pilot testing

Face validity and internal consistency are the validity and reliability tests conducted in this study. According to Hair et al. (2020), the pilot testing sample should be derived from the exact targeted participants. Also, the authors suggested that researchers should assess the validity and reliability of their questionnaires. Accordingly, the researchers should refine the questionnaire (Hair et al., 2020). Following their recommendation, the validity tests were conducted to reflect the pilot testing, and the items from the previous sections were modified. Hence, this section discusses the translation process of this study's developed survey, the face validity test, the reliability test and the implications of these tests on the present questionnaire.

3.4.6.1 Translation and Face Validity

The context of the current study is KSA, where the dominant language among administrative staff and faculty members is Arabic. Sekaran and Bougie (2019) claim that ensuring that an instrument (e.g., a survey) is translated into the language locals recognise is crucial. Besides, the Sekaran and Bougie suggest that the survey should be translated by an expert in the targeted context (e.g., KSA). Also, the authors advise paying attention to conceptual equivalence, which refers to the possibility that particular words have different meanings in diverse cultures.

The current survey will be issued in Arabic and English (see Appendices C and D), the first and second main spoken languages in KSA, respectively. Following Sekaran and Bougie's suggestion, a certified translation office in KSA will be selected carefully to translate the survey from English to Arabic. Accordingly, since the researcher comprehends Arabic and English efficiently and understands the meaning of every item in the survey, the translation will be validated by the researcher, and the conceptual equivalence will be taken into account. Finally, the translated questionnaire is sent back to the translation agency for lingual confirmation and stamping procedure. The author keeps the stamped official translation of the survey for both languages, which can be provided upon request.

In order to ensure that the items are understandable in both English and Arabic versions, a pre-testing of the developed instruments was conducted to affirm the face validity. Face validity confirms whether the items and scales in a specific survey measure the aimed content (Sekaran & Bougie, 2019). Validity should be examined by asking experts 'whether the measure seems to be getting at the concept that is the focus of attention' (Bryman, 2016, p. 158). Indeed, having ambiguous terminologies, words, phrases and statements in a survey's items could threaten the survey's validity (Sue & Ritter, 2012). Therefore, this study conducts face validity before distributing the survey among the targeted audience and experts in the field. In doing so, the items' validity was examined by requesting experts' feedback to confirm that the items do not include ambiguous statements (Bell et al., 2019; Sekaran & Bougie, 2019). Twelve experts from the targeted audience, who could speak Arabic and English, collaborated in testing the validity and removing the ambiguity and complexity of the questionnaire before testing its reliability. Table 6.0 reflects some information on these experts and their backgrounds.

Table 6.0 Face Validity

	Expert	Position	HEI
1	Jamal Alhamlan	Head of Department	Jouf University
2	Mohammed Alqahtani	Head of Department	King Khalid University
3	Abdulelah Alshammari	Lecturer	King Abdulaziz University
4	Mohajer Alowisi	Lecturer	Imam Mohammad Ibn Saud Islamic University

5	Hassan Alalmai	Lecturer	Prince Sattam Bin Abdulaziz University
6	Mohammed Saharti	Lecturer	University of Jeddah
7	Hothaifa Aleid	Administrator	King Saud University
8	Husam Bakhaider	Lecturer	University of Jeddah
9	Yousef Alsharari	Lecturer	Jouf University
10	Fahad Al-Rashidi	Lecturer	Jouf University
11	Ahmad Qasmi	Assistant Professor	Jouf University
12	Salah Mortada	A department Supervisor	Jouf University

The face validity test led to multiple updates to the survey's items, aiming for clarity. Firstly, different items were thought to have the same meaning. So, they have been clearly distinguished. The wording issue was figured out, where some statements were too long. Ambiguous phrases and terminologies were replaced with more suitable terms. For instance, the item 'I intend to use the blockchain applications in the next <n>months' was replaced with 'I intend to use the blockchain applications in the future'. Similarly, there are more specific changes based on whether the participants were users or non-users of blockchain. For the same example earlier, blockchain users see 'I intend to continue using the blockchain applications in the future' instead of 'I intend to use the blockchain applications in the future'. All the changes were conducted in both Arabic and English survey versions. Therefore, the clarity and comprehension of survey items were confirmed prior to the reliability test. The validity test and adjustments were made for both user and non-user items.

3.4.6.2 Pilot Study

Pilot studies are significant in affirming that the questionnaire's items are apparent. Previous scholars have recommended commencing piloting a questionnaire with a set of ordinary participants, namely part of the targeted participants (Bryman, 2015, 2016; Sekaran & Bougie, 2019; Hair et al., 2016). Researchers should conduct their study in order to recognise potential problems within the questionnaire items (Nunan et al., 2020). Furthermore, it ensures that the questionnaire as a whole functions effectively (Bryman, 2016). A pilot study is more important if the survey is disseminated online because it is difficult for the researcher

to clarify the items for participants (Bryman, 2015). Thus, reliability is conducted in this pilot study.

Reliability is tested in this pilot study to conform the consistency among items. Reliability concerns 'whether an instrument can be interpreted consistently across different situations' (Field, 2013, p60). According to Bryman (2016), reliability indicates 'the consistency of a measure of a concept' (p.156). Bryman divided reliability into three factors, namely, stability, internal reliability and inter-rater reliability. As the current study represents a multi-item scale, the most convenient type to measure this scale is the internal consistency, which is typically measured by Cronbach's alpha (Creswell & Creswell, 2018; Bryman, 2016). The alpha levels range between .7 and .9, which usually represent an acceptable value in research (Creswell & Creswell, 2018; Bryman, 2016). Therefore, the internal reliability measurement is conducted in the current pilot study to ensure that the reliability value is in an acceptable range.

Determining the sample size of a pilot study has been the subject of various arguments from previous scholars. Some authors argue that the sample size is based on the purpose of a study (Hertzog, 2008; Johanson & Brooks, 2010). Others argue that the sample size of piloting an instrument should be ten per cent of the total final study size (Lackey & Wingate, 1998). Other scholars argue that the higher the sample size, the better with a minimum of thirty participants (Johanson & Brooks, 2010). Hair et al. (2020) stated that in the case of rewording the items extensively, a large sample of participants should be embraced. For instance, as the current research acquires mainly 31 items, Hair et al. (2020, p.297) consider 62 respondents to be 'preferably large'. Another stance was represented by Hertzog (2008) to distinguish between participants in two groups. Hertzog noted that researchers who obtain two groups should attain responses from 30 to 40 participants in their pilot study for each group. Based on these recommendations, the author of this study obtained a conservative position with at least 62 respondents and distinguished between the user and non-user groups, as each group's participants encountered different wording items in the survey for UTAUT's questions. Therefore, the pilot study of this study's instrument contains 31 blockchain users and 32 non-users. The users' and non-users' category is applied only to the UTAUT's constructs.

The current study's survey was piloted by disseminating a Google Form link among 63 prospective respondents of the targeted sample. It ensured the participants could smoothly reach the researcher by delivering the contact information (i.e., WhatsApp number and email) with the Google Form link. Also, the researcher delivered the aim and objectives of the ongoing study to participants within the link. These procedures should encourage participants to respond and benefit by offering assistance whenever needed for participants (e.g., clarifying

items). It was also confirmed that the responses should be from users and potential users of blockchain technology in HEIs, KSA.

After collecting the data, they were gathered and coded into electronic software (i.e., SPSS Statistics 28) to test the reliability of the framework's antecedents. Cronbach's coefficient alpha is the utilised measuring tool for the existing survey research because it is the most utilised and functional test for internal reliability (Johanson & Brooks, 2010; Cronbach, 1951; Creswell & Creswell, 2018).

Prior to conducting a reliability test, reversing the negatively phrased items is necessary. Hair et al. (2020) stated that not reversing negatively wording items may show misleading reliability results. The authors stated that the negatively worded items should be 'reversed-coded'. Following Hair et al. (2020), the researcher recoded Sec5 and FC3 items by reversing the codes whereby one was recoded as a 7, 2 was recoded as 6 and so forth. The first negative construct is Sec5, 'Internet hackers (criminals) might take control of my checking account if I used a blockchain application'. The second negative construct in the survey is FC3 'The blockchain applications are not compatible with other systems I use'. This reversal increased the reliability of the Sec5 to the accepted level for both groups for the security construct. However, it failed to reach the acceptable levels of alpha value for the FC construct.

The outcomes of the Cronbach's Coefficient Alpha reliability test are reported in Table 7.0. The reliability test involves the two groups (users and non-users of blockchain), whereby each group is reported individually to ensure that the items are reliable for both groups.

Table 7.0 Reliability for the Pilot Study

Construct	Number of items	Cronbach's Alpha
Trust-Users	3	.770
Security-users	5	.811
PE-Users	4	.776
EX-Users	3	.877
SI-Users	4	.852
FC-Users	4	.566
BI-Users	3	.974
AW	4	.915
Trust-Non-Users	3	.7
Security-Non-Users	5	.900

PE-Non-Users	4	.825
EX-Non-Users	3	.938
SI-Non-Users	4	.885
FC-Non-Users	4	.415
BI-Non-Users	3	.920

The above table highlights a reliability test for the conducted pilot study for two groups, namely users and potential users of blockchain among KSA-HEIs' employees. This test aimed to affirm that the scale items operate effectively individually and as a whole instrument (Bryman, 2016). The original number of items for each construct varies between 3 to 5 items. The previous Table shows that items range between .415 to .938. These results indicate that most of the reliability values exceed the value of .7, which reflects acceptability (Creswell & Creswell, 2018; Bryman, 2016). However, one construct showed less than the accepted 0.7 reliability value. This non-acceptable value for the FC's construct occurs for users and non-users. Hence, handling the facilitating condition's low-reliability value and checking the need to handle other items is necessary.

Handling non-reliable items occurs by examining scores less than .3 of alpha correlation value increase the Cronbach's alpha value. Hair et al. (2020, p.263) stated that 'Items in a scale that are correlated with other items in the scale at a level lower than 0.30 should be evaluated for removal from the scale'. Meanwhile, Hair and others (2020) advised that the minimum number of items should be three items. The removed items are FC3 (users: .123 and non-users: -293), security5-users (.189) and PE4-non-users (.259). Therefore, three items were removed from further investigation (i.e., FC3, Security5, and PE4) because they have less than .3 in the item-total correlation (Hair et al., 2020).

Removing the items with a reliability score less than .3 increases the security, FC, and PE constructs. The reliability value of FC3-users increases from .566 to .759. Similarly, FC3-non-users increases from .415 to .802. In addition, the users of blockchain in the PE construct rose from .776 to .880, while the nonusers for performance expectance increased from .825 to .949. Finally, the alpha value for SEC-users increases from .811 to .891.

As a result of removing the three items, all the remaining constructs equal more than .8 in terms of Cronbach's Alpha value. However, the trust construct has less than .8 but more than .7, which is still an accepted range for a construct that includes only three items.

3.4.7 Ethical Considerations

Ethical considerations must not be avoided, specifically in research. Researchers are advised to consider potential ethical issues may arise during their study (Punch, 2014; Hesse-Biber, 2017). According to Creswell and Creswell (2018), 'researchers need to protect their research participants; develop a trust with them; promote the integrity of research, guard against misconduct and impropriety that might reflect in their organizations or institutions; and cope with new, challenging problems' (p.88). Ethics could be described as 'the study of what are good, right, or virtuous courses of action' (Punch, 2014, p36). To accomplish the aim of this study, the following ethical considerations during the data collection period are taken into account.

The present research must conform to the principles of the Aston University Research Integrity and Ethics Committee. The Research Integrity Office (RIO) (2022) stated that these principles stem from 'widely accepted principles and practices governing research and other academic activities' (p.2). RIO stated the core elements of ethical principles. These principles involve having the minimum risk of harm to both parties, researchers and research participants. The considered risk includes but is not limited to emotional, financial, social, environmental or/and physical harm. The second element involves the informed consent by participants, whereby sufficient information should be provided to the participants. Participants should be aware of the research aim and brief background; they are not coerced into participation and can withdraw from the survey at any time. The third element concerns confidentiality, whereby privacy and anonymity of data are taken into considerable account and addressed. Also, the researcher must conform to Data Protection legalisation. The fourth fundamental principle is maintaining the dignity of participants. The fifth element pertains to research integrity, which must be at its highest possible standard.

To confirm that these principles are met in the present research, a Business and Social Science Research Ethics Committee reviewed ethical documents that mainly involve the research ethics application form, participants information sheet, and consent form. These forms are attached in the appendices.

After attaining the ethical approval from the ethical committee at Aston University, the researcher commenced the data collection with the assistance of Jouf University, Saudi Arabia. Their assistance is based on the Facilitating a Researcher Task tool. Jouf University has assisted in distributing the survey among the targeted audience. Appendix F shows the approval of Jouf University to disseminate the survey among the participants. Based on tJouf University's approval, ethical approval from Aston University's ethical committee was obtained

to approve the dissemination procedures of the survey with the support of Jouf University. Jouf University sent the survey to related administrative departments in these universities, which disseminated the survey among their employees. Accordingly, the survey was sent to employees who work for HEIs in Saudi Arabia.

By receiving a message via emails or other system (based on their HEI's system), participants receive a message that includes a QR code and a link that leads to the Google Form-based questionnaire. This message does not include any incentives to participate in the survey to avoid any potential bias. The following section explains the data analysis and justifies the selection of the analysis tool.

3.5 Data Analysis

Based on the discussed methodological ground, data were collected from administrative and academic employees who are current or potential users of blockchain who work for HEIs in KSA. This section is structured based on Creswell and Creswell's (2018) suggestions. To analyse data, three main computer programmes were utilised, namely, Excel, SPSS Statistics 28 and SmartPLS software. After deriving the data from Google Forms, Excel is going to be used to display and initially organise data. For instance, Excel will be utilised to change the wording items' answers (e.g., Strongly Disagree) to a numerical answer (e.g., 01) for further analysis. In addition, SPSS is going to be employed for further data cleaning and to provide descriptive analysis of profile and demographical questions, model items and the blockchain areas question. Additionally, the proposed model will be tested by using SmartPLS based PLS-SEM. Both SPSS and Smartpls will be employed to conduct MGA in three different approaches, i.e., MANOVA, permutation and bootstrapping.

3.5.1 PLS-SEM

The complete collected data are mainly analysed based on the PLS-SEM approach. According to Hair et al. (2014, p4), two common methods dominate SEM practice among researchers, namely, 'covariance-based SEM (CB-SEM) and partial least squares SEM (PLS-SEM, also called PLS path modelling)'. Hair et al. (2014) differentiate between the two methods by stating that CB-SEM is mainly used to affirm (or reject) proposed theories and the underlying hypotheses. CB-SEM affirms/rejects hypotheses by highlighting how closely a conceptual framework can reproduce the variance/covariance matrix for a collected dataset. In comparison, PLS-SEM concentrates on explaining and exploring the variance of the dependent variables of a proposed model (Chin et al., 2020).

The goal of a study is a significant factor in selecting a suitable analysis research tool. Generally, Hair et al. (2011) stated that if the research goal is theory testing and confirmation, the author's suitable approach is the CB-SEM. On the other hand, if the research's goal is to predict or develop a theory, the author's appropriate approach is PLS-SEM. In more detail, Chin et al. (2020) highlighted that the selection of the analysis technique depends on whether the study's goal is explanation and/or predictive. The authors noted that CB-SEM should be employed if a study utilises confirmatory/explanatory modelling. The authors stated that studies, such as the current study, are usually not restricted to the CB-SEM approach because they are not restricted to confirmatory/explanatory modelling. Instead, researchers should employ the PLS-SEM proposed by Joreskog (1982), which is referred to as the 'casual-predictive' technique. In other words, the PLS-SEM technique integrates CB-SEM with other approaches (e.g., Machine Learning) to demonstrate a higher predictive accuracy and well-developed causal explanations (Chin et al., 2020). Aiming to attain such a result with the proposed model of the present study, the PLS-SEM is executed to test the proposed model.

Furthermore, the type of the proposed framework in a study assists in determining the suitable analysis tool (e.g., CB-SEM or PLS-SEM). Hair et al. (2014) constructs in the SEM modules are divided into endogenous and exogenous constructs. The endogenous constructs are perceived as dependent variables that are explained by other variables. Also, they can act as independent variables. In contrast, the exogenous constructs are perceived as independent variables that do not have arrows pointing at them (Hair et al., 2014). Relatedly, Hair et al. (2012) found in their review that types of models are categorised into 1) focused, 2) unfocused and 3) balanced models. While the focused type reflects that exogenous variables at least double the existence of endogenous, the unfocused type reflects that endogenous variables exist at least two times more than the exogenous variables. Hair and others stated that a balanced model exists between the focused and unfocused models. The proposed module is considered a balanced model in the present study because the endogenous constructs are more than the exogenous variables but do not double them. In more detail, trust, EX, PE and BI are endogenous variables, while security, AW and FC are exogenous variables. Hair et al. (2012) advise employing PLS-SEM for models that reflect the balanced type.

Another factor in selecting a suitable analysis technique is the field of this study. PLS-SEM technique has been utilised in various fields, including accounting (Nitzl et al., 2016), operations management (Peng & Lai, 2012), management information systems (Shiau et al., 2019; J. Hair et al., 2017), and so on. Specifically, the PLS-SEM is preferable in management information system research, such as the present study (Ringle & Sarstedt, 2016).,Similar studies to the present research concerning blockchain adoption have conducted PLS-SEM as

an analysis tool (e.g., Queiroz et al., 2021; Mansoor et al., 2023; Ullah et al., 2021; Abu Afifa et al., 2022).

In addition, the PLS-SEM approach has been determined in this study due to its analysis of certain constructs. According to Ringle and Sarstedt (2016), the PLS-SEM technique is specifically beneficial when a study concentrates on analysing a particular set of constructs as the central sources of explanation. The authors recommended that users who apply UTAUT's constructs as key sources of explanation should utilise PLS-SEM applications. Hence, since the model of the present study relies mainly on the UTAUT (Venkatesh et al., 2003), PLS-Sem is adopted.

In summary, the present study employs PLS-SEM due to the following factors. Firstly, SEM models are considered to overcome the first-generation regression tools. Secondly, the model of the present study will be tested based on the casual-testing technique, which basically integrates the prediction and confirmatory/explanatory techniques. In addition, the balanced stance between the focused and unfocused constructs in the proposed models enhances the stance of PLS-SEM's selection. Finally, the increased usage of PLS-SEM in different management sectors and the employment of this technique in similar previous studies foster the justification of employing the PLS-SEM technique in the present study.

3.5.2 Multi-Group Analysis

This study involves respondents (i.e., staff segmentations) that are likely to differ significantly among themselves (see 3.4.5- Content of instrument). Different employees are likely to be heterogeneous in their perceptions and assessments of latent constructs (Sarstedt & Ringle, 2010). The group comparison procedure is significant in relation to blockchain implementation because decision-makers in HEIs are required to consider heterogeneity among employees' perceptions (Cheah et al., 2020; Klesel et al., 2022). Meanwhile, overlooking staff's heterogeneity may cause biased results and mislead study findings (Becker et al., 2023; Ringle & Sarstedt, 2016). Hence, there is a need to take heterogeneity among employees' segmentations into consideration and compare the confidence intervals.

Investigating heterogeneity in this research leads to comparing different groups among HEIs' employees. The group comparison might be conducted through statistical tests that include parametric and non-parametric methods. This research conducts MANOVA as a parametric method. However, parametric approaches are inconsistent with PLS-SEM non-parametric nature and have limitations due to their reliance on distributional assumptions (Hair et al., 2017). This inconsistency leads this study to apply Permutation and bootstrapping tests

as non-parametric approaches (Matthews, 2017). The last two tests can be employed in conjunction with PLS_SEM (Hair et al., 2017; Cheah et al., 2020).

In more detail, MANOVA, permutation and bootstrapping approaches deliver different results. MANOVA's primary purpose is to compare means across various groups to identify the significant differences related to the dependent variables. The purpose of choosing MANOVA is to compare the statistical differences between employees' answers based on the 7-point Likert scale. The results of MANOVA assist in identifying the levels of agreement per subgroup for each dependent variable. It has been selected in this study mainly due to 1) its flexibility to compare groups with a smaller number of participants and 2) its ability to deliver the significant differences concerning the mean between groups (Sarstedt et al., 2011; Khan & Rayner, 2003; Blanca et al., 2017). On the other hand, permutation and bootstrapping-MGA tests, are conducted to examine other statistical estimations beyond the mean (e.g., path coefficients) (Hair et al., 2017). The last two tests provide more comprehensive outcomes in terms of measuring the effect of the differences among groups. They examine significant differences between subgroups and the impact of all relationships related to a developed model in a study per subgroup (Hair et al., 2017; Cheah et al., 2020). Hence, the selected MGA tests for this study are MANOVA, permutation, and bootstrapping methods to provide complementary and comprehensive results for various groups of respondents.

Empirically, this study employs three various MGA tests, i.e., MANOVA, permutation and bootstrapping, to investigate the differences between employees' segmentations' subgroups. The segmentations in this study consist of nationality, gender, age, job types, experience, users and non-users of blockchain and regions in KSA. As mentioned above, the MANOVA is implemented to test the mean in relation to the dependent variables only (i.e., trust, EX, PE and BI). The permutation test is implemented to find the significant differences in the path coefficient between the segmentations' subgroups. The bootstrapping test is performed to determine the significant impact per subgroup in relation to this study's model and compare it to the complete findings.

3.5.2.1 MANOVA

The first method to investigate the differences among participants' differences is MANOVA, specifically, Hotteling's T^2. Hair Jr. et al. (2019) described MANOVA as a statistical technique used to 'compare group differences on two or model dependent variables' (p.372). The authors described Hotteling's T^2 as a special case of MANOVA used with two groups. To illustrate, stated that the differences between various groups could be investigated by using univariate techniques, such as the t-value test and Analysis of Variance (ANOVA). On the

other hand, if a researcher has more than one dependent variable, they should use the extended versions of the univariate techniques, i.e., MANOVA. The authors highlighted that these procedures consist of Hotelling's T2 and MANOVA assessments. Also, Hair and others noted that the t-test and Hotelling's T2 are limited in assessing only two groups of an independent variable (e.g., gender). In contrast, ANOVA and MANOVA are capable of handling two or more group situations.

In comparison between ANOVA and MANOVA, the first indicates a univariate metric that assesses group differences on one metric-dependent variable (Hair et al., 2019), while the latter indicates a case with multiple metric-dependent variables (Kent, 2015). In MANOVA, a researcher could assess the interaction between dependent variables to contrast the group differences (Field, 2018). To highlight, the null hypothesis of ANOVA tests the equality in means across groups of an outcome variable. In contrast, the null hypothesis of MANOVA tests the equality of vectors of means on several outcome variables across variable groups (Hair et al., 2019). For instance, the dependent variables of this study are BI, PE, EX and trust (see Figure 18). Using ANOVA instead of MANOVA to test the differences among groups for every dependent variable separately may cause type-1 error (false indication of significant results) (Warne, 2020; Tabachnick & Fidell, 2019). Therefore, the present study's most suitable difference tests to compare the means are the MANOVA and Hotelling's T^2 due to the existence of multiple dependent variables (Field, 2018). These tests are conducted in SPSS.

The minimum sample of MANOVA in this study is based on Cohen's (1992) guideline. The application of this guideline is based on 1) the effect size represented in Table 26.0, 2) four dependent variables (trust, PE, EX and BI), 3) 31 subgroups 4) significance level (.05), and 5) statistical power (.80). The Cohen's equation resulted in requiring approximately 11 respondents for each group. Therefore, any subgroup that obtains fewer than 11 participants is excluded from the MANOVA analysis.

However, some subgroups are not excluded as they could be integrated by using the median-split approach. This approach is implemented in this study for the age and experience segmentations. The purpose of this integration is that some of the age and experience subgroups do not meet the minimum requirements of the sample sizes proposed by Cohen (1992). Hence, the age and experience segmentations were diminished to two subgroups. The median split is implemented by 1) finding the median, 2) dividing the data based on the median and 3) running the MGA assessment (Iacobucci et al., 2015). The median-split procedure is implemented through SPSS. The updated subgroups for age are older employees and younger employees, whereas the renewed subgroups for years of experience involve more experienced and less experienced employees. Regarding the experience group,

the first subgroup represents employees with less than ten years of experience (less experienced staff). In contrast, the second group concerns employees with more than ten years of experience. Therefore, the regions of KSA are excluded from further analysis in relation to MANOVA. The analysed-by-MANOVA groups include nationality, gender, age, job type, experience and users and nonusers.

The other two methods are permutation and bootstrapping tests to assess the significant differences between groups in relation to this study's proposed model.

3.5.2.2 Permutation and Bootstrapping-based MGA Tests

The other two methods to investigate the differences among employees' segmentations are the permutation and bootstrapping-based MGA. The purpose of applying both of these tests is the complementary findings they provide. While the permutation test shows whether there are significant differences between group-specific PLS-SEM findings (Ringle et al., 2024), the bootstrapping shows whether a subgroup (e.g., female) has significant correlations among latent variables. The permutation test compares segments' subgroups (e.g., male compared to female), whereas the bootstrapping compares the path coefficients' significance to the complete results. The permutation approach exchanges responses between two subgroups and re-estimates the proposed model for each permutation (Chin & Dibbern, 2010; Hair et al., 2017; Ringle et al., 2024). For instance, the permutation result might yield a significant difference in the influence of PE and BI for males and females, highlighting the path coefficient is higher for females. However, this test does not consider the possibility that the significant effect of PE on BI might be significant for one subgroup only (e.g., male). So, the bootstrapping approach is employed to compare the significant effect between latent variables for each subgroup (e.g., female) with the complete results (e.g., female and male employees). This example applies to the other segments and subgroups. Thus, this study applies permutation to demonstrate the significant differences among subgroups similar to recent studies and based on experts' recommendations (Alraja, 2022; Hair et al., 2017; Ben Arfi et al., 2021). Moreover, this study employs a bootstrapping method to investigate the significant relationships between variables per cluster (Ben Arfi et al., 2021).

This study follows Matthews's (2017) and Cheah and others' (2020) phases to investigate permutation and bootstrapping methods. According to Matthews (2017) and Cheah et al. (2020), the first step relates to preparing data and generating groups. To note, this step was divided into two phases in Cheah and others' papers. The first step relates to selecting the categorical variable (e.g., age) and confirming that the subgroups are large enough for statistical power. The minimum sample size for each subgroup should aim for a statistical

power of 80% (Cohen, 1992; Hair et al., 2021). In determining the sample size, this study considers that the typical statistical power is 80%, and the significance level is 5% (Wong, 2013; Matthews, 2017; Cohen, 1992; Hair et al., 2021).

In more detail concerning the sample size, Cohen's (1992) guideline is applied in this study to determine the minimum acceptable sample size per subgroups (e.g., male and female). Cohen's instructions are implemented due to their integrability with PLS-SEM and recommendations from previous scholars (e.g., Hair et al., 2017; Matthews, 2017). After implementing Cohen's guideline, the minimum sample size for each subgroup is 76.

In other words, any segmentation (e.g., gender) that includes a subgroup (e.g., male) with less than 76 participants will be excluded from further analyses. However, the median-split procedure was implemented for age and year-of-experience categories to have more participants for each subgroup (Iacobucci et al., 2015). This approach has been implemented in recent related studies (Tewari et al., 2023; Kang & Moreno, 2020; Widyanti et al., 2024). Hence, the groups with less than 76 participants are excluded from further analysis related to the permutation and bootstrapping tests (i.e., nationality, regions in KSA and users and non-users). On the other hand, the permutation and bootstrapping tests are implemented with segmentations with subgroups that obtain a minimum of 76 participants (i.e., gender, age, job type and years of experience).

Subsequent to the first step, the measurement invariance of the composite model (MICOM) is implemented as a second step to avoid misguiding outcomes (Klesel et al., 2022; Cheah et al., 2020; Matthews, 2017). MICOM results confirm that the differences between subgroups do not stem from differences in the model's variables (Ringle et al., 2024). MICOM was introduced by Henseler et al. (2016) which proposed three steps, i.e., 1) configural invariance, 2) compositional invariance, and equality of composite mean values and variances. These steps are conducted before performing the permutation and bootstrapping tests.

In the third step, Matthews (2017) and Cheah et al. (2020) suggest that the permutation and bootstrapping-based MGA outcomes are analysed, interpreted and reported. For bootstrapping results, the significant path coefficients are compared to the complete results per subgroup (Cheah et al., 2020). While the permutation is based on Chin and Dibbern's (2010) suggestions, the bootstrapping-based MGA follows Henseler et al. (2009).

Therefore, this study applies MANOVA, permutation, and bootstrapping approaches to test the significant differences in HEI staff segmentations.

3.6 Conclusion

The present chapter discusses the methodology used for this study. Philosophically, the positivism paradigm was conducted in the present research underlying the quantitative design. Based on the justified selection of quantitative strategy, an online survey was found to be the most suitable instrument to collect data from the targeted population. The targeted population involves administrative and academic staff at HEIs in Saudi Arabia. The simple random technique was implemented to collect 437 responses. Items were derived from previous studies when developing the survey. Initially, these items were modified to suit the investigated technology (blockchain) and the investigated population. As most of the participants of the study natively speak Arabic, the survey was translated from English to Arabic, giving the participants the choice to participate in either language. Accordingly, validity (face validity) and reliability (internal consistency) were conducted as pilot testing. These tests caused wording changes to the items in both languages before disseminating the questionnaire. Moreover, the survey was ethically and carefully investigated. After ethical consideration, the survey was disseminated to the participants online based on a Google Form link. Finally, this chapter sheds light on the implementation of the PLS-SEM and MGA techniques to analyse the collected data. While the first clearly shows the significant and insignificant relationships among constructs, the latter is used to examine the significant differences between different employees. The MGA approaches involving MANOVA, permutation and bootstrapping were introduced and their purpose in this study was explained. Analysing and reporting the introduced methods are presented in the following chapter.

Chapter 4: Findings

4.1 Introduction

The present chapter introduces the analysis of the collected data from administrative and academic participants who work at HEIs in Saudi Arabia. As mentioned in the previous chapter, the data were obtained using Google Forms. After the data collection procedure, this chapter exhibits the data analysis findings. The employed software programmes in the present study are Excel, Statistical Package for the Social Sciences (SPSS) and mainly SmartPLS-4. This chapter commences with the data preparation, including dealing with missing data, outliers, suspicious responses, and the normal distribution. Accordingly, the following section represents the results of two bias assessments (i.e., non-response and full collinearity). Descriptive statistics on respondents' profiles and model constructs are consequently discussed. Finally, the model testing, including the outer and inner models, is performed and reported in detail. The outer model mainly consists of inspecting the reliability and validity. On the other hand, the inner model demonstrates data related to collinearity, coefficient of determination, effect size, predictive relevance and significance. The significance and insignificance are computed for the complete results and per subsample of this study's participants.

4.2 Data Preparation

Prior to running the analysis, a researcher should clean the data by inspecting missing values, outliers, and normality. Hair et al. (2020) stated that researchers must examine their data before analysing them. Indeed, screening and cleaning data from errors is necessary before the data analysis (Sue & Ritter, 2012). In more detail, after the data collection, the data were exported from the Google Forms sheets into Excel sheets. This process was implemented in both languages. This study's survey had two web links; every link leads to a language (English and Arabic) with a precise clarification of what link leads to what language. After obtaining the data and employing Microsoft Excel, the Arabic responses were converted into English, and both versions were aggregated into one dataset. The additional data adjustments encompass missing values, outliers and suspicious responses.

4.2.1 Missing Values

It is a frequent occurrence in research to obtain incomplete responses in a survey questionnaire. In other words, researchers commonly encounter the missing data problem

(Hair et al., 2020; Byrne, 2016; Hair et al., 2019). Missing data refers to left-behind responses to questions of a survey (De Vaue, 2014). Grimm and Wagner (2020) stated that missing observations could refer to the total missingness of responses or items missing. The *total missing* reflects the total missingness of a case in a single dataset, while the *items missing* concern a missing response (Grimm & Wagner, 2020).

Hair et al. (2020) emphasise that missing data can significantly affect the validity of research findings. Further, the existence of missing data may negatively influence the usage of the PLE-SEM technique as it is not designed to analyse data that encompass missing data (Hair et al., 2021; Kline, 2023). Thus, Hair et al. (2020) suggest resolving them before starting to analyse data. The authors stated that any missing data could be handled by removing the observations or estimating the missing values by replacing the blank with the mean. In the present study, only under-control data exists, which will be re-arranged but not changed.

To highlight the arrangement process, the missing values could be classified into structured, unstructured and total missing values. Byrne (2016) mentioned that missing values could be categorised into structured and unstructured missing data. While the first may occur beyond the researcher's control, the latter occurs under the researcher's control (Bryman, 2016). De Vaue (2014) stated that the unstructured missing data may happen because respondents were not required to answer a specific question in the survey. This study has no unstructured missing study due to the required-to-answer feature in Google Forms. In other words, answering the questions is mandatory to complete the questionnaire. So, the present study does not involve any unstructured missing data that are not under control (Byrne, 2016). Indeed, there is no total or single missingness of any case or item (Grimm & Wagner, 2020).

However, the present research obtains structured (under control) missing data. In the present research, two main types of participants were obtained (users and non-users of blockchain in HEIs). During the survey, these two groups faced different questions in wording but the same in meaning. For instance, the blockchain's users encounter the question, 'I find the blockchain applications useful in my job', while the non-users of blockchain encounter the question, 'I would find the blockchain applications useful in my job'. This example applies to all UTAUT's items. This difference is because the user is an actual user while the non-user refers to a potential user. The non-user was given a scenario in which he/she might be a blockchain user in the future. To illustrate, the blockchain's user misses the non-user question and vice versa, but they answer the items in a different wording style. Although that does not appear in the survey in front of participants, the missing items appear clearly in the dataset after downloading them. Thus, the structured missing items were acquired, which were entirely under control.

Dealing with the structured missing data occurs by integrating the answers of participants in Excel. For instance, the two items 'I find the blockchain applications useful in my job' and 'I would find the blockchain applications useful in my job' that appear for the two groups (users and non-users) will be integrated under one indicator. In this example, the indicator is PE1. This process applies to all UTAUT constructs involving different wording statements but the same meaning for both groups (users and non-users).

After combining all the answers for the users and non-users, no missing values were found for any construct. The requirement to complete all questions in the survey was the primary factor that prevented any missing observations. Integrating the results between users and non-users is the second factor in obtaining no missing values.

4.2.2 Outliers

Outliers should be examined to confirm that all answers are reasonable and logical. *Outliers* are responses' scores that distinctly vary from other scores (Kline, 2016; Hair et al., 2020; Field, 2018). In other words, Hair et al. (2020) described an outlier as a unique answer(s) with no apparent rationale. The authors stated that outliers could affect the findings' validity. Also, they could be a source of bias (Field, 2018). Thus, determining and dealing with outliers is compulsory (Hair et al., 2020). Hair et al. (2020) advised operating the outliers within the data-cleaning phase. The authors stated that one should distinguish between the univariate and multivariate outliers to handle the outliers. Therefore, this section discussed the univariate and multivariate outliers.

4.2.2.1 Univariate Assessment

Kline (2016) referred to univariate outliers as extreme values in one variable. In this section, the univariate outliers are examined following four methods. These methods involve 1) determining the highest and lowest range of scores (Saunders et al., 2023), 2) spotting outliers based on distribution graphs (i.e., boxplots) (Hoyle, 2012; Tabachnick & Fidell, 2019), 3) implementing the univariate outliers' equation by Kline (2016) and 4) calculating the z score (Tabachnick & Fidell, 2019; Field, 2018). These four methods are performed to verify that no outliers remain in this study's dataset as they complement each other.

As this research adopts a seven-point Likert scale, the highest score must be 7 (Strongly agree), whereas the lowest score must be 1 (Strongly disagree). The 'neutral' option represents the middle option (4). Any value exceeding the seven score could be considered extreme, while any value below one could be considered an outlier (phase one). This outlier

might occur when participants respond to the results by entering wrong numbers, such as '77' instead of '7' (Kline, 2016). As the present research adopts an online survey tool based on Google Forms, participants were not able to manually enter any values in Google Forms because they saw the answers as multiple choices. So, it is unattainable for participants to add numbers out of the 1 to 7 range. However, oversights may occur in the coding process (Kline, 2016), specifically after downloading the data from Google Forms and transforming a written answer (e.g., Strongly Agree) to a code (e.g., '7'). To avoid this issue, the 'find and replace' feature in Excel was leveraged to automatically replace the written words (e.g., strongly disagree) with a code (e.g., 7). To confirm that the coding procedure has no values above or under the 1 to 7 points of the employed Likert scale, the SPSS maximum and minimum values test was conducted. It was confirmed that all the values range from 1 to 7. Therefore, as the maximum observation is seven and the lowest observation is one of all items, this ranging test shows no outliers in the current dataset.

In addition, some outliers were identified within the 7-point Likert scale threshold based on the 'outliers' test in SPSS. This test differs from the aforementioned ranging test as it occurs within the maximum and minimum values range (1-7). The univariate outliers of this study were determined by employing SPSS. Specifically, the test was implemented by locating the extreme values in boxplots in which every boxplot graph represents a specific item (phase two). Field (2018) noted that SPSS exhibits extreme scores with an asterisk symbol (*) in the boxplots. The boxplot's figures in SPSS exhibited some extreme scores that existed in the present dataset that should be dealt with. After determining the extreme boxplot scores, the Kline's (2016, p.72) equation was computed (phase three). The equation is as follows:

$$Univariate\ Outliers = \frac{X - Median}{1.483\ (\mathrm{MAD})}$$

To determine X in the above equation, the scores were derived from participants' answers for a specific item as presented in the boxplots. To illustrate, a participant may answer 1 (strongly disagree) for the 'Trust1' item, which replaces the X in the above equation. As shown in Table 8.0, all the X scores are 1. The median in the above equation reflects the item's median, whereby the X was detected in the boxplots. For instance, if the boxplot graph shows a univariate case in item 'Trust1', the median score of this item is calculated. The median is alleged to be 'more robust against outliers than the mean' (Kline, 2016, p.74). To determine the Median Absolute Deviation (MAD), the variables' scores have been calculated in SPSS. The results greater than 2.24 are potential univariate outliers and should be dealt with (Kline, 2016).

Table 8.0 Kline's Equation for Univariate Outliers

Item(s)	Median	Univariate Score(s) (X)	MAD	Univariate Outlier (Kline's Equation)	Observation IDs
Trust2, PE2, PE3 EX1, EX2, EX3, and FC2	6 for all items	1 for all items	1 for all items	3.37 for all items	126, 421, 107, 213, 22, 20, 303, 32, 293, 115

The previous table demonstrates all the detected univariate outliers by implementing boxplots and Kline's (2016) equation in sequence. The association between indicators and their observations is highlighted in detail in the following Table (9.0), confirming that all the observations in the previous Table (8.0) exist in the following Table (9.0). The calculated values in the previous table include the median, the X score and MAD, which were calculated using SPSS. These scores were implemented based on Kline's equation:

$$Univariate\ Outliers = \frac{1-6}{1.483\ (1)} = 3.37$$

Kline alleged that potential univariate outliers should be considered if the equation's result exceeds 2.24. It could be noticed that all results exceeded the value of 2.24. This result (3.37) indicates that all the cases in the above Table are considered to be handled (Hair et al., 2020; Kline, 2016). However, z score test was conducted to confirm the detected outliers before dealing with them (phase 4). In this test, the z score must not exceed the threshold of 3.29 (Tabachnick & Fidell, 2019). Arguably, Kline (2016) stated that obtaining a z score that falls in the range of ±3.00 indicates a univariate outlier. As a role of thump, Hair Jr. et al. (2019) contend that standard values are acceptable up to four. In this study, as a conservative stance, any standard score over 3.00 or less than -3.00 is considered a potential univariate outlier. This stance is due to the potential sensitivity of outliers on the findings (Hair et al., 2020). Table 9.0 shows the results of the z scores related to this study's items.

Table 9.0 Z Scores Test for Univariate Outliers

Item(s)	The z score	Observation IDs
Trust1	-3.41027	303*,107*, 421*
Trust2	-3.41254	126,107*,421*

Trust3	-3.07199	157, 293*, 115*, 303*, 107*,421*
PE1	-3.77645	107*
PE2	-3.6048	213*
PE3	-3.49953	107*, 22, 303*
Ex1	-3.75739	303*, 32*
Ex2	-3.86798	303*, 32*
Ex2	-3.01659	107*, 186*
EX3	-3.02390	186*,169
Ex3	-3.87178	303*,32*,107*
Fc2	-3.36960	213, 293,115, 32, 20
Fc4	-3.11538	163, 431, 107, 213, 32, 20

* Mutual values between two items or more.

The previous Table shows all potential univariate outliers based on z scores. It is confirmed that no outliers were detected earlier by employing Kline's equation that do not exist in the z scorer's Table. To illustrate, all scores shown in the previous Table exist in Kline's equation results in Table 8.0. Nevertheless, five additional cases resulted from the z score test. After merging the outcomes of Table 8.0 and Table 9.0, fifteen cases were found as univariate outliers. All the detected values are subjected to be omitted to avoid any influence on the findings.

4.2.2.2 Multivariate Assessment

The other type of outliers is the multivariate, which represents an unusual combination of extreme values related to two or more variables (Kline, 2016; Tabachnick & Fidell, 2019). It is recommended that the multivariate outliers be calculated through the Mahalanobis distance (D2) (Kline, 2016). Hair Jr. et al. (2019) stated that Mahalanobis 'measures each observation's distance in multidimensional space from the mean centre of all observations, providing a single value for each observation no matter how many variables are considered' (p.89). The distance obtains a chi-square distribution, taking into account the degree of freedom (df), which reflects the number of independent variables (Kline, 2016; Field, 2018).

In performing Mahalanobis, this study considers three components, i.e., level of significance, Mahalanobis distance and degree of freedom (df). Hair Jr. et al. (2019) stated that when applying the Mahalanobis distance, a researcher should perform a conservative

level of significance (e.g..001). Moreover, Field (2018) noted that the Mahalanobis distance should not exceed 25 for a large sample size (this study obtains a large sample size). Similarly, Hair Jr. et al. (2019) remarked that the Mahalanobis distance divided by the df should not surpass 4 for large samples. In other words, the pursued rules in this study to consider a potential outlier as a multivariate outlier is that 1) Mahalanobis distance has more value than 25, the significance level of P value is less than .001, and D2/DF exceeds 4 (Hair et al., 2019; Field, 2018) (see Table 10). The applicability of one of these three rules on any observation indicates that this observation is considered a potential outlier and is added to the following Table. For instance, case ID '18' neither has a d2 value of more than 25 nor a d2/df value of more than 4. However, it involves a significant value that is less than .001. So, it is added to the following Table as a potential multivariate outlier.

Table 10.0 Mahalanobis for Multivariate Outliers

Case Number	Mahalanobis Distance	Significance value (P<001)	D2/df
421	62.58244	.00000	10.43
417	34.39798	.00001	5.73
293	31.96321	.00002	5.33
115	30.15358	.00004	5.03
32	26.97414	.00015	4.50
18	23.72	.00059	3.95

The previous Table shows all the variables that obtain more than 25 in Mahalanobis distance, p<001 and/or D^2/df is more than four. Indeed, all other cases not mentioned in the above Table have a distance of less than 25, p>001, or D2/df is less than 4. Notable, only cases '417' and '18' do not exist in the univariate outliers.

4.2.2.3 Handling Univariate and Multivariate Outliers

Dealing with extreme values is significant because it may affect the findings significantly. Hair et al. (2020) argue that quantitative researchers who obtain extreme cases typically remove these cases. The authors believe that outliers could distort the total picture of data. Thereby, the existence of outliers could misrepresent the authentic characteristics of the collected data. Also, the authors stated that the extreme values may influence the validity of the findings. Handling outliers among previous scholars is controversial. Treating outliers might lead to retaining, transforming (based on the mean) or eliminating the extreme values.

Among the three alternatives, this study eliminates the extreme values. Extracting the outliers from the dataset is the most appropriate option due to the following factors. Initially, the present outliers adopt the PLS-SEM in which the extreme values 'do influence the ordinary lease squares regression in PLS-SEM' (Hair et al., 2021, p.19; Hair et al., 2019). Moreover, retaining outliers may negatively affect the findings' validity (Hair et al., 2020). Further, keeping them may irritate obtaining a source of bias (Field, 2018). Alternatively, the removal of outliers causes a reflection of a more realistic picture of the participants' stance (Hair et al., 2020). Considerably, existing empirical studies in technology adoption remove their outliers (Carter et al., 2020a; Brown et al., 2012; Bakri et al., 2023; Alammary et al., 2022). Also, the outliers of the present research exist without an apparent reason; hence, they must be removed (Hair et al., 2020). In addition, the total detected outliers are small in number (17), and the remaining cases are considered representative, and generalisability could be achieved (see 3.4.3-determining the sampling size). Therefore, the univariate and multivariate outliers were eliminated in this study.

4.2.3 Suspicious Response Patterns

Conducting suspicious response patterns is essential before the data analysis to spot the non-engaged participants in a survey. Suspicious responses could be referred to as straight-lining (e.g., Hair et al., 2021; Chin et al., 2020), speeding (e.g., Carter et al., 2020a) or unusual responses (e.g., Carter et al., 2020). Sarstedt and Mooi (2019) stated that straight lining occurs when a single observation obtains almost the exact response for all items. For instance, as the present research obtains the 7-point Likert scale, a single participant may select only 1 (disagree) for all items (Sarstedt & Mooi, 2019; Ibrahim et al., 2022). Suspicious responses may mitigate the quality and reliability of collected data (Oyman et al., 2022). Detecting the straight lining is specifically essential for the present research as it adopts an online survey instrument. Suspicious responses are more common in online surveys because participants are less engaged in the answering procedure (Sarstedt & Mooi, 2019). Also, it could be more common in this research because it investigates an emerging technology where some participants may not be aware of blockchain technology, which may lead them to select midpoint 'Neutral' option (DeCastellarnau, 2018; Sturgis et al., 2014).

This study eliminates the suspicious responses based on the standard deviation guideline. Each observation was computed to detect these suspicious responses. The guideline reflects that the closer the standard deviation to zero, the more participants were suspicious in the survey, as a value close to 0 represents quite similar answers to all questions (Oyman et al., 2022). In order to obtain acceptable variability in the present research, cases

with standard deviation values below 0.5 are going to be extracted from further analysis following previous studies (Y. Wang et al., 2023; Oyman et al., 2022) (see Table 11.0). Hence, the following table shows all deleted observations due to the suspicious responses of participants who most likely did not engage in the survey.

Table 11.0 Standard Deviation for Suspicious Responses

Observation ID	Standard Deviation
1	0
8	0
42	0
71	0
90	0
111	0
146	0
181	0
188	0
203	0
413	0
40	0.1766
57	0.176
209	0.254
133	0.353
166	0.353
59	0.3950
132	0.465
121	0.474
174	0.487
107	0.489
124	0.491

4.2.4 Normality

Normality tests can be assessed statistically (Tabachnick & Fidell, 2019). Skewness and kurtosis are the main statistical methods to investigate normal distribution (Kline, 2016; Tabachnick & Fidell, 2019; Hair et al., 2019; Field, 2018). Skewed distribution ‘implies that the

shape of unimodal distribution' (Kline, 2016, p74). The present study tests the normality test based on the statistical approach.

Kline states that a positive skew implies that the majority of the values are below the mean, while a negative skew implies that most of the values are above the mean. In comparison, the kurtosis test highlights the peakiness of a distribution (Tabachnick & Fidell, 2019). To demonstrate, Field (2018) divided the kurtosis test into two types, i.e., Leptokurtic and Platykurtic. *Leptokurtic* refers to the positive kurtosis where most of the values are clustered in one point, and the distribution looks pointy (long and thin tails). On the other hand, *platykurtic* tends to be more flattening than normally distributed data (short and thick tails) (Kline, 2016; Field, 2018). The present research tested normality by calculating skew and kurtosis portrayals.

Field (2018) stated that the researchers should aim for properties where variables' values are neither too skewed nor too kurtosis. The author states that the ideal normal distributions occur when the skew's or kurtosis's value equals zero. In other words, Field stated that scores are considered deviated from normality if skew and kurtosis values go up or below zero. However, normally distributed cases of variables are difficult to occur in reality (Bryman & Cramer, 2012). To highlight, researchers tend to determine the thresholds of normal distributions (Bryman & Cramer, 2012). Therefore, the researcher of the present study tests the normality based on given-in-research thresholds.

Practically, the researcher of this study employs SPSS to obtain the skewness and kurtosis results. Meanwhile, it is taken into consideration that PLS-SEM is a non-parametric method, reflecting a non-assumption normality stance (Hair et al., 2021). Additionally, obtaining more than 200 observations in a study is considered a large sample (Tabachnick & Fidell, 2019). Obtaining more than 200 observations reduces the effect of non-normality as the sampling error reduces (Hair et al., 2019). Field (2018) stated that 'there is a very strong case for never using significance tests to assess assumptions' (p.284 Furthermore, Skewness and Kurtosis are more sensitive to normality significance tests if the collected sample is (Kline, 2016; Tabachnick & Fidell, 2019). These significant tests include *z* scores, Kolmogorov–Smirnov and Shapiro–Wilk (Hair et al., 2019; Field, 2018). Indeed, these significance tests should be neglected in large samples, such as the present study's sample (Hair et al., 2019; Field, 2018). Therefore, these significant tests are disregarded in the present normality test, as recommended by Hair et al. (2019).

Instead, recommended and acceptable thresholds of skewness and kurtosis values are applied in this study to test normality. Following Kline (2016), statistical Skewness values below 3 and Kurtosis values below 8 should not be a source of concern for normality. The

absolute values of Skewness and Kurtosis in the present study fall under 3 in Skewness and under 8 in Kurtosis (see Table 12.0)

Table 12.0 demonstrates the variables of the present study and highlights Skewness and Kurtosis statistical values. Also, this Table reflects the standard error of these two statistical methods. These statistics are shown for both models' and demographical constructs. It can be seen in this Table that neither Skewness' values exceed 3 nor Kurtosis' values are above 8, which reflects falling into the acceptance range in terms of normality (Kline, 2016).

Table 12.0 Normality Test

	Skewness		Kurtosis	
	Statistics	**Standard Error**	**Statistics**	**Standard Error**
Model's Constructs				
AW	-.451	.123	-.656	.245
Trust	-.524	.123	-.601	.245
Security	-.532	.123	-.582	.245
PE	-.598	.123	-.440	.245
EX	-.485	.123	-.545	.245
SI	-.210	.123	-.850	.245
FC	-.455	.123	-.293	.245
BI	-1.221	.123	2.194	.245
Demographical Constructs				
Gender	.504	.123	-1.755	.245
Age	.284	.123	.152	.245
HE's type	2.396	.123	3.76	.245
Job type	-.184	.123	-1.976	.245
Experience	-.923	.123	-.092	.245
Region	1.71	.123	2.065	.245

4.2.5 Total and Remaining Responses after Data Cleaning

In the current study, the targeted population is the HEI's academic and administrative employees in KSA. The total number of responses received was 437, reduced to 399 after removing 38 cases due to missing data, outliers and suspicious responses. In more detail, 17 cases representing univariate multivariate outliers were detected. All outliers were mutual

observations between the univariate and multivariate outliers except two. Only the observations “417” and “18” are outliers detected on the multivariate outliers but not the univariate outliers. This joint ground between the univariate and multivariate extreme scores fosters the reliability of the detected outliers (see Table 13.0).

Similarly, the following Table illustrates the deemed unusual responses with a standard deviation of less than 0.5. Twenty-two suspicious responses were detected in the present study, whereby case “107” jointly exists with the outliers. Hence, the remaining cases until this phase in this study are 399, which is higher than the minimum representative cases (384). The following Table summarises all the removed data. Table 13.0 demonstrates all the removable observation IDs for the eliminated data.

Table 13.0 Cases Extracted from Further Analysis

Assessment Type	Total Cases
Univariate Outliers	303, 107, 421, 126, 157, 115, 293, 22, 32, 186, 169, 20, 163, 431, 213
Multivariate Outliers	417, 421*, 18, 32*, 293*, 115*
Suspicious Responses	1, 8, 42, 71, 90, 111, 146, 181, 188, 203, 413, 40, 57, 209, 133, 166, 59, 132, 121, 174, 107**, 124

* Mutual values between univariate and multivariate outliers. **Mutual value(s) between unengaged responses and outliers.

The following Table demonstrates the total statistics of the removed observations.

Table 14.0 Eliminated and Remaining Data

Cases	Total (Subtracted)	Percentage
Total of Respondents	437	100%
Outliers	(17)	3.89%
Suspicious Responses	(21)*	4.8%
Total of deleted data	**38**	**8.7%**
Remaining Respondents	**399**	**91.31%**

* One case is mutual with outliers. So, the total cases for suspicious responses are 22.

Table 14.0 highlights the total received data from the targeted responses. Accordingly, it shows the cases that were eliminated because answers reflect outliers and participants did not totally engage in the survey. Also, it shows that the total remaining cases is 399, which

reflects 91.31% of the total cases. This number reflects that the remaining cases remain representative (see 3.4.4).

4.3 Bias Assessments

Bias assessments consist of non-response and common method tests, among others. These tests have been employed in existing research related to technology adoption (e.g., Alazab et al., 2021; Jan Pieters et al., 2022; Karamchandani et al., 2020). The importance of conducting a bias test stems from the need to write rigorous research (Jordan & Troth, 2020). Also, bias could lead to false findings (Tehseen et al., 2017). Regarding bias, researchers might unintentionally ask questions that direct the participants to specific answers, influencing the covariance among correlated items (Hair et al., 2019). Another concern is whether the instructions at the beginning of a questionnaire have influenced the answers in a particular direction (Kock & Lynn, 2015).

The first bias test discussed in this study is the non-response bias. It could be described as 'the mistake one expects to make in estimating a population characteristic based on a sample of survey data in which, due to non-response, certain types of survey respondents are under-represented' (Berg, 2005, p.3). On the other hand, the common method bias could be described as 'relationships among variables and/or constructs are influenced by the data collection method (e.g., same collection method, questionnaire format, or even scale type)' (Hair et al., 2019, p.727). The latter may occur when the estimations of the relationships between variables are biased due to conducting the same measurement tool (e.g., Likert-type scale) for all latent variables (Jordan & Troth, 2020; Kock & Lynn, 2015). The two tests are conducted in this study.

4.3.1 Non-Response Bias

In this study, the non-response bias test was conducted by comparing early and late responses (Mentzer & Lambert, 2015). In more detail, the first 50 responses were compared with the last 50 responses. An independent sample t-statistic test was employed (Queiroz & Fosso Wamba, 2019; Alazab et al., 2021; Pieters et al., 2022). The result of the non-response bias revealed no significant variation between the early and later responses of the survey, indicating the lack of non-response bias (see Table 15.0).

Table 15.0 Non-Response Bias Test

Variable	T-Test	P Value

AW	.205	.838
Trust	-1.735	.086
Security	.291	.771
PE	-1.157	.250
EX	-1.300	.197
SI	-.077	.939
FC	-1.346	.181
BI	-1.378	.171

4.3.2 Common Method Bias

Common method bias reflects the variance of the common method result (Hair et al., 2019). Common method bias tests include Harman's single factor test, unmeasured latent factor technique, Correlation Marker technique, confirmatory factor analysis marker technique, Unmeasured Latent Method construct, IV technique and Full Collinearity Assessment Approach, among others (Jordan & Troth, 2020; Fuller et al., 2016; Kock & Lynn, 2015, 2012). Selecting the appropriate technique may depend on the selected analysis procedure (e.g., PLS-SEM), the scale-measurement approach (e.g., Likert Scale), the popularity of the test in the researcher's field or the reliability score (e.g., Cronbach's Alpha >.7) (Jordan & Troth, 2020; Fuller et al., 2016; Hair et al., 2019). Based on these components (Kock & Lynn, 2015, 2012) and following previous studies (e.g., Bouteraa et al., 2024; Sham et al., 2023; Kock & Lynn, 2015), this study opts for the Full Collinearity Assessment.

In order to perform the Full Collinearity Assessment approach, Kock and Lynn (2012, 2015) suggested running the variance inflation factors (VIFs). Kock and Lynn (2015) stated that VIF values must not exceed 3.3. If the VIFs are greater than 3.3 in PLS-SEM, it indicates the existence of common method bias (Kock, 2023). Therefore, SmartPLS 4 was operated to calculate the VIFs and inspect the common method bias. This test was conducted by SmartPLS 4.

The same test is used as the first stage of the inner model analysis, where it suggested that the VIF value should not exceed 5 (see 4.5.2.1 for more detail) (Hair et al., 2019, 2022)

The result reveals no common method bias test as all the VIF values are below 3.3 (Kock & Lynn, 2015; Kock, 2023), as the following Table shows.

Table 16.0 Full Collinearity Assessment Approach

Collinearity	VIF

EX->BI	2.855
EX->PE	1.752
FC->BI	2.640
PE->BI	3.107
SI->BI	2.580
Sec->BI	2.132
Sec->EX	1.777
Sec->PE	1.893
Sec->Trust	1.000
Trust->BI	2.668
Trust->EX	1.777
Trust->PE	2.141
AW->BI	1.974
AW x PE->BI	3.106
AW x SI->BI	2.159
AW x EX->BI	2.727
AW x FC->BI	2.662

4.4 Profile of Respondents, Descriptive Statistics, and Differences among Groups

The online questionnaire was distributed among HEIs that exist in Saudi Arabia. Specifically, the administrative employees and academic staff who work for public and private HEIs represent the targeted population of the study. This study obtained 437 responses with different profiles, as presented in this section. However, the screening and cleaning procedures, including removing outliers and suspicious participant responses, have reduced the total responses to 399. Additionally, five more observations were removed because of 'not consenting' to participate in the survey, yielding 394 observations in total. To highlight, participants must consent to participate in the survey before filling out the questions. If they do not consent, the survey is submitted with the participation rejection. In this study, five respondents out of 399 declined to participate in the survey. Hence, their answers were extracted, and thereby, the remaining data are 394 observations, which remains more than the minimum required data of at least 384 responses (see 3.4.4).

Respondents who consented to participate answered fundamental questions related to their profiles. These questions are divided into categories, and the differences between the groups within these categories will be investigated using MANOVA.

4.4.1 Respondents' Profiles

In the online survey, participants filled out questions about their profiles and demographics (see 3.4.5). These questions demonstrate various groups covered in the present study, which are statistically described in this section. This section reports mainly the frequency of every group and the percentage of each group in a specific category. The categories include the employees' nationality (Saudi or not), gender, job type, job task, experience, HEI's regions and blockchain user (or non-users).

4.4.1.1 Nationality

The first category is nationality, whereby participants choose whether they are Saudi citizens or not. The participants of this study consisted of 330 Saudi participants, while 64 participants were from other countries. As shown in Figure 10.0, the outcome highlights that 83.8% of the respondents are Saudis, whereby only 16.2% are not Saudi employees.

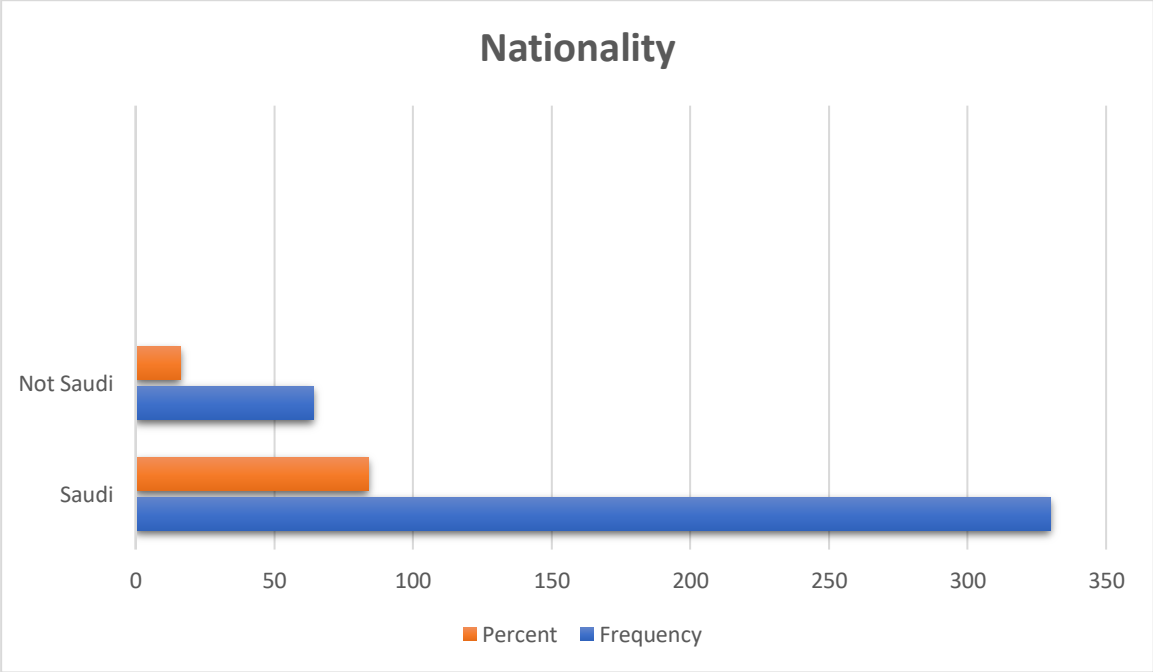

Figure 10.0 Descriptive Statistics of Saudi and Non Saudi Staff

4.4.1.2 Gender

In this category, the participants choose their gender. This study obtains 245 male observations and 149 female observations. The following bar chart shows that 62.2% of the

respondents are male, while 37.8% are female (see Figure 11.0).

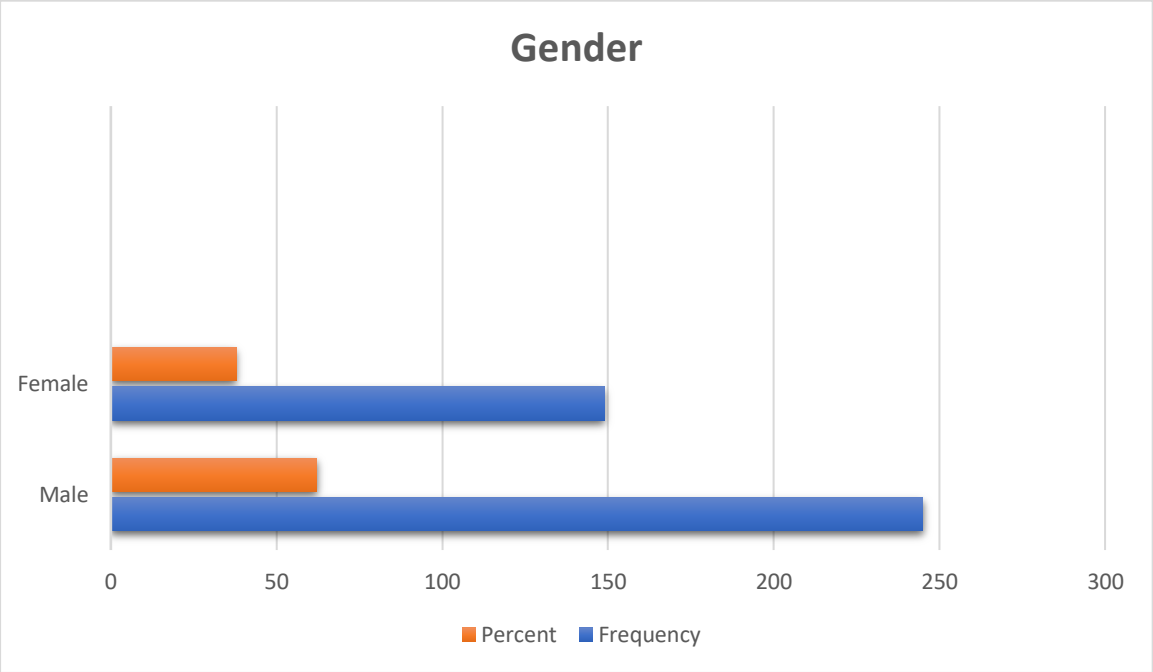

Figure 11.0 Descriptive Statistics for Gender

4.4.1.3 Age

In this category, the participants were asked to determine their age group. The following chart shows that most respondents are 25 to 54 years old. The highest percentage of respondents is for the age group of 35-44 years, with 45.2%. On the other hand, the lowest percentages are employees under 24 years old (2.5%) and over 65 years old (1%), respectively (see Figure 12.0).

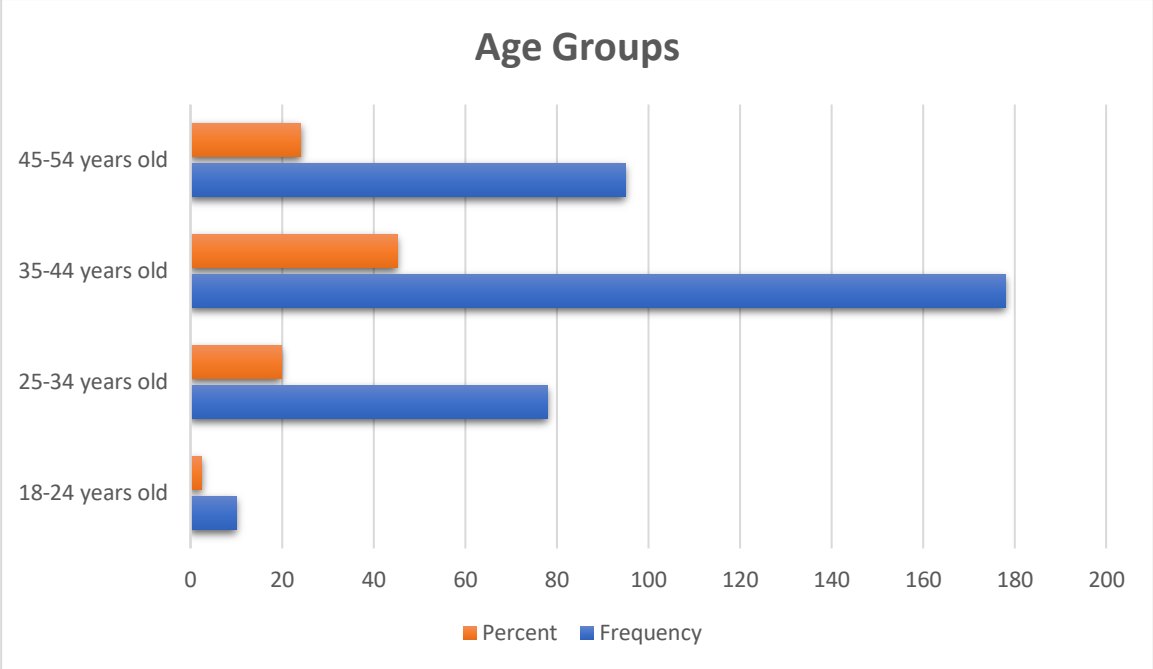

Figure 12.0 Descriptive Statistics for Age Groups

4.4.1.4 Job Type

In this category, respondents were asked to determine their job type, namely, whether they were administrative employees or academics. The following Figure exhibits that 45.4% with 179 participants of the respondents were administrative employees. In comparison, 54.6% with 215 respondents were academics (see Figure 13.0).

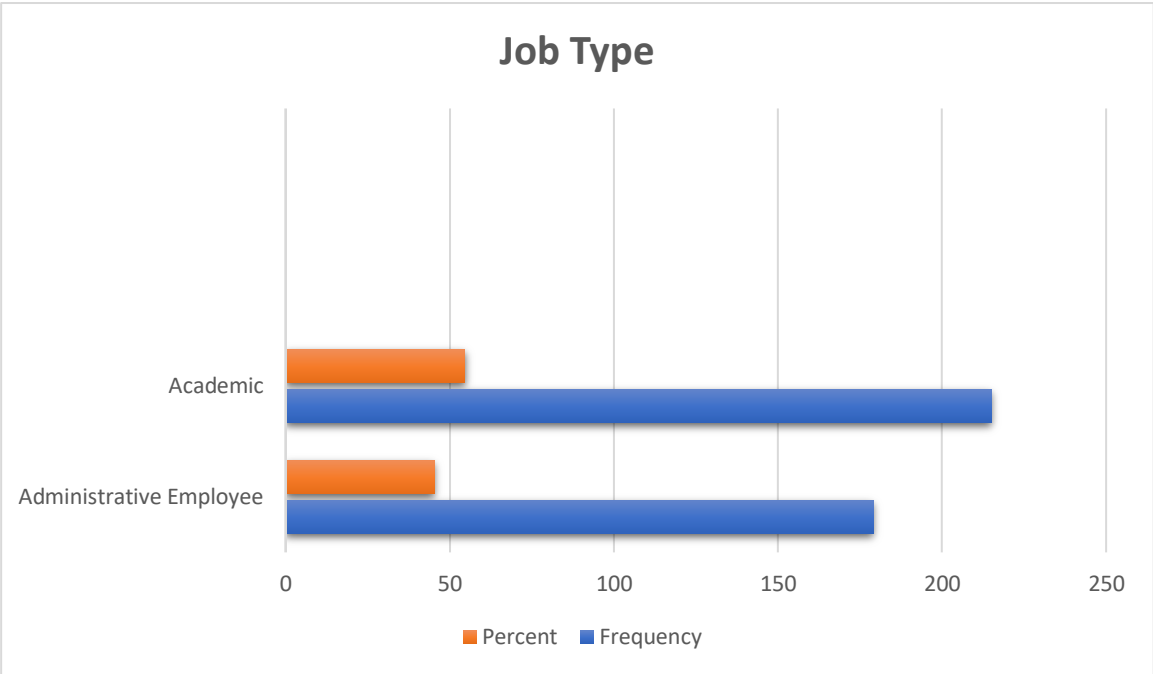

Figure 13.0 Descriptive Statistics for Job Types

4.4.1.5 Experience

In terms of years, participants were asked to select one of the given ranges that reflect their experience as employees in Saudi HEIs. The result shows that the majority of participants have more than ten years of experience, with 45.2% and 178 frequency. Employees with 5-10 years of working experience account for approximately 29% of the 115 participants. The other two groups reflect around 16% collectively (see Figure 14.0). It is worth noting that females were found to have much less experience than males. The average experience for females was 3.89 years of experience, while the average experience for males was 4.19 years of experience. This difference was found statistically significant based on the p-value of Levene's Test for Equality of Variances. Although this result is out of this study's scope, it is worth noting that this significance should be explored in future research.

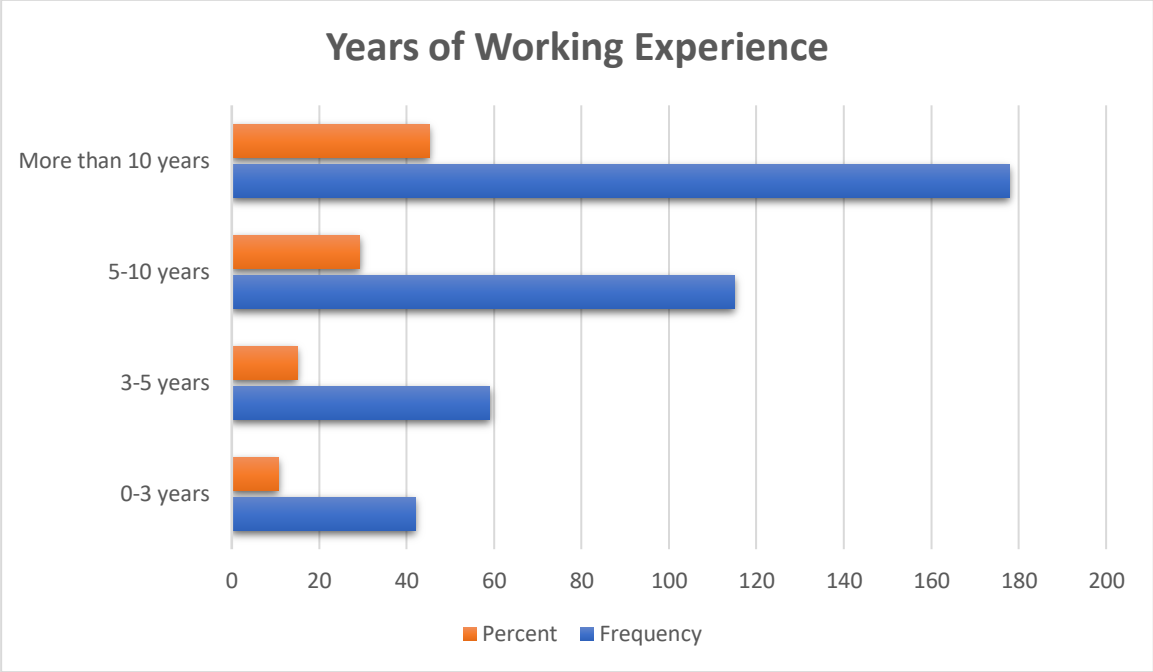

Figure 14.0 Descriptive Statistics for Years of Experience

4.4.1.6 Users and Non-users

In this category, participants were asked whether they have actually used a blockchain-based application(s) during their work. Findings demonstrated that 332 participants have not used blockchain in their work, whereas 62 participants have used one or more blockchain-based application(s). The users reflect 15.7% of the respondents, while 84.3% of the participants in the survey have not used blockchain in their work (see Figure 15.0).

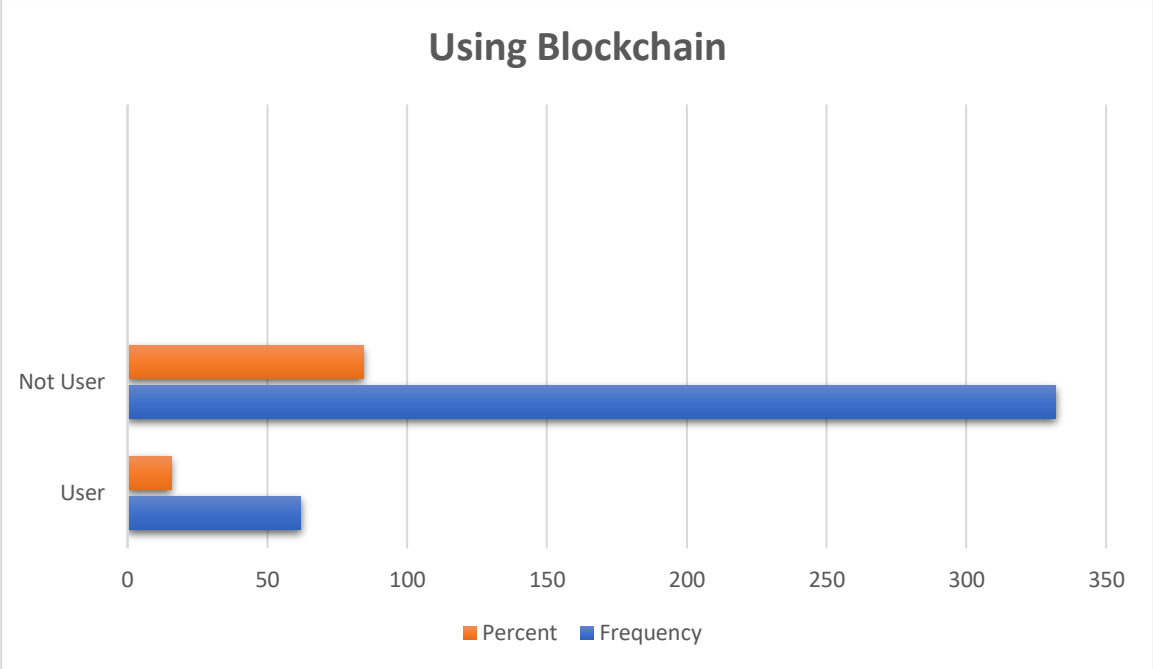

Figure 15.0 Descriptive Statistics for Users and Non-Users of Blockchain

4.4.1.7 The Usability of Blockchain

To answer RQ3, participants were asked to determine which area needs to embrace blockchain applications the most. This determination is related to a question and an objective in the present study. The areas built in this study's literature review section. These areas consist of certificate management, financial operations, storing and sharing data, recruiting, copyright, student assessment, and distance learning. Also, participants were provided with 'not sure' and 'other' options. The 'other' option enables the participants to write different areas that demand the adoption of blockchain applications. The descriptive statistics show that 32.7%, 27.4% and 16.2% of the participants selected financial operations, certificate management and student assessments, respectively. These are the most needed areas to adopt blockchain applications. In other words, around 60% of HEIs' employees in Saudi Arabia believe that blockchain-based applications should be mainly implemented for financial operations and certificate management. This finding meets one of this study's aims and will be the base of further recommendations in the conclusion chapter.

The 'other option was selected by 1.5% of the participants, and wrote that all the mentioned areas need the adoption of blockchain applications. In contrast, 0.5% of the participants selected 'other' and opted for the lack of the need to adopt a blockchain-based application in any area. The following Figure shows these results in detail (see Figure 16.0).

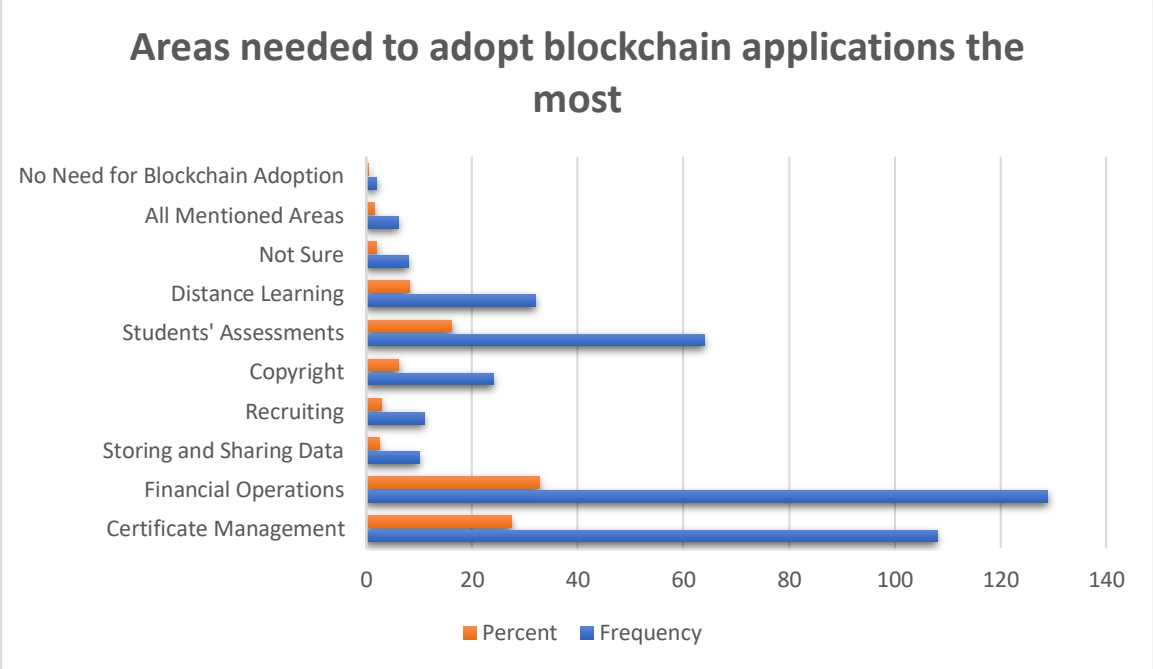

Figure 16.0 Descriptive Statistics for Areas Require Blockchain Usage

4.4.1.8 Regions of the HEIs

As the present study attempts to cover all HEIs in Saudi Arabia, participants were asked to choose what HEI they work for. Accordingly, the HEIs were coded based on the regions. Saudi Arabia consists of 13 provinces (regions), as shown in the Figure below. It represents the percentage of participants working in universities in specific regions. The chart demonstrates that 41.1% of the participants participated in HEIs in Riyadh province with 162 participants. This percentage is followed by Mecca and Eastern provinces, where 23.6% and 11.4% of the respondents were from these two regions, respectively. The other regions involved participants with percentages that range from 0.5% to 5.6% (see Figure 17.0).

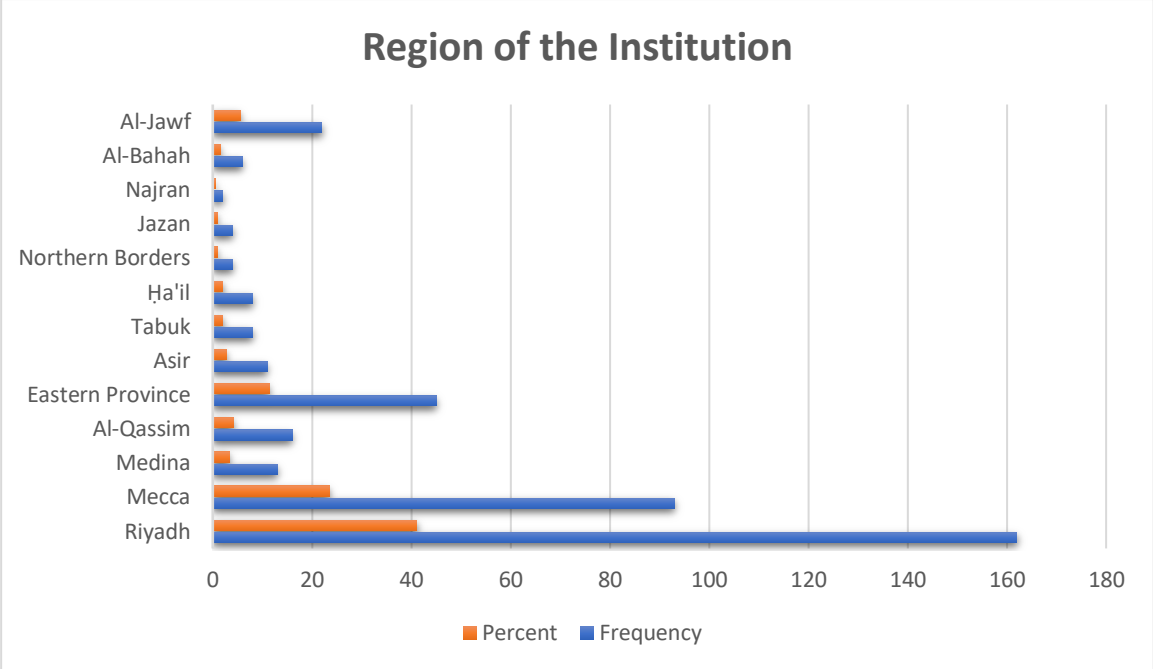

Figure 17.0 Descriptive Statistics for Regions of the HEIs

Upon discussing the frequency and percentages of each group's participants, MANOVA is employed to test the significant differences among groups within each category.

4.4.2 Descriptive Statistics of the Model's Items

As part of the distributed online survey, the participants encountered questions related to blockchain (e.g., trust, privacy, security and AW) and UTAUT constructs. The descriptive analysis of these constructs consists of the identity of every item, the range of the scores, the mean and the standard deviation (see Table 17.0). In the model constructs' items, participants encounter a 7-Likert scale, ranging from strongly disagree (1) to strongly agree (7). The descriptive statistics show that scores fall between 1 and 7. In other words, neither value goes beyond 1, nor a value goes above 7. Moreover, the mean values range between 4.51 and 5.90, which refers to the tendency toward an agreeable tendency perspective. Additionally, all standard deviation values are less than 2, which indicates that it is closer to the mean, referring to what could be considered consistency of opinions among participants (standard deviation >3.0) (Hair et al., 2020).

Table 17.0 Descriptive Statistics for Model's Constructs

Descriptive Statistics	N	Minimum	Maximum	Mean	Std. Deviation
Trust1	394	2	7	5.66	1.221

Trust2	394	2	7	5.55	1.185
Trust3	394	2	7	5.46	1.302
Sec1	394	1	7	4.98	1.717
Sec2	394	1	7	5.06	1.535
Sec3	394	1	7	4.79	1.681
Sec4	394	1	7	5.01	1.517
PE1	394	2	7	5.70	1.165
PE2	394	2	7	5.62	1.177
PE3	394	2	7	5.52	1.207
EX1	394	2	7	5.65	1.121
EX2	394	3	7	5.64	1.090
EX3	394	3	7	5.67	1.069
SI1	394	1	7	4.67	1.567
SI2	394	1	7	4.77	1.513
SI3	394	1	7	5.11	1.378
FC1	394	1	7	5.13	1.379
FC2	394	2	7	5.48	1.188
FC4	394	2	7	5.41	1.273
BI1	394	1	7	5.81	1.153
BI2	394	1	7	5.90	1.142
BI3	394	1	7	5.74	1.192
AW1	394	1	7	4.70	1.814
AW2	394	1	7	4.64	1.791
AW3	394	1	7	4.91	1.663
AW4	394	1	7	4.54	1.768
AW5	394	1	7	4.51	1.858
Valid N (listwise)	394				

PE=performance Expectancy, EX= Effort Expectancy, SI= Social Influence, FC= Facilitating Conditions, Sec= Perceived Security, AW=awareness and BI= Behaviour Intention

After showing the descriptive statistics of this study's indicators, the following section discusses the model testing procedure.

4.5 Model Testing

Following the selection of the PLS-SEM statistical technique to analyse data and test the model (see 3.5), the data preparation was confirmed, and descriptive data were discussed in the previous sections. Sequentially, this section discusses the findings of this study's proposed framework. The findings are tested based on a multi-stage procedure, which includes` measurement model assessment (outer model) and structural model assessment (inner model) (Hair et al., 2022; Hair et al., 2014; Henseler et al., 2017; Chin, 2010). As this study applies PLS-SEM, the outer and inner model terms are used to describe the multi-stage procedures instead of structural or measurement models (Henseler & Sarstedt, 2013; Hair et al., 2019).

4.5.1 Outer Model

The outer model (or measurement model) refers to the relationship between the unobserved/latent variables and manifest/observed variables (indicators/items) (Henseler & Sarstedt, 2013; Hair et al., 2019). The outer models could be assessed based on reflective or formative bases. This study initiates the discussion of the outer model with the formative and reflective approaches, yielding the selection of the reflective model. Progressively, the reliability and validity of the data are reported as a commencement phase to discuss the inner model.

According to Hair et al. (2019), the reflective approach assumes that the latent variables cause the indicators, which are modelled as the constructs' outcomes. The authors argue that all indicators should be conceptually associated and covary. Also, a reflective method requires acquiring a representative sample. Further, they informed that the indicators can be added or removed based on whether they show coverage of the latent variable. In other words, the indicators' sole role is to represent the latent variables. In examining the reflective approach, Hair and others (2019) suggest that indicator reliability and internal consistency must be established in the reflective outer model, as it is a prerequisite for the validity tests. The validity tests must be conducted internally (i.e., convergent validity) and externally (i.e., discriminant validity) (Hair et al., 2019). The reflective measurement model encompasses four angles of each latent variable, i.e., size and significance of indicator loadings, internal consistency reliability and convergent and discriminant validity tests (see Table 19.0) (Hair et al., 2017; Hair et al., 2019).

On the other hand, Hair et al. (2019) stated that formative scales occur when the manifest variables define the latent variables. In other words, the indicators are not required

to be conceptually associated with their latent variables except in the relationships to other antecedents. This unnecessary conceptual linkage causes the formative scales not to require collinearity among items, reflecting pointless usage of internal consistency (e.g., reliability and validity). Further, the authors stated that the validity in formative scales is only developed through predictive or criterion validity. Moreover, validity in formative scales is 'contingent on the constructs utilised in the validation process' (Hair et al., 2019, p.731).

The selection approach between the reflective and formative models should be based on theoretical reasonings and comparisons between the two models (Hair et al., 2019; Diamantopoulos & Winklhofer, 2001). Table 18.0 reflects the differences between these two measurement models.

Table 18.0 Differences between Reflective and Formative Scales

Characteristics	Indices of:	
	Reflective	**Formative**
Causality of construct	Measured indicators assumed caused by factor.	Assumed causally formed from item indicators.
Conceptual relationship among items	All items are conceptually related because they have a common cause.	No requirement of conceptual linkage to other items.
Domain of items	Representative sample of potential items. All items have the same meaning.	Exhaustive inventory of all possible items. Items each have different meanings.
Covariance among items	Collinearity among items expected.	No expectation of collinearity. High collinearity among formative items questions the approach.
Internal consistency	Required.	Not required and in fact problematic.
Forms of construct validity	Standard psychometric assessment	Only external construct validity.
Interpretational Confounding	Rare if factor is identified and meets ROT for convergence.	Inherent as formative loadings depend on outcomes.

Retrieved from Hair et al. (2019, p.732)

As the above Table represents, there are differences between reflective and formative measurement models. Based on these differences, the suitable measurement scale for the

present study is the reflective outer model (Hair et al., 2019). Indeed, the established model of the present study has a presumption that the constructs yield the development of the indicators. Also, all items of the present study have a common cause (i.e., measuring the associated construct), whereby the items reflect conceptual relationships. Moreover, all the given statements in the developed questionnaire had the same meaning and required a representative sample. In addition, the lack of internal validity is a severe concern of the formative model (Wilcox et al., 2008), leading to the importance of using internal validity in this study. The final reason is that some scholars have recognised additional issues associated with the usage of the formative model, which has led to question any usage of the formative measure at all (Borsboom et al., 2003; Bollen & Ting, 2000; Ping, 2004; Wilcox et al., 2008; Hair et al., 2019). Thus, this study selects the reflective measurement over the formative measurement model.

Based on the selection of the reflective scale, the internal consistency reliability, indicator reliability and convergent and discriminant validity are implemented (Hair et al., 2019; Hair et al., 2017). These assessments should be implemented in phases, starting with indicator reliability, internal consistency reliability, convergent validity and discriminant validity assessments (Hair et al., 2021). These reliability and validity tests are conducted using SmartPLS4. The results of these reliability and validity values are reflected on rules of thumb suggested by previous authors (see Table 19.0).

Table 19.0 Rules of Thumb for Outer Model

Term	Metric	Desirable Values	Reference(s)
Indicator Reliability	Outer Loadings	>0.708	Hair et al. (2019)
Internal Consistency Reliability	Cronbach's Alpha	<0.6 is poor; values between 0.6 and 0.7 are acceptable in exploratory studies. 0.7 to 0.9 ranges from good to excellent; 0.9 to 0.95 values are somewhat high; ≥0.95 are too high.	Hair et al., (2020)
	Composite Reliability	>0.7 to <0.95 are accepted values.	Hair et al. (2019)
Convergent Validity	Average Variance Extracted (AVE)	AVE >0.50	

Discriminant Validity	Heterotrait-Monotrait (HTMT) ratio of correlations.	HTMT <.9 for conceptually similar constructs and <0.85 in distinct constructs.	Henseler et al. (2015)

4.5.1.1 Reliability

In PLS-SEM, reliability could be divided into indicator and internal constancy reliability.

4.5.1.1.1 Indicator Reliability

According to Hair et al. (2019), indicator reliability should be assessed by examining the loadings. Loadings greater than .708 reflect that the latent variables represent more than 50% of the item's variance (Purwanto & Sudargini, 2021). Hence, loadings >0.708 highlight acceptable item reliability (Hair et al., 2019; Hair et al., 2021).

In the present study, none of the indicators obtains less than .708 (see Table 20.0). Therefore, all items are retained for sequence analyses.

Table 20.0 Indicator Reliability Results

Items/constructs	AW	BI	EX	FC	PE	SI	Sec	Trust
AW1	.901							
AW2	.888							
AW3	.903							
AW4	.847							
AW5	.861							
BI1		.943						
BI2		.928						
BI3		.929						
EX1			.914					
EX2			.955					
EX3			.918					
FC1				.847				
FC2				.861				
FC4				.869				

PE1	.908			
PE2	.936			
PE3	.932			
SI1		.908		
SI2		.916		
SI3		.862		
Sec1			.910	
Sec2			.924	
Sec3			.932	
Sec4			.892	
Trust1				.887
Trust2				.918
Trust3				.902

PE=performance Expectancy, EX= Effort Expectancy, SI= Social Influence, FC= Facilitating Conditions, Sec= Perceived Security, AW=awareness and BI= Behaviour Intention

4.5.1.1.2 Internal consistency

In addition to the indicator reliability, Hair et al. (2021) stated that the internal consistency reliability is analysed in PLS-SEM by Cronbach's Alpha (Cronbach, 1951), Composite Reliability rho_c (Chin, 1998) and Composite Reliability rho_a (Dijkstra & Henseler, 2015). Composite Reliability rho_a is recommended over the other two metrics because it falls 'between the conservative Cronbach's aloha and the liberal Composite Reliability rho_c' (Hair et al., 2021, p.77). Further, the Composite Reliability rho_c might overestimate the actual reliability of unobserved variables values (Dijkstra & Henseler, 2015). Also, rho_a has been implemented in recent studies in the field of technology adoption (Mansoor et al., 2023; Sarnacchiaro et al., 2024; Azam & Ahmad, 2024; Vasuthevan et al., 2024). Hence, the Composite Reliability rho_a is executed in this study based on SmartPLS4 (Ringle et al., 2024). The results of the Composite Reliability rho_a are represented in Table 21.0. It demonstrates that all the reliability scores fall between 0.8 and 0.95, which reflects excellent reliability results (Hair et al., 2020).

Table 21.0 The Composite Reliability

Item	Composite Reliability rho_a
AW	0.930
BI	0.927
EX	0.925
FC	0.833

PE	0.916
SI	0.878
Sec	0.935
Trust	0.887

PE=performance Expectancy, EX= Effort Expectancy, SI= Social Influence, FC= Facilitating Conditions, Sec= Perceived Security, AW=awareness and BI= Behaviour Intention

4.5.1.2 Construct validity

Construct validity is described by Hair et al. (2019) as the extent to which a set of observed variables actually depicts the unobserved variables that are designed to be gauged. The construct validity in the PLS-SEM outer model must be established by implementing convergent and discriminant validity (cHair et al., 2017).

4.5.1.2.1 Convergent Validity

Convergent validity represents the degree to which the latent variable converges in order to interpret the variance of its observed variables (Hair et al., 2021). The recommended metric to assess the latent variable's convergent validity is the average variance extracted (AVE) (Fornell & Larcker, 1981; Henseler et al., 2009; Hair et al., 2021). An AVE must equal or more than 0.5, as obtaining a 0.5 AVE or higher indicates that an unobserved variable interpret 50% or more of the observed variable's variance that compose the latent variable (Hair et al., 2021; Henseler et al., 2009; Fornell & Larcker, 1981; Götz et al., 2009; Hair et al., 2022). Hence, the present study tests the convergent validity by employing the AVE metric in SmartPLS (Ringle et al., 2024). Table 22 demonstrates that all AVE values are greater than 0.5.

The result shows that all the scores are between .738 and 871, implying that the latent variables explain 73.8% or more of the observed variables' variance.

Table 22.0 Convergent Validity

Item	Average Variance Extracted (AVE)
AW	0.775
BI	0.871
EX	0.864
FC	0.738
PE	0.856
SI	0.803

Sec	0.836
Trust	0.814

PE=performance Expectancy, EX= Effort Expectancy, SI= Social Influence, FC= Facilitating Conditions, Sec= Perceived Security, AW=awareness and BI= Behaviour Intention

4.5.1.2.2 Discriminant Validity

Discriminant validity indicates the degree to which a predictor variable varies from other predictor variables in a model (Teo et al., 2008; Hair et al., 2021). In research, discriminant validity in PLS-SEM has been tested in various ways, including but not limited to the Fornell and Larcker (1981) Criterion, cross-loading (Chin, 1998) and Heterotrait-Monotrait (HTMT) ratio of correlations (Henseler et al., 2015). This study selects the HTMT ratio of correlations test over the others (Henseler et al., 2015). Regardless of their common use in previous studies (Ringle et al., 2012), the Fornell and Larcker Criterion and cross validity are avoided in this study due to their inefficient sensitivity in spotting discriminant validity issues (Henseler et al., 2015). Alternatively, the HTMT ratio of correlations is chosen based on the guidance of recent authors when a researcher employs PLS-SEM (Hair et al., 2021; Radomir & Moisescu, 2019; Henseler et al., 2015; Voorhees et al., 2016), such as the present study.

This research adopts the HTMT to evaluate the discriminant validity. The HTMT method refers to correlations of indicators for single constructs (Hair et al., 2021). These tests may or may not be employed separately, as previous authors who have published in renowned journals have used one or more discriminant value assessments in various fields (Ringle et al., 2012). Concerning discriminant values for HTMT, previous studies have had two various stances of HTMT threshold values. A number of previous authors have suggested that the cut-off value of HTMT should be >0.9 (Gold et al., 2001; Teo et al., 2008), whereas other authors argue that HTMT should not exceed 0.85 (Voorhees et al., 2016; Kline, 2016). Other authors suggest that if the constructs are conceptually similar, values of discriminant validity are acceptable up to 0.9, whereas distinct latent variables should score less than 0.85 in HTMT (Hair et al., 2019; Henseler et al., 2015). As a conservative stance and due to the distinction among constructs, the present study adopts the recommendation by authors who suggest the threshold value should be 0.85 (Henseler et al., 2015; Hair et al., 2019).

Table 23.0 reflects the HTMT scores to determine the discriminant validity. The scores indicate that all the values are less than 0.85.

The result of HTMT ranges between .575 and .828, referring to the fact that there is no value more than 0.85. These values refer to obtaining high discriminant validity among constructs.

Table 23.0 HTMT Discriminant Validity

Items	BI	EX	FC	PE	SI	Sec	Trust
BI							
EX	0.661						
FC	0.716	0.764					
PE	0.779	0.729	0.734				
SI	0.601	0.671	0.828	0.704			
Sec	0.575	0.601	0.617	0.662	0.639		
Trust	0.633	0.691	0.726	0.783	0.673	0.726	

PE=performance Expectancy, EX= Effort Expectancy, SI= Social Influence, FC= Facilitating Conditions, Sec= Perceived Security, AW=awareness and BI= Behaviour Intention

As Hair et al. (2019) suggested, this section initially discusses the outer model, starting with justifying the selection of the reflective measurement model based on the differences between the formative and reflective models. Consequently, the reliability and validity tests were conducted based on suggested criteria adopted from previous studies (Hair et al., 2019; Hair et al., 2021; Henseler et al., 2015). The following section discusses the inner model as the second aspect of the multi-stage procedure (Hair et al., 2017; Hair et al., 2019; Hair et al., 2021; Henseler et al., 2017).

4.5.2 Inner Model

The inner model (or structural model) refers to the conceptual components of the PLS-SEM, which encompass the relationships between latent constructs and their paths (Hair et al., 2019; Henseler & Sarstedt, 2013; Hair et al., 2014; Henseler et al., 2009). Previous scholars have suggested that specific assessments should be employed to evaluate the inner model. For instance, Hair et al. (2019) recommend that the inner measurement assessments consist of collinearity, coefficient determination, effect size, predictive relevance and path coefficient. This study follows this recommendation due to its popularity in related fields and to the reliability of Hair's suggestions in social science.

The inner model assessments should begin with evaluating the structural model's collinearity issues. After that, the inner model should be evaluated based on the degree to which the exogenous variable affects the endogenous variable(s). This effect should be assessed based on the 'coefficient of determination (R^2), the effect size (f^2), cross-validating redundancy (Q^2) and the size and significance of the path coefficients' (Hair et al., 2019, p.781). Based on this recommendation, this study conducts these assessments using

SmartPLs 4 (Ringle et al., 2024) and evaluates them against specific metrics and thresholds (see Table 24.0).

Table 24.0 Rules of Thumb for Inner Model

Term	Metric	Desirable Values/ guidelines	Reference(s)
Collinearity	Variance inflation factor (VIF)	Approximately equal 3 and lower (e.g., 3.3). It must be less than 5.	Kock (2023); Hair et al. (2021) (2019);
Coefficient of determination	R^2	R^2 falls between 0 to 1, whereby values of ≥ 0.19 represent weak relationship. ≥ 0.33 represent moderate relationship. ≥ 0.67 represent substantial relationship.	Chin (1998)
Effect Size	f^2	General effect size guideline: <0.02 no effect 0.02 small effect 0.15 medium effect 0.35 large effect	Hair et al. (2019); Cohen (1988)
		Moderating effect size guideline: <0.005 no effect. ≥ 0.005 small effect. ≥ 0.01 medium effect. ≥ 0.025 large effect.	Kenny (2018)

Predictive relevance	cross-validated predictive ability test (Q^2)	>0.00	Hair et al. (2019);
Path coefficient (β) significance	p-value	p ≤ 0.05	Kock (2015)
	t-value	t-value>1.645	Hair et al. (2020)
	Path coefficient (β)	P< 0.5 if the value zero does not fall into 95% confidence interval.	Hair et al. (2021); Henseler and Fassott, (2010)
Path coefficient relevance	Path coefficients	Path coefficients fall between -1 and +1. The closer to +1 the stronger the positive relationship and the closer to -1 the stronger the negative relationship.	Hair et al. (2021)

4.5.2.1 Collinearity

As discussed in the outer model (see Section 4.5.1), collinearity could be divided into two components, namely, classical (vertical) and lateral collinearity. Integrating these two tests has led to the proposal of the full collinearity VIFs by enabling simultaneous evaluation of vertical and lateral collinearity (Kock & Lynn, 2012, 2015). Hair (2019) states that VIF values of more than five indicate the presence of multicollinearity. The previous results in Table 25 demonstrates that no value is above five, and almost all values are 3 or lower, indicating that no critical issue exists concerning the collinearity of latent variables.

4.5.2.2 Coefficient of Determination

The coefficient of determination (R^2) is described as 'a measure of the proportion of the variance in the endogenous construct(s) that is explained by the predictor constructs' (Hair et al., 2019, p.760). It deals with measuring in-sample predictive power (Butler & Wilson, 2007; Rigdon, 2012). According to Hair et al. (2019), the R^2 value falls between 0 and 1, where zero

indicates no relationship and one reflects a perfect relationship. The authors explained that a greater R^2 value up to one indicates a more comprehensive explanation of PLS-SEM, which ultimately produces a better prediction of the endogenous construct(s).

In terms of values, Chin (1998) recommended that R^2 values of 0.19, 0.33, or 0.67 for observed constructs in PLS-SEM's inner model reflect small, moderate and substantial relationships, respectively. By employing SmartPLS4, R^2 adjusted square shows R^2=.615, R^2=.426, R^2=.598, and R^2=.436 for behavioural usage, EX, PE and trust as endogenous variables, respectively. These results imply that exogenous variables in this study's developed model account for moderating variance among the endogenous variables, as they are above 0.33 and less than .67 (Chin, 1998). Therefore, all the endogenous constructs in the present study are moderately varied by their exogenous variables (see Table 25.0)

Table 25.0 Examining the Coefficient of Determination

Endogenous Constructs	R-square	R-square adjusted
BI	.626	.615
EEX	.429	.426
PE	.602	.598
Trust	.437	.436

PE=performance Expectancy, EX= Effort Expectancy and BI= Behaviour Intention

4.5.2.3 Effect size

The effect size (f^2) could be employed following the result of the coefficient of determination. Effect size represents the variance in R^2 values if a particular exogenous latent variable is omitted from the model (Hair et al., 2019). Also, the f^2 metrics indicate the strength intensity between exogenous and endogenous variables (Hair et al., 2020). According to Cohen (1988), f^2 statistics, 0.02, 0.15, and 0.35 represent small, medium and large effects, respectively. Considerably, the moderator variables' effect size may have lower measurements in order to present a lower, medium or large effect size (Kenny, 2018; Rasoolimanesh et al., 2021; Hair et al., 2022). The f^2 values for moderator variables are 0.005.001 and .025 for small, medium and large effects (Kenny, 2018).

Further, Table 26.0 explains the effect size of every exogenous construct on all endogenous constructs in the present study. In investigating f^2 statistics through SmartPLS, four endogenous variables exist in this study, namely, BI, trust, EX and PE. Besides BI, the other three variables are endogenous and exogenous variables at the same time(mediators).

The results revealed that exogenous constructs that have a large effect size (f^2>0.35) are SEC and its variance impact on trust (f^2=.777) and AW and its variance effect on BI (f^2=.062). Moderate effects (f^2>0.15 and <.35) occur between the EX and its variance effect on PE (f^2=.159), PE and its variance influence BI (f^2=.156), trust and its variance impact PE (f^2=.173) and trust with its variance effect on EX (f^2=.205). Furthermore, the small effect size (f^2>0.02 and <0.15) among other constructs encompasses the variance between FC on BI (f^2=.043) security and PE (f^2=.040). Further, the moderating variable of AW between facilitating condition and BI could be considered a small effect size (f^2=.027). However, this specific moderating effect might be considered a large effect, according to Kenny (2018). The other constructs (i.e., EX, SI and other moderators) do not influence the variance of behavioural usage (R^2) as their f^2 is lower than .02.

Therefore, it could be concluded that the largest effect on the coefficient of determination (R^2) of BI is PE.

Table 26.0 Effect Size (f^2)

Constructs	F-square
AW->BI	.062
EX->BI	.004
EX->PE	.159
FC->BI	.043
PE->BI	.156
SI->BI	.002
Sec->BI	.010
Sec->PE	.040
Sec->Trust	.777
Trust->BI	.003
Trust->EX	.205
Trust->PE	.173
AW* PE->BI	0.00
AW* EX->BI	0.00
AW* SI->BI	0.00
AW* FC->BI	0.027

PE=performance Expectancy, EX= Effort Expectancy, SI= Social Influence, FC= Facilitating Conditions, Sec= Perceived Security, AW=awareness and BI= Behaviour Intention

4.5.2.4 Predictive Relevance

Another frequently used and recommended metric, as part of the PLS-SEM inner model, is the q-square (Q^2) (Shmueli et al., 2016; Hair et al., 2019). It measures the quality of how a developed model and its parameter estimates reconstruct a measurement of well-observed values (Chin, 1998). In its association with PLS-SEM, Q^2 could be assessed based on a blindfolding procedure (Chin, 1998; Hair et al., 2020) or a cross-validated predictive ability test (CVPAT) (Liengaard et al., 2021; Hair et al., 2021; Hair et al., 2022). These two assessments were built based on the cross-validation methodology (Stone, 1974; Seymour, 1974) and have been employed in literature to compute the Q^2 metric (Shmueli et al., 2016; Liengaard et al., 2021).

Besides the blindfolding procedure commonly used in literature, this usage has been recently criticised for various factors. Shmueli et al. (2016) argue that the blindfolding procedure has critical limitations in PLS-SEM. The first limitation is blindfolding does not fully integrate internal consistency with predictive relevance accuracy. Second, the calculation method of blindfolding's outcomes does not totally demonstrate the type of heterogeneity linked with the accurate out-of-sample prediction The blindfolding procedure also concentrates on aggregating the prediction of one's dataset rather than measuring the prediction of specific observations. Indeed, software programmes could not produce observation-wise predictions for new observations. The final limitation is that the blindfolding procedure encounters challenges in assessing the contextual terms (Shmueli et al., 2016). These limitations have yielded to the proposal of CVPAT by Liengaard et al. (2021) and its extension by Sharma et al. (2023).

Compared with the blindfolding procedure, CVPAT is developed based on cross-validation along with out-of-sample prediction error (P. N. Sharma et al., 2023; Liengaard et al., 2021). CVPAT assists in comparing the predictive strengths of a developed model to determine whether the model is reliable and not influenced by sampling error (Liengaard et al., 2021). CVPAT assists in obtaining the predictive capabilities of a developed model (Hair et al., 2022). In addition, this CVPAT metric is calculated automatically in the used SmartPLS 4 in this study, which facilitates obtaining accurate and authentic values for the predictive relevance (Ringle et al., 2024). Further, this metric is highly recommended by recent and renowned literature and authors to be used instead of blindfolding procedure (Hair et al., 2021; Hair et al., 2022; Ringle et al., 2024). Hence, the CVPAT is adopted and used in the present study.

To obtain an acceptable result for CVPAT, Ringle et al. (2024) stated that the average loss difference scores are required to be negative. Also, previous studies in the field relied on reporting the average loss difference to represent the CVPAT results (e.g., Lavaei Adaryani et al., 2024). Therefore, findings revealed that all the average loss difference values are negative (see Table 27.0). This result indicates that the developed model of the present study reflects predictive capabilities (Hair et al., 2022).

Table 27.0 Predictive Relevance (Q^2)

Endogenous Construct	Average loss difference	t value	p value
BI	-0.557	6.447	0.000
EX	-0.318	6.551	0.000
PE	-0.442	6.717	0.000
Trust	-0.541	9.457	0.000

PE=performance Expectancy, EX= Effort Expectancy and BI= Behaviour Intention

4.5.2.5 Coefficient Significance and Relevance

The final suggested metric is related to the significance and relevance of the path coefficient (β) (Hair et al., 2021; Hair et al., 2019). It is suggested that the significance and relevance of the path coefficient be evaluated in SmartPls4 by employing a bootstrapping procedure (Ringle et al., 2022; Hair et al., 2019; Hair et al., 2021; Wong, 2013; Streukens & Leroi-Werelds, 2016). Bootstrapping provides t-value, path coefficients and p-value statistics to determine the significance testing for the PLS-SEM inner models (Hair et al., 2019; Wong, 2013; Hair et al., 2022).

In running the standard-algorithm bootstrapping in SmartPLS, the 10,000 bootstrap subsamples option is suggested to be the ideal selection in terms of the PLS-SEM parameter estimations (Streukens & Leroi-Werelds, 2016; Hair et al., 2021). It is selected in the present study. Relatedly, the selected confidence interval method in SmartPls-4 is percentile bootstrap (Becker et al., 2023; Aguirre-Urreta & Rönkkö, 2018; Ringle et al., 2024), which is a tool to construct bootstrap confidence interval (Hair et al., 2021). Also, the selected test in this study is the one-tailed type due to the hypothesised positive path coefficient in the present study (i.e., positive directional hypothesis between exogenous and endogenous latent variables) (Kock, 2015; Hair et al., 2020; Field, 2018).

Regarding statistically significant values, the path coefficients where the p-value is ≤ 0.05 indicate a significant relationship between constructs if no ≤ zero values existed within

the 95 per cent confidence interval (Hair et al., 2019). In terms of relevance, the path coefficients range between ±1, whereby the closer a value to ±1 indicates a positive or negative relationship, and the closer a value to 0 indicates a weak or non-existent relationship (Hair et al., 2021). In addition, a one-tailed T value greater than 1.645 indicates a significant statistical result (Hair et al., 2020). Therefore, the p-value, t-value and path coefficients will be computed in the present study, confirming that no zero falls within the 95% confidence interval. The outcomes of these metrics demonstrate the significance and relevance of exogenous and endogenous variables in this study to determine whether the hypotheses of this study are accepted or rejected.

4.5.2.5.1 Direct Relationships

This section reports the path coefficient results, t-value, and p-value to empirically test the formulated hypotheses in the present study. The hypotheses were developed and discussed in Section 2.6.4. The results of the direct hypothesised relationships are presented in Table 28.0.

H1 investigated the relationship between PE and BI. The results revealed that PE is the main driver of BI (β=.424, p <.001). Thus, H1 is accepted. This significant result suggests that employees in HEIs are more likely to adopt blockchain technology if they believe it will enhance their job performance. In other words, the more they perceive blockchain as beneficial to their work, the more inclined they are to accept and use it.

H2a evaluated the correlation between EX and PE. The results revealed a significant and positive relationship between EX and PE (β=.333, p <.001). Thus, H2 is accepted. This significant result indicates that the perceived ease of using blockchain enhances the belief that it will improve job performance among HEI staff in KSA.

H2b assessed the effect of EX on BI. This result showed an insignificant effect of EX on BI (β=.065 p=.094). Thus, H3 is rejected. This insignificant result reflects the perceived ease of utilising blockchain does not enhance employees' intention to use it.

H3 discussed the potential influence of SI on BI. The results showed a lack of a direct relationship between SI and BI (β=-.038= p <.217). Thus, H3 is rejected. This insignificant result shows that the perceptions of administrative staff and academics in KSA about how their influential peers view blockchain usage in their work are not significantly linked to their intention to adopt it.

H4 postulated a significant and positive relationship between FC and BI. The results confirm this postulation (β=.203, p<.001). Thus, H4 is approved. This significant result

demonstrates that the more employees perceive that their institution supports and facilitates blockchain adoption, the more likely they are to embrace its use in their professional roles.

H5a expected a significant effect between trust and BI. The results revealed an insignificant influence of trust on BI (β=-.051p= 0.219). Thus, H5a is rejected. This insignificant result suggests that a higher level of trust in blockchain among administrative staff and academics in HEIs in KSA does not lead to increased acceptance of its use.

H5b evaluated the relationship between trust and PE. The results demonstrated a significant relationship between the two constructs (β=.384, p<.001). Thus, H5b is accepted. This significant result suggests that the more employees trust blockchain and perceive it as less risky to use, the more they believe it will improve their job performance.

H5c suggested the relationship between trust and EX. The results demonstrated a significant and positive relationship between trust and EX (β=.456, p<.001). Thus, the hypothesis is accepted. This significant result implies that the more employees trust blockchain and perceive it as less risky to use, the easier they believe blockchain is to use.

H6a evaluated the influence of SEC on BI. The results revealed a significant direct and positive relationship between SEC and BI (β=.090, p= 035). Thus, H6a is approved. This result suggests that the perception that blockchain secures their data more and enables the data to be more controllable has a significant and positive influence on blockchain acceptance.

H6b assumed a relationship between SEC and PE. The results showed a significant relationship between SEC and PE (β=.173, p<.001). Thus, H6b is accepted. This significant result implies that staff's perceptions of blockchain's ability to safeguard against cyberattacks and provide better control over their data significantly and positively influence their belief that blockchain enhances their job performance.H6c inspected the impact of SEC on trust. The result revealed a significant relationship between SEC and trust (β=.661, p<.001). Thus, H6c is accepted. This significant result demonstrates a positive correlation between the perception that blockchain protects employees' data against threats and cyberattacks, allows them to control their data, and a lower risk judgment of blockchain.

H6d concerns the potential relationship of the effect of security on EX. The results confirmed the existence of this relationship (β=.257, p<.001). Thus, H6d is supported. This significant relationship demonstrates that the more employees perceive blockchain as a secure technology, the more they believe it requires less effort to use.

H7a regarded the relationship between AW and BI. The results confirmed the impact of AW on BI (β=.213, p<.001). Thus, H7a is accepted. This result implies that the knowledge of administrative staff and academics regarding blockchain's presence, features, and relevance to their job tasks has a significant positive influence on their acceptance of blockchain.

4.5.2.5.2 Moderating Relationships

A moderating effect arises when a moderator construct alters the strength level or the direction between two constructs in a model (Henseler & Fassott, 2010; Hair et al., 2014; Ringle et al., 2024). In this study, AW of blockchain was hypothesised to influence the strength of the direct relationships between UTAUT constructs and BI. To empirically test the moderating effect of AW, Smartpls-4 software was employed to analyse the collected data. The reported results are pertinent to the path coefficient t value and p value. The following results are related to the moderating effect hypothesised in the present study.

H7b assessed the moderating impact of AW between PE and BI. The results revealed the lack of effect of AW on the relationship between PE and BI (β=.018, p= 337). Thus, H7b is rejected.

H7c evaluated the moderating role of AW between EX and BI. The results demonstrated the lack of impact of AW between PE and BI (β=-.004, p= 475). Thus, H7c is rejected.

H7d evaluates the moderating role of AW between SI and BI. The result revealed an insignificant impact of AW on the relationship between SI and BI (β=-.004, p= 472). Thus, H7d is rejected.

H7e discussed the impact of AW, as a moderator variable, on the relationship between FC and BI. The results revealed a significant effect between FC and BI (β=.188, p= .013). Thus, H7e is accepted. The AW influence on the FC and BI are negative. That means that the increase in awareness reduces the impact of FC on BI.

In order to measure the moderating effect of AW in general, a comparison of the R^2 results was conducted. The R^2 alteration is significant to report (Ramayah et al., 2017). Initially, the R^2 adjusted result for BI without the moderator. Comparably, the R^2 adjusted square result with the moderation effect of AW on the relationships between UTAUT constructs and BI was performed. The results of R^2 without the moderation was .595. The results of R^2 with the moderation was .626. Therefore, there is a .03 in R^2 after adding the AW as moderator. These results reflect that the moderator causes .03 of variance in BI.

To determine which moderating effect causes this change of variance on BI and whether the change is significant, the f^2 was computed. The f-square revealed one moderating effect between this study's hypothesised moderators. The AW moderating effect exists more clearly between FC and BI, revealing that f^2=.027. The effects of the other moderators are unclear as their f^2 outcomes are less than .000. All findings were reported in Table 26.0. The effect size of AW between FC and BI reflected a weak effect (Henseler & Fassott, 2010; Cohen, 1988). However, Kenny (2018) considers the attained result in the present study (f^2=.027) to be a large effect size because it is more than .025. The Kenny's suggested values can be considered to reflect more realistic standards for moderating effect because moderation effect size (f^2) usually yields small results (Rasoolimanesh et al., 2021; Hair et al., 2022; Aguinis et al., 2005). The effect size must not be overlooked regardless its small or large effect (Chin et al., 2003).

Therefore, AW causes .02 of variance on the BI. The moderating effect of AW between FC and BI is significant and influences the effect size on BI. Therefore, the AW impact on the relationship between FC and BI is significant and must be carefully considered.

Table 28.0 Complete Results of The Direct and Moderating Paths Coefficients

Hypothesis	Paths	Path Coefficients (β)	T value	P values	5% Confidence intervals	95% Confidence intervals	Result
H1	**PE->BI**	0.424***	6.497	0.000	0.315	0.529	Accept
H2a	**EX->PE**	0.333***	7.306	0.000	0.259	0.407	Accept
H2b	**EX->BI**	0.065	1.319	0.094	-0.016	0.145	Reject
H3	**SI->BI**	-0.038	0.781	0.217	-0.115	0.047	Reject
H4	**FC->BI**	0.203***	3.498	0.000	0.109	0.300	Accept
H5a	**Trust->BI**	-0.051	0.774	0.219	-0.158	0.060	Reject
H5b	**Trust->PE**	0.384***	6.745	0.000	0.289	0.477	Accept
H5c	**Trust->EX**	0.456***	8.621	0.000	0.367	0.540	Accept
H6a	**Sec->BI**	0.090*	1.809	0.035	0.007	0.169	Accept
H6b	**Sec->PE**	0.173***	3.504	0.000	0.091	0.254	Accept
H6C	**Sec->Trust**	0.661***	20.813	0.000	0.608	0.713	Accept
H6d	**Sec->EX**	0.257***	4.709	0.000	0.168	0.348	Accept
H7a	**AW->BI**	0.213***	4.549	0.000	0.135	0.289	Accept
H7b	**AW x PE->BI**	0.018	0.314	0.377	-0.070	0.115	Reject
H7c	**AW x EX->BI**	-0.004	0.064	0.475	-0.090	0.089	Reject
H7d	**AW x SI->BI**	-0.004	0.070	0.472	-0.101	0.089	Reject
H7e	**AW x FC->BI**	-0.188*	2.239	0.013	-0.327	-0.049	Accept

***p<.001, **p<.01 and *p<.05, PE=performance Expectancy, EX= Effort Expectancy, SI= Social Influence, FC= Facilitating Conditions, Sec= Perceived Security, AW=awareness and BI= Behaviour Intention

4.5.2.5.3 Indirect Relationships

According to Hayes and Rockwood (2020), mediators might be formulated in different forms, such as single, parallel and serial indirect relationships. In this study's framework, the mediation relationships involve parallel, single and serial-forms mediation relationships (Hayes & Rockwood, 2020), similar to previous studies (e.g., Robertson & Barling, 2013; Gratz et al., 2015; Lee, 2023; Ashrafi & Easmin, 2023; Chen, 2022; Duong et al., 2023). These relationships are discussed in more detail in this section.

The present study disregards formulating explicit hypotheses for the mediating relationships. In relation to the PLE-SEM tool, research practitioners do not tend to consider explicit hypotheses concerning to the mediating effects (Nitzl et al., 2016; Hair et al., 2021; Hair et al., 2022; Carrión et al., 2017). In other words, the mediating hypotheses in this study are presented implicitly and indirectly. For instance, the hypothesised direct relationship between SEC and PE and the direct relationship between PE and BI reflect an implicit and mediating role of PE between SEC and BI. However, this mediating role is not explicitly hypothesised during the hypothesis development.

Although this implicit approach was significantly criticised in previous studies who asserted the need to hypothesise the mediating effect explicitly (Rungtusanatham et al., 2014; Memon et al., 2018), studies related to mediation and PLS-SEM did not criticize the implicit mediating relationships between latent variables (Nitzl et al., 2016; Hair et al., 2021; Hair et al., 2022; Carrión et al., 2017). Indeed, studies that explicitly hypothesise mediation do not exceed 15-20 percent (Rungtusanatham et al., 2014; Memon et al., 2018; Nitzl et al., 2016; Ringle et al., 2012). High percentage of existence literature has led to apply the implicit mediating hypotheses (Ringle et al., 2012; Nitzl et al., 2016). In addition, studies that have applied UTAUT and related to blockchain technology tend not to generate explicit hypothesises of the mediating relationships; yet, they have tested the indirect relations and present them in their analysis (e.g., Ferri et al., 2021; Adaryani et al., 2024; Mendoza-Tello et al., 2018). Similarly, studied in the HEIs industry that implemented UTAUT have not explicitly hypothesised the mediating relationships between constructs. Nevertheless, they have tested them and reported them in their analysis. For instance, Parhamnia (2022) reported the mediation results for UTAUT-2 determinants pertaining to mobile usage of library services in HEIs among students, and did not generate mediation hypotheses. This case applies on multiple studies that have applied UTAUT or UTAUT 2 without hypothesising the mediation correlations (e.g., Al-Rahmi et al., 2022). Additionally, the present study hypothesise direct relationships among latent variables. These direct relationships generate mediating relationship without the need for explicit hypotheses for mediation. In addition, formulating additional mediating relationships may make the framework more complex and more difficult

to understand. Furthermore, theoretical background is essential in terms of building mediating relationships (Hair et al., 2021). However, to the best of the author's knowledge, there is no solid theoretical background that can support this study's mediating relationships related to the blockchain intention to use in HEIs. Hence, the explicit formulation of mediating hypotheses of the present study is neglected.

As outcomes of the PLS-SEM analyses, this study's findings represent single and serial indirect effects between exogenous variables and BI. Beginning with its mediating role, PE significantly mediates the effects of SEC, EX and trust on the BI, separately (see Table 29.0). In other words, single-indirect effects occur between SEC, EX and trust, independently, on BI through PE (Hayes & Rockwood, 2020). Regarding SEC, the single and serial indirect paths toward the BI were expected to occur through Sec->PE->BI, Sec->EX->BI, Sec->Trust->PE->BI and Sec->EX->PE->BI. The latter two paths reflect the serial mediating relationships (Hayes & Rockwood, 2020). Similarly, trust impact on BI was expected to occur through single and serial indirect paths, i.e., Trust->PE->BI, Trust->EX->BI and Trust->EX->PE->BI. The latter reflects the serial mediating relationship (Hayes & Rockwood, 2020).

Empirically, the results revealed that EX had a significant indirect impact on the BI through PE (β=.142, p < .001). The total effect of EX was found to be significantly influencing BI (β=.206, p < .001). However, the EX showed an insignificantly direct effect on BI. This result reveals an indirect-only (full mediation) relationship between EX (Zhao et al., 2010; Hair et al., 2021; Nitzl et al., 2016; Hair et al., 2022). Therefore, PE mediates SEC, trust and EX.

Furthermore, the results revealed a significant and positive indirect effect of SEC on BI (β=.074, p=.00103). The total effect (without the existence of mediation) of SEC on BI was significant and positive (β=.353, p <.001). The direct effect (with the existence of mediation) between SEC and BI revealed a significant and positive indirect relationship on the BI (β=.90, p=.035). These results indicate a partial mediation (or complementary mediation) as all three paths are significantly positive (Zhao et al., 2010; Hair et al., 2021; Nitzl et al., 2016; Hair et al., 2022).

In terms of serial relationships (Hayes & Rockwood, 2020), results revealed that trust and PE significantly and positively mediate the relationship between SEC and BI (β=.108, p <.001). Similarly, the path Sec->Trust->EX->BI reflects a sequential-significant indirect effect of security on BI (β=.043, p <.001). SEC had a significant and positive influence on BI totally (β=.353 p=. <.001) and directly (β=.090, p=.035). Similarly, serial-significant mediating results revealed a significantly indirect correlation of SEC through 1) EX and 2) PE (β=.036, p <.001). The total and direct effects of SEC on BI were found to be positive and significant, as mentioned above. These results reflect the partial and complementary mediating relationships

between SEC and BI through 1) trust and 2) PE and through 1) EX and 2) PE (Carrión et al., 2017; Hair et al., 2022).

Additionally, findings showed a single significant indirect influence between trust and BI through PE (β=.163, p=.229). The results, without any consideration of mediating effect existence (total effect) regarding trust, demonstrated a significant relationship between trust and BI (β=.205, p=.002). Considering the inclusion of the mediating effect, the direct effect result between trust and BI was insignificant (β=-.051, p=.219). Therefore, the indirect-only relationship is the obtained mediating type in this indirect relationship between trust and BI (Zhao et al., 2010; Hair et al., 2021; Nitzl et al., 2016; Hair et al., 2022).

Similarly, trust was found to have a serial-significant indirect effect on BI through 1) EX and 2) PE (β=.064 p=. <.001). Trust was found to have a total significant effect on BI (β=.205 p=.002). However, the direct effect of trust was found insignificant (β=.-.051 p=.219). Therefore, an indirect-only correlation of trust on BI is the acquired result concerning this case of mediation (Zhao et al., 2010; Hair et al., 2021; Nitzl et al., 2016; Hair et al., 2022).

These indirect-only relationships imply that trust does not directly influence the BI. However, it influences BI through other mediating variables. The indirect effect of trust (total indirect effect) significantly influences BI (β=.257 p=. <.001). That suggests that trust significantly influences PE, which significantly and positively influences the BI. Also, trust significantly affects EX, which in turn significantly influences PE. Ultimately, PE significantly influences the intention to use blockchain technology among HEIs' employees.

The other indirect relationships highlighted insignificant effects. The trust and EX mediating roles for SEC presented no significant indirect relationship because they (trust and EX) do not directly influence the intention to use blockchain (see Table 28.0 for direct effects) (Zhao et al., 2010; Hair et al., 2021; Nitzl et al., 2016; Hair et al., 2022). A similar case occurs with the insignificantly indirect relationship between trust and BI through EX (see Table 29.0).

Table 29.0 Complete Results of Indirect Relationships

Paths	Path Coefficients (β)	T value	P values	5% Confidence intervals	95% Confidence intervals	Result
EX->PE->BI	0.142***	5.222	0.000	0.098	0.187	Significant

Sec->PE->BI	0.074**	3.080	0.001	0.036	0.114	Significant
Sec->EX->BI	0.017	1.250	0.106	-0.004	0.040	Insignificant
Sec->Trust->BI	-0.034	0.771	0.220	-0.105	0.040	Insignificant
Sec->Trust->PE->BI	0.108***	4.486	0.000	0.071	0.149	Significant
Sec->Trust->EX->BI	0.020	1.280	0.100	-0.005	0.045	Insignificant
Sec->Trust->EX->PE->BI	0.043***	4.399	0.000	0.028	0.060	Significant
Sec->EX->PE->BI	0.036**	3.272	0.001	0.020	0.056	Significant
Trust->PE->BI	0.163***	4.641	0.000	0.107	0.223	Significant
Trust->EX->BI	0.030	1.285	0.099	-0.007	0.068	Insignificant
Trust->EX->PE->BI	0.064***	4.566	0.000	0.043	0.089	Significant

***p<.001, **p<.01 and *p<.05, PE=performance Expectancy, EX= Effort Expectancy, SI= Social Influence, FC= Facilitating Conditions, Sec= Perceived Security, AW=awareness and BI= Behaviour Intention

In summary, the hypotheses testing consists of 17 hypotheses, whereby 6 of them yielded insignificant relationships while the others revealed significant effects among independent and dependent variables. Three significant results were related to the direct relationships, while the other three were pertinent to the moderating influence of AW. All the direct significant relationships showed positive effects while one significant moderating influence revealed a negative significant relationship. Following the previous discussion of this study's findings, 11 hypotheses were accepted, while six were rejected. Considerably, three of the rejected hypotheses were related directly to the BI, while the other three are related to the moderating effects between UTAUT determinants and BI. The path-coefficient results of the developed hypotheses are reflected in the proposed conceptual framework in Figure 18.0.

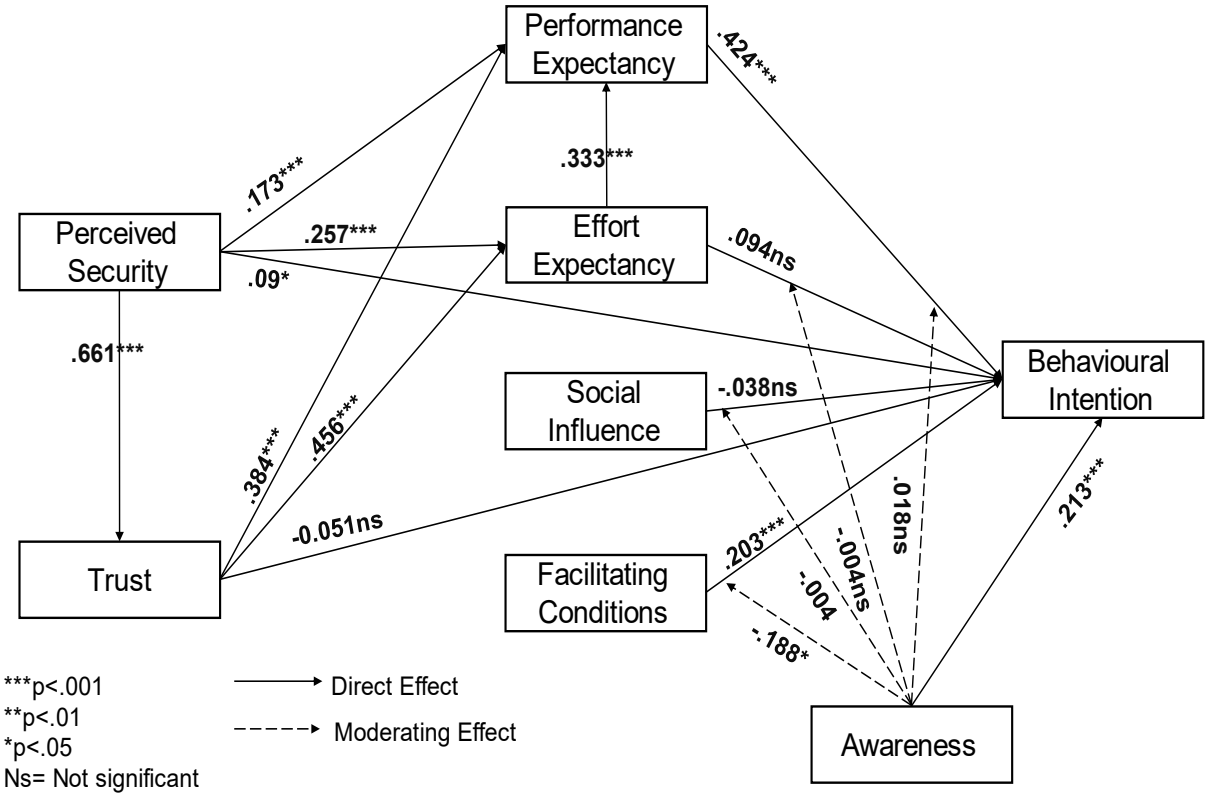

Figure 18.0 The Path Coefficient Results of the Conceptual Framework

4.5.3 MGA Results

After reporting the PLS-SEM relationships in the above sections, it is significant to investigate employee heterogeneity. Overlooking heterogeneity might yield biased findings (Becker et al., 2023; Ringle & Sarstedt, 2016). The findings of this section address RQ2. This section reports the results of three MGA methods, namely, MAMNOVA, permutation, and bootstrapping (see Section 3.5.2 for more detail). The latter two approaches are conducted in combination with PLS-SEM.

4.5.3.1 MANOVA

As discussed in Section 3.5.2.1, Hotelling's T^2 and MANOVA are employed in the present study to assess the differences among various personal characteristics (categories) of this study's participants in relation to the dependent variables of the present study (i.e., trust, EX, PE and BI). The results involve reporting groups with no significant differences (i.e., nationality, age and the HEIs regions in Saudi Arabia). The reason for reporting them is to test where the mean is located in terms of the Likert Scale. To highlight, the Likert scale in this study's survey ranges from 1 to 7, where one refers to strongly disagree and seven indicates

strongly agree. If the mean result is between 1 and 2, it is between strongly disagree and disagree. Similarly, if the result falls between 2-3,3-4,4-5,5-6 and 6-7, it indicates that the result falls between disagree to somewhat disagree, somewhat disagree to neutral, neutral to somewhat agree, somewhat agree to agree and agree to strongly agree, respectively.

These statistics also apply to the significant differences in results from the MANOVA. The point is to know where each group's category mean has fallen. This may lead to the conclusion that a group agrees with a dependent variable more than other variables. Further, the results between 4.51 and 7 indicate the intent to agree with the questions related to those dependent variables. In other words, falling within this range reflects that participants somewhat agree to strongly agree with the dependent variables of this study.

The following statistics highlight MANOVA and Hotelling's T2 results for this study's participants categories. As the minimum sample size for MANOVA for this study is 11 (see Section 3.5.2.1), the provinces of Saudi Arabia category is excluded from further analysis because its subgroups have lower than the acceptable sample size (Cohen, 1992).

4.5.3.1.1 The Non-Significant Results

MANOVA findings did not demonstrate significant differences between the Saudi and non-Saudi employees in Saudi HEIs related to this study's dependent variables, i.e., trust, PE, EX and BI. Similarly, the age groups did not significantly differ in the mean in relationship with this study's dependent variables. Finally, the different locations of HEIs in KSA did not cause significant differences among their employees.

4.5.3.1.1.1 Nationality

In testing the differences between Saudi and non-Saudi employees in HEIs, the MANOVA result shows no significant differences between the two groups. More importantly, the mean of all the two groups is located between 5.526 and 5.843, indicating that they agree to all dependent variables. The greatest mean is related to BI for Saudis. In comparison, the highest mean for expatriates was related to the trust in blockchain (see Table 30.0).

Table 30.0 Mean Differences between Saudi and Non-Saudi Employees

	Dependent Variable	Mean for Saudi	Mean for expatriates	F-statistics	P-value
Nationality	Trust	5.5273	5.7188	1.583	.209
	EX	5.6556	5.6406	.012	.914
	PE	5.6313	5.5260	.495	.482

	BI	5.8439	5.6771	1.269	.261

4.5.3.1.1.2 Age

Regarding age, after the median-split approach was conducted for the age groups, the number of groups was reduced to two. The first group (younger employees) consists of 198 participants, while the older group involves 196 participants. MANOVA results did not show significant differences between the two age groups. The mean of the age subgroups for all dependent variables ranges between 5.48 and 5.87, confirming no significant differences concerning the mean (see Table 31.0).

Table 31.0 Mean Differences between Age Ranges Employees

	Dependent Variable	Mean for Younger Participants	Mean for Older Participants	F-statistics	P-value
Nationality	Trust	5.6364	5.4796	1.952	.163
	EX	5.6835	5.6224	.355	.551
	PE	5.6700	5.5578	1.036	.309
	BI	5.8721	5.7611	1.031	.311

4.5.3.1.2 The Significant Results

The MANOVA significant differences are pertinent to gender, job type, experience, and blockchain users and non-users. Meanwhile, the mean of all the following groups indicates that all participants somewhat agree to strongly agree with this study's dependent variables, i.e., trust, PE, EX and BI.

4.5.3.1.2.1 Gender

Concerning gender, there are significant differences between males and females in terms of EX (F-value=4.515=, p-value=.034) and BI (F-value=5.172, p-value=.023). However, no significant results are related to the other dependent variables (i.e., trust and PE).

In more detail, the mean for male respondents concerning EX is 5.568 while the mean for female respondents is 5.791, indicating that female respondents expect blockchain to have more ease than males. Likewise, the mean for male respondents in relation to blockchain intention is 5.720. In contrast, the mean for female participants is 5.975, implying that females have more intention to accept blockchain technology in HEIs in Saudi Arabia. The highest mean was associated with the BI for both groups (see Table 32.0).

Table 32.0 Mean Differences between Female and Male

	Dependent Variable	Mean for Male	Mean for Female	F-statistics	P-value
Gender	Trust	5.538	5.590	.200	.655
	EX	5.568	5.791	4.515	.034
	PE	5.568	5.689	1.120	.290
	BI	5.720	5.975	5.172	.023

4.5.3.1.2.2 Job Type

This study obtains responses from administrative and academics in HEIs; the result of MANOVA shows that there are significant differences between the two groups in relation to BI (F=8.881, p-value=.006), trust (F=13.171, p-value=.001), EX (F=12.577, p-value=.001 and PE (F=12.343, p-value=.001). Hence, there are differences between the academic and administrative staff concerning all the dependent variables in the present study.

In more detail, the mean values of administrative employees are 5.778, 5.849, 5.808 and 5.981 for trust, EX, PE and BI, respectively. By comparison, academics in HEIs have mean values of 5.375, 5.489, 5.452 and 5.679 for trust, EX, PE and BI, respectively. These results indicate that administrative employees have higher scores than academics in all the dependent variables. In other words, the administrative employees trust blockchain more than academics do. The administrative employees perceive blockchain to facilitate their jobs more than academics. The administrative employees believe more academics that blockchain would benefit their job performance. Finally, they have more BI to accept blockchain technology than academics. The highest mean for the two groups is related to BI (M=5.981). Further details are exhibited in Table 33.0.

Table 33.0 Mean Differences between Administrative Employees and Academics

	Dependent Variable	Mean for Administrative employees	Mean for Academics	F-statistics	P-value
Job Type	Trust	5.778	5.375	13.171	.001
	EX	5.849	5.489	12.577	.001
	PE	5.808	5.452	12.343	.001
	BI	5.981	5.679	8.881	.006

4.5.3.1.2.3 Experience

Regarding years of experience of HEIs' employees, the median-split approach was conducted to avoid the minimum size issue for the subgroups (Cohen, 1992). The new groups

are the less experienced staff (less than ten years of experience) and more experienced staff (more than ten years of experience). The total number of less experienced participants staff is 216 whereas the total number of more experienced employees is 178.

The MANOVA result demonstrates significant differences among different ranges of years of experience for the PE (F=10.950, p-value=.001) and BI only (F=5.238, p-value=.023). The other dependent variables do not reflect significant differences in the mean between the two experience periods.

Table 34.0 reflects significant differences in the mean (M) between the less experienced (M=5.777) and more experienced (M=4157) HEIs staff in relation to the PE. Similarly, the less experienced staff represented a higher mean for the less experienced staff (M=5.9298) in comparison to more experienced employees (M=5.6798).

Table 34.0 Mean Differences of Years of Working Experience

	Dependent Variable	Mean for Less Experienced Staff	Mean for More Experienced Staff	F-statistics	P-value
Experience	Trust	5.6389	5.4607	2.503	.114
	EX	5.694	5.603	.791	.374
	PE	5.777	5.4157	10.950	.001
	BI	5.9298	5.6798	5.238	.023

4.5.3.1.2.4 Users and Non-Users of Blockchain

The MANOVA result demonstrates significant differences between the users and non-users of blockchain in correlation to trust (F=10.426, p-value=.001) and PE (F=8.304, p-value=.004). However, there are no differences between the two groups on the other dependent variables, i.e., EX and BI.

To illustrate, the mean values for users related to trust, EX, PE and BI are 5.973, 5.763, 5.978 and 6.018, respectively. In comparison, the mean values of non-users concerning trust, EX, PE and BI are 5.480, 5.632, 5.546 and 5.779, respectively (see Table 35.0). These results demonstrate that actual blockchain users trust blockchain more than non-users. Similarly, it shows that blockchain users believe in the ease of using blockchain-based applications more than non-users. Also, blockchain users are more confident that blockchain technology does increase their job performance. Likewise, the users of blockchain comprehend the reasons behind using blockchain among their important ones (e.g., colleagues, friends or family members) more than the non-users. Finally, users significantly differ from non-users in their

intention to use blockchain, as they intend to continue using it, while the non-users have less intention to use it. Note that although the mean for EX and BI is higher for users than for non-users, the difference is not significant.

Concerning the users and non-users, the lowest mean was related to social impact for both groups. On the other hand, the highest mean was related to the BI for both groups.

Table 35.0 Mean Differences between Users and Non-Users

	Dependent Variable	Mean for users	Mean for non-users	F-statistics	P-value
Users and non-users	Trust	5.973	5.480	10.426	.001
	EX	5.763	5.632	.867	.352
	PE	5.978	5.546	8.304	.004
	BI	6.018	5.779	2.590	.110

In summary, the MANOVA results exhibit insignificant differences in the mean of nationality, age and different provinces in KSA. In comparison, MANOVA shows significant differences between the categories: gender, years of experience and users and non-users of blockchain in HEIs in Saudi Arabia. These differences are related to the dependent variables of the present study, i.e., trust, EX, PE and BI. The MANOVA result indicates gender differences in EX and BI only. Significant statistics also appear between administrative employees and academics in all the dependent variables of the present study. Various ranges of periods of experience demonstrate a significant difference related to PE between participants with over ten years of experience compared to 3-5 and 5-10 years of experience. Finally, MANOVA shows a significant difference between users and non-users of blockchain concerning trust and PE. The highest mean scores among groups were related to BI, PE and EX, respectively.

4.5.3.2 Permutation

As discussed in Section 3.5.2.2, the permutation test is implemented in this study following Matthews' (2017) phases. Briefly, the phases began with selecting the categorical variables for this study. Some variables were excluded from further analysis for failing to meet the minimum requirements for the sample size proposed by Cohen (1992), i.e., 76 participants. The extracted variables are nationality and the users and non-users of blockchain.

The investigated variables based on the permutation method in SmartPLS are gender, age, job types and experience. All these categories were examined against the MICOM procedure, starting with step one (the configural invariance). This step was implemented

following Matthews (2017) and Henseler et al. (2016) (see Appendix G). See Table 19 to check the rules of thumb implemented in Step 1. Consequently, steps two (compositional invariance) and three (the equality of the mean and variance values) were computed and then reported in Appendix H (Henseler et al., 2016). The result reflected that all the investigated segments (gender, age, staff categories and levels of experience) had passed MICOM's steps one and two successfully. Yet, the third step was not fulfilled- the mean and variances were inequal- resulting in partial measurement variance. Hence, the standardised coefficients results regarding the analyses and interpretation of the permutation results could be established in SmartPLS (Matthews, 2017; Chin & Dibbern, 2010; Hair et al., 2017; Henseler et al., 2016). The one-tailed, 5000 permutations and 0.05 significance level were selected in SmartPLS to perform the permutation analysis (Matthews, 2017; Hair et al., 2017).

Therefore, the following results of gender, age, administrative and academic staff, and levels of experience are operated and reported in the following results (Matthews, 2017; Hair et al., 2017; Cheah et al., 2020).

Starting with gender, Table 36.0 highlights significant differences between HEIs' employees, females and males, concerning the direct relationship between security and behavioural intention.

Table 36.0 Assessment of Permutation-based Test for Gender

Paths	Path Coefficients (β) for Males	Path Coefficients (β) for Females	Difference in β	Permutation P Value
PE->BI	0.473	0.254	0.219	0.059
EX->PE	0.276	0.434	-0.158	0.054
EX->BI	0.053	0.083	-0.029	0.385
SI->BI	-0.063	0.032	-0.095	0.193
FC->BI	0.127	0.327	-0.201	0.056
Trust->BI	0.032	-0.195	0.226	0.055
Trust->PE	0.452	0.281	0.171	0.076
Trust->EX	0.423	0.499	-0.076	0.247
Sec->BI	0.025	0.211	-0.185	0.040
Sec->PE	0.113	0.263	-0.150	0.067
Sec->Trust	0.299	0.207	0.092	0.216
Sec->EX	0.695	0.609	0.086	0.099
AW->BI	0.473	0.254	0.070	0.249

***p<.001, **p<.01 and *p<.05, PE=performance Expectancy, EX= Effort Expectancy, SI= Social Influence, FC= Facilitating Conditions, Sec= Perceived Security, AW=awareness and BI= Behaviour Intention

In the similar test, the following table reflects the permutation test for two different groups of ages (older and younger). The result in Table 37.0 reflects that only one relationship reflects significant differences between older and younger employees, namely, the impact of security on trust.

Table 37.0 Assessment of Permutation-based Test for Age

Paths	Path Coefficients (β) for Younger Staff	Path Coefficients (β) for Older staff	Difference in β	Permutation P Value
PE->BI	0.314	0.529	-0.216	0.054
EX->PE	0.385	0.284	0.102	0.141
EX->BI	0.053	0.039	0.015	0.439
SI->BI	-0.075	-0.009	-0.065	0.261
FC->BI	0.273	0.151	0.122	0.162
Trust->BI	-0.043	-0.030	-0.012	0.470
Trust->PE	0.362	0.423	-0.061	0.308
Trust->EX	0.441	0.477	-0.037	0.382
Sec->BI	0.146	0.017	0.129	0.100
Sec->PE	0.208	0.133	0.075	0.229
Sec->Trust	0.599	0.714	-0.115	0.033
Sec->EX	0.271	0.241	0.030	0.393
AW->BI	0.161	0.292	-0.131	0.084

***p<.001, **p<.01 and *p<.05, PE=performance Expectancy, EX= Effort Expectancy, SI= Social Influence, FC= Facilitating Conditions, Sec= Perceived Security, AW=awareness and BI= Behaviour Intention

Moreover, the permutation test was employed for the types of job category, investigating the significant difference between administrative and academic staff in relation to this study's model. The results in Table 38.0 highlight a significant difference in two paths, i.e., PE->BI and EX->BI.

Table 38.0 Assessment of Permutation-based Test for Types of Job

Paths	Path Coefficients (β) for Academic Staff	Path Coefficients (β) for Administrative Staff	Difference in β	Permutation P Value
PE->BI	0.494	0.259	0.235	0.043
EX->PE	0.298	0.372	-0.074	0.226
EX->BI	-0.017	0.256	-0.273	0.002
SI->BI	-0.067	0.035	-0.102	0.162
FC->BI	0.223	0.159	0.065	0.303
Trust->BI	-0.055	-0.028	-0.028	0.436
Trust->PE	0.409	0.349	0.060	0.305
Trust->EX	0.414	0.499	-0.085	0.216
Sec->BI	0.113	0.078	0.036	0.373
Sec->PE	0.127	0.226	-0.099	0.156
Sec->Trust	0.639	0.667	-0.029	0.337
Sec->EX	0.246	0.256	-0.010	0.465
AW->BI	0.262	0.151	0.111	0.128

***p<.001, **p<.01 and *p<.05, PE=performance Expectancy, EX= Effort Expectancy, SI= Social Influence, FC= Facilitating Conditions, Sec= Perceived Security, AW=awareness and BI= Behaviour Intention

Finally, Table 39.0 reflects the results of the two levels of experience. After implementing the median-split approach, employees were divided into staff with less than ten years of experience and employees with ten or more years of experience. The permutation test results reveal significant differences in the relationship between EX and BI to use blockchain. Similarly, there is a significant difference in the path FC->BI between less and more than ten years of experienced staff in the HEIs within KSA (see Table 39.0).

Table 39.0 Assessment of Permutation-based Test for Years of Experience

Paths	Path Coefficients (β) for Less Experienced Staff	Path Coefficients (β) for More Experienced Staff	Difference in β	Permutation P Value
PE->BI	0.396	0.442	-0.046	0.373

EX->PE	0.375	0.298	0.077	0.202
EX->BI	-0.004	0.164	-0.168	0.048
SI->BI	-0.037	-0.012	-0.025	0.407
FC->BI	0.271	0.037	0.234	0.027
Trust->BI	-0.057	0.022	-0.079	0.297
Trust->PE	0.329	0.441	-0.112	0.165
Trust->EX	0.368	0.544	-0.176	0.054
Sec->BI	0.095	0.068	0.027	0.403
Sec->PE	0.176	0.161	0.014	0.431
Sec->Trust	0.661	0.661	0.000	0.497
Sec->EX	0.311	0.200	0.112	0.153
AW->BI	0.154	0.262	-0.107	0.133

***p<.001, **p<.01 and *p<.05, PE=performance Expectancy, EX= Effort Expectancy, SI= Social Influence, FC= Facilitating Conditions, Sec= Perceived Security, AW=awareness and BI= Behaviour Intention

4.5.3.3 MGA Bootstrapping

Based on the introduction of MGA bootstrapping interrelated with PLS-SEM (see Section 3.5.2.2), this study follows Cheah et al.'s (2020) steps in applying bootstrapping-based MGA. The steps begin with preparing data and generating categorical groups (e.g., gender). The following step concerns implementing MICOM (see Appendices G and H). The final step is pertained to testing for MGA comparisons in SmartPLS following Henseler and others' (2009) approach.

The investigated categories based on the bootstrapping method in SmartPLS are gender, age, experience and job types (administrative and academic employees). All these segments have passed the MICOM steps (see Appendix G), yielding partial measurement invariance. The standardised coefficients results in relation to the structural model could be compared across groups in SmartPLS (Matthews, 2017; Chin & Dibbern, 2010; Hair et al., 2017; Henseler et al., 2016). In this section, the group-specific relationships among this study's latent variables are analysed separately (per subgroup) based on the bootstrapping-MGA approach to compare it with the complete results presented in Section 4.5.2.5 (Matthews, 2017). For instance, the path coefficient for female groups is compared to the complete dataset that does not distinguish between females and males. Thus, this investigation aims to examine significant relationships pertaining to this study's proposed framework per subgroup

compared to the complete results, which contributes to answering RQ2 (see Section 3.5.2.2 for further details).

The bootstrapping-MGA test is applied to gender, age, types of jobs and years of experience to test the proposed model for these categories' subgroups. Analysing these categories is based on this study's framework, which involves direct, moderating and indirect relationships.

4.5.3.3.1 Bootstrapping-MGA Test for Gender

As mentioned above, the gender category contains female and male employees working for HEIs in KSA. The bootstrapping-based MGA test involves direct, moderating and indirect relationships to determine the path coefficient significance and relevance based on this study's framework (for more detail, see Section 4.5.2.5).

4.5.3.3.1.1 Bootstrapping-MGA Test for Female Staff

Starting with female staff, this study separates the female group from the complete results (Matthews, 2017). The outcomes of this female group are compared to the complete findings presented in Table 28.0 to determine the direct and moderating effects of the proposed framework. The direct and moderating relationships for females reveal similar results to the complete findings except in one path. The direct relationship of trust on BI is significant for female employees. The other results are compatible with the complete findings (see Table 40.0). Although the P-value of the path of AW x SI->BI is less than 0.05, it is still considered insignificant because of the presence of 0 between the 5% and 95% confidence intervals (Hair et al., 2019).

Table 40.0 Direct and Moderating Relationships for Female Employees

Paths	Path Coefficients (β) for Female Employees	T value	P values	5% Confidence intervals	95% Confidence intervals	Result
PE->BI	0.254***	2.317	0.007	0.095	0.429	Significant
EX->PE	0.434***	1.956	0.000	0.332	0.536	Significant
EX->BI	0.083	0.894	0.162	-0.052	0.225	Insignificant

SI->BI	0.032	1.789	0.381	-0.128	0.217	Insignificant
FC->BI	0.327**	1.932	0.002	0.126	0.509	Significant
Trust->BI	-0.195*	0.902	0.034	-0.347	0.003	Significant
Trust->PE	0.281***	2.021	0.000	0.158	0.404	Significant
Trust->EX	0.499***	1.749	0.000	0.374	0.622	Significant
Sec->BI	0.211**	2.022	0.006	0.051	0.325	Significant
Sec->PE	0.263***	0.918	0.000	0.150	0.372	Significant
Sec->Trust	0.609***	2.085	0.000	0.515	0.699	Significant
Sec->EX	0.207**	2.317	0.004	0.075	0.329	Significant
AW->BI	0.193*	1.956	0.010	0.043	0.316	Significant
AW x PE->BI	-0.019	0.894	0.428	0.009	0.377	Insignificant
AW x EX->BI	0.189	1.789	0.047	**-0.211**	**0.134**	Significant
AW x SI->BI	-0.108	1.932	0.154	-0.282	0.065	Insignificant
AW x FC->BI	-0.377*	0.902	0.018	-0.609	-0.026	Significant

***p<.001, **p<.01 and *p<.05, PE=performance Expectancy, EX= Effort Expectancy, SI= Social Influence, FC= Facilitating Conditions, Sec= Perceived Security, AW=awareness and BI= Behaviour Intention

To test the indirect influence of female staff, this result was compared to Table 29.0, which represented the complete results of the indirect relationships of this study. The comparison procedure resulted in similar significant and insignificant results in the full-findings table except for one relationship. The difference concerned the indirect effect of Sec on BI through Trust, which was revealed to be significant among females (see Table 41).

Table 41.0 Indirect Relationships for Female Employees

Paths	Path Coefficients (β)	T value	P values	5% Confidence intervals	95% Confidence intervals	Result
EX->PE->BI	0.110**	2.317	0.010	0.040	0.196	Significant
Sec->PE->BI	0.067*	1.956	0.025	0.019	0.129	Significant
Sec->EX->BI	0.017	0.894	0.186	-0.011	0.051	Insignificant
Sec->Trust->BI	-0.118*	1.789	0.037	-0.216	0.002	Significant
Sec->Trust->PE->BI	0.043*	1.932	0.027	0.013	0.086	Significant
Sec->Trust->EX->BI	0.025	0.902	0.183	-0.015	0.076	Insignificant
Sec->Trust->EX->PE->BI	0.034*	2.021	0.022	0.011	0.065	Significant
Sec->EX->PE->BI	0.023*	1.749	0.040	0.005	0.047	Significant
Trust->PE->BI	0.071*	2.022	0.022	0.023	0.137	Significant
Trust->EX->BI	0.041	0.918	0.179	-0.025	0.122	Insignificant
Trust->EX->PE->BI	0.055*	2.085	0.019	0.018	0.103	Significant

***p<.001, **p<.01 and *p<.05, PE=performance Expectancy, EX= Effort Expectancy, SI= Social Influence, FC= Facilitating Conditions, Sec= Perceived Security, AW=awareness and BI= Behaviour Intention

4.5.3.3.1.2 Bootstrapping-MGA Test for Male Staff

With the other gender subgroup, the bootstrapping-MGA method is applied to compare the direct and moderating effects of the male employees' responses and the total dataset represented in Table 28.0 (i.e., female and male). The result of this comparison unveiled that male employees have more insignificant results than the complete results. Besides all the

similarities with the complete results in Table 28.0, the male employees perceive Sec to insignificantly affect BI to use blockchain. Similarly, the male employees' results revealed an insignificant AW effect between the FC and BI (see Table 42.0).

Table 42.0 Direct and Moderating Relationships for Male Employees

Paths	Path Coefficients (β)	T value	P values	5% Confidence intervals	95% Confidence intervals	Result
PE->BI	0.473***	5.792	0.000	0.330	0.599	Significant
EX->PE	0.276***	4.247	0.000	0.172	0.389	Significant
EX->BI	0.053	0.829	0.204	-0.052	0.159	Insignificant
SI->BI	-0.063	1.118	0.132	-0.151	0.035	Insignificant
FC->BI	0.127*	1.992	0.023	0.021	0.231	Significant
Trust->BI	0.032	0.424	0.336	-0.090	0.156	Insignificant
Trust->PE	0.452***	5.792	0.000	0.317	0.575	Significant
Trust->EX	0.423***	5.751	0.000	0.303	0.544	Significant
Sec->BI	0.025	0.416	0.339	-0.073	0.127	Insignificant
Sec->PE	0.113*	1.653	0.049	0.000	0.225	Significant
Sec->Trust	0.695***	18.848	0.000	0.633	0.755	Significant
Sec->EX	0.299***	3.942	0.000	0.171	0.421	Significant
AW->BI	0.263***	4.541	0.000	0.172	0.364	Significant

AW x PE->BI	-0.068	0.932	0.176	-0.201	0.038	Insignificant
AW x EX->BI	0.043	0.562	0.287	-0.074	0.177	Insignificant
AW x SI->BI	0.008	0.107	0.457	-0.129	0.126	Insignificant
AW x FC->BI	-0.100	1.194	0.116	-0.237	0.040	Insignificant

***p<.001, **p<.01 and *p<.05, PE=performance Expectancy, EX= Effort Expectancy, SI= Social Influence, FC= Facilitating Conditions, Sec= Perceived Security, AW=awareness and BI= Behaviour Intention

Regarding the indirect effect, male employees are compared to the complete results highlighted in Table 29.0. The male employees' bootstrapping-based MGA results highlighted similar results of all indirect correlations in Table 29.0. However, the mediating role of performance expectancy between security and BI was insignificant among male employees (See Table 43.0).

Table 43.0 Indirect Relationships for Male Employees

Paths	Path Coefficients (β)	T value	P values	5% Confidence intervals	95% Confidence intervals	Result
EX->PE->BI	0.131***	3.586	0.000	0.073	0.193	Significant
Sec->PE->BI	0.053	1.560	0.059	0.000	0.111	Insignificant
Sec->EX->BI	0.016	0.781	0.217	-0.016	0.051	Insignificant
Sec->Trust->BI	0.022	0.422	0.337	-0.063	0.108	Insignificant
Sec->Trust->PE->BI	0.149***	4.162	0.000	0.092	0.209	Significant
Sec->Trust->EX->BI	0.016	0.807	0.210	-0.016	0.048	Insignificant

Sec->Trust->EX->PE->BI	0.038**	3.084	0.001	0.020	0.061	Significant
Sec->EX->PE->BI	0.039**	2.375	0.009	0.016	0.069	Significant
Trust->PE->BI	0.214***	4.240	0.000	0.131	0.297	Significant
Trust->EX->BI	0.023	0.812	0.208	-0.022	0.068	Insignificant
Trust->EX->PE->BI	0.055**	3.172	0.001	0.030	0.086	Significant

***p<.001, **p<.01 and *p<.05, PE=performance Expectancy, EX= Effort Expectancy, SI= Social Influence, FC= Facilitating Conditions, Sec= Perceived Security, AW=awareness and BI= Behaviour Intention

4.5.3.3.2 Bootstrapping-MGA Test for Age

The age category in this study involves the older and younger employees who work for HEIs in KSA. The results based on the Bootstrapping-MGA analysis are presented as direct, moderating and indirect relationships based on this study's model.

4.5.3.3.2.1 Bootstrapping-MGA Test for Older Employees

For older employees, the direct and moderating relationships were computed separately for the completed results. Subsequently, the significant and insignificant findings of older staff are compared to the complete results exhibited earlier in Table 28.0. The comparison results indicated that older employees find security to not significantly affect their BI when utilising blockchain in HEIs. In addition, the moderating role of awareness in the relationship between SI and BI is significant for the older staff. Similarly, the moderating role of awareness concerning the effect of PE on BI is significant among older staff. One may argue that the AW moderating effect between FC and BI was insignificant in terms of the older staff. However, this is true when considering the P-value result only; however, the confidence interval results revealed otherwise. As there is no 0 value between 5% Confidence intervals and 95% Confidence intervals, this result should be reported as significant regardless of the p-value result (Hair et al., 2019; Matthews, 2017). Finally, the complete set of results reveals an insignificant impact of the moderating role of AW between SI and BI; however, this relationship is significant among older employees. The older staff's significant and insignificant results are presented in Table 44.0.

Table 44.0 Direct and Moderating Relationships for Older Employees

Paths	Path Coefficients (β)	T value	P values	5% Confidence intervals	95% Confidence intervals	Result
PE->BI	0.529***	5.949	0.000	0.369	0.662	Significant
EX->PE	0.284***	4.136	0.000	0.174	0.399	Significant
EX->BI	0.039	0.497	0.310	-0.083	0.171	Insignificant
SI->BI	-0.009	0.140	0.444	-0.119	0.106	Insignificant
FC->BI	0.151**	2.364	0.009	0.049	0.257	Significant
Trust->BI	-0.030	0.358	0.360	-0.167	0.112	Insignificant
Trust->PE	0.423***	4.687	0.000	0.270	0.565	Significant
Trust->EX	0.477***	6.622	0.000	0.358	0.595	Significant
Sec->BI	0.017	0.262	0.397	-0.091	0.124	Insignificant
Sec->PE	0.133*	1.655	0.049	-0.002	0.263	Significant
Sec->Trust	0.714***	19.104	0.000	0.652	0.774	Significant
Sec->EX	0.241***	3.321	0.000	0.120	0.357	Significant
AW->BI	0.292***	4.473	0.000	0.180	0.394	Significant
AW x PE->BI	0.141*	1.810	0.035	0.021	0.275	Significant
AW x EX->BI	0.039	0.500	0.309	-0.093	0.163	Insignificant

AW x SI->BI	-0.148*	2.218	0.013	-0.243	-0.024	Significant
AW x FC->BI	-0.125	1.518	0.065	-0.269	-0.001	Significant

***p<.001, **p<.01 and *p<.05, PE=performance Expectancy, EX= Effort Expectancy, SI= Social Influence, FC= Facilitating Conditions, Sec= Perceived Security, AW=awareness and BI= Behaviour Intention

In addition, the indirect results were conducted in contrast to Table 29.0. This table contains complete results regardless of the age of the employees. However, this analysis focuses on each group of employees separately. Starting with the indirect relationships of this study's framework for older employees, the results present only one difference between the complete results and the older staff. The difference is the mediating role of PE between Sec and BI. This relationship is insignificant for older employees (see Table 45.0).

Table 45.0 Indirect Relationships for Older Employees

Paths	Path Coefficients (β)	T value	P values	5% Confidence intervals	95% Confidence intervals	Result
EX->PE->BI	0.150***	3.652	0.000	0.084	0.219	Significant
Sec->PE->BI	0.070	1.596	0.055	-0.001	0.144	Insignificant
Sec->EX->BI	0.009	0.482	0.315	-0.021	0.042	Insignificant
Sec->Trust->BI	-0.022	0.356	0.361	-0.122	0.080	Insignificant
Sec->Trust->PE->BI	0.160***	3.624	0.000	0.089	0.234	Significant
Sec->Trust->EX->BI	0.013	0.477	0.317	-0.028	0.063	Insignificant
Sec->Trust->EX->PE->BI	0.051**	3.138	0.001	0.028	0.081	Significant
Sec->EX->PE->BI	0.036*	2.264	0.012	0.013	0.065	Significant

Trust->PE->BI	0.224***	3.680	0.000	0.125	0.325	Significant
Trust->EX->BI	0.018	0.479	0.316	-0.039	0.087	Insignificant
Trust->EX->PE->BI	0.072**	3.215	0.001	0.039	0.111	Significant

***p<.001, **p<.01 and *p<.05, PE=performance Expectancy, EX= Effort Expectancy, SI= Social Influence, FC= Facilitating Conditions, Sec= Perceived Security, AW=awareness and BI= Behaviour Intention

4.5.3.3.2.2 Bootstrapping-MGA Test for Younger Employees

Moreover, the direct and moderating effects for younger staff among latent variables are reported in the following table and compared to the total findings presented in Table 28.0. This comparison exhibits no differences between the insignificant and significant regarding the direct moderating results (see Tables 29.0 and 46.0).

Table 46.0 Direct and Moderating Relationships for Younger Employees

Paths	Path Coefficients (β)	T value	P values	5% Confidence intervals	95% Confidence intervals	Result
PE->BI	0.314***	3.646	0.000	0.180	0.462	Significant
EX->PE	0.385***	6.505	0.000	0.288	0.483	Significant
EX->BI	0.053	0.835	0.202	-0.052	0.158	Insignificant
SI->BI	-0.075	0.976	0.165	-0.192	0.058	Insignificant
FC->BI	0.273**	2.727	0.003	0.112	0.441	Significant
Trust->BI	-0.043	0.411	0.341	-0.213	0.130	Insignificant
Trust->PE	0.362***	5.269	0.000	0.247	0.475	Significant
Trust->EX	0.441***	5.859	0.000	0.317	0.565	Significant

Sec->BI	0.146*	1.949	0.026	0.017	0.261	Significant
Sec->PE	0.208***	3.373	0.000	0.104	0.306	Significant
Sec->Trust	0.599***	11.653	0.000	0.515	0.683	Significant
Sec->EX	0.271***	3.392	0.000	0.136	0.400	Significant
AW->BI	0.161*	2.268	0.012	0.039	0.274	Significant
AW x PE->BI	-0.120	1.214	0.112	-0.284	0.040	Insignificant
AW x EX->BI	0.012	0.138	0.445	-0.113	0.158	Insignificant
AW x SI->BI	0.115	1.363	0.086	-0.031	0.244	Insignificant
AW x FC->BI	-0.240	1.812	0.035	-0.447	-0.013	Significant

***p<.001, **p<.01 and *p<.05, PE=performance Expectancy, EX= Effort Expectancy, SI= Social Influence, FC= Facilitating Conditions, Sec= Perceived Security, AW=awareness and BI= Behaviour Intention

In contrast to the complete results for all participants (see Table 29.0), the bootstrapping-based MGA analysed method is applied for younger employees. The comparison results for indirect relationships between complete findings and younger staff reveal identical results between the two results in terms of significant and insignificant results (see Table 47.0). Simply put, the indirect results significant and insignificant results are the same between complete results and younger employees.

Table 47.0 Indirect Relationships for Younger Employees

Paths	Path Coefficients (β)	T value	P values	5% Confidence intervals	95% Confidence intervals	Result
EX->PE->BI	0.121**	3.077	0.001	0.063	0.190	significant

Sec->PE->BI	0.065*	2.405	0.008	0.026	0.115	significant
Sec->EX->BI	0.014	0.776	0.219	-0.014	0.047	Insignificant
Sec->Trust->BI	-0.026	0.407	0.342	-0.128	0.079	Insignificant
Sec->Trust->PE->BI	0.068**	2.827	0.002	0.035	0.113	significant
Sec->Trust->EX->BI	0.014	0.801	0.212	-0.013	0.044	Insignificant
Sec->Trust->EX->PE->BI	0.032**	2.586	0.005	0.015	0.055	significant
Sec->EX->PE->BI	0.033*	2.160	0.015	0.012	0.061	significant
Trust->PE->BI	0.114**	2.946	0.002	0.059	0.185	significant
Trust->EX->BI	0.023	0.808	0.209	-0.022	0.074	Insignificant
Trust->EX->PE->BI	0.053**	2.697	0.004	0.025	0.090	significant

***p<.001, **p<.01 and *p<.05, PE=performance Expectancy, EX= Effort Expectancy, SI= Social Influence, FC= Facilitating Conditions, Sec= Perceived Security, AW=awareness and BI= Behaviour Intention

4.5.3.3.3 Bootstrapping-MGA Test for Job Types

The job type's segment in this study contains academic and administrative staff. The bootstrapping-based MGA yields direct, moderating and indirect results for academic and office workers separately.

4.5.3.3.3.1 Bootstrapping-MGA Test for Academics

Starting with the academic staff, the bootstrapping-based MGA was performed to compare the direct and moderating results to determine the significant and significant relationships presented in this study. The comparison was conducted with the completed results demonstrated in Table 28.0. The findings reveal identical significant and insignificant effects between the academic and complete results (see Table 48.0).

Table 48.0 Direct and Moderating Relationships for Academics

Paths	Path Coefficients (β)	T value	P values	5% Confidence intervals	95% Confidence intervals	Result
PE->BI	0.494***	6.549	0.000	0.362	0.612	Significant
EX->PE	0.298***	5.220	0.000	0.206	0.394	Significant
EX->BI	-0.017	0.281	0.389	-0.119	0.080	Insignificant
SI->BI	-0.067	1.070	0.142	-0.164	0.044	Insignificant
FC->BI	0.223**	3.127	0.001	0.109	0.344	Significant
Trust->BI	-0.055	0.671	0.251	-0.187	0.083	Insignificant
Trust->PE	0.409***	5.492	0.000	0.284	0.527	Significant
Trust->EX	0.414***	5.672	0.000	0.294	0.536	Significant
Sec->BI	0.113*	1.789	0.037	0.006	0.213	Significant
Sec->PE	0.127*	1.848	0.032	0.012	0.239	Significant
Sec->Trust	0.639***	14.846	0.000	0.566	0.709	Significant
Sec->EX	0.246**	3.255	0.001	0.119	0.368	Significant
AW->BI	0.262***	4.280	0.000	0.156	0.359	Significant
AW x PE->BI	0.033	0.395	0.346	-0.107	0.166	Insignificant
AW x EX->BI	-0.073	1.045	0.148	-0.183	0.044	Insignificant

AW x SI->BI	0.050	0.671	0.251	-0.077	0.166	Insignificant
AW x FC->BI	-0.239**	2.425	0.008	-0.397	-0.074	Significant

***p<.001, **p<.01 and *p<.05, PE=performance Expectancy, EX= Effort Expectancy, SI= Social Influence, FC= Facilitating Conditions, Sec= Perceived Security, AW=awareness and BI= Behaviour

Additionally, the indirect results of academics are compared to the full results represented in Table 29.0. In the bootstrapping-based MGA analysis, the result of the indirect relationships concerning academics revealed the exact results as the complete results in terms of significant and insignificant relationships (see Table 49.0)

Table 49.0 Indirect Relationships for Academics

Paths	Path Coefficients (β)	T value	P values	5% Confidence intervals	95% Confidence intervals	Result
EX->PE->BI	0.147***	4.407	0.000	0.095	0.205	Significant
Sec->PE->BI	0.063*	1.795	0.036	0.006	0.122	Significant
Sec->EX->BI	-0.004	0.264	0.396	-0.032	0.019	Insignificant
Sec->Trust->BI	-0.035	0.665	0.253	-0.121	0.054	Insignificant
Sec->Trust->PE->BI	0.129***	4.064	0.000	0.079	0.183	Significant
Sec->Trust->EX->BI	-0.004	0.272	0.393	-0.032	0.022	Insignificant
Sec->Trust->EX->PE->BI	0.039***	3.315	0.000	0.022	0.060	Significant
Sec->EX->PE->BI	0.036**	2.401	0.008	0.014	0.064	Significant
Trust->PE->BI	0.202***	4.203	0.000	0.125	0.283	Significant

Trust->EX->BI	-0.007	0.275	0.392	-0.050	0.035	Insignificant
Trust->EX->PE->BI	0.061***	3.564	0.000	0.036	0.091	Significant

***p<.001, **p<.01 and *p<.05, PE=performance Expectancy, EX= Effort Expectancy, SI= Social Influence, FC= Facilitating Conditions, Sec= Perceived Security, AW=awareness and BI= Behaviour Intention

4.5.3.3.3.2 Bootstrapping-MGA Test for Office Workers

Table 50.0 Direct and Moderating Relationships for Administrative Staff

Paths	Path Coefficients (β)	T value	P values	5% Confidence intervals	95% Confidence intervals	Result
PE->BI	0.259**	2.469	0.007	0.096	0.440	Significant
EX->PE	0.372***	4.858	0.000	0.247	0.500	Significant
EX->BI	0.256**	3.036	0.001	0.119	0.397	Significant
SI->BI	0.035	0.499	0.309	-0.074	0.158	Insignificant
FC->BI	0.159*	1.874	0.030	0.015	0.293	Significant
Trust->BI	-0.028	0.323	0.373	-0.170	0.111	Insignificant
Trust->PE	0.349***	4.082	0.000	0.207	0.489	Significant
Trust->EX	0.499***	6.645	0.000	0.371	0.619	Significant
Sec->BI	0.078	1.037	0.150	-0.049	0.199	Insignificant
Sec->PE	0.226***	3.313	0.000	0.110	0.331	Significant
Sec->Trust	0.667***	13.544	0.000	0.585	0.747	Significant

Sec->EX	0.256**	3.253	0.001	0.127	0.387	Significant
AW->BI	0.151*	2.119	0.017	0.042	0.275	Significant
AW x PE->BI	-0.008	0.109	0.457	-0.125	0.124	Insignificant
AW x EX->BI	0.038	0.400	0.345	-0.105	0.205	Insignificant
AW x SI->BI	-0.142	1.611	0.054	-0.293	-0.009	Insignificant
AW x FC->BI	-0.022	0.145	0.442	-0.267	0.239	Insignificant

***p<.001, **p<.01 and *p<.05, PE=performance Expectancy, EX= Effort Expectancy, SI= Social Influence, FC= Facilitating Conditions, Sec= Perceived Security, AW=awareness and BI= Behaviour Intention

Relatedly, the indirect-bootstrapping MGA results are compared to the complete-indirect findings presented in Table 29.0. The findings of this comparison yielded some differences between the administrative results indirect relationships and the complete results that involve academics and administrative employees together. Firstly, whereas the complete results demonstrated insignificant effect of the mediating role of EX between Sec and BI, this relationship is significant among administrative employees in HEIs. Similarly, the total results in Table 29.0 revealed an insignificant mediating role of EX between trust and BI, while this mediating role of EX was found significant among the administrative only. Moreover, the Sec indirect effect of behavioural intention through trust and then EX was found significant among administrative results, which contracts the previous results for the total findings.

For more detail, the comparison was conducted between Table 29.0 for total results and Table 51.0 for administrative-only indirect findings.

Table 51.0 Indirect Relationships for Administrative Employees

Paths	Path Coefficients (β)	T value	P values	5% Confidence intervals	95% Confidence intervals	Result
EX->PE->BI	0.096*	2.263	0.012	0.033	0.173	Significant

Sec->PE->BI	0.059*	1.782	0.037	0.014	0.119	Significant
Sec->EX->BI	0.066*	2.115	0.017	0.022	0.123	Significant
Sec->Trust->BI	-0.018	0.320	0.375	-0.115	0.075	Insignificant
Sec->Trust->PE->BI	0.060*	1.984	0.024	0.019	0.117	Significant
Sec->Trust->EX->BI	0.085**	2.691	0.004	0.037	0.140	Significant
Sec->Trust->EX->PE->BI	0.032*	2.150	0.016	0.011	0.059	Significant
Sec->EX->PE->BI	0.025*	1.745	0.041	0.006	0.051	Significant
Trust->PE->BI	0.090*	2.035	0.021	0.028	0.173	Significant
Trust->EX->BI	0.128**	2.708	0.003	0.055	0.209	Significant
Trust->EX->PE->BI	0.048*	2.132	0.017	0.016	0.089	Significant

***p<.001, **p<.01 and *p<.05, PE=performance Expectancy, EX= Effort Expectancy, SI= Social Influence, FC= Facilitating Conditions, Sec= Perceived Security, AW=awareness and BI= Behaviour Intention

4.5.3.3.4 Bootstrapping-MGA Test for Levels of Experience

The level of experience category in the present study pertains to less experienced and more experienced staff. As mentioned above, the less experienced staff are staff with less than ten years of working experience in HEIs. In contrast, the more experienced staff are employees with more than ten years of experience in HEIs. The bootstrapping-based MGA results for this study's framework revealed direct, moderating and indirect results for less and more experienced staff groups.

4.5.3.3.4.1 Bootstrapping-MGA Test for Less Experienced Staff

Establishing the direct and moderating relationships, a comparison procedure is conducted for less experienced staff with all employees (see Table 28.0). While most of the results are similar, two of them are not. The first difference pertains to the significant result of Sec on BI found in the complete dataset. However, the effect of SEC on BI is insignificant for

less experienced staff. In addition, the AW moderating role is significantly and positively affecting the SI impact on BI to use blockchain (see Table 52.0).

Table 52.0 Direct and Moderating Relationships for Less Experienced Staff

Paths	Path Coefficients (β)	T value	P values	5% Confidence intervals	95% Confidence intervals	Result
PE->BI	0.396***	4.798	0.000	0.275	0.474	Significant
EX->PE	0.375***	6.184	0.000	-0.103	0.093	Significant
EX->BI	-0.004	0.062	0.475	-0.152	0.080	Insignificant
SI->BI	-0.037	0.524	0.300	0.152	0.418	Insignificant
FC->BI	0.271***	3.334	0.000	-0.208	0.085	Significant
Trust->BI	-0.057	0.641	0.261	0.197	0.458	Insignificant
Trust->PE	0.329***	4.101	0.000	0.242	0.504	Significant
Trust->EX	0.368***	4.689	0.000	-0.041	0.216	Significant
Sec->BI	0.095	1.219	0.112	0.048	0.297	Insignificant
Sec->PE	0.176*	2.322	0.010	0.587	0.731	Significant
Sec->Trust	0.661***	15.203	0.000	0.169	0.439	Significant
Sec->EX	0.311***	3.811	0.000	0.047	0.264	Significant
AW->BI	0.154**	2.339	0.010	-0.240	0.099	Significant
AW x PE->BI	-0.065	0.632	0.264	-0.135	0.130	Insignificant

AW x EX->BI	-0.027	0.327	0.372	0.000	0.266	Insignificant
AW x SI->BI	0.143*	1.761	0.039	-0.493	-0.097	Significant
AW x FC->BI	-0.299**	2.492	0.006	0.275	0.474	Significant

***p<.001, **p<.01 and *p<.05, PE=performance Expectancy, EX= Effort Expectancy, SI= Social Influence, FC= Facilitating Conditions, Sec= Perceived Security, AW=awareness and BI= Behaviour Intention

The indirect effect findings related to the less experienced staff are compared to the full results in Table 29.0. The comparison findings reveal that the less experienced staff obtain identical indirect relationships to the findings of the complete results (see Tables 28.0 and 53.0).

Table 53.0 Indirect Relationships for Less Experienced Employees

Paths	Path Coefficients (β)	T value	P values	5% Confidence intervals	95% Confidence intervals	Result
EX->PE->BI	0.149***	3.751	0.000	0.088	0.218	Significant
Sec->PE->BI	0.070	2.062	0.020	0.018	0.128	Significant
Sec->EX->BI	-0.001	0.060	0.476	-0.034	0.029	Insignificant
Sec->Trust->BI	-0.038	0.635	0.263	-0.139	0.058	Insignificant
Sec->Trust->PE->BI	0.086**	3.129	0.001	0.046	0.136	Significant
Sec->Trust->EX->BI	-0.001	0.060	0.476	-0.026	0.024	Insignificant
Sec->Trust->EX->PE->BI	0.036**	2.752	0.003	0.018	0.061	Significant
Sec->EX->PE->BI	0.046**	2.447	0.007	0.019	0.081	Significant

Trust->PE->BI	0.130**	3.147	0.001	0.069	0.204	Significant
Trust->EX->BI	-0.001	0.060	0.476	-0.038	0.036	Insignificant
Trust->EX->PE->BI	0.055**	2.963	0.002	0.029	0.089	Significant

***p<.001, **p<.01 and *p<.05, PE=performance Expectancy, EX= Effort Expectancy, SI= Social Influence, FC= Facilitating Conditions, Sec= Perceived Security, AW=awareness and BI= Behaviour Intention

4.5.3.3.4.2 Bootstrapping-MGA Test for More Experienced Staff

The other group that is part of the levels of experience is employees with more than ten years of experience. This study investigates the direct and moderating effect for staff with more than ten years of experience. The significant results for this segment are compared to the total findings reported in Table 28.0. This comparison yielded similar significant results between the two sets. However, differences exist between the more experienced staff and the complete results. The complete result yielded an insignificant effect of EX on BI; however, this effect was significant in pertinent to more experienced staff. Moreover, the effect of Sec on BI was significant for all data sets; however, it does not influence the more experienced staff to accept the use of blockchain. The FC was significant for the total set of employees to accept blockchain usage; however, this relationship was insignificant among more experienced staff. In terms of moderating effects, the total set showed a significant moderating role of AW on the effect of FC on BI. However, this effect vanishes among more experienced workers. Additionally, while the AW moderating role of the SI effect on BI was insignificant in the complete findings, it is significant among more experienced employees. Tables 29 and 54 represent this comparison's results statistically.

Table 54.0 Direct and Moderating Relationships for More Experienced Staff

Paths	Path Coefficients (β)	T value	P values	5% Confidence intervals	95% Confidence intervals	Result
PE->BI	0.442***	4.214	0.000	0.259	0.602	Significant
EX->PE	0.298***	4.315	0.000	0.188	0.416	Significant

EX->BI	0.164*	1.987	0.023	0.033	0.305	Significant
SI->BI	-0.012	0.174	0.431	-0.116	0.107	Insignificant
FC->BI	0.037	0.436	0.331	-0.107	0.170	Insignificant
Trust->BI	0.022	0.238	0.406	-0.120	0.182	Insignificant
Trust->PE	0.441***	5.452	0.000	0.304	0.570	Significant
Trust->EX	0.544***	7.842	0.000	0.423	0.654	Significant
Sec->BI	0.068	1.064	0.144	-0.033	0.177	Insignificant
Sec->PE	0.161**	2.447	0.007	0.051	0.268	Significant
Sec->Trust	0.661***	14.169	0.000	0.582	0.737	Significant
Sec->EX	0.200**	2.788	0.003	0.084	0.319	Significant
AW->BI	0.262***	3.871	0.000	0.145	0.367	Significant
AW x PE->BI	0.085	1.130	0.129	-0.036	0.211	Insignificant
AW x EX->BI	-0.011	0.125	0.450	-0.160	0.132	Insignificant
AW x SI->BI	-0.117*	1.849	0.032	-0.208	-0.002	Significant
AW x FC->BI	0.002	0.017	0.493	-0.181	0.170	Insignificant

***p<.001, **p<.01 and *p<.05, PE=performance Expectancy, EX= Effort Expectancy, SI= Social Influence, FC= Facilitating Conditions, Sec= Perceived Security, AW=awareness and BI= Behaviour Intention

The indirect results of the more experienced staff show similar findings to the more experienced staff in all paths except two. These two paths are Sec->Trust->EX->BI and Trust-

>EX->BI (see Table 55.0). These two paths were insignificant for the complete results involving all levels of experience. However, they are significant in relation to the more experienced staff.

Table 55.0 Indirect Relationships for More Experienced Employees

Paths	Path Coefficients (β)	T value	P values	5% Confidence intervals	95% Confidence intervals	Result
EX->PE->BI	0.132***	3.294	0.000	0.069	0.199	Significant
Sec->PE->BI	0.071*	2.076	0.019	0.019	0.130	Significant
Sec->EX->BI	0.033	1.514	0.065	0.004	0.074	Insignificant
Sec->Trust->BI	0.014	0.235	0.407	-0.078	0.122	Insignificant
Sec->Trust->PE->BI	0.129**	3.119	0.001	0.064	0.200	Significant
Sec->Trust->EX->BI	0.059*	1.892	0.029	0.012	0.114	Significant
Sec->Trust->EX->PE->BI	0.047**	3.122	0.001	0.024	0.073	Significant
Sec->EX->PE->BI	0.026*	1.976	0.024	0.008	0.051	Significant
Trust->PE->BI	0.195**	3.249	0.001	0.099	0.297	Significant
Trust->EX->BI	0.089*	1.886	0.030	0.018	0.173	Significant
Trust->EX->PE->BI	0.072**	3.110	0.001	0.036	0.111	Significant

***p<.001, **p<.01 and *p<.05, PE=performance Expectancy, EX= Effort Expectancy, SI= Social Influence, FC= Facilitating Conditions, Sec= Perceived Security, AW=awareness and BI= Behaviour Intention

To summarise, Appendix I represents all the comparisons between complete and subgroup's direct, indirect and moderating results.

4.6 Conclusion

In the present chapter, the data analysis procedures were discussed in detail. The data were derived from Google Forms. Consequently, the cleaning process was operated using Excel and SPSS software programs. Initially, the dataset was cleaned by handling missing values, outliers and straight-lining responses. The handling process caused the removal of 38 cases, leaving 399 responses. Accordingly, three unbiased assessments were conducted, namely, non-response and Full Collinearity Approach tests. The two assessments are related to the common method bias. The results revealed a dearth of bias in the collected data.

Furthermore, this chapter demonstrated the profile of respondents, descriptive statistics, and differences between groups. The profiles of respondents highlighted the frequency and valid percentages. The descriptive statistics were associated with this study's developed model, whereby the total number of responses, minimum, maximum, mean, and standard deviation were calculated and exhibited. Finally, differences between groups were demonstrated. The following chapter represents testing the developed model in the current study.

In addition, the model testing was discussed in this chapter. The test was performed based on the multi-stage procedure, including measurement and structural model assessments. (Hair et al., 2022; Hair et al., 2014; Henseler et al., 2017; Chin, 2010). The measurement assessment discussed mainly the reliability and validity assessments. On the other hand, the structural measurement model involved discussing the collinearity, coefficient of determination, effect size, predictive relevance, path coefficient significance and relevance. The path coefficient results revealed 11 significant results out of 17 direct hypotheses. Moreover, seven out of eleven indirect relationships were found to be significant. Finally, the MGA results were reported based on MANOVA, permutation and bootstrapping techniques. The MANOVA represented statistically significant means in the level of agreement pertinent to participants' responses to this study's items. The Permutation Test highlighted the differences between every category's subsample (e.g., male and female). Finally, the bootstrapping showed the significant impact for every proposed relationship in this study's framework and compared it to the total results. The following chapter discusses the reported results in detail.

Chapter 5: Discussion

5.1 Introduction

This chapter discusses the acquired findings from the data analysis chapter in more detail. First, the empirical results from the formulated model are summarised, interpreted, compared with existing literature and justified based on the proposed framework in this study. These results answer RQ1 by determining the direct, moderating and indirect factors that affect the employees' acceptance of blockchain. Second, RQ2 is discussed in more detail through MGA tests, namely, MANOVA, permutation and bootstrapping techniques to determine the differences among employees various groups. Finally, RQ3 is addressed by determining the areas in HEIs where blockchain is most needed.

To recap, blockchain technology adoption has recently been receiving a growing interest in scientific research (Adaryani et al., 2024). This investigates the determinants that drive employees to accept or reject blockchain-based applications in HEIs (see Chapter 1). To determine the drivers and inhibitors of using blockchain, the UTAUT antecedents were the primary variables to investigate. These variables include PE, EX, SI, facilitating condition and BI. However, UTAUT determinants are not tightly associated with blockchain technology, nor do they examine the effect of its characteristics. This gap yields the extension of the UTAUT with some of the blockchain-related characteristics, i.e., perceived security, trust and AW determinants (See Chapter 2). Therefore, hypotheses were developed based on UTAUT determinants and additional individual characteristics to determine the acceptance of blockchain among HEIs' employees (see Chapter 2).

In order to test these hypotheses, an empirical study was conducted based on a survey collected from 394 HEIs' administrative staff and academics in Saudi Arabia (see Chapter 3). These employees were categorised differently in terms of nationality (Saudi and non-Saudi), age groups, provinces in Saudi provinces, gender, job types, experience and usability status of blockchain. Following, the collected responses were empirically analysed and tested based on the PLS-SEM. The results were ultimately reported to test the developed hypotheses (see Chapter 4). The obtained results included direct, moderating and indirect relationships. These relationships were analysed for all participants collectively. Also, every segment's (e.g., gender) subsample (e.g., female) was compared with the other subgroup (e.g., male). The comparison was conducted by employing MANOVA to compare the means, permutation to compare the path coefficients and bootstrapping-based MGA to compare the significance and insignificance of each subgroup to the complete results.

In relation to the RQ of this study, the answer to RQ1 is based on the extension of UTAUT by individual characteristics related to blockchain. The RQ1 is achieved by determining the influence of the proposed factors on blockchain acceptance among HEI's employees. The RQ2 is addressed by using the MGA test, which represents the differences between staff. The third RQ is addressed by determining the areas where blockchain is most needed based on employees' experience.

Therefore, the obtained results are discussed in this chapter.

5.2 The Proposed Model Results

In the previous chapter, the obtained results were analysed and reported. The data were analysed using PLS-SEM, specifically the bootstrapping technique for the complete results (Hair et al., 2022). In this section, the direct, moderating and indirect connections between the framework's variables are discussed. This discussion addresses this study's RQ1 concerning the direct, moderating and indirect drivers and barriers toward the blockchain acceptance among HEIs' employees in KSA.

In relation to the underpinning theory, Venkatesh et al. (2003) found that UTAUT explains 70% of the variance of BI (adjusted R^2). In comparison, this study accounts for .615 of the variances in BI.598 in PE.436 in trust and .426 in EX. All variance values for this study's endogenous variables are considered moderating relationships as they are above 0.33 and less than .67 (Chin, 1998). Therefore, the R^2 of this study's framework is satisfactory.

To recap, this study's hypotheses resulted in 13 positively accepted hypotheses out of 17. Six hypotheses were rejected. These outcomes cover the direct and moderating results. In addition, the indirect results yielded 7 significant results out of 11.

5.2.1 Performance Expectancy

PE refers to the extent to which HEIs' employees believe that blockchain will enhance their work performance (Venkatesh et al., 2003). This study hypothesised PE to significantly and positively affect blockchain adoption among HEIs' employees in Saudi Arabia (H1). As depicted in Figure 18.0, PE significantly and positively correlated with BI (β=.424, p-value <.001). Thus, this hypothesis is accepted. Moreover, this study uncovers that PE is the most influential factor affecting BI among HEIs' employees in Saudi Arabia (β=.424). This is substantiated by the effect size of the path PE → BI, as it reflects the highest score in BI

(f^2=.156). Hence, PE is the most potent positive driver of blockchain acceptance among HEIs' employees in KSA.

To interpret this result, this study proves that PE has a significant and positive impact on BI. This outcome implies that the degree to which HEIs' employees believe that blockchain will improve their job performance is the primary driver of accepting the use of blockchain in HEIs. In other words, the more employees perceive blockchain to enhance their job performance, the more they accept its usage.

In light of extant-related scholarly studies, PE has been widely found to be a significant and positive driver of BI to use technologies in various industries. Pertinent with blockchain, this relationship has existed in various industries, including, but not limited to, computational advertising (G. Wang et al., 2023), SC (Nguyen et al., 2023; A. Sharma et al., 2023; Adaryani et al., 2024), finance (Sham et al., 2023) and tourism (Chang et al., 2022; Sarnacchiaro et al., 2024). In addition, empirical studies related to the HEIs domain, but not blockchain, have found PE to be a significant and positive driver of BI. These studies have involved academic and/or administrative employees for different technologies. These technologies involve, for example, big data (Azam & Ahmad, 2024), learning management systems (LMS) (García-Murillo et al., 2023), blended learning (Anthony et al., 2023), e-learning (Alammary et al., 2022), among others. Combining blockchain and HEIs settings, Al-Riyami et al. (2023) investigated the Fourth Industrial Revolution (FIR), including blockchain, among academics in KSA and found comparable results. These results are similar to this study's findings that PE significantly and positively affects the acceptance of blockchain among administrative employees and academics among HEIs in KSA. More detailed results are exhibited in Section 2.6.3.

Additionally, this study finds PE to be the most influential factor on BI among administrative workers and academics in KSA. This result is aligned with previous deductions that found PE to be the primary forecaster of BI to use blockchain (Mokthar & Sapuan, 2023; Lee, 2023; Kumari et al., 2023; Sham et al., 2023). Indeed, a recent review found PE to be the most significant sway on BI in HEI sector (Xue et al., 2024). For instance, PE was found to have the most substantial effect on BI pertinent to diverse systems such as big data (Azam & Ahmad, 2024), mobile learning (Chao & Chen, 2023) and information and community technology (Mbazu et al., 2024). Therefore, this study substantiates that PE is the most influential factor that leads administrative and academic staff to accept blockchain in the HEIs industry in Saudi Arabia.

This significantly positive relationship may indicate employees' expectancy that blockchain-based applications can enhance their job performance. However, this justification requires further investigation.

This finding contributes to the theory by reinforcing the critical role of PE in predicting BI toward the use of blockchain among administrative and academic employees within HEIs in KSA. PE influence on BI is reflects the strongest effect size on BI. The result confirms that the effect of PE on BI is relation to Blockchain, HEIs and this study's participants (academic and administrative employees) is still significant.

For practice, this result highlights the necessity for HEIs in KSA to prioritise strategies that enhance employees' perception of blockchain's influence on their job performance. Internal webinars, informative emails, infographics are among various methods that could deliver blockchain benefits to employees concerning their job performance. Ensuring that employees perceive tangible benefits from blockchain utilisation will be critical in driving its successful adoption within the HEIs sector.

5.2.2 Effort Expectancy

EX refers to the degree of blockchain's ease of use among HEIs' employees in Saudi Arabia. This study hypothesises that EX has a significant and positive relationship with PE, which, in turn, impacts BI to use blockchain (H2a). The results revealed that the hypothesis concerning the path EX → PE is accepted. The above subsection reported a significant relationship between PE and BI. Thus, PE mediates the relationship between EX and BI (see Table 29.0). Besides, this study hypothesises that EX positively and significantly influences BI. However, the hypothesis concerning the path EX→BI is rejected (See Table 28.0). Thus, EX is an insignificant direct predictor of BI in this study. However, EX significantly and indirectly predicts BI through PE. Accordingly, EX has an indirect-only relationship with BI (Zhao et al., 2010; Hair et al., 2022; Nitzl et al., 2016; Hair et al., 2021). Remarkably, the direct insignificant relationship between EX and BI induces some indirect paths of SEC and trust to be insignificant, according to the complete results (see Table 29.0).

To interpret the findings, this study found that EX affects PE significantly and positively. In other words, blockchain's ease of use positively and significantly impacted the perception that it will evolve job performance (PE) among HEIs' administrative staff and academics in KSA. EX has a direct relationship with PE, and PE (as aforementioned) is directly linked to BI. Therefore, EX significantly affects the BI to use blockchain indirectly (through PE) Nevertheless, this study finds that the ease of using blockchain has an insignificant direct relationship with the BI to use blockchain.

Extant studies have revealed that blockchain's EX has a significant and positive relationship with the blockchain adoption. This significant relationship has been found in

various fields, such as tourism (e.g., Sarnacchiaro et al., 2024), SC (e.g., Lavaei Adaryani et al., 2024), accounting (e.g., Jena, 2024), among others. Likewise, previous studies have found in the field of HEIs that EX has a significant and positive relationship the BI to use various technologies (e.g., AL-Nuaimi et al., 2022; Anthony et al., 2023; Azam & Ahmad, 2023; García-Murillo et al., 2023; Mbazu et al., 2023; Mujalli et al., 2022; Nikou & Aavakare, 2021; Salem & Elshaer, 2023; Sultana, 2020; Tatlı et al., 2024). Combining blockchain and HEIs, Al-Riyami et al. (2023) found a significant and positive relationship between EX and BI to adopt FIR technologies (including blockchain).

However, this study uncovers an insignificant relationship between EX and BI. Further, the acquired result has been found in earlier studies. In light of blockchain, previous studies have found EX insignificantly related to BI to use blockchain technology. These studies were pertained to various industries such as the SC (Pieters et al., 2022; Figueiredo et al., 2023; Nguyen et al., 2023; Wong, Tan et al., 2020), Waqf blockchain (Mokthar & Sapuan, 2023) e-commerce technologies (Jain et al., 2022), SMEs (Khazaei, 2020), public sector (Latif & Zakaria, 2020) and finance (Kumari et al., 2023). In addition, existing investigations that have involved academics and/or administrative staff within their investigation of various technologies have discovered an insignificant association between EX and BI (Lee et al., 2019; Rotar, 2023; Kazemian & Grant, 2023; Bayaga & du Plessis, 2024; Alammary et al., 2022; Chávez Herting et al., 2023; Hu et al., 2020; Kolil & Achuthan, 2023; Toh et al., 2023; Tseng et al., 2022). Remarkably, more than 40% of extant papers have found EX to be insignificantly affecting the behavioural acceptance in the HEIs domain (Xue et al., 2024), indistinguishable from this study's findings. Moreover, extant research has highlighted that EX has been found insignificant within HEIs in KSA for various technologies. For instance, previous studies that investigated some stakeholders (e.g., students, academics or administrative office) in Saudi Arabia have found it to be an insignificant driver of blockchain (Alammary et al., 2022; Al-Azawei & Alowayr, 2020; Altalhi, 2021).

In terms of the relationship between EX and PE (H2b), this study had similar results to extant studies. Previous studies related to blockchain technology have found that EX is a significant predictor of PE (Abu Afifa et al., 2023; Kumari et al., 2023). Additionally, previous studies that are related to HEIs industry found a significant impact of EX in relation to PE (Yadegaridehkordi et al., 2018; Buabeng-Andoh & Baah, 2020). These findings are consistent with this study's findings, which found a significant and positive relationship between EX and PE related to blockchain in the HEIs settings among administrative and academic staff.

The obtained insignificant relationship between EX and BI could be due to the linkage with employees' type, levels of experience and the context of Saudi Arabia. Similarly, the type

of participants (i.e., administrative employees) and the level of experience are most likely significant factors for this insignificant relationship. As proven in Section 4.5.3.3, the EX direct influence on BI is significant among administrative employees and staff with more than ten years of experience. Finally, the context of Saudi Arabia could be another factor in this relationship. Employees in KSA may not accept or reject a technology based on its ease or complexity. The difference in context could be different in EX, as proven in previous studies (e.g., Queiroz & Fosso Wamba, 2019). These arguments require further studies and investigations to confirm or reject.

This finding contributes to the theory by delivering the limited role of EX in predicting BI toward the use of blockchain among administrative and academic employees within HEIs in KSA. The influence of EX on BI exhibits an insignificant effect size, suggesting that EX does not play a decisive role in shaping the employees' willingness to use blockchain

For a practical standpoint, this result highlights that HEIs in KSA may not need to prioritize strategies focused on enhancing EX when promoting blockchain adoption. Instead, efforts could be redirected toward more influential factors that drive BI. Resources allocated to EX-related initiatives, such as engagement surveys or workplace experience enhancements, might be more effectively invested in areas that have a stronger impact on employees' intent to use blockchain.

5.2.3 Social Influence

In the present study, SI, as a driver of blockchain acceptance, refers to the level to which employees who work for HEIs in KSA perceive that influential individuals around them believe that they should use blockchain in their work. This study hypothesised that SI significantly and positively affects employees' acceptance of blockchain (H3). However, the result of SI on BI was found insignificant (β=-.038, p-value=.195). Thus, H3 is rejected. Therefore, SI is an insignificant factor of blockchain acceptance among HEIs' employees in Saudi Arabia.

To interpret this result, the SI insignificantly affects BI to use blockchain in HEIs. This result conveys that the perception that HEIs' administrative staff and academics in KSA perceive that their influential surroundings' thoughts regarding their use of blockchain in their work is insignificantly linked to their acceptance.

In contradiction to the present study's result, previous scholars have informed that SI significantly and positively affects BI. Concerning blockchain, previous authors have found that the SI significantly and positively impacts blockchain acceptance in relation to various

areas, such as finance (NAZIM et al., 2021), accounting (Ferri et al., 2021; Abu Afifa et al., 2023), SC (A. Sharma et al., 2023; Zhang et al., 2023), gamification (Vorobeva et al., 2023), among others. Besides, studies related to the HEIs field have uncovered significant and positive relationships concerning various technologies for administrative employees and/or academics at various HEIs(Azam & Ahmad, 2024; Kazemian & Grant, 2023; Anthony et al., 2023; Mbazu et al., 2024; Tatlı et al., 2024). However, the present study reveals SI to have neither a significant nor a positive effect on BI among academic and administrative staff in HEIs settings in KSA. Indeed, this study's result contradicts the abovementioned studies.

Nevertheless, multiple studies on blockchain and the HEI sector have had similarly insignificant findings. Concerning blockchain, these studies are related to various sectors such as SC (Kabir et al., 2021; Figueiredo et al., 2023; Nguyen et al., 2023), banking (Mansoor et al., 2023), e-commerce (Jain et al., 2022), tourism (Chang et al., 2022) and finance (Bakri et al., 2023). Concerning the HEI sector, more than 40% of UTAUT studies have found SI insignificant in relation to BI (Xue et al., 2024), which is consistent with this study’s findings. The founded insignificant result in this study is compatible with earlier studies within the HEIs setting involving various technologies, including, but not limited to, LMS (García-Murillo et al., 2023; Abbad, 2021; AL-Nuaimi et al., 2022; Bervell & Umar, 2017), Enterprise social network (Kazemian & Grant, 2023), geospatial technology (Cascante-Campos, 2023), PowerPoint (Chávez Herting et al., 2023), mobile phones (Hu et al., 2020) and other technologies (Toh et al., 2023; Sultana, 2020; Mtebe & Raisamo, 2014). All these studies involve (partially or totally) administrative and/or academic staff. Therefore, the current study corresponds to these studies' findings whereby the effect of SI on BI occurs in the involvement of academics and/or administrative employees. This justification requires further investigation in future studies.

Accordingly, the context of a study may play a crucial role in the SI effect on behavioural acceptance. Queiroz and Fosso Wamba (2019) found SI significant in India but insignificant in the USA. Thus, the context may cause insignificant effect of SI on BI. However, this justification requires further investigations.

This finding contributes to theory by determining that SI does not predict the BI to use blockchain among administrative and academic employees within HEIs in KSA. The influence of SI on BI demonstrates an insignificant effect size, indicating that social influence does not substantially shape employees’ acceptance of BI. The result adds to the existing body of knowledge that the effect of SI on BI in the context of blockchain, HEIs, and this study’s participants (academic and administrative employees) remains negligible.

Practitioners within HEIs in KSA may not prioritize strategies that rely on social influence to drive blockchain adoption. Colleagues’ advocacy, managerial endorsement or

family perceptions have no influence on academic and administrative employees' acceptance to use blockchain. Instead, the focus should be on factors that predict blockchain acceptance among employees.

5.2.4 Facilitating Conditions

FC refers to employees' feelings toward the readiness of the HEI they work for to foster and support the use of blockchain technology. This study investigates the relationship between FC and BI among HEIs' administrative and academic staff in KSA. It is hypothesised that the FC has a significant and positive relationship with the BI to use blockchain (H4). The findings of this study proved this hypothesis to be significant. Thus, it is accepted (see Table 28.0). Accordingly, FC is a critical driver of blockchain acceptance among HEIs' employees.

To interpret, the results revealed a significant and positive relationship between FC and blockchain acceptance among administrative staff and academics in HEIs in Saudi Arabia. In simpler terms, this suggests that the more employees believe that HEIs endorse blockchain technology, the more likely they accept to embrace its usage in their professional responsibilities.

The present study's findings, consistent with extant literature, reiterate the significant impact of FC on blockchain acceptance in the HEIs industry. Regarding blockchain, scholars have found that FC positively and significantly affects the BI to use blockchain technology. The results are relevant to various fields that have investigated blockchain, including, but not limited to, SC (Kabir et al., 2021; Pieters et al., 2022; Zhang et al., 2023; A. Sharma et al., 2023), FIR (Al-Riyami et al., 2023), Waqf Blockchain (Mokthar & Sapuan, 2023), press industry (Pham & Thi Nguyet, 2023) and tourism (Sarnacchiaro et al., 2024; Chang et al., 2022), among others. Furthermore, extant literature has found FC to significantly and positively influence BI to use blockchain in the HEIs industry. These studies concern office employees and faculty members in HEIs industry regarding various technologies, such as big data (Azam & Ahmad, 2024), LMS (García-Murillo et al., 2023; Bayaga & du Plessis, 2024), blended learning (Anthony et al., 2023), information and community technology (Mbazu et al., 2024) and paperless technologies (Tatlı et al., 2024). Therefore, this study proves and emphasise the significant relationship between FC and BI to use blockchain within the HEIs contexts.

Th FC significant influence on BI has a significant contribution to theory. It confirms the theoretical the significance of FC on BI towards blockchain adoption among administrative and academic employees in HEIs in KSA. By confirming the continued relevance of FC in this

context, the study deepens our understanding of how institutional support influences the adoption of emerging technologies within HEIs.

In practice, the findings emphasise the importance of FC on BI within HEIs in KSA. Decision-makers should ensure that employees can access to the necessary tools, developmental sessions, and technical assistance to facilitate blockchain adoption. Practicians should invest in fostering IT infrastructure and establishing dedicated support teams to address potential challenges of using blockchain. Creating an environment where employees feel supported in using blockchain increases the acceptance of blockchain among administrative and academic employees.

5.2.5 Trust

The concept of trust in blockchain pertains to how employees perceive the risks associated with blockchain technology. When individuals view blockchain as less risky, they are more inclined to place trust in it. Conversely, if employees perceive it as a riskier technology, they are less likely to trust it. As a blockchain-related intrinsic feature, this study investigates trust between two parties (employees and blockchain) against three UTAUT antecedents (i.e., PE, EX and BI).

First, trust in blockchain is hypothesised to have a significant and positive relationship with BI (H5a). Employees who judge blockchain as less risky are more inclined to accept its use. On the other hand, employees who perceive blockchain as riskier trust will negatively contribute to their acceptance of using blockchain. H5 was found to not be statistically significant to BI; therefore, it is rejected. Second, this study hypothesises a significant and positive relationship between trust and PE (H5b), which, in turn, affects BI. This relationship was found to be positive and significant (see Table 29.0) thus, the hypothesis is accepted. In other words, PE mediates the relationship between trust and BI. Finally, this study hypothesised that trust significantly and positively influences EX (H5c). The relationship between trust and EX is proven to be positive and significant (β=.456, p-value <.001). Thus, this hypothesis is accepted.

Additionally, trust is found to only affect BI through PE and the serial path Trust->EX->PE->BI (See Table 29.0). Trust does affect EX, which, in turn, does not directly affect BI to use blockchain. This result implies that EX does not mediate the relationship between trust and BI. Therefore, trust has an indirect-only relationship with BI (Zhao et al., 2010; Hair et al., 2022; Nitzl et al., 2016; Hair et al., 2021). Remarkably, the insignificant direct relationship between trust and BI yields insignificant indirect paths related to SEC (see Table 28).

To interpret these results, trust has an insignificant direct relationship with BI to use blockchain. However, it has significant and positive relationships with PE and EX. The relationship between trust and BI implies that the higher trust in blockchain among administrative staff and academics of HEIs in KSA does not lead them to accept its use. Regarding the relationship between trust and PE, the more employees trust blockchain and judge it as less risky to use, the more they believe it will enhance their job performance. Thereby, the more employees believe in the blockchain system to improve their job performance, the more they accept its usage. Thus, trust increases the BI to use blockchain under the condition of a significant and positive impact of PE on BI (indirectly). Further, the relationship between trust and EX implies that the more these employees trust blockchain and judge it as less risky to use, the more they perceive blockchain to be easier to use.

Unlike this study's results, previous studies investigating blockchain have found trust to significantly and positively influence BI in various industries. These industries include, but are not limited to, SC (Kabir et al., 2021; Queiroz et al., 2021), gamification (Vorobeva et al., 2023), banking (Mansoor et al., 2023; Jena, 2022), finance (Kumari et al., 2023; Bakri et al., 2023), accounting (Jena, 2024; Abu Afifa et al., 2023) and tourism (Sarnacchiaro et al., 2024), public sector and SMEs (Khazaei, 2020). Besides, existing studies that investigated trust in the HEIs industry have found it to significantly and positively affect BI. These studies are related to various technologies, such as mobile acceptance (Parhamnia, 2022; Al-Azawei & Alowayr, 2020). These studies contradict the current study's findings.

Indeed, this study conflicts with all these previous findings, yielding an insignificant relationship between trust and blockchain acceptance among HEIs' employees in KSA. Previous studies have also found an insignificant influence of trust on BI. Previous studies related to various industries, such as operation and SC management (Zhang et al., 2023; Wong, Tan et al., 2020), big-data (Abdullah Sani et al., 2021) and press industry (Pham & Thi Nguyet, 2023) have found similar results. Concerning HEIs, other studies have found trust to be insignificantly correlated to BI. For instance, Lee et al. (2019) found an insignificant relationship between trust and BI among students, academics and IT professionals, mainly in HEI and involving other industries. The present study supports and confirms the extant insignificant direct relationship between trust and BI. Therefore, the importance of trust may vary based on the technology and the industry.

This study finds trust to significantly and positively impact PE (H5b). This result is compatible with previous studies that have investigated blockchain in other settings, such as finance (Kumari et al., 2023), tourism (Chang et al., 2022; Sarnacchiaro et al., 2024) and accounting (Abu Afifa et al., 2023). To the best of the author's knowledge and based on Xue

and others' (2024) systematic review and the investigation in Section 2.6.3, the present study is the first to examine this connection between trust and PE in the HEIs industry based on UTAUT.

Moreover, this study reveals that employees' trust significantly and positively affects EX (H5c). This finding is consistent with Abu Afifa's (2023) finding, who investigated this relationship among accountants and Chang et al. (2022) who found a similar relationship in the tourism industry. However, to the author's best knowledge (see Section 2.6.3), the current study is the first to find this significant relationship in the HEIs industry. Therefore, this study has consistent results with other papers in other industries confirming that trust in blockchain significantly and positively influences EX.

Justifying the reason behind the insignificantly direct impact of trust on BI is an uneasy task. Nonetheless, following the investigation of heterogeneity in this study. The female employees were found to perceive trust to significantly influence their BI to use blockchain. Therefore, male employees' insignificant perception of the role of trust in their BI is most likely a primary contribution to the found result.

This finding contributes to the theory by emphasizing the significant role of FC in predicting BI toward the use of blockchain among administrative and academic employees within HEIs in KSA. The result confirms that the effect of FC on BI, in the context of blockchain, HEIs, and this study's participants (academic and administrative employees), is both substantial and meaningful.

For practice, this result underscores the need for HEIs in KSA to foscus on strategies that enhance the availability of essential resources, tools, and support for staff. Providing sufficient training, technical assistance, and access to blockchain-related resources is critical in fostering employees' acceptance to use blockchain technology. Ensuring that staff feel fully supported in their blockchain adoption will be critical in driving its successful implementation within HEIs in KSA.

5.2.6 Perceived Security

SEC in this study refers to the perception of HEIs' employees pertained to blockchain safeguards against cyberattacks, threats and the extent to which the employees control their data (See Section 2.6.4.6). The current investigation examined the direct paths of SEC on BI, PE, trust and EX. Initially, SEC were hypothesised to have a significant and positive relationship with BI ($H6_a$). This study found SEC to be a significant and positive driver of behavioural acceptance among HEIs' employees in Saudi Arabia (See Table 29). Thus, this

hypothesis is accepted. Furthermore, this study hypothesised that the SEC significantly and positively affects PE ($H6_b$), which, in turn, influenced BI to use blockchain. This study's findings revealed that SEC has a significant and positive relationship with PE. Thus, this hypothesis is accepted. Additionally, SEC was hypothesised to have a significant and positive relationship with trust ($H6_c$). This study found that this hypothesis to be significant and positive. Thus, this hypothesis is accepted. Finally, the study hypothesised SEC to have a significant and positive effect on EX ($H6_d$). As anticipated, this study's findings unveiled a significant and positive relationship between SEC and EX (β=.257, p-value <.001). Thus, this hypothesis is accepted. Therefore, SEC has a direct and significant relationship with BI, PE, trust and EX. Remarkably, SEC has indirect connections with BI. Indirectly, SEC affects BI through the following paths:

1) Sec->Trust->PE->BI (β=.074, p-value= .001),

2) Sec->Trust->PE->BI (β=.108, p-value <.001),

3) Sec->Trust->EX->PE->BI (β=.043, p-value <.001) and

4) Sec->EX->PE->BI (β=.036, p-value =001).

Therefore, SEC affects BI directly and indirectly, revealing a partial mediation relationship. Particularly, complementary mediation is found, whereby significant direct and indirect relationships positively impact BI (Zhao et al., 2010; Hair et al., 2022; Nitzl et al., 2016; Hair et al., 2021).

However, the effect of SEC on trust, which, in turn, is connected to BI (Sec->Trust->BI), was found insignificant (β=-.034, p-value=.220) because trust does not directly affect BI. Correspondingly, the paths of SEC, whereby EX influences BI directly (Sec->EX->BI and Sec->Trust->EX->BI), were found insignificant (see Table 29.0) because EX does not directly influence BI.

To interpret these results, SEC significantly and positively affects BI, PE, trust and EX. This study's findings proved that the perception that blockchain secures their data more and enables the data to be more controllable (SEC) has a significant and positive influence on blockchain acceptance. Precisely, SEC is a significant driver of blockchain acceptance among administrative staff and academics in HEIs. In addition, the administrative and academic staff's perceptions that blockchain safeguards against cyberattacks and enables them to control their data (SEC) significantly and positively influences them to believe that blockchain enhances their job performance (PE). Thereby, as mentioned above, PE had a significant and positive impact on BI, yielding a mediating role of PE between SEC and BI. Furthermore, the results demonstrated a significant and positive correlation between the perception that blockchain maintains employees' data secure against threats and cyberattacks and allows them to control

their data (SEC) and the lower risk judgment of blockchain (trust). As aforementioned, trust significantly influences PE, which significantly and positively influences BI. Thereby, the serial-mediation path of Sec->Trust->PE->BI is significant. Similar cases occur with the paths Sec->Trust->EX->PE->BI and Sec->EX->PE->BI (see Table 29.0). Another significant and positive correlation exists between SEC and EX. This relationship demonstrates that the more employees perceive blockchain as a secure technology, the more they perceive it to be demanding less effort to use. For instance, the employees may perceive cyberattacks against a blockchain-based application as challenging, leading them to believe it is difficult to use. Remarkably, EX and trust have an insignificantly direct effect on BI. In these cases, they cause indirect paths between SEC and BI (see Table 29.0).

This study uncovers that the SEC of blockchain affects its acceptance among administrative staff and academics (H6a). This finding is compatible with studies that concern blockchain adoption in various fields, including, but not limited to, tourism (Sarnacchiaro et al., 2024) and SMEs (Khazaei, 2020). Further, this study obtained findings similar to those in the HEI sector, such as Alomari and Abdullah (2023), who found security to significantly and positively affect students' attention concerning cryptocurrency acceptance. However, to the best of the author's knowledge and based on Xue and others' (2024) systematic review, only one study investigated the SEC within the HEIs industry, i.e., Alomari and Abdullah (2023). This study investigated students only and not employees. So, the current study is the first to investigate this relationship among HEIs' employees for blockchain applications.

Furthermore, this study finds SEC to have a significant and positive influence on PE (H6b). This result is similar to previous scholarly studies concerning blockchain in the tourism industry (Sarnacchiaro et al., 2024; Chang et al., 2022). This present study proves previous findings that SEC significantly and positively influence PE in the HEIs industry in Saudi Arabia. PE was found to affect BI among administrative employees and academics to use blockchain in HEI sector. Therefore, SEC indirectly affects BI (see Table 29.0).

Besides, this study reveals that SEC significantly and positively affects trust in blockchain technology in HEIs (H6c). This result is similar to previous studies' findings investigating blockchain technology in other industries. These industries include but are not limited to tourism (Sarnacchiaro et al., 2024) and HEIs (Lee et al., 2019). The latter study investigated academics and IT professionals in various industries. The only study that concerns the HEIs industry based on UTAUT and found a similar relationship is Almaiah et al. (2019). The authors found that SEC significantly and positively affects students' trust in mobile learning. However, to the author's best knowledge, the present study has a unique result related to the HEIs administrative employees and academics, together, based on UTAUT. The

results prove that SEC significantly and positively affects administrative and academic staff's trust in blockchain technology in HEIs.

Finally, this study finds SEC to significantly and positively influence EX (H6d). This finding is similar to previous studies investigating blockchain technology in the tourism industry (Chang et al., 2022). As a result of the author's investigation and based on the investigation of a recent systematic review (Xue et al., 2024), the present study is the only study that investigated the impact of security on EX in the HEIs settings. Therefore, this study unveils a significant and positive relationship between SEC and EX in the HEI sector among administrative employees and academics. However, the EX does not mediate the relationship between SEC and BI due to the insignificant direct influence of EX on BI.

This finding contributes to the theory by highlighting the significant and direct effect of SEC on BI towards the use of blockchain among administrative and academic staff within HEIs in KSA. Based on the significant indirect paths, (Sec->Trust->PE->BI, Sec->Trust->PE->BI, Sec->Trust->EX->PE->BI and Sec->EX->PE->BI). SEC plays a central role in shaping employees' intentions to use blockchain. The significant paths (β=.074, p-value=.001; β=.108, p-value<.001; β=.043, p-value<.001; and β=.036, p-value=.001) confirm the strong influence of SEC on BI through the aforementioned mediating factors.

In practice, this result guides decision-makers to prioritize SEC when developing strategies for blockchain adoption, Ensuring that employees feel confident in the security of blockchain systems will be essential for fostering trust and enhancing their perceptions of its utility and effectiveness in their roles. HEIs should focus on strengthening security protocols and delivering these measures clearly to staff. Also they should reassure the SEC of blockchain through training and resources to mitigate employees concerns about SEC. Strengthening employees' confidence in blockchain security will play a pivotal role in driving its successful adoption within the HEIs sector.

5.2.7 Awareness

In the present study, AW refers to the administrative employees' and academics' knowledge concerning blockchain's presence, features, advantages, facilitators and usefulness for their job tasks. Initially, this study hypothesised a significant and positive relationship between AW and BI (H7a). The findings revealed a significant and positive relationship between AW and blockchain acceptance among HEIs' employees. Thus, this hypothesis is accepted.

In addition, this study hypothesised a significant moderating relationship (regardless of the direction) between UTAUT antecedents (i.e., PE, EX, SI and FC) and BI. The findings of this study revealed that AW, as a moderator, demonstrated only one significant influence on the correlations between UTAUT determinants and BI. Therefore, all the hypotheses related to AW moderating roles are rejected except one path. AW reflects a significant and negative effect between FC and BI (see Table 29).

To interpret the direct relationship, this study's results reveal a significant and positive association between AW and BI. This result suggests that the knowledge of administrative workers and academics toward blockchain's presence, traits, and usefulness related to their job tasks has a significant and positive influence on their acceptance of blockchain. In other words, the more these employees know blockchain, the more they accept its use. Hence, AW is a significant driver of blockchain acceptance among administrative employees and academics in HEIs in Saudi Arabia.

To explain the moderating effects of AW between UTAUT and BI, the findings indicated that AW has one significant moderating effect and three insignificant moderating relationships. To clarify, the knowledge of blockchain existence, characteristics, advantages, easiness, and usefulness (AW) among administrative employees and academics does not significantly moderate the relationship between the employees' perception that blockchain enhances their job performance (PE) and the blockchain acceptance among HEIs' employees in KSA (BI). This study also demonstrates no significant moderating role in the correlation between blockchain's EX and acceptance. To interpret it, the knowledge of blockchain presence, attributes, benefits, easiness, and effectiveness (AW) among administrative employees and academics has an insignificant moderating influence between the perception of blockchain easiness to use (EX) and blockchain acceptance. Furthermore, this study encountered an insignificant relationship between the moderating role of AW and the relationship between SI and BI. To demonstrate, the AW of blockchain has no significant moderating role between the perception of administrative staff and academics that their significant others believe they should use blockchain (SI) and the acceptance of using blockchain (BI).

This study found a negatively significant relationship of AW between FC and BI. This relationship signifies that the more knowledge of blockchain among administrative and academic personnel obtain, the more this knowledge significantly reduces the influence of the employees' belief concerning the institutional support of blockchain (FC) on blockchain acceptance. This significant result insinuates that the more employees are aware of blockchain, the less impact of FC is essential for them to accept blockchain. Therefore, only one hypothesis is accepted in the moderating role of AW.

This study found similar results to previous studies investigating blockchain AW in the HEIs industry. To the best of the authors' knowledge and based on recent systematic reviews (e.g., Alshamsi et al., 2022; Taherdoost, 2022), no extant studies have investigated the blockchain's AW influence on BI based on UTAUT. Recent studies have found a significant and positive relationship between blockchain AW and BI in HEIs (e.g., Chawla et al., 2024), yet not based on the UTAUT. AW of other technologies (not blockchain) has significantly and positively affected BI in the HEIs setting. These technologies are blended learning among academics (Anthony et al., 2023), recycling attitude among students and academics (Wan et al., 2012), mobile learning (Sabah, 2016; Salem & Elshaer, 2023) and LMS (Alomari & Abdullah, 2023).Salem and Elshaer (2023) referred to AW as M-learning services. This study is unique in terms of investigating administrative employees, which, to the best of the author's knowledge and based on a recent review (Xue et al., 2024), have yet to be investigated in previous studies in HEIs.

In contradiction with previous studies, this study found an insignificant moderating role of AW between PE and BI, EX and BI and SI and BI. Kumari et al. (2023) uncovered that AW significantly moderates between PE and BI concerning blockchain in finance. Kumari and others were the only scholars, to the best of the authors' knowledge, who investigated AW moderating role concerning blockchain technology. The authors examined only the moderating of AW between PE and BI, not the other UTAUT antecedents. Besides, only one study investigated AW as a moderator in the HEIs industry (Daniali et al., 2022). This study investigated Mobile 4.5G Service in the HEIs setting, revealing results of AW moderating role in the correlation of PE and BI, EX and BI and SI and BI. Their results revealed a significant effect on the relationship between PE and BI for both low and higher levels of AW. Also, they found a significant effect of the high level of AW among students on the relationship between EX and BI and between SI and BI. However, they found no significant role of the low level of AW as a moderator between EX and BI and between SI and BI.Daniali and others (2022) did not investigate the moderating role of AW between FC and BI. Thus, the current study investigates a new moderating role of AW that, to the author's knowledge, has not been examined in the HEIs realm. This role is the moderating role of AW between FC and BI. Unlike previous studies, this study found no significant moderating role of AW between PE and BI, EX and BI and SI and BI. However, the moderator role of AW between FC and BI is significant in this study, similar to Al-Azizi et al. (2018).

The distinct results within this study compared to previous studies might have occurred for various reasons. Firstly, they might have occurred due to the shortage of evidence regarding the AW moderating role between UTAUT antecedents and BI. To the best of the authors' knowledge, only two studies investigated the AW moderating effect between UTAUT

determinants and BI concerning blockchain or HEIs (Daniali et al., 2022). Only one study investigated all the UTAUT antecedents, as illustrated above (i.e., Al-Azizi et al., 2018). However, this study investigated the mobile usage in the government sector, which is not the area of this study. Secondly, a low level of AW of blockchain among administrative employees and academics in KSA could have created non-significant results. To highlight, Daniali et al. (2022) found various non-significant relationships related to participants with lower AW of the 4.5G service. Finally, to the best of the author's knowledge, this study investigated new participants that have never been explored in previous studies in terms of AW's moderating role (i.e., administrative employees and academics) based on UTAUT.

In terms of contribution to theory, this study highlights the significant role of awareness in predicting BI towards the acceptance of blockchain among administrative and academic staff within HEIs in KSA. The significant path demonstrates a meaningful relationship between awareness and BI, confirming that increasing employees' understanding of blockchain can directly influence their intentions to use it. This contribution is meaningful specifically for the blockchain and HEI industry. In addition,

The findings contribute to the theory by revealing the significant and negative moderating effect of awareness between FC and BI towards the BI to use blockchain among administrative and academic staff within HEIs in KSA. While FC is found as a strong predictor of BI, awareness moderates this relationship in a way that weakens its positive impact. The negative moderating effect suggests that as employees become more aware of blockchain, the influence of FC on their BI diminishes. In addition, the findings suggested that awareness does not significantly moderate the effects of PE, EX, and SI on BI. These findings suggest that awareness does not substantially influence the relationships between these factors and BI. These moderating results direct future studies to investigate the AW effect between FC and BI and potentially neglect the moderating effect of the other antecedents on BI.

For decision-makers, this result demonstrates the importance for HEIs to focus on raising awareness about blockchain among their academic and administrative staff. Providing informative resources, conducting workshops, organising awareness campaigns, among others, is significant in enhancing employees' acceptance of blockchain. Increasing employees' awareness of blockchain will help to create a positive environment for its adoption and encourage greater BI to use it within the HEIs sector.

Regarding the moderating effect of AW between the UTAUT antecedents and BI, the results revealed a significant negative moderating effect of FC on BI. Specifically, as employees' awareness of blockchain increases, the level of support they require decreases.

This suggests that decision-makers can reduce the resources allocated to blockchain support as awareness grows, ultimately saving both time and money.

After discussing the complete results, MGA is discussed in the following section.

5.3 MGA Results

While the previous results represent the complete and bootstrapping-based MGA results, the differences between groups are analysed in this section. This section addresses RQ2. The present study's participants are the administrative and academic staff in HEIs located in Saudi Arabia. These employees represent heterogeneous in nationality, gender, age, job types and levels of experience. The differences among staff represent categories of this study, whereby every category includes at least two subgroups. For instance, the gender category contains from male and female. These difference between the subgroups are investigated through MANOVA and Permutation methods. Additionally, the difference between each subgroup and the complete results was investigated based on the bootstrapping-based MGA and reported in the previous section.

5.3.1 MANOVA Results

MANOVA method was implemented in this study due to its flexibility in testing significant differences among subgroups. This study is based on the 7-point Likert scale, where 1=strongly disagree, 2=disagree, 3=somewhat disagree, 4=neutral, 5=somewhat agree, 6=agree and 7= strongly agree. MANOVA provides outcomes that are nearer to one of these 7-point figures. The more adjacent the mean of the results to one of these numbers, the more the participants demonstrated their agreement level to a dependent variable—the closer to 7, the higher the agreement to a dependent variable and vice versa. For instance, the highest mean for females is 5.720, which is related to BI; this result indicates that females agree to adopt blockchain as the closest scale is 6 (agree). This example applies to all other groups and categories. The purpose is to highlight the relationship between various dependent variables of this study and the various groups. The dependent variables of this study are BI, PE, trust and EX.

5.3.1.1 Mean Differences among Groups

In comparison with the agreement and disagreement levels among participants, the highest mean for most groups was associated with BI (see Section 4.5.3.1). The results demonstrated that most groups intend to accept using blockchain in their HEIs tasks. On the

other hand, the lowest mean generally was related to SI. This result implies that the extent to which employees perceive that important others believe they should utilise blockchain (SI) within their work is less agreeable than other dependent variables. This MANOVA result demonstrates a significant indicator that decision-makers generally receive less resistance to accepting blockchain among HEIs' employees in KSA.

However, some groups differ in which dependent variable is the most significant. For instance, MANOVA reveals that the greatest mean is different between Saudi and non-Saudi employees in the HEI sector. While Saudis, who work for HEIs, perceive BI as the most agreeable variable in UTAUT, the non-Saudi employees perceive risk judgement of blockchain (trust) as the most significant dependent variable (see Table 30). These differences should be considered by decision-makers when applying blockchain to these groups.

5.3.1.2 Non-Significant Differences' Findings

Concerning the insignificant results, MANOVA highlights that the categories within nationality and age groups do not significantly differ. The first group is the nationality (see Table 30.0). This group consists of Saudi and non-Saudi employees who work for Saudi HEIs. The results revealed that these two subgroups have no significant differences in the mean of the dependent variables. This result is consistent with previous studies (e.g., Rodrigues et al., 2016). Additionally, the age subgroups (i.e., younger or older staff) did not represent differences in the mean of the dependent variables (see Table 31.0). This result is aligned with previous research (e.g., Vinitha & Vasantha, 2017). Therefore, the subgroups of the above categories (Saudis in comparison to expatriates and older compared to older employees) do not differ significantly in the mean of PE, EX, trust and BI. To highlight, these groups do not significantly differ in the mean regarding whether blockchain will enhance their job performance (PE). Similarly, there is no significant difference between the subgroups' mean in relation to the easiness of utilising blockchain technology (EX). Moreover, the different categories (nationality and age) obtain no significant differences in results concerning the risk judgement of blockchain (trust).

The non-significant differences within nationality's and age's subgroups may come from various reasons, specifically. In the context of Saudi Arabia, HEIs are likely to provide training and development programmes when introducing new technology (Singh et al., 2022). These training courses might be delivered to employees regardless of their age and nationality. Therefore, this might cause non-significant differences in terms of the mean between these two categories' (nationality and age) subgroups.

5.3.1.3 Significant Differences' Findings

Unlike the previous two groups, the other groups have partial or entirely significant differences pertaining to the present study's dependent variables. The partial significant difference indicates that a group may significantly differ in some of (not all) the dependent variables. For instance, female and male employees in HEIs have significant differences only in EX and BI. The two genders do not significantly differ in the other dependent variables of this study's framework. This example applies to other groups in this section, i.e., working experience and users and non-users. In comparison, the entire significant differences are pertinent to all the dependent variables. The groups with partial or entire significant differences among their categories are gender, job type, years of experience and users and non-users of blockchain.

Firstly, MANOVA demonstrates significant differences between females and males, which pertained only to EX and BI (see Table 32.0). Concerning the mean difference in EX, the result indicates that females perceive the ease of using blockchain as a significant factor more than male employees. The significant difference in EX for women compared to men has been highlighted in previous studies (Orji, 2010; Venkatesh & Morris, 2000; Goswami & Dutta, 2016). Similarly, a significant difference occurs between females and males in association with BI variables. This result is aligned with prior research (Okazaki & Renda dos Santos, 2012). These findings demonstrate that females are more accepting of blockchain than males. This result is also compatible with Wang et al. (2009), who suggested that this result may occur due to the increase in female employment in Taiwan. The same case could be applied to Saudi Arabia in the light of Vision 2030, as women have been recently more empowered to occupy administrative roles in HEIs' KSA (Mulligan, 2019; KSA Vision 2030, 2016). This may elucidate why women in Saudi HEIs are more accepting of adopting blockchain technology. However, validating such a justification requires further investigation in future studies.

In addition, MANOVA revealed significant differences between academics and administrative staff (job type). These significant differences concern this study's dependent variables (see Table 33). Interestingly, the administrative employees have higher means in all independent variables of the current study. To illustrate, administrative employees believe that blockchain enhances their job performance (PE) more than academics. The administrative employees in Saudi HEIs also believe in the importance of the ease of using blockchain more than academics do (EX). Likewise, administrative employees trust blockchain more than academics as they judge it as less risky. Finally, administrative staff intend to use blockchain more than academics. This result is compatible with Hu et al. (2020), who found significant differences among various employees within the HEIs. Based on MANOVA, all these

differences are significant between the two job types' subgroups. These differences could be due to the nature of blockchain, as blockchain-based applications might be perceived as serving administrative employees more clearly and efficiently than they serve academic purposes (see Section 2.3.1.7).

The third group with a significant difference is the years of working experience. MANOVA revealed significant differences regarding two levels of experience related to the PE and BI latent variables (see Table 34.0). The less experienced staff were found to agree more than senior staff with the importance of applying blockchain to improve their task performance (PE). Similarly, earlier career workers have higher behavioural intention than highly experienced employees (BI). This result is aligned with previous research (Altawallbeh et al., 2015). Interestingly, less experienced staff obtained higher means in all dependent variables. These lower values for people with more than 10 years of experience could be because expert employees resist the change more than less experienced employees. Also, Newer staff are likely to be more eager to use new technologies to gain experience, unlike older employees. However, these justifications require more evidence in future studies.

The final group of MANOVA's significant result is related to pre-adopters and post-adopters of blockchain technology in HEIs located in KSA. Only a few HEIs in KSA have adopted a blockchain application(s) in their system, such as Taibah University and KAUST (Taibah Valley, 2023; KAUST, 2018). The existence of blockchain users in few HEIs in Saudi Arabia leads to investigate whether current blockchain users would significantly have different stances concerning this study's dependent variables. The MANOVA findings revealed significant differences in the mean concerning PE and trust. These significant differences indicate that blockchain users believe it enhances their job performance. Also, they trust blockchain more than non-users. The significant difference in trust importance may stem from initial scepticism toward blockchain prior to adoption. Trust may increase as employees use a blockchain-based application. Additionally, employees who have experienced blockchain might have the perception that blockchain increases job performance. These justifications require further investigation in future research.

The MANOVA findings contributes to theory by demonstrating the significant differences between subgroups. These differences suggest that demographic and occupational factors play an important role in shaping employees' perceptions and intentions regarding blockchain adoption. By identifying these subgroup variations, the study contributes to a deeper understanding of how different groups within HEIs may engage with blockchain in distinct ways.

Practically, this result suggests that HEIs in KSA should tailor their strategies for blockchain adoption according to the specific needs and characteristics of different subgroups. Customising the adoption process to address the unique concerns or priorities of each subgroup will likely improve the overall success of blockchain integration across the institution. The following MGA methods specify the significant differences between groups and determine what factors decisionmakers should focus on to foster the acceptance of blockchain among subgroups.

5.3.2 Permutation Test

This study applies the permutation test to test the differences among categories' (e.g., gender) subgroups (e.g., female and male). The primary purpose of conducting this test is to answer RQ2 regarding the significant differences in path coefficients among various characteristics of employees based on the permutation approach. This permutation test was implemented after computing the MICOM procedure (see Section 4.5.3.2).

Regarding gender, the permutation test highlighted a significant difference of the impact of security on BI to use blockchain technology. The path coefficient for female employees is significantly higher than males (see Table 36).

In addition, the permutation test revealed significant differences among younger and older employees in HEIs. This study discovered significant differences between the two subsamples in the correlation between security and trust. Indeed, the older staff perceives security to affect their trust in blockchain significantly higher than younger employees (see Table 37.0).

Moreover, based on the permutation test, this study discovered that PE on BI and EX on BI significantly differ between academic and administrative staff. The other relationships have no significant differences in relation to the path coefficient (see Table 38.0).

Finally, the permutation test was applied to different levels of experience. Staff who have been working in the HEIs for less than ten years were compared to other workers with more than ten years of experience. The findings unveiled that the two subsamples significantly differ in the relationship between EX and BI along with FC and BI.

These findings contribute to the theory by revealing significant differences between subgroups based on the permutation test. These findings provide valuable insight into how demographic and experiential factors shape employees' perceptions and intentions regarding blockchain adoption. Future research should consider the differences between these groups.

In practice, these results suggest that decision-makers should consider demographic factors, such as gender, age, job type, and experience, when developing strategies for blockchain adoption. For instance, tailored strategies that address the various perceptions of security, trust, and other variables between genders or age groups can enhance the relevance and effectiveness of blockchain implementation. Similarly, the distinct needs of academic and administrative staff, along with employees at varying stages of their careers, should be considered to ensure that training and adoption strategies resonate with all subgroups. By recognising these differences, HEIs can foster their staff and improve the likelihood of successful blockchain adoption within the institution.

5.3.3 Discussion of Bootstrapping-based MGA

The present research employs bootstrapping-based PLS-SEM approach to compare every subsample (e.g., female) to the complete results (e.g., female and male). The main purpose of this test is to figure out what are the significant and insignificant relationships in relation to this study's framework per subgroup in comparison to the complete results. Finding out the a significant result for a subgroup that was not significant in the complete dataset means that decision-makers are required to deal with this group differently in relation to the found significant relationship. For instance, the EX is insignificant only among administrative and staff and employees with more than 10 years of experience. Such results should be considered among decision-makers when implementing blockchain. The other purpose of implementing bootstrapping-MGA test is to provide evidence regarding the obtained insignificant results in the developed framework. The results may confirm the above-mentioned justifications regarding the significant and insignificant outcomes in Section 5.2. This test does not compare the categories' subgroups to avoid contradiction with the permutation results.

5.3.3.1 Bootstrapping-MGA Test for Gender

Beginning with the female staff, direct and moderating results were computed. Two significant differences have been detected between the female and complete findings (see Table 40.0). Interestingly, the female participants find trust to be a significant hinder of BI to use blockchain, because the path coefficient is negative. In terms of the indirect and moderating results for gender, the comparison between the female and complete outcomes yields one difference. The female respondents find security to affect behavioural intention through trust (see Table 41.0).

Moreover, the bootstrapping-based MGA approach revealed the significant and insignificant path coefficients for the male subgroup. The results of this test were compared to the complete dataset, where gender was not divided. The male employees' findings revealed an insignificant effect of SEC on BI. Similarly, the male employees' results detected that awareness does not moderate the direct relationship between FC and BI. In addition, the indirect relationship revealed a single difference, where Sec did not significantly affect BI through PE among male participants.

Therefore, it is evident that male employees reduced the insignificant effect of trust on BI. Moreover, they weakened the effects of the indirect relationship between Sec on BI through PE. Similarly, they decreased the direct impact of SEC on BI and the moderating effect of AW between FC and BI in the total dataset.

5.3.3.2 Bootstrapping-MGA Test for Age

The bootstrapping approach tests the significant results with the age subsamples. The age subgroups contain the older and younger staff who work for HEIs in KSA. The outcomes of these subgroups are compared to the complete groups of the indirect, direct and moderating results. Regarding the direct impact, the older employees perceive an insignificant impact of Sec on BI. Concerning the moderating role of AW, two distinguished results were related to the older employees. First, there is an insignificant moderating effect of AW of FC on BI. Second, AW has a significant moderating effect on the direct relationship between SI and BI. In the indirect relationships represented in Table 45.0, older staff's findings differ from the complete results in the relationship of Sec on behavioural intention through PE.

In addition, younger employees' dataset was separated from the complete dataset (all employees) and compared to it. The comparison results revealed that the younger employees have identical results in comparison to the total dataset. In other words, no differences in significance results were derived from the confidence intervals and p-value results between the younger and complete data concerning the direct, moderating and indirect relationships (See Appendix I).

Therefore, it could be argued that the older employees perceived the Sec effect on BI to be insignificant. This insignificance is obtained even when PE mediates the relationship between Sec and BI. That implies that the older employees weaken the effect of Sec on BI in the total dataset.

5.3.3.3 Bootstrapping-MGA Test for Types of Staff

This study employed the bootstrapping method to analyse the data for the academic group after being separated from the total obtained dataset. Subsequently, a comparison was conducted. The comparison results yielded differences in the significant impacts between the complete and the administrative workers' results. The contrast procedure revealed that the academic subgroup has identical results to the complete dataset of this study in relation to the direct, indirect and moderating effects.

While academics' findings had identical results to the complete outcomes, administrative employees' findings differed from the complete results. This type of workers perceives EX to significantly affect BI. Nonetheless, they perceive Sec to have an insignificant direct impact on BI. Concerning the moderating impact, the increase of awareness has no effect on the relationship between FC and BI among office staff. Regarding the indirect impact, administrative staff perceive Sec to indirectly affect BI through EX. Moreover, trust indirectly influenced their BI through EX. As a sequential effect, the path Sec->Trust ->EX->BI was found to be significant among administrative employees. Similarly, EX was found to mediate the effect of trust on BI. These two mediating paths were found insignificant in the complete dataset. The other relationships are the same as the complete results.

Therefore, EX is a significant predictor of BI to use blockchain among administrative staff. Similarly, the paths Sec->Trust->EX->BI and Trust->EX->BI are significant among administrative employees. On the other hand, Sec direct influence on BI and AW moderating effect between FC and BI are insignificant among administrative employees. Thus, the administrative employees, as a subgroup, weaken the significant results effects of these correlations.

5.3.3.4 Bootstrapping-MGA Test for Levels of Experience

Similar to the other subsamples, the bootstrapping was performed to compare the less and more experienced staff with the complete results. The comparison was conducted with the direct, moderating and indirect relationships proposed in this study's framework.

Regarding employees with less than ten years of experience, the less-experienced staff differ in one direct relationship and one moderating effect. In comparison to the total findings, the Sec's direct influence on BI is insignificant among these employees. Moreover, the moderating influence of AW between SI and BI is significant. On the other hand, all indirect correlations are similar to the complete dataset.

On the other hand, the bootstrapping test revealed differences between more experienced staff and the total result concerning the proposed direct, moderating and indirect effects of this study. Interestingly, the impact of EX on BI was found to be significant among more experienced staff. This relationship was only significant among two subgroups (see Appendix I). Moreover, the highly experienced staff are the only group that had insignificant results between FC and BI. Moreover, there is an insignificant influence between the Sec and BI among more experienced staff. Concerning the moderating effect, AW significantly moderates the relationship between SI and BI. However, it does not influence the FC effect on BI. All these effects vary from the complete dataset. Regarding the path Sec->Trust->EX->BI, it was insignificant with the complete set. However, this path significantly affected BI to use blockchain among more experienced workers. Similarly, the mediating effect of EX between trust and BI was significant among these employees.

Therefore, the EX direct influence on BI was significant among by more experienced staff. The FC effect on BI was insignificant by the more experienced subsample. The moderating effect of AW between FC and BI was decreased by the more experienced staff.

5.3.3.5 Theoretical and Practical Implications of the Bootstrapping-MGA Test

The bootstrapping-MGA findings contribute to theory by highlighting the influence of exogenous variables on endogenous variables, as determined by the bootstrapping tool. The results reveal significant differences in the factors that influence BI across different groups. For example, the factors affecting BI for female employees differ from those affecting BI for male employees. These results suggest that future studies should consider the heterogeneity when considering technology adoption by investigating in detail what factors influence every subgroup of the employees in order to increase their intention to adopt the specified technology.

For decisionmakers, these results suggest that HEIs should adopt a more detailed approach when developing blockchain adoption strategies. By recognising that the factors influencing BI vary between different groups, tailored strategies can be implemented for each group. For instance, if trust and perceived benefits play a more significant role for one gender, strategies should be adjusted accordingly to cater to those perceptions. This approach will ensure that adoption strategies connect more effectively with different employee groups, leading to a more successful and inclusive blockchain implementation process across the HEI.

5.4 The Most Significant Variables

Considering the combined results of employees, the strongest effects of this study are PE on BI (f^2=.156), AW on BI (f^2=.062) and FC on BI (f^2=.043). These findings highlight the most influential factors shaping employees' behavioural intentions towards the acceptance of blockchain within HEIs. PE is the most influential factor of BI. These results suggest that the perception that blockchain benefits the employees' job performance is the most significant predictor of their intention to use it. PE also is a significant mediator of other variables, i.e., security, trust and effort expectancy. AW is the second most influential factor of BI to use blockchain within HEIs. Employees who are more aware of blockchain's potential are more inclined to develop an intention to use it, implying that increasing awareness through training, information campaigns, or exposure can reinforce PE and further drive BI. FC is the third most influential predictor of BI. This result indicates that employees' intentions are influenced by the availability of necessary resources, support and infrastructure. While FC is important, it is less significant than PE and AW. These factors are the most significant factors for the complete results.

Considering heterogeneity, the most influential factors affecting female employees' intention to use blockchain are FC, PE, and SEC, respectively. For male staff, the strongest the three strongest predictors of BI are PE, AW, and trust through PE. Among older employees, the most significant factors influencing BI are PE, AW, and FC, respectively. In contrast, younger employees perceive PE, FC and AW as the most critical predictors of BI, respectively. Similarly, academics believe that the PE, FC and AW are the dominant factors of BI, respectively. In comparison, the administrative staff perceive PE, EX and FC to be the most significant factors of BI. Regarding experience levels, less-experienced employees perceive PE, FC, and AW as the most influential factors in BI, respectively. In comparison, more experienced staff identify PE, AW, and trust via PE as the strongest predictors of BI, respectively.

In addition, as noted in Appendix I, some variables are significant among all the subgroups. Other factors are significant among the majority of the groups. For instance, the effect of PE on BI is perceived among all the subgroups. Similarly, the influence of awareness on BI is presented to be significant among all the subgroups. Also, the paths of EX->PE->BI, Sec->Trust->EX->PE->BI, Sec->EX->PE->BI, Trust->PE->BI and Trust->EX->PE->BI are significant among all these groups. All these relationships should not be neglected by research and practitioners. For theory, future studies should implement these paths when discussing other technologies' adoption in different fields. Taking these factors into focused considerations assists in implementing tailored strategies regarding the factors that affect

different subgroups. Therefore, Considering the overall results and heterogeneity, PE is the most dominant factors for employees to accept blockchain. It is not only the strongest predictor of BI in the overall results and for almost all groups (except female), but it also serves as a crucial mediator. It links EX, trust and SEC to BI. AW follows as the most influential factor of BI, and should not be neglected by scholars and practicians. Finally, FC is the third strongest predictor of BI. FC plays a critical role in predictions administrative and academic employees' willingness to use blockchain.

For future research, the aforementioned factors and relationships should not be overlooked when examining the adoption of other emerging technologies across different industries. Understanding the variations in how different subgroups interact with blockchain adoption factors allows for more tailored and effective implementation strategies. For practice, HEIs should adopt targeted approaches that address the unique concerns of different employee groups. Decision-makers should implement tailored strategies that are inclusive, well-supported and aligned with the specific needs of various staff categories (e.g., female).

5.5 Conclusion

This chapter discussed the obtained findings, which answer the RQ1 and RQ2. The RQ1 was addressed by discussing the attained direct, indirect and moderating effects among latent variables. The RQ2 was met by conducting MANOVA, permutation and bootstrapping-based MGA approaches. RQ3 was addressed by determining the areas where blockchain is most needed.

The following chapter concludes the present study. It involves a summary of the essential findings, discussion of the theoretical contributions and practical implications, and ending with the study's limitations and recommendations for future investigations.

Chapter 6: Conclusion

6.1 Introduction

This chapter generally discusses the overall results. It starts with a summary of the research objectives, research questions, developed framework, and main findings. Following a summarised description of the findings, the contributions and theoretical implications are discussed. After that, the practical implications and recommendations for practitioners and decision-makers are presented. This chapter ends with stating the limitations and future study directions. The last section of this chapter concludes all the previous dialogues.

6.2 Research Overview

The aim of the present study is to examine factors that predict the employees' acceptance of implementing blockchain in HEIs in KSA. In order to accomplish this aim, sub-objectives were generated and accomplished. Each objective corresponds to one of this study's RQs. For instance, addressing the objective of identifying the potential existence of significant differences among various groups means that RQ2 is addressed. This example extends to the remaining research objectives and questions.

Coping with the majority of RQs and the objectives is achieved through the development of a novel theoretical framework based on UTAUT constructs and additional significant individual characteristics (see Section 2.6). The UTAUT constructs include PE, EX, SI FC and BI. The added individual characteristics involve Sec, trust and AW. These constructs were carefully built and justified, resulting in this study's hypotheses. The hypotheses were developed to propose rational relationships between the independent and dependent variables (see Section 2.6.4). The hypotheses framed this study's conceptual model (see Figure 7.0). The relationships between these latent variables yield in answering RQ1 and RQ2 of this study. RQ3 was addressed by a direct question regarding employees' perception about where blockchain is most needed within the HEI sector.

To empirically test the formulated hypotheses, an online survey was conducted, resulting in collecting from administrative and academic personnel across HEIs in Saudi Arabia. The data were analysed based on PLS-SEM and MGA methods to address the RQ1 and RQ2, and the proposed hypotheses accordingly. The first RQ was addressed by determining the factors that directly, indirectly and moderately affect blockchain acceptance. The following subsections provide deeper insights into these findings.

6.2.1 Direct Effects

In more detail, one of the dimensions in answering RQ1 is related to testing the direct relationships based on the PLS-SEM approach. The first step to address this RQ is concerned with determining the direct factors that drive or hinder HEIs' employees' acceptance or rejection of blockchain usage.

The direct findings demonstrated significant and insignificant results related to the proposed framework. The hypotheses testing through the PLS-SEM tool revealed interesting results regarding direct effects. Directly, 11 hypotheses out of 17 yielded significant effects among the proposed exogenous and endogenous variables. In their direct relationships, PE, FC, SEC and AW significantly affected the BI to use blockchain among administrative and

academic employees within HEIs in KSA. In addition, this study found direct effects of SEC on trust, PE, and EX. Moreover, it revealed a significant influence of EX on PE. Also, this study detected significant connections between trust in blockchain and PE, EX and BI. However, EX, SI, and trust demonstrated insignificant direct correlations with BI (see Table 29). These findings contribute to answering RQ1.

6.2.2 Moderating Effect

The moderating effect of AW between UTAUT constructs and BI were computed based on PLS-SEM to address another aspect of RQ1.

This study found a significant moderating impact of AW in the relationship between FC and BI. The awareness of blockchain significantly moderates the FC effect on BI. The other moderating effects of AW between PE, EX and SI on BI were found to be insignificant. This result addresses RQ1 (see Table 28.0).

6.2.3 Indirect Effects

The final aspect of RQ1 is the indirect paths of exogenous variables toward BI to use blockchain, which were investigated based on PLS-SEM. Seven out of eleven relationships through trust, PE and EX were found to be significantly related to blockchain acceptance (see Table 29.0).

In more detail, the EX was hypothesised to affect PE, whereby PE directly influences BI. As mentioned earlier, findings revealed that EX significantly affects PE. Also, the results demonstrated a significant impact of PE on BI. Therefore, EX indirectly affects BI through PE.

In addition, the present research hypothesised Sec to affect PE, EX and trust, which in turn, were hypothesised to affect BI. As mentioned above, the effects of Sec on PE, EX and trust are significant. While the PE showed significant direct impact on BI, the effects of EX and trust on BI were not significant. Therefore, all paths where PE directly influence BI are significant indirect relationships between Sec and BI. On the other hand, all paths where EX or trust were directly influencing BI reflect insignificant indirect relationships between SI and BI. These results involve the serial indirect relationships. For more details, see Table 29.0.

Similarly, this study proposed trust to influence PE and EX, which in turn, were hypothesised to influence BI. As mentioned above, the trust's direct impact on PE and EX was revealed to be significant. Also, the direct impact of PE on BI was reported as significant, whereas the direct impact of EX on BI is insignificant. Thus, paths where PE directly influences

BI are significant indirect paths between trust and BI. On the other hand, all the paths where EX directly influence BI are insignificant indirect paths between trust and BI. These paths include the serial mediating paths. Related statistics were reported in Table 29.0.

6.2.4 MGA Results

To address RQ2, the MGA test was conducted. This test was employed to determine the differences among the employees' groups and what factors affect each group to accept the use of blockchain. In more detail, MGA was computed using three different methods, i.e., MANOVA, permutation and bootstrapping-based. The MANOVA test was conducted to determine the mean of agreement related to the study's items related to the proposed dependent variables (BI, PE, EX and trust). For more detail about MANOVA, refer to Sections 3.5.2.1 and 4.5.3.1. The other type of research is permutation, aiming to determine the significant differences between subgroups (e.g., female and male). More details of permutation test are discussed in Sections 3.5.2.2 and 4.5.3.2. The third MGA-related test is the bootstrapping-based PLS-SEM. The purpose of this result is to 1) propose the significant and insignificant path coefficients among this study's proposed variables and 2) compare every subgroup's findings with the complete results. Further details are exhibited in Sections 3.5.2.2 and 4.5.3.3.

6.2.4.1 MANOVA Results

MANOVA revealed significant differences among various demographical groups. The first group is nationality, which contains non-Saudi and Saudi participants. In the non-Saudi subgroup, the highest agreed-upon dependent variable is trust. In comparison, the most agreed with outcome variable for the Saudis is BI. The highest mean of all the other subgroups is related to the BI, indicating the highest agree score.

Moreover, MANOVA revealed insignificant and significant differences between this study's defined subsamples in relation to the dependent variables (PE, EX, trust and BI). MANOVA demonstrated insignificant differences regarding dependent variables related to the nationality and age groups.

However, MANOVA identified significant differences among various groups in relation to this study's dependent variables. The first detected significant difference was related to EX, where the level of agreement of this variable was significantly different between females and males. The female had higher mean than male employees (see Table 32.0). Moreover, significant differences were determined between administrative and academic employees in

relation to all dependent variables of this study. The agreement level to the items was higher with administrative employees with all outcome variables. In addition, significant differences were related to the experience. The less experienced staff significantly agree more than the more experienced staff to this study's items in relation to PE and BI. Finally, the users and non-users of blockchain significantly differ in their agreement to trust blockchain and PE. The current users of blockchain agree more than the non-users with items regarding blockchain trust and its effect on their performance expectancy in the workplace.

6.2.4.2 Permutation Results

The permutation test was the second MGA result implemented in this study to answer RQ2. This test determined the significant differences in path coefficients (not the mean) among this study's subsamples. For instance, this study found a significant difference between females and males in the path coefficient regarding the direct impact between Sec and BI. The path coefficient for female employees was significantly higher than males (see Table 36.0). Similarly, the impact of Sec on trust was significantly different between younger and older staff. The older staff found Sec to be a more impactful driver of trust in blockchain (see Table 37.0). Moreover, administrative and academic staff significantly differ in their perceptions regarding the impact of PE on BI and EX on BI. While academics had a higher path coefficient in relation to the effect of PE on BI, the administrative employees had a stronger perception regarding the influence of EX on BI (see Table 38.0). Finally, the permutation test yielded significant differences between employees with more and less than ten years of experience regarding the effects of EX on BI and FC on BI. The more experienced staff perceive EX to be a more significant predictor of their BI to use blockchain. On the other hand, the less experienced staff believed more in the effect of FC on BI.

6.2.4.3 Bootstrapping-based MGA Results

The final dimension regarding the address of RQ2 is to test the direct, indirect and moderating effects of the proposed hypotheses on each subgroup. Also, this section compares every subsample (e.g., male) with the complete results (e.g., male and female).

Bootstrapping-based MGA revealed similar results between the female group and complete results regarding all the direct relationships. The results highlighted similar significant and insignificant results between female outcomes and the complete findings in all paths except one. Among female employees, trust significantly affects BI. In the indirect effect,

the path Sec->Trust->BI was found to be significant among the female group but not the complete set (see Appendix I).

Compared to the total findings, the male group found that most of the direct, moderating and indirect results were similar. However, the male group perceived Sec on BI and the AW moderating effect between FC and BI to be insignificant. Also, the Sec does not affect the BI through PE among male staff.

In addition, the bootstrapping revealed similarities between the older and complete obtained data from employees. Directly, older staff perceived the impact of Sec on BI as insignificant. Another difference compared to the full dataset is the significant moderating effect of AW between SI and BI. Indirectly, one difference was detected in the indirect effect (i.e., Sec->PE->BI), which was significant in pertinent to older staff.

Relatedly, the younger staff results were identical to the full attained results of this study. Similarly, the academics presented identical results regarding the direct, indirect and moderating effects.

However, the administrative staff demonstrated different results than the full results. Unlike the complete obtained data, the administrative staff group found the following paths significant: 1) Sec->EX->BI, 2) Sec->Trust->EX->BI, 3) Trust->EX->BI and 4) EX->BI. The findings showed that office workers were one of two subgroups that found EX to significantly influence BI. On the other hand, other results were found significant with the complete data but insignificant among the administrative staff. These insignificant results are the direct effect of Sec on BI and the moderating influence of AW between FC and BI.

Additionally, the staff with less than ten years of experience revealed differences in the significant results compared to the whole set of participants. Directly, the Sec on BI was insignificant among the less experienced group. In terms of moderation, AW significantly moderated the effect of SI and BI among less experienced staff. The indirect results were identical.

Finally, workers with over ten years of experience demonstrated specific relationships, both significant and insignificant, that varied from the overall results. Directly and indirectly, significant effects among more experienced staff were determined in these paths: 1) EX->BI, 2) Sec->Trust->EX->BI and 3) Trust->EX->BI. In the moderating effect, AW was detected to significantly influence the relationship between SI and BI. On the other hand, the effects of Sec on BI and FC on BI were found insignificant among more experienced staff. This subgroup is the sole subsample that perceives FC to be an insignificant predictor of BI.

6.2.5 Areas of Blockchain in HEIs

The fulfilment of RQ3 was addressed by directly asking participants about their perceptions regarding the areas where blockchain is most needed. The participants believed in the need for blockchain implementation in areas related to financial operations, certificate management and student assessment (see Section 4.4.1.7).

6.3 Contributions and Implications of the Research

The current research contributes theoretically to existing knowledge and provides decision-makers with recommendations regarding blockchain acceptance in HEIs.

6.3.1 Theoretical Contribution and Implications

The enhancement of UTAUT with blockchain-related characteristics is the primary theoretical contribution of the present research. The UTAUT constructs are PE, EX, SI and FC, while the additional factors concern Sec, trust and AW of blockchain.

This study enhances the UTAUT, yielding significant implications for future researchers. Future studies may take advantage of the proposed framework to investigate the adoption of blockchain technology in the HEIs industry in various contexts. Further, the developed framework may deliver results for other technologies with similar blockchain features. These features are security, privacy, trust and AW. The existence of these characteristics in other technologies may demonstrate similar results within the HEIs industry. Additionally, although the HEIs industry was investigated in the present study, the proposed framework is highly likely to be applicable to other industries. Hence, the proposed model could be used by future researchers to investigate other technologies and various disciplines.

In addition, this study contributes in confirming contradictory findings that were rarely investigated. In addition, it adds new knowledge by empirically establishing relations related to technology adoption (see Section 2.6.3).

This study has found that female significantly differ in the years of experience compared to male (see Section 4.4.1.5). Future studies should explore the factors behind these significant differences, particularly within the HEIs sector in KSA. Exploring the organisational or cultural factors may contribute to this gap in experience between the two genders. Future researchers also may consider the moderating role of gender-related experience difference in technology adoption models (e.g., UTAUT). For instance, they may investigate its moderating influence between PE, SEC, FC or trust and BI in relation to

emerging technologies. Understanding these aspects could help HEIs tailor more inclusive and effective adoption strategies related to female employees.

Methodologically, this study contributes to proving the value of MGA methods in relation to technology adoption research in HEIs. By implementing MANOVA, permutation and bootstrapping-based MGA, heterogeneity was found to be mandatory in related research. This is because this study found significant differences in the comparison between subsamples (e.g., females and males). Moreover, it found differences between every subgroup in comparison to the complete results.

Therefore, future researchers could use the proposed framework to empirically investigate a technology adoption in various industries (if applicable). Also, they might use the MGA followed approach to investigate the heterogeneity of participants.

6.3.2 Practical Implications and Recommendations

Following the theoretical implications, findings can bring practical implications that may benefit decision-makers in the HEIs industry, especially in KSA. Decision-makers within the HEIs industry may adopt blockchain for its various benefits. These benefits include improving the management of students' and employees' records, enhancing trust, more data control, transparency, cost reduction and higher security, among others (Alammary et al., 2019). Nevertheless, decision-makers should consider challenges that may hinder the blockchain acceptance.

Although the decision to adopt blockchain in Saudi HEIs is based on a top-down decision, it is necessary to consider employees' acceptance of blockchain (Pieters et al., 2022). Neglecting employees' acceptance may significantly threaten the successful application of blockchain technology in HEIs. To address this issue, this study assists decision-makers in determining the factors that influence the acceptance of blockchain in HEIs in Saudi Arabia among office staff and academicians.

So, this study mainly determines significant and insignificant factors that drive, hinder or have an insignificant impact on blockchain acceptance among HEIs' employees. In relevance, this study considers the heterogeneity of employees' subgroups providing the decision-makers with detailed considerations of the distinguished characteristics of their employees.

Based on this study's findings, decision-makers in HEIs are suggested to consider the following recommendations to avoid the resistance of blockchain among employees. Firstly, and in relation to PE, decision-makers are recommended to adopt blockchain-based

applications that enhance task efficiency and productivity for employees. Regarding the effect of EX on PE & BI, HEIs' practicians should provide easier-to-use applications to increase employees' job performance, which in turn, increases their BI to use blockchain. However, they should be cautious of the fact that the EX solely does not significantly affect BI, except among particular types of employees (see Appendix I).

Considering the insignificant connection between SI and BI, strategic leaders are encouraged to disregard the consideration of SI among employees. Moreover, the FC was a significant predictor of BI indicating the necessity to build infrastructure that supports blockchain adoption. Nonetheless, this action is not necessary among participants with more than ten years of experience because FC does not affect their BI to use blockchain. Regarding the trust factor, decision-makers must enhance trust in blockchain among employees, specifically female employees. Enhancing trust may occur by reducing risk perceptions of blockchain, which in turn, may increase their confidence in this technology. For instance, employees should be assured that blockchain applications are secure, user-friendly, and effective in supporting job performance improvements. In addition, the perceived security of blockchain must be considered concentrate on blockchain security and privacy by ensuring the safeguarding of employees' data. This concentration builds trust, increases the perception of blockchain ease, supports the perception of how blockchain enhances the employees' performance and ultimately fosters the acceptance of blockchain. Finally, decision-makers are recommended to enhance or establish the blockchain awareness among staff through different channels (e.g., training courses, emails, etc.).

Building on Section 5.4 concerning the most significant factors, beneficiaries in HEIs may prioritise some factors over the others to apply the model at the speed of need. Since PE is the most influential factor, practicians in HEIs should immediately prioritise initiatives that demonstrate blockchain's tangible benefits for job performance. This can be achieved through real-world case studies, hands-on workshops, and interactive demonstrations showcasing efficiency gains. As PE also acts as a mediator linking SEC, trust, and EX to BI, strengthening these areas will have a compounded effect on employees' willingness to adopt blockchain. Additionally, decision-makers should implement campaigns that increase the knowledge of blockchain. They may educate the academic and administrative employees on blockchain's benefits, capabilities, features and potential use. Informative webinars, training sessions and digital resources are examples of methods that can increase employees' knowledge of blockchain. The third priority in implementing blockchain is the FC. HEIs should employ strategies that support the adoption of blockchain. For instance, they should ensure that academic and administrative employees have seamless access to blockchain infrastructure, technical support, and related digital resources. This includes optimising user-friendly

interfaces, integrating blockchain into existing workflows, and providing immediate troubleshooting assistance. Therefore, as a speed of need, decision-makers should prioritise strategies related to PE, FC and AW, respectively, to avoid the failure of adopting blockchain.

Considerably, this study also suggests the areas where blockchain-based applications should be implemented, based on employees' perceptions. Blockchain is mostly needed to be implemented to enhance financial exchanges, certificate management and assessments of students. These areas should be prioritised be decision-makers when implementing blockchain.

6.4 Limitations and Future Studies

The present study developed a UTAUT-based framework with additional constructs based on blockchain-related characteristics. The purpose was to explain their direct, indirect and moderating effect on the BI to use blockchain among HEIs' employees in KSA. However, this study has limitations, similar to all the other studies, due to the inability to cover all the aspects of the research area. Therefore, this section discusses the limitations of this study. The limitations mainly regard context, constructs, participants and methodology. Based on these limitations, future directions for research are noted.

Context: The present study was implemented in Saudi Arabia. Applying the same factors in other contexts may yield different outcomes, specifically for UTAUT (Wang et al., 2022). For instance, Queiroz and Fosso Wamba (2019) found significant differences between the USA and India regarding some UTAUT latent variables related to blockchain technology. These findings imply that different countries may yield different findings. The present study was established only in the KSA. Hence, this study suggests testing the proposed model in other contexts of HEIs other than KSA.

Constructs: The present study examined UTAUT constructs and only three factors related to the blockchain technology. Future studies may expand the developed model by adding other attributes of blockchain, such as transparency and immutability. Additionally, this study focuses on the individual level. Extending the current model with organisational factors (e.g., TOE constructs) is suggested in upcoming dedications. Further, this study does not include the moderators proposed in UTAUT (i.e., gender, age and experience) (Venkatesh et al., 2003). Future studies should investigate the effect of these moderators. Finally, the actual usage construct was removed in this study. Upcoming investigations may return this construct.

Participants: This study faced challenges in reaching actual blockchain users, as only a few HEIs in Saudi Arabia have adopted blockchain applications. This challenge might have occurred due to the novelty of blockchain (Pieters et al., 2022). Thus, future researchers

should focus more on participants who have been exposed to blockchain. Finding such participants also should lead to the suggestion of reinstating the 'actual use' construct, which was removed in the present study due to the deficiency of a representative sample of users. In addition, this study only focuses on the administrative employees and academics in HEIs in KSA. Future studies are encouraged to investigate IT experts or top managers.

Industry: This study investigated the HEIs' industry. However, the proposed framework was not explicitly correlated to the HEIs industry. The connection was more to the blockchain's characteristics. Other industries that are currently or potentially implementing a blockchain-based application(s) might benefit from the presented framework. Therefore, future studies that investigate blockchain may implement the developed framework with other industries (e.g., banks).

Technology: The present study was conducted in relation to blockchain technology only and did not consider other technologies. Blockchain's characteristics were integrated with the UTAUT constructs to investigate the blockchain's intention to be used among HEIs' employees. The investigated characteristics are security, privacy, trust and AW. However, the perceptions of these characteristics may apply to other technologies (e.g., Artificial Intelligence). Therefore, future studies may investigate the proposed framework with other technologies with similar characteristics those mentioned above.

Methodology: This study was conducted using a structured approach, whereby data were collected through an online survey. Deeper insights from employees are suggested for future research. These insights may also be derived from potential users, actual users, IT experts or/managers. Conducting a different qualitative method, such as interviews, focus groups and others, could assist in obtaining a deeper understanding of blockchain adoption in the HEIs in Saudi Arabia. In addition, this study employs the cross-sectional approach due to time and collection methodology restrictions. Executing a longitudinal study or cross-country methods, for instance, to analyse the collected data could be another venue for investigation in future studies.

6.5 Conclusion

This chapter discussed the overall results, answering RQs. After reiterating the aim of the study, this chapter starts by connecting the previous chapters. Moreover, every RQ was linked to the suitable answer that has been attained in the present research. The discussion with the obtained answers starts with the complete dataset to address RQ1. This discussion entailed reporting the direct, moderating, and indirect effects. In addressing RQ2, the MGA results were discussed based on MANOVA, permutation and bootstrapping results. Finally,

RQ3 was answered by reporting the areas where blockchain technology is most needed. This section also incorporated the contributions, implications, and limitations of this study.

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Appendices

Appendix A: Applications of Blockchain

The following Table (A1) summarises the frameworks and applications that can solve issues in the educational institutions by providing some academic certificates-related features (e.g., issuing, verifying, viewing, validating the academic certificates) in addition to the blockchain main advantages mentioned earlier (see Section 2.3.3.1).

Table A1: The Blockchain-based Certificate Applications and Frameworks

Source(s)	Application's name	Type	Competitive advantages
Rustemi et al. (2024)	DIAR	Framework	Privacy, potential abuse, transparency, and the limited capacity to digitize numerous services
Alkhammash et al. (2022)	DASC	Framework	Enhancing privacy and security
Malsa et al. (2021)	CERTbchain	Framework	Enhancing security, transparency and providing immutability.
Rasool et al. (2020)	Docschain	Framework	Provide privacy
Nguyen et al. (2018)	CVSS	Framework	Provides privacy and transparency
Ranosys Technologies (2019)	OpenCerts	Platform	Increases security and reduces cost
Alnafrah and Mouselli (2021)	-	Framework	Enhances security, transparency and immutability
Alruwaili (2020)	E-learning chain (ELC)	Framework	Enhances security and transparency
Khandelwal et al. (2020)	-	Framework	-
Alshahrani et al. (2020)	-	Framework	Enhances trust, security, privacy, SI and efficiency

Ghaffar and Hussain (2019)	BCEAP	Framework	Immutable, easy to use and available for public.
Han et al. (2018)	-	Framework	Enhances security and reduces privacy concerns
Budhiraja and Rinkle Rani (2020)	TUDocChain	Framework	Evolves security
Srivastava et al. (2019)	-	Framework	Evolves security
Bahrami et al. (2020)	-	Framework	Provides transparency, cost-effective verification system and increases security and privacy. Plus, it provides accessibility, availability and consistency
Gayathiri et al. (2020)	-	Framework	Security and accuracy
Rooksby Dimitrov (2017)	-	System	-
An and Chen (2021)	ElearnChain	Application	Focuses on increasing privacy. Enhances security. Provides immutability and auditability
Lab (2016); Agustin et al. (2020); Oyelere et al. (2020)	Blockcerts	Application	Provides privacy and integrated with Learning machine.
Kolvenbach et al (2018)	-	Application	Enhances Security
Chen et al. (2018).	Certchain	Application	Focuses on enhancing security. Provides auditability.
Huynh et al. (2018)	Unicert	Application	Provides Anti-counterfeiting system. Increases privacy.
Liu et al. (2021)	Educhain	Application	Provides error traceback and improves security.
RecordsKeeper (2018)	RecordSkeepers	Application	Provides transparency, immutability,

			disintermediation and collaboration
Turkanović et al. (2018)	EduCTX	Application	Enhances security and provides auditability.
Xu et al. (2017)	Educational Certificate Blockchain (ECBC)	Application	Enhances security, trust and privacy. Provide a lower latency.
Tariq et al. (2019)	Cerberus	Application	Keeps data privacy, integrity and revocation. Easy to use
Arenas and Fernandez (2018)	CredenceLedger	Application	Security and transparency
Colle et al. (2018); Gradba (2016)	gradbase	Application	Enhances privacy, links to social media (e.g., Linkedin) and provides free verification for educational institutions.
Zebi (2019)	ZebiEdu	Application	Increases trust, students' control of their data and re-time response for verification requests from students and HEIs.
BCDiploma (2018)	BCdiploma	Application	Increasing security, reliability and latency

This following Table concerns applications that summarises the current blockchain-based applications in HEIs that are relevant to credential authentication, financial exchanges, storing and sharing data, recruiting, copyright, assessment and multipurpose case uses.

Table A2: Blockchain Applications and Frameworks in the Education Discipline

Theme	Source(s)	Description
Certificate management-frameworks	Alnafrah and Mouselli (2021); Alruwaili, (2020); Khandelwal et al. (2020); Alshahrani et al. (2020); Ghaffar and Hussain (2019); Han et al. (2018); Budhiraja and Rinkle Rani (2020);	To issue, validate, store, monitor and share digital certificates.

	Srivastava et al. (2019); Bahrami et al. (2020); Gayathiri et al. (2020); Rustemi et al. (2024); Malsa et al. (2021); Rasool et al. (2020); Nguyen et al. (2018); Ranosys Technologies (2019)	
Certificate management-platforms	An and Chen (2021); Lab, (2016); Kolvenbach et al. (2018); J. Chen et al. (2018); Huynh et al. (2018); Liu et al. (2021); RecordsKeeper (2018); Turkanović et al. (2018); Xu et al. (2017); Tariq et al. (2019); Arenas and Fernandez (2018); Rooksby and Dimitrov (2017); Zebi (2019); Bcdiploma (2021); Colle et al. (2018); Alkhammash et al. (2022)	To issue, validate, store, monitor and share digital certificates.
Financial exchanges	Nakamoto (2008)	To accept tuition fees by a cryptocurrency.
Storing and sharing data	Sharples and Domingue (2016); Curmi and Inguanez (2019); Guustaaf et al. (2021); Kumaresh (2020); Nair et al. (2019)	To store and share data that belong to HEIs and/or students.
Recruiting	Kuvshinov et al. (2018); Chen (2018); The Chronobank Team (2016); APII (2016)	To strengthen and ease the communication between students and potential employers. Moreover, it assists human-resources departments in HEIs to verify the profiles of applicants who have profiles in a blockchain platform.
Copyright	Binded (2017); Bernstein (2021); Inayatulloh et al. (2023); Gipp et al. (2017); Pozi et al. (2018); Andi et al. (2019)	To provide authors with a secured vault to save their work without the concern of having their outcomes stolen.
Assessments	Shen and Xiao (2018); Sahonero-Alvarez (2019); Tentea and Ionescu (2019); Jain et al. (2021); Mitchell et al. (2019); Luo et al. (2024); Zheng (2021)	To increase transparency in distance learning. For instance, Sahonero-Alvarez proposed a framework for

		automatic marketing and awarding students with digital badges based on smart contracts.
Multi-purposing projects	Sony Global Education (2017); Arndt (2019); Saleh et al. (2020); Jirgensons and Kapenieks (2018); Ocheja et al. (2018); Kanan et al. (2019); Xu (2024); Badlani et al. (2022); Lizcano et al. (2020)	To provide multiple or additional features for HEIs. For example, SGE is a system that facilitates record management for educational institutions and analyses these records by utilising AI.

Appendix B: Summary of Extant Studies' Review

Table B1: Results of Hypothesis Testing of UTAUT Related to Blockchain

Industry	Author(s)	PE->BI	EX->PE	EX->BI	SI->BI	FC->BI	Trust->BI	Trust->PE	Trust->EX	Sec->BI	Sec->PE	Sec->Trust	Sec->EX	AW->BI	AW x PE->BI	AW x EX->BI	AW x SI->BI	AW x FC->BI
Supply chain	Kabir et al. (2021)	Y		Y	N	Y	Y											
Supply chain	Pieters et al. (2022)	Y		N	Y	Y												
HEIs-Academics	Al-Riyami et al. (2023)	Y		Y	Y	Y												
Gamification	Vorobeva et al. (2023)	N		Y	Y	N	Y											

Waqf Blockchain	Mokthar and Sapuan (2023)	Y	N	Y	Y	
Computational advertising	Wang et al. (2023)	Y	Y	Y		
Supply chain	Figueiredo et al. (2023)	N	N	N	N	
Operation and SC management	Q. Zhang et al. (2023)	N	Y	Y	Y	N
Banking setting	Mansoor et al. (2023)	Y	y	N	y	Y
Logistics	Nguyen et al. (2023)	Y	N	N	Y	

Supply chain	Sharma et al. (2023)	Y		Y	Y	Y					
Human resource management	Vijh et al. (2023)	N		Y	Y	Y					
press industry	Pham and Thi Nguyet (2023)	N		Y		Y	N				
Finance	Kumari et al. (2023)	Y	Y	N	Y	N	Y				Y
Crypto among Malaysian	Sham et al. (2023)	Y		Y	Y	N					
Accounting (professionals)	Jena (2024)	Y				Y	Y				

Tourism	Sarnacchiaro et al. (2024)	Y		Y	Y	Y	Y	Y		Y	Y	Y
Supply chain (total effect)	Lavaei Adaryani et al. (2024)	Y		Y	Y	N						
Accounting	Abu Afifa et al. (2023)	Y	Y	Y	Y		Y	Y	Y			
Supply chain	Queiroz et al. (2021)	N		Y	Y	Y	Y					
Italian Firms	Caldarelli et al. (2020)	Y		Y	Y	y						
E-commerce Platforms	Jain et al. (2022)	Y		N	N	Y						

Logistics	Nguyen et al. (2023)	Y		Y	Y	Y						
Banking	Jena (2022)	Y			Y	Y						
Supply Chain	Queiroz and Fosso Wamba (2019)											
	India	Y		Y	N							
	USA	Y		N	Y							
SMEs	Khazaei (2020)	Y	N	Y		Y			Y			N
Tourism	Chang et al. (2022)	Y	Y	N	Y		Y	Y		Y	Y	

Finance	Bakri et al. (2023)	N	Y	N	N	Y
Finance	NAZIM et al. (2021)	N	Y	Y	Y	
Supply chain	Wong et al. (2020)	N	N			N
Supply Chain	Alazab et al. (2021)	Y	Y	Y	Y	
Different Industries	Lee (2023)	Y	Y(Indirectly)	Y(Indirectly)	Y(Indirectly)	
Accounting	Ferri et al. (2020)	Y	Y	Y		
Public Sector	Latif and Zakaria (2020)	Y	N	Y	N	Y

HEIs (students, academics) and other industries (IT professional).	Lee et al. (2019)		N			N					Y							
Big-data	Abdullah Sani et al. (2021)	Y				N												
Healthcare	Mousa Altamimi et al. (2024)		N	Y	Y													

Table B2: Results of Hypothesis Testing of UTAUT Related to HEIs Industry

Tech.-Participants	Author(s)	PE->BI	EX->PE	EX->BI	SI->BI	FC->BI	Trust->BI	Trust->PE	Trust->EX	Sec->BI	Sec->PE	Sec->Trust	Sec->EX	AW->BI	AW x PE->BI	AW x EX->BI	AW x SI->BI	AW FC->BI	x

Virtual Learning-Students	Zhou et al. (2022)	Y	Y	Y	N	
Social Media Use- Students	Al-Rahmi et al. (2022)	Y	Y	Y		
Big-data in Libraries-Administrative Employees	Azam and Ahmad (2023)	Y	Y	Y	Y	
Mobile acceptance in Libraries-students	Parhamnia (2022)	Y	Y	Y	Y	Y
Use of M-learning-nursing students	Chao and Chen (2023)	Y	Y	Y	Y	
Online Courses-academics	Rotar (2023)	Y	N		N	
Learning management	García-Murillo et al. (2023)	Y	Y	N	Y	

systems (LMS) - academics							
Enterprise social network - academics	Kazemian and Grant (2023)						
	Consumptive use	Y	N	N	N		
	Contributive use		Y	Y	N		
Blended Learning-Academics	Anthony et al. (2023)	Y	Y	Y	Y		Y
Information and community technology-academics	Mbazu et al. (2023)		Y	Y	Y		
Learning Management Systems-Administrative staff	Bayaga and du Plessis (2023)	Y	N	Y	Y		
E-learning-Students	Shah et al. (2024)	Y	Y	Y			

Artificial Intelligence-Students	Bouteraa et al. (2024)	Y	N	Y			
Paperless Technologies-Academics and Administrative Staff	Tatlı et al. (2024)	Y	Y	Y			
E-learning-academics	Alammary et al. (2022)		N		N		N
Learning technologies during COVID-19 and beyond-Academics and Students	Vasuthevan et al. (2024)	Y	N		N		
Usage of Moodle, an e-learning system-Students	Abbad (2021)	Y	Y	N			

E-learning - Academics	Abdekhoda et al. (2022)	Y	Y	Y	Y	
M-learning-students	Abu-Al-Aish and Love (2013)	Y	Y			
E-learning management system - Students and others	Ahmed et al. (2021)	Y	Y	Y	Y	
Learning management system-students	Ain et al. (2016)	Y	N	Y	N	
Mobile learning technology-students	Alasmari and Zhang (2019)		Y	Y	Y	
Mobile learning acceptance-students	Al-Azawei and Alowayr (2020)					
	(1) Iraq	Y	N	N		Y
	(2) Saudi Arabia	Y	N	Y		Y

Mobile learning-Students	Alowayr and Al-Azawei (2021)	Y	Y	N	Y
E-training courses-students	Alghamdi et al. (2022)	Y	Y	Y	Y
Mobile Learning-students	Alghazi et al. (2021)	Y	Y	N	
collaborative classroom-Students	Ali et al. (2016)	Y	Y	Y	Y
Learning management systems-students and faculty	AL-Nuaimi et al. (2022)				
	Students	Y	Y	Y	N
	Academic	Y	Y	N	N
MOOC-students	Altalhi (2021)	N	N	N	N
Google Classroom-students	Alotumi (2022)	N	N	N	N

E-learning-Students	Almaiah and Alyoussef (2019)	Y	Y	N	Y		
Mobile Learning-students	Almaiah et al. (2019)	Y	Y	N	Y		Y
Mobile-based educational application (LabSafety)-students	Ameri et al. (2020)	Y	N	Y	N		
Mobile-learning-students	Arain et al. (2019)	Y	N	N	N		
Web-based services-students	Arif et al. (2018)	Y	Y	Y			
Blended learning in medical education-students	Azizi et al. (2020)	Y	Y	Y			

LMS - academics	Bervell and Umar (2017)	N	Y	N	Y
Google Classroom acceptance-students	Bervell et al. (2022)	N	N	N	
LMS - academics	Bervell and Arkorful (2020)				Y
Mobile Assisted Language Learning-Students	García Botero et al. (2018)	N	N	N	Y
Psychometric quality of an instrument-students	González Bravo et al. (2020)	Y	N	N	
Mobile technologies-students	Briz-Ponce et al. (2017)			Y	
Online education-students	Cao et al. (2021)	Y	Y		N

Using geospatial technologies-faculty for teaching geography	Cascante-Campos (2023)					
	Desk GIS	Y	Y	N		
	Digital Globes	Y	Y	Y		
	GPS	Y	Y	Y		
	Remote Sensing	Y	Y	Y		
	Web-based GIS	Y	Y	Y		
M-learning-Students	Chao (2019)					
	Including moderator main effect	Y	N		Y	
	Including interaction effect	Y	Y		Y	
Artificial Intelligence - students, academics and administrative staff	Chatterjee and Bhattacharjee (2020)			Y		

online learning- students	Chen and Hwang (2019)	Y	Y	N	
E-learning- students	Dečman (2015)	Y	N	Y	
Social network sites- Students and perspective teachers	Durak (2019)	Y	Y	Y	
Video conferencing tools- students	Edumadze et al. (2023)	Y	Y	Y	Y
E-learning- students	El-Masri and Tarhini (2017)				
	Qatar	Y	Y	Y	N
	USA	Y	N	N	Y
Augmented reality technology- students	Faqih and Jaradat (2021)	Y	Y	Y	Y
MOOCs- students	Fianu et al. (2020)	Y	N	N	

Educational webcasts-students	Giannakos and Vlamos (2013)	Y	Y		
PowerPoint-academics	Chávez Herting et al. (2023)	N	N	N	Y
mobile devices for language learning-students	Hoi (2020)	Y	N	Y	Y
LMOOCs-students	Hsu (2023)				
	Without moderating effect	N	Y	Y	
	With moderating effect	Y	Y	Y	
Mobile technologies-academics	Hu et al. (2020)				
	Without moderating effect	Y	N	N	N

	With moderating effect	Y	N	N	Y
Mobile learning-students	Huan et al. (2015)	Y	N	N	N
E-learning-students	Humida et al. (2022)				Y
E-Textbooks-students	Hung et al. (2018)				
	Experienced students	Y	N	N	Y
	Inexperienced students	Y	N	Y	
Mobile Learning-students	Kaisara et al. (2022)	Y	Y	Y	N
social learning system-students	Khechine et al. (2020)	N	N	N	Y
LMS- students	Khechine et al. (2023)	Y	N	Y	Y
LMS- students	Khechine et al. (2023)				
	Y	N	N	Y	

	N	N	N	Y	
Mobile virtual labs-academics and teachers	Kolil and Achuthan (2023)				
	Group 1	Y	N	Y	N
	Group 2	Y	N	Y	Y
Google Classroom-students	Kumar and Bervell (2019)	Y	N	N	N
Desktop video conferencing-students	Lakhal et al. (2013)	Y	N		Y
Jazzquiz interactive -students	N. Li et al. (2022)	N	Y	N	
mobile learning (2023-students	Z. Li et al. (2023)	Y	N	Y	Y
Computer-based assessment-students	J. W. Lin and Lai (2019)	Y	N	Y	
Computer-supported	J. W. Lin and Lin (2019)	N	N	Y	

collaborative learning CSCL)-students					
Mobile Learning Technologies-students-Saudi Arabia	Lutfi et al. (2022)	Y	Y	N	Y
ICT resources-teachers	Ma et al. (2022)			Y	
E-learning -students	Malanga et al. (2022)	Y	N		Y
Xrm- students	Maleševic et al. (2021)	N	Y	N	N
Elearning-students	Yunus et al. (2021)	Y	Y	Y	Y
MOOC-students	Meet et al. (2022)	Y	Y	N	Y
	Moghavvemi et al. (2017)				

E-learning-students	Beginning of the semester	Y	N	Y	
	End of the semester	Y	N	Y	
MOOC (2020-students	Mohan et al. (2020)	Y	N	N	N
Mobile learning behaviours among-students	Moorthy et al. (2019)	N	N	Y	N
Use Open Educational Resources-academics	Mtebe and Raisamo (2014)	N	Y	N	N
Blackboard Platform - students and academics-Saudi Arabia	Mujalli et al. (2022)	Y	Y	Y	N
Mobile phone by university students	Nikolopoulou et al. (2020)	Y	N	Y	N

literacy and digital Technology- students, academics and administrative staff.	Nikou and Aavakare (2021)	Y	Y			
VR- students	Noble et al. (2022)	Y	Y	Y		
Recycling attitudes and behaviour- students academics	Wan et al. (2012)			Y		Y
Learning innovation- students and academics	Obienu and Amadin (2021)			Y		
E-learning- students	Ogemdi Uchenna and Uzoma	Y	Y	Y		

	Oluchukwu (2022)				
Collaborative computer-based learning- students	Oluwajana and Adeshola (2021)	Y	Y	N	Y
Blended learning- students	Prasad et al. (2018)	Y	Y	N	
Medical Education eLearning Platforms- students	Prasetyo et al. (2021)				
	Initial Model	Y	N	N	N
	Final Model	Y			
LMS- students	Qendraj et al. (2022)	Y	Y	Y	
Social media-based learning- students and academics	Rahman et al. (2021)	Y	Y	Y	Y

LMS- students	Raza et al. (2021)	Y	Y	Y	N		
Podcast aggregator in Accounting Education- students	Martins et al. (2020)						
	Group 1	N	N	Y			
	Group 2	Y	N	Y			
M-learning adoption- students	Sabah (2016)			Y			Y named M-learning services)
Mobile learning- students	Sabri et al. (2022)	Y	Y	Y	Y		
Mobile Learning -	Salem and Elshaer (2023)	Y	Y	Y	Y		Y

academics-Saudi Arabia					
M-learning-students	Shukla (2021)	Y	Y	Y	Y
M-learning-students	Sidik and Syafar (2020)	Y	Y		
Mobile Learning-students	Sitar-Taut and Mican (2021)	Y			Y
Animation and storytelling applying-students	Suki and Suki (2017)	Y	Y	N	Y
Mobile Cloud Learning-Students, academics and administrative workers	Sultana (2020)	Y	Y	N	N
E-learning-students	Tandon et al. (2022)	Y	Y	N	Y

Accentuating technology-academics	Toh et al. (2023)	N		N	N	N
MOOC-academics	Tseng et al. (2022)	Y		N	Y	Y
Digital games-Students	Udeozor et al. (2023)	N		N	N	N
ClassStart-Students	Thongsri et al. (2019)	Y		N	Y	
Business simulation games-Students	Wang et al. (2020)	N		N	N	Y
E-learning-Students	Xu et al. (2022)	N		Y	Y	N
Cloud-based technology-Students	Yadegaridehkordi et al. (2018)	Y	Y	Y	Y	N
E-learning-Students	Yakubu and Dasuki (2019)	Y		Y	N	Y
CourseWiki system-students	Yueh et al. (2015)	N		N	Y	N

E-learning-students	Zacharis and Nikolopoulou (2022)	Y		N	Y	N					
E-learning-students	K. Zhang and Yu (2022)	Y		Y	Y	Y					
E-learning-students	Z. Zhang et al. (2022)				Y	Y					
E-learning-Academics	Aziz et al. (2022)	Y		Y	Y	Y					
Cryptocurrency- Students-Saudi Arabia	Alomari and Abdullah (2023)	Y		Y	Y	N			Y		Y
LMS- Pre-service teachers (students)	Buabeng-Andoh and Baah (2020)		Y			N					
M-learning-Students	Al-Adwan et al. (2018)				Y	Y					
Mobile Learning-Students	Sung et al. (2015)	Y	Y	Y							

Mobile 4.5G Service-Students	Daniali et al. (2022)	Y	Y	Y	
AI (ChatGPT)-Students-Saudi Arabia.	Sobaih et al. (2024)	Y	Y	Y	N
M-learning-Students	Almulla (2024)			Y	
M-learning Students in KSA	Nassuora (2013)	Y	Y	N	N
M-learning among students in KSA	Al-Hujran et al. (2014)	Y	Y	Y	N
M-learning among students	Lawrence (2016)	Y	Y	N	Y

PE= Performance Expectancy, EX= Effort Expectancy, SI=Social Influence, FC=Facilitating Conditions, Sec=Security, and AW=Awareness

Table B3: Significance Statistics of UTAUT-based Studies Regarding Blockchain Adoption in Various Industries

Category	PE->BI	EX->PE	EX->BI	SI->BI	FC->BI	Trust->BI	Trust->PE	Trust->EX	Sec->BI	Sec->PE	Sec->Trust	Sec->EX	AW->BI	AW x PE->BI	AW x EX->BI	AW x SI->BI	AW x FC->BI
Significant effect	26	2	23	25	24	12	3	2	2	2	2	1	0	1	0	0	0
Insignificant effect	9	0	12	9	9	5	0	0	0	0	0	0	1	0	0	0	0
Not tested	2	35	2	3	4	20	34	35	35	35	35	36	36	36	37	37	37
otal	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37
Total Hypotheses	35	2	35	34	33	17	3	2	2	2	2	1	1	1	0	0	0
Significance Rate (%)	74.29	100	65.71	73.53	72.73	70.59	100	100	100	100	100	100	0	100	0	0	0

PE= Performance Expectancy, EX= Effort Expectancy, SI=Social Influence, FC=Facilitating Conditions, Sec=Security, and AW=Awareness

Table B4: Significance Statistics of UTAUT-based Studies Regarding Technology Adoption in HEIs Only

Category	PE->BI	EX->PE	EX->BI	SI->BI	FC->BI	Trust->BI	Trust->PE	Trust->EX	Sec->BI	Sec->PE	Sec->Trust	Sec->EX	AW->BI	AW x PE->BI	AW x EX->BI	AW x SI->BI	AW x FC->BI
Significant effect	108	3	77	81	52	5	0	0	1	0	1	0	5	0	0	0	0

Insignificant effect	**21**	**0**	**54**	**45**	**40**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**
Not tested	**10**	**136**	**8**	**13**	**47**	**134**	**139**	**139**	**138**	**139**	**138**	**139**	**133**	**139**	**139**	**139**	**139**
Total	**139**	**139**	**139**	**139**	**139**	**139**	**139**	**139**	**139**	**139**	**139**	**139**	**139**	**139**	**139**	**139**	**139**
Total Hypotheses	**129**	**3**	**131**	**126**	**92**	**5**	**0**	**0**	**1**	**0**	**1**	**0**	**6**	**0**	**0**	**0**	**0**
Significance Rate (%)	**83.72**	**100**	**58.78**	**64.29**	**56.52**	**100**	**NA**	**NA**	**100**	**NA**	**100**	**NA**	**83.33**	**NA**	**NA**	**NA**	**NA**

PE= Performance Expectancy, EX= Effort Expectancy, SI=Social Influence, FC=Facilitating Conditions, Sec=Security, and AW=Awareness

Table B5: Significance Statistics of UTAUT-based Studies Regarding Academic and Administrative Employees

Category	PE->BI	EX->PE	EX->BI	SI->BI	FC->BI	Trust->BI	Trust->PE	Trust->EX	Sec->BI	Sec->PE	Sec->Trust	Sec->EX	AW->BI	AW x PE->BI	AW x EX->BI	AW x SI->BI	AW x FC->BI
Significant effect	28	0	25	22	17	0	0	0	0	0	1	0	3	0	0	0	0
Insignificant effect	5	0	12	11	12	1	0	0	0	0	0	0	1	0	0	0	0
Not tested	8	41	4	8	12	40	41	41	41	41	40	41	37	41	41	41	41
Total	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41
Total Hypotheses	33	0	37	33	29	1	0	0	0	0	1	0	4	0	0	0	0
Significance Rate (%)	84.85	NA	67.57	66.67	58.62	0	NA	NA	NA	NA	100	NA	75.00	NA	NA	NA	NA

PE= Performance Expectancy, EX= Effort Expectancy, SI=Social Influence, FC=Facilitating Conditions, Sec=Security, and AW=Awareness

Table B6: Significance Statistics of UTAUT-based Studies in HEIs in KSA

Category	PE->BI	EX->PE	EX->BI	SI->BI	FC->BI	Trust->BI	Trust->PE	Trust->EX	Sec->BI	Sec->PE	Sec->Trust	Sec->EX	AW->BI	AW x PE->BI	AW x EX->BI	AW x SI->BI	AW x FC->BI
Significant effect	15	0	15	9	7	1	0	0	1	0	0	0	2	0	0	0	0
Insignificant effect	1	0	3	9	7	0	0	0	0	0	0	0	1	0	0	0	0

Not tested	**3**	**19**	**1**	**1**	**5**	**19**	**19**	**19**	**18**	**19**	**19**	**19**	**16**	**19**	**19**	**19**	**19**
Total	**19**	**19**	**19**	**19**	**19**	**20**	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**19**
Total Hypotheses	**16**	**0**	**18**	**18**	**14**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**3**	**0**	**0**	**0**	**0**
Significance Rate (%)	**93.75**	**NA**	**83.33**	**50.00**	**50.00**	**100**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**66.67**	**NA**	**NA**	**NA**	**NA**

PE= Performance Expectancy, EX= Effort Expectancy, SI=Social Influence, FC=Facilitating Conditions, Sec=Security, and AW=Awareness

Appendix C: The Questionnaire in English

Part one: Demographics

1. **Nationality.**

Saudi	Not-Saudi
☐	☐

2. **What is the primary funding of your institution?**

Public University	Private University	Others
☐	☐	☐

3. **What is your position?**

Administrative Employee	Academic
☐	☐

4. **What is your role?**

Teaching	Administrating	Technical	Other
☐	☐	☐	☐

5. **What is the name of your institution?**

1	Umm Al-Qura University	☐
2	Islamic University of Madinah	☐

3	Imam Muhammad bin Saud Islamic University	☐
4	King Saud University	☐
5	King Abdulaziz University	☐
6	King Fahd University of Petroleum and Minerals	☐
7	King Faisal University	☐
8	King Khalid University	☐
9	Qassim University	☐
10	Taibah University	☐
11	Taif University	☐
12	University of Ha'il	☐
13	Jazan University	☐
14	Jouf University	☐
15	Al-Baha University	☐
16	University of Tabuk	☐
17	Najran University	☐
18	Northern Border University	☐
19	Princess Nourah Bint Abdul Rahman University	☐
20	King Saud bin Abdulaziz University for Health Sciences	☐
21	Imam Abdulrahman bin Faisal University	☐

22	Prince Sattam bin Abdulaziz University	☐
23	Shaqra University	☐
24	Majmaah University	☐
25	Saudi Electronic University	☐
26	University of Jeddah	☐
27	University of Bisha	☐
28	King Abdullah University of Science and Technology	☐
29	University of Hafr Al Batin	☐
30	Arab Open University	☐
31	University of Business and Technology	☐
32	Prince Sultan University	☐
33	Fahad bin Sultan University	☐
34	Prince Mohammad bin Fahd University	☐
35	University of Prince Mugrin	☐
36	Alfaisal University	☐
37	Al Yamamah University	☐
38	Dar Al Uloom University	☐
39	Effat University	☐

40	Dar Al-Hekma University	☐
41	Riyadh Elm University	☐
42	Al Maarefa University	☐
43	Mustaqbal University	☐
44	Al Asala Colleges	☐
45	Gulf Colleges	☐
46	Sulaiman Al Rajhi University	☐
47	Onaizah Colleges	☐
48	Ibn Rushd College	☐
49	Ibn Sina National College	☐
50	Al-Baha Private College of Science	☐
51	Batterjee Medical College	☐
52	Al-Riyada College for Health Science	☐
53	Al-Rayan College	☐
54	Arab East College	☐
55	Inaya Medical Colleges	☐
56	Al Ghad International College for Applied Medical Science	☐
57	Buraydah College	☐

58	Jeddah International College	☐
59	Saad College of Nursing and Allied Health Sciences	☐
60	Fakeeh College for Medical Science	☐
61	Mohammad Al Mana College for Medical Science	☐
62	Prince Sultan College of Business	☐
63	Vision Colleges in Jeddah	☐
64	Vision Colleges in Riyadh	☐
65	Northen College of Nursing	☐
66	ALFAYHA COLLEGE	☐
67	ALMOOSA COLLEGE OF HEALTH SCIENCE	☐
68	General Organization for Technical and Vocational Training	☐
69	Prince Sultan Military Fac. for Health Science, Dhahran	☐
70	Royal Commission for Jubail and Yanbu	☐
71	Institute of Public Administration I.P.A	☐

Part two: Please indicate your level of agreement or disagreement with this statement.

1. **Blockchain technology applications are trustworthy.**

Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
☐	☐	☐	☐	☐	☐	☐

2. **Blockchain technology applications keep their promises and commitments.**

Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
☐	☐	☐	☐	☐	☐	☐

3. **Blockchain technology applications keep my best interests in mind.**

Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
☐	☐	☐	☐	☐	☐	☐

4. **I would feel secure storing sensitive information into a blockchain application.**

Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
☐	☐	☐	☐	☐	☐	☐

5. **Blockchain applications are a secure means through which to sensitive information.**

Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
☐	☐	☐	☐	☐	☐	☐

6. **I would feel totally safe providing sensitive information about myself over a blockchain application.**

Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
☐	☐	☐	☐	☐	☐	☐

7. **Overall, blockchain applications are a safe place to store sensitive information.**

Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
☐	☐	☐	☐	☐	☐	☐

8. **I would find the blockchain applications useful in my job.**

Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
☐	☐	☐	☐	☐	☐	☐

9. **Using the blockchain applications enables me to accomplish tasks more quickly.**

Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
☐	☐	☐	☐	☐	☐	☐

10. **Using the blockchain applications increases my productivity.**

Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
☐	☐	☐	☐	☐	☐	☐

11. **My interaction with the blockchain applications would be clear and understandable.**

Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
☐	☐	☐	☐	☐	☐	☐

12. **It would be easy for me to become skilful at using the blockchain applications.**

Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
☐	☐	☐	☐	☐	☐	☐

13. I would find the blockchain applications easy to use.

Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
☐	☐	☐	☐	☐	☐	☐

14. Learning to operate the blockchain applications is easy for me.

Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
☐	☐	☐	☐	☐	☐	☐

15. People who influence my behaviour think that I should use the blockchain applications.

Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
☐	☐	☐	☐	☐	☐	☐

16. People who are important to me think that I should use the blockchain applications.

Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
☐	☐	☐	☐	☐	☐	☐

17. The senior management of this business has been helpful in the use of the blockchain applications.

Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
☐	☐	☐	☐	☐	☐	☐

18. In general, the organization has supported the use of the blockchain applications.

Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
☐	☐	☐	☐	☐	☐	☐

19. I have the resources necessary to use the blockchain applications.

Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
☐	☐	☐	☐	☐	☐	☐

20. I have the knowledge necessary to use the blockchain applications.

Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
☐	☐	☐	☐	☐	☐	☐

21. A specific person (or group) is available for assistance with blockchain applications difficulties.

Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
☐	☐	☐	☐	☐	☐	☐

22. I intend to use the blockchain applications in the next <n>months.

Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
☐	☐	☐	☐	☐	☐	☐

23. I predict I would use the blockchain applications in the next <n>months.

Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
☐	☐	☐	☐	☐	☐	☐

24. I plan to use the blockchain applications in the next <n>months.

Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
☐	☐	☐	☐	☐	☐	☐

25. I follow news and developments about the blockchain technology.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
☐	☐	☐	☐	☐

26. I discuss with friends and people around me about blockchain technology.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
☐	☐	☐	☐	☐

27. I read about the benefits and issues of blockchain technology.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
☐	☐	☐	☐	☐

28. I seek advice on computer web sites or magazines about blockahin applications.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
☐	☐	☐	☐	☐

29. I am aware of the blockchain technology use benefits, problems and consequences.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
☐	☐	☐	☐	☑

Appendix D: The Questionnaire in Arabic

الجزء الأول: معلومات عامة

1. **الجنسية:**

سعودي ☐ غير سعودي ☐

2. **المؤسسة التي تنتمي لها هي مؤسسة:**

حكومية ☐ خاصة ☐ غير ذلك ☐

3. **ماهو مركزك الوظيفي؟**

موظف إداري ☐ عضو هيئة تدريس ☐

4. **ماهو دورك الوظيفي؟**

تقني ☐ إداري ☐ تدريسي ☐ غير ذلك ☐

5. **ماهي الجامعة التي تنتمي لها؟**

1	الجامعة الإسلامية بالمدينة المنورة
2	جامعة الأعمال والتكنولوجيا
3	جامعة الإمام عبدالرحمن بن فيصل
4	جامعة الإمام محمد بن سعود الإسلامية
5	جامعة الأمير سطام بن عبدالعزيز
6	جامعة الأمير سلطان
7	جامعة الأمير فهد بن سلطان
8	جامعة الأمير محمد بن فهد
9	جامعة الأمير مقرن بن عبدالعزيز
10	جامعة الأميرة نورة بنت عبدالرحمن
11	جامعة الباحة
12	جامعة الجوف
13	جامعة الحدود الشمالية
14	الجامعة السعودية الإلكترونية
15	جامعة الطائف
16	الجامعة العربية المفتوحة
17	جامعة الفيصل

18	جامعة القصيم
19	جامعة المجمعة
20	جامعة المستقبل
21	جامعة المعرفة
22	جامعة الملك خالد
23	جامعة الملك سعود
24	جامعة الملك سعود بن عبدالعزيز للعلوم الصحية
25	جامعة الملك عبدالعزيز
26	جامعة الملك عبدالله للعلوم والتقنية
27	جامعة الملك فهد للبترول والمعادن
28	جامعة الملك فيصل
29	جامعة اليمامة
30	جامعة أم القرى
31	جامعة بيشة
32	جامعة تبوك
33	جامعة جازان
34	جامعة جدة
35	جامعة حائل
36	جامعة حفر الباطن
37	جامعة دار الحكمة
38	جامعة دار العلوم
39	جامعة رياض العلم
40	جامعة سليمان الراجحي
41	جامعة شقراء
42	جامعة طيبة
43	جامعة عفت
44	جامعة نجران
45	كليات الأصالة الأهلية
46	كليات الخليج الأهلية
47	كليات الريان الأهلية بالمدينة المنورة
48	كليات الشرق العربي للدراسات العليا
49	كليات بريدة الأهلية
50	كليات عنيزة الأهلية
51	كلية ابن رشد للعلوم الإدارية
52	كلية ابن سينا الاهلية

53	كلية الأمير سلطان العسكرية للعلوم الصحية
54	كلية الامير سلطان للإدارة
55	كلية الباحة الاهلية للعلوم
56	كلية البترجي الطبية للعلوم والتكنولوجيا
57	كلية الجبيل الصناعية
58	كلية الرؤية بالرياض
59	كلية الرؤية لطب الأسنان والتمريض بجدة
60	كلية الريادة للعلوم الصحية
61	كلية الشمال للتمريض
62	كلية العناية الطبية
63	كلية الغد الدولية للعلوم الطبية التطبيقية
64	كلية الفيحاء الأهلية
65	كلية الموسى للعلوم الصحية
66	كلية جدة العالمية
67	كلية سعد للتمريض والعلوم الصحية
68	كلية فقيه للعلوم الطبية
69	كلية محمد المانع للعلوم الطبية
70	كلية ينبع الجامعية
71	نادي المؤسسة العامة للتدريب التقني والمهني بالرياض

الجزء الثاني: يرجى الإشارة إلى مستوى موافقتك أو عدم موافقتك على هذا البيان.

1. **تطبيقات تقنية *البلوك تشين* جديرة بالثقة.**

لا أتفق بشدة	لا أتفق	لا أتفق إلى حد ما	محايد	أتفق إلى حد ما	أتفق	أتفق بشدة
☐	☐	☐	☐	☐	☐	☐

2. **تطبيقات تقنية *البلوك تشين* تحافظ على الوعود والالتزامات.**

لا أتفق بشدة	لا أتفق	لا أتفق إلى حد ما	محايد	أتفق إلى حد ما	أتفق	أتفق بشدة
☐	☐	☐	☐	☐	☐	☐

3. **تطبيقات تكنولوجيا *البلوك تشين* تضع مصلحتي في الاعتبار.**

لا أتفق بشدة	لا أتفق	لا أتفق إلى حد ما	محايد	أتفق إلى حد ما	أتفق	أتفق بشدة
☐	☐	☐	☐	☐	☐	☐

4. سأشعر بالأمان عند تخزين المعلومات الحساسة في أحد تطبيقات ال*بلوك تشين*.

لا أتفق بشدة	لا أتفق	لا أتفق إلى حد ما	محايد	أتفق إلى حد ما	أتفق	أتفق بشدة
☐	☐	☐	☐	☐	☐	☐

5. تطبيقات *البلوك تشين* هي وسيلة آمنة يتم من خلالها حفظ معلومات حساسة.

لا أتفق بشدة	لا أتفق	لا أتفق إلى حد ما	محايد	أتفق إلى حد ما	أتفق	أتفق بشدة
☐	☐	☐	☐	☐	☐	☐

6. سأشعر بالأمان التام عند تقديم معلومات حساسة عن نفسي عبر تطبيق *البلوك تشين*.

لا أتفق بشدة	لا أتفق	لا أتفق إلى حد ما	محايد	أتفق إلى حد ما	أتفق	أتفق بشدة
☐	☐	☐	☐	☐	☐	☐

7. بشكل عام، تعد تطبيقات *البلوك تشين* مكانًا آمنًا لتخزين المعلومات الحساسة.

لا أتفق بشدة	لا أتفق	لا أتفق إلى حد ما	محايد	أتفق إلى حد ما	أتفق	أتفق بشدة
☐	☐	☐	☐	☐	☐	☐

8. سأجد تطبيقات *البلوك تشين* مفيدة في عملي.

لا أتفق بشدة	لا أتفق	لا أتفق إلى حد ما	محايد	أتفق إلى حد ما	أتفق	أتفق بشدة
☐	☐	☐	☐	☐	☐	☐

9. يتيح لي استخدام تطبيقات *البلوك تشين* إنجاز المهام بسرعة أكبر.

لا أتفق بشدة	لا أتفق	لا أتفق إلى حد ما	محايد	أتفق إلى حد ما	أتفق	أتفق بشدة
☐	☐	☐	☐	☐	☐	☐

10. يزيد استخدام تطبيقات *البلوك تشين* من إنتاجيتي.

لا أتفق بشدة	لا أتفق	لا أتفق إلى حد ما	محايد	أتفق إلى حد ما	أتفق	أتفق بشدة
☐	☐	☐	☐	☐	☐	☐

11. سيكون تفاعلي مع تطبيقات *البلوك تشين* واضحًا ومفهومًا.

لا أتفق بشدة	لا أتفق	لا أتفق إلى حد ما	محايد	أتفق إلى حد ما	أتفق	أتفق بشدة
☐	☐	☐	☐	☐	☐	☐

12. سيكون من السهل بالنسبة لي أن أصبح ماهرًا في استخدام تطبيقات *البلوك تشين*.

لا أتفق بشدة	لا أتفق	لا أتفق إلى حد ما	محايد	أتفق إلى حد ما	أتفق	أتفق بشدة
☐	☐	☐	☐	☐	☐	☐

13. سأجد أن تطبيقات *البلوك تشين* سهلة الاستخدام.

لا أتفق بشدة	لا أتفق	لا أتفق إلى حد ما	محايد	أتفق إلى حد ما	أتفق	أتفق بشدة
☐	☐	☐	☐	☐	☐	☐

14. تعلم كيفية تشغيل تطبيقات *البلوك تشين* أمر سهل بالنسبة لي.

لا أتفق بشدة	لا أتفق	لا أتفق إلى حد ما	محايد	أتفق إلى حد ما	أتفق	أتفق بشدة
☐	☐	☐	☐	☐	☐	☐

15. يعتقد الأشخاص الذين يؤثرون في سلوكي أنه يجب علي استخدام تطبيقات *البلوك تشين*.

لا أتفق بشدة	لا أتفق	لا أتفق إلى حد ما	محايد	أتفق إلى حد ما	أتفق	أتفق بشدة
☐	☐	☐	☐	☐	☐	☐

16. يعتقد الأشخاص المهمون بالنسبة لي أنه يجب علي استخدام تطبيقات *البلوك تشين*.

لا أتفق بشدة	لا أتفق	لا أتفق إلى حد ما	محايد	أتفق إلى حد ما	أتفق	أتفق بشدة
☐	☐	☐	☐	☐	☐	☐

17. لقد ساعدت الإدارة العليا فيما يتعلق بهذا العمل من خلال استخدام تطبيقات *البلوك تشين*.

لا أتفق بشدة	لا أتفق	لا أتفق إلى حد ما	محايد	أتفق إلى حد ما	أتفق	أتفق بشدة
☐	☐	☐	☐	☐	☐	☐

18. دعمت المنظمة بشكل عام استخدام تطبيقات *البلوك تشين*.

لا أتفق بشدة	لا أتفق	لا أتفق إلى حد ما	محايد	أتفق إلى حد ما	أتفق	أتفق بشدة
☐	☐	☐	☐	☐	☐	☐

19. لدي الموارد اللازمة لاستخدام تطبيقات *البلوك تشين*.

لا أتفق بشدة	لا أتفق	لا أتفق إلى حد ما	محايد	أتفق إلى حد ما	أتفق	أتفق بشدة
☐	☐	☐	☐	☐	☐	☐

20. لدي المعرفة اللازمة لاستخدام تطبيقات *البلوك تشين*.

لا أتفق بشدة	لا أتفق	لا أتفق إلى حد ما	محايد	أتفق إلى حد ما	أتفق	أتفق بشدة
☐	☐	☐	☐	☐	☐	☐

21. شخص معين (أو مجموعة من الأشخاص) متاحين للمساعدة في صعوبات تطبيقات *البلوك تشين*.

لا أتفق بشدة	لا أتفق	لا أتفق إلى حد ما	محايد	أتفق إلى حد ما	أتفق	أتفق بشدة
☐	☐	☐	☐	☐	☐	☐

22. أعتزم استخدام تطبيقات *البلوك تشين* في الأشهر القادمة.

لا أتفق بشدة	لا أتفق	لا أتفق إلى حد ما	محايد	أتفق إلى حد ما	أتفق	أتفق بشدة
☐	☐	☐	☐	☐	☐	☐

23. أتوقع أنني سأستخدم تطبيقات *البلوك تشين* في الأشهر القادمة.

لا أتفق بشدة	لا أتفق	لا أتفق إلى حد ما	محايد	أتفق إلى حد ما	أتفق	أتفق بشدة
☐	☐	☐	☐	☐	☐	☐

24. أخطط لاستخدام تطبيقات *البلوك تشين* في الأشهر القادمة.

لا أتفق بشدة	لا أتفق	لا أتفق إلى حد ما	محايد	أتفق إلى حد ما	أتفق	أتفق بشدة
☐	☐	☐	☐	☐	☐	☐

25. أتابع الأخبار والتطورات حول تقنية *البلوك تشين*.

لا أتفق بشدة	لا أتفق	محايد	أتفق	أتفق بشدة
☐	☐	☐	☐	☐

26. أناقش مع الأصدقاء والأشخاص من حولي حول تقنية *البلوك تشين*.

لا أتفق بشدة	لا أتفق	محايد	أتفق	أتفق بشدة
☐	☐	☐	☐	☐

27. قرأت عن فوائد ومشاكل تكنولوجيا *البلوك تشين*.

لا أتفق بشدة	لا أتفق	محايد	أتفق	أتفق بشدة
☐	☐	☐	☐	☐

28. أطلب المشورة بشأن مواقع الويب الخاصة بالكمبيوتر أو المجلات حول تطبيقات *البلوك تشين*.

لا أتفق بشدة	لا أتفق	محايد	أتفق	أتفق بشدة
☐	☐	☐	☐	☐

29. أنا على دراية بفوائد استخدام تقنية البلوك تشين ومشاكلها وعواقبها.

لا أتفق بشدة	لا أتفق	محايد	أتفق	أتفق بشدة
☐	☐	☐	☐	☐

Appendix E: Ethical Approval from Aston University

Aston University

Aston University
Aston Triangle
Birmingham
B4 7ET
0121 204 3000

Date: 6th December 2022

Mohammed Alhumayzi
Copy: Dr Luciano Batista; Prof Vladlena Benson
College of Business and Social Sciences

Dear Mohammed Alhumayzi,

Study title:	Factors Affecting Employees' Acceptance of Blockchain in the Higher Education Institutions in the Kingdom of Saudi Arabia
REC REF:	#BSS21014

Confirmation of Ethical Opinion

On behalf of the Committee, I am pleased to confirm a favourable opinion for the above research on the basis described in the application form, protocol and supporting documentation listed below.

Approved documents

The final list of documents reviewed and approved by the Committee is as follows:

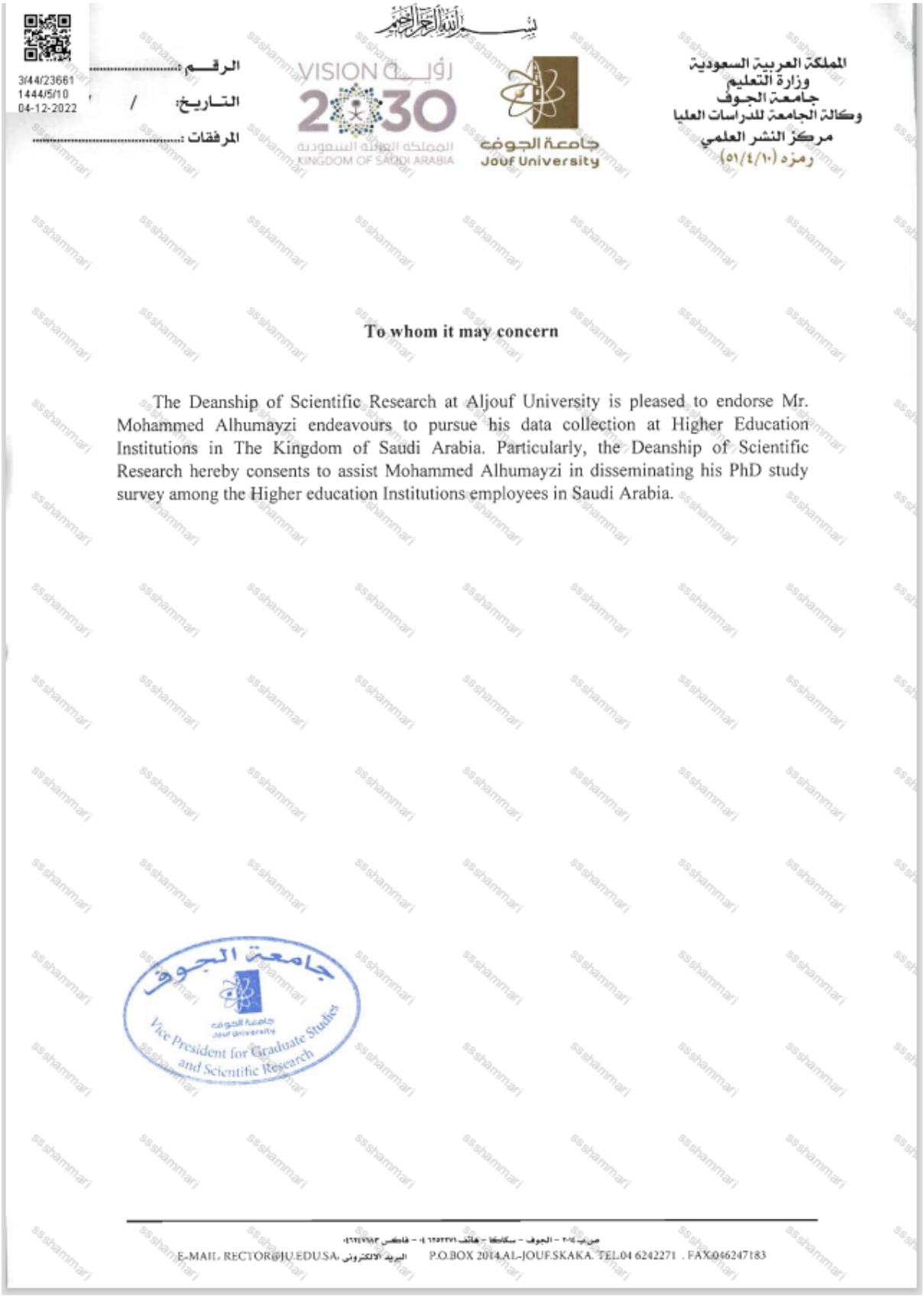
Document	*Version*	*Date*
Research Ethics Application Form	2	04/12/2022
Participant Information Sheet	2	04/12/2022
Consent Form	2	04/12/2022
Questionnaire Arabic	2	04/12/2022
Questionnaire English	2	04/12/2022
Approval from Aljouf University	N/A	04/12/2022

With the Committee's best wishes for the success of this project.

Yours sincerely,

Dr Alexis Paton
Chair of the Business & Social Sciences Research Ethics Committee

Appendix F: Endorsement Letter from Jouf University to Disseminate the Survey among Participants



بسم الله الرحمن الرحيم

المملكة العربية السعودية
وزارة التعليم
جامعة الجوف
وكالة الجامعة للدراسات العليا
مركز النشر العلمي
رمزه (٥١/٤/١٠)

جامعة الجوف
Jouf University

رؤية VISION 2030
المملكة العربية السعودية
KINGDOM OF SAUDI ARABIA

الرقم: .....
التاريخ: / /
المرفقات: .....

3/44/23661
1444/5/10
04-12-2022

To whom it may concern

The Deanship of Scientific Research at Aljouf University is pleased to endorse Mr. Mohammed Alhumayzi endeavours to pursue his data collection at Higher Education Institutions in The Kingdom of Saudi Arabia. Particularly, the Deanship of Scientific Research hereby consents to assist Mohammed Alhumayzi in disseminating his PhD study survey among the Higher education Institutions employees in Saudi Arabia.

جامعة الجوف
جامعة الجوف Jouf University
Vice President for Graduate Studies and Scientific Research

ص.ب ٢٠١٤ – الجوف – سكاكا – هاتف ٦٢٤٢٢٧١ ٠٤ – فاكس ٦٢٤٧١٨٣
E-MAIL: RECTOR@JU.EDU.SA البريد الالكتروني P.O.BOX 2014,AL-JOUF,SKAKA. TEL.04 6242271 . FAX.046247183

Appendix G: MICOM Results for Permutation and Bootstrapping-based MGA Tests (MICOM- Step1)

Table G1: Outer Loading for Females

Items/constructs	AW	BI	EX	FC	PE	SI	Sec	Trust
AW1	0.926							
AW2	0.921							
AW3	0.925							
AW4	0.849							
AW5	0.890							
BI1		0.947						
BI2		0.918						
BI3		0.936						
EX1			0.924					
EX2			0.962					
EX3			0.939					
FC1				0.884				
FC2				0.839				
FC4				0.877				
PE1					0.915			
PE2					0.938			
PE3					0.922			
SI1						0.935		
SI2						0.918		
SI3						0.886		
Sec1							0.906	
Sec2							0.915	
Sec3							0.922	
Sec4							0.876	
Trust1								0.842
Trust2								0.924
Trust3								0.907

Table G2: Outer Loading for Males

Items/constructs	AW	BI	EX	FC	PE	SI	Sec	Trust
AW1	0.883							
AW2	0.864							
AW3	0.890							
AW4	0.845							
AW5	0.838							
BI1		0.939						
BI2		0.932						
BI3		0.924						
EX1			0.908					
EX2			0.951					
EX3			0.905					
FC1				0.814				
FC2				0.878				
FC4				0.869				
PE1					0.904			
PE2					0.935			
PE3					0.938			
SI1						0.871		
SI2						0.908		
SI3						0.871		
Sec1							0.915	
Sec2							0.930	
Sec3							0.938	
Sec4							0.899	
Trust1								0.910
Trust2								0.915
Trust3								0.901

Table G3: Outer Loading for Older Staff

Items/constructs	AW	BI	EX	FC	PE	SI	Sec	Trust
AW1	0.914							
AW2	0.893							

AW3	0.906							
AW4	0.891							
AW5	0.892							
BI1		0.932						
BI2		0.909						
BI3		0.915						
EX1			0.915					
EX2			0.952					
EX3			0.915					
FC1				0.830				
FC2				0.878				
FC4				0.891				
PE1					0.909			
PE2					0.945			
PE3					0.943			
SI1						0.892		
SI2						0.905		
SI3						0.886		
Sec1							0.920	
Sec2							0.930	
Sec3							0.940	
Sec4							0.869	
Trust1								0.902
Trust2								0.932
Trust3								0.900

Table G4: Outer Loading for Younger Staff

Items/constructs	AW	BI	EX	FC	PE	SI	Sec	Trust
AW1	0.887							
AW2	0.883							
AW3	0.903							
AW4	0.799							
AW5	0.824							
BI1		0.954						

BI2	0.945							
BI3	0.945							
EX1		0.915						
EX2		0.958						
EX3		0.923						
FC1			0.862					
FC2			0.850					
FC4			0.848					
PE1				0.907				
PE2				0.923				
PE3				0.918				
SI1					0.908			
SI2					0.917			
SI3					0.864			
Sec1						0.900		
Sec2						0.921		
Sec3						0.922		
Sec4						0.914		
Trust1								0.869
Trust2								0.897
Trust3								0.905

Table G5: Outer Loading for The Academic Staff

Items/constructs	AW	BI	EX	FC	PE	SI	Sec	Trust
AW1	0.888							
AW2	0.876							
AW3	0.884							
AW4	0.851							
AW5	0.844							
BI1		0.942						
BI2		0.927						
BI3		0.933						
EX1			0.905					
EX2			0.955					

EX3		0.895						
FC1			0.790					
FC2			0.849					
FC4			0.866					
PE1				0.887				
PE2				0.928				
PE3				0.928				
SI1					0.875			
SI2					0.909			
SI3					0.874			
Sec1						0.901		
Sec2						0.914		
Sec3						0.928		
Sec4						0.864		
Trust1								0.867
Trust2								0.908
Trust3								0.892

Table G6: Outer Loading for The Administrative Staff

Items/constructs	AW	BI	EX	FC	PE	SI	Sec	Trust
AW1	0.910							
AW2	0.895							
AW3	0.919							
AW4	0.833							
AW5	0.872							
BI1		0.942						
BI2		0.925						
BI3		0.920						
EX1			0.924					
EX2			0.952					
EX3			0.938					
FC1				0.899				
FC2				0.877				
FC4				0.873				

PE1					0.930			
PE2					0.941			
PE3					0.931			
SI1						0.921		
SI2						0.907		
SI3						0.883		
Sec1							0.917	
Sec2							0.933	
Sec3							0.930	
Sec4							0.923	
Trust1								0.899
Trust2								0.926
Trust3								0.918

Table G7: Outer Loading for Less Experienced Staff

Items/constructs	AW	BI	EX	FC	PE	SI	Sec	Trust
AW1	0.886							
AW2	0.884							
AW3	0.890							
AW4	0.847							
AW5	0.869							
BI1		0.943						
BI2		0.926						
BI3		0.937						
EX1			0.900					
EX2			0.950					
EX3			0.912					
FC1				0.839				
FC2				0.855				
FC4				0.881				
PE1					0.910			
PE2					0.925			
PE3					0.915			
SI1						0.905		

SI2						0.927		
SI3						0.886		
Sec1							0.906	
Sec2							0.926	
Sec3							0.937	
Sec4							0.884	
Trust1								0.875
Trust2								0.890
Trust3								0.873

Table G8: Outer Loading for More Experienced Staff

Items/constructs	AW	BI	EX	FC	PE	SI	Sec	Trust
AW1	0.915							
AW2	0.890							
AW3	0.919							
AW4	0.848							
AW5	0.850							
BI1		0.942						
BI2		0.927						
BI3		0.919						
EX1			0.929					
EX2			0.960					
EX3			0.930					
FC1				0.854				
FC2				0.878				
FC4				0.852				
PE1					0.902			
PE2					0.942			
PE3					0.944			
SI1						0.888		
SI2						0.888		
SI3						0.863		
Sec1							0.916	
Sec2							0.922	

Sec3	0.924	
Sec4	0.896	
Trust1		0.896
Trust2		0.946
Trust3		0.928

Table G9: The Composite Reliability for Females

Item	Composite Reliability rho_a
AW	0.930
BI	0.927
EX	0.925
FC	0.833
PE	0.916
SI	0.883
Sec	0.935
Trust	0.887

Table G10: The Composite Reliability for Males

Item	Composite Reliability rho_a
AW	0.917
BI	0.924
EX	0.918
FC	0.834
PE	0.917
SI	0.878
Sec	0.941
Trust	0.895

Table G11: The Composite Reliability for Older Staff

Item	Composite Reliability rho_a
AW	0.942
BI	0.909
EX	0.921
FC	0.843
PE	0.925
SI	0.896
Sec	0.936

Trust	0.901

Table G12: The Composite Reliability for Younger Staff

Item	Composite Reliability rho_a
AW	0.919
BI	0.944
EX	0.928
FC	0.829
PE	0.905
SI	0.881
Sec	0.937
Trust	0.870

Table G13: The Composite Reliability for Academics

Item	Composite Reliability rho_a
AW	0.923
BI	0.928
EX	0.915
FC	0.812
PE	0.902
SI	0.882
Sec	0.923
Trust	0.873

Table G14: The Composite Reliability for Administrative Staff

Item	Composite Reliability rho_a
AW	0.937
BI	0.922
EX	0.936
FC	0.860
PE	0.928
SI	0.889
Sec	0.946
Trust	0.902

Table G15: The Composite Reliability for Less Experienced Staff

Item	Composite Reliability rho_a
AW	0.927

BI	0.931
EX	0.915
FC	0.839
PE	0.905
SI	0.899
Sec	0.934
Trust	0.855

Table G16: The Composite Reliability for More Experienced Staff

Item	Composite Reliability rho_a
AW	0.933
BI	0.921
EX	0.936
FC	0.833
PE	0.921
SI	0.860
Sec	0.935
Trust	0.916

Table G17: Convergent Validity for Females

Item	Average Variance Extracted (AVE)
AW	0.815
BI	0.872
EX	0.887
FC	0.751
PE	0.856
SI	0.834
Sec	0.819
Trust	0.795

Table G18: Convergent Validity for Males

Item	Average Variance Extracted (AVE)
AW	0.747
BI	0.868
EX	0.849
FC	0.729
PE	0.857

SI	0.780
Sec	0.848
Trust	0.826

Table G19: Convergent Validity for Older Staff

Item	Average Variance Extracted (AVE)
AW	0.809
BI	0.844
EX	0.860
FC	0.751
PE	0.869
SI	0.800
Sec	0.838
Trust	0.831

Table G20: Convergent Validity for Younger Staff

Item	Average Variance Extracted (AVE)
AW	0.740
BI	0.899
EX	0.868
FC	0.728
PE	0.839
SI	0.804
Sec	0.836
Trust	0.793

Table G21: Convergent Validity for Academics

Item	Average Variance Extracted (AVE)
AW	0.755
BI	0.873
EX	0.844
FC	0.698
PE	0.837
SI	0.785
Sec	0.814
Trust	0.790

Table G22: Convergent Validity for Administrative Staff

Item	Average Variance Extracted (AVE)
AW	0.786
BI	0.863
EX	0.879
FC	0.779
PE	0.873
SI	0.817
Sec	0.857
Trust	0.837

Table G23: Convergent Validity for Less Experienced Staff

Item	Average Variance Extracted (AVE)
AW	0.766
BI	0.875
EX	0.848
FC	0.737
PE	0.840
SI	0.821
Sec	0.834
Trust	0.773

Table G24: Convergent Validity for More Experienced Staff

Item	Average Variance Extracted (AVE)
AW	0.783
BI	0.864
EX	0.884
FC	0.742
PE	0.864
SI	0.774
Sec	0.836
Trust	0.853

Appendix H: MICOM Results for Permutation and Bootstrapping-based MGA Tests (Step 2 and Step 3)

Table H1: MICOM (Step 2) Results for Gender

	Original correlation	Correlation permutation mean	5.0%	Permutation p value
AW	1.000	1.000	0.999	0.807
BI	1.000	1.000	1.000	0.118
EX	1.000	1.000	1.000	0.426
FC	1.000	0.999	0.997	0.728
PE	1.000	1.000	1.000	0.955
SI	0.999	0.999	0.998	0.148
Sec	1.000	1.000	1.000	0.107
Trust	1.000	1.000	1.000	0.290

Table H2 MICOM (Step 3a) Mean Results for Gender

	Original difference	Permutation mean difference	5.0%	95.0%	Permutation p value
AW	-0.044	0.002	-0.172	0.170	0.331
BI	-0.235	0.000	-0.170	0.171	0.011
EX	-0.220	0.001	-0.173	0.171	0.016
FC	-0.169	0.001	-0.175	0.172	0.056
PE	-0.111	0.002	-0.169	0.176	0.138
SI	-0.196	0.000	-0.170	0.172	0.028
Sec	-0.042	0.001	-0.169	0.173	0.340
Trust	-0.048	0.001	-0.171	0.173	0.317

Table H3: MICOM (Step 3b) Variance Results for Gender

	Original difference	Permutation mean difference	5.0%	95.0%	Permutation p value
AW	-0.265	0.003	-0.197	0.207	0.012
BI	-0.033	0.005	-0.351	0.356	0.431
EX	0.040	0.005	-0.199	0.216	0.386
FC	-0.128	0.002	-0.219	0.229	0.174
PE	0.121	0.001	-0.215	0.222	0.189
SI	-0.053	0.005	-0.179	0.193	0.308
Sec	-0.072	0.007	-0.195	0.217	0.266
Trust	0.080	0.006	-0.194	0.211	0.269

Table H4: MICOM (Step 2) Results for Age

	Original correlation	Correlation permutation mean	5.0%	Permutation p value
AW	1.000	1.000	0.999	0.495
BI	1.000	1.000	1.000	0.942
EX	1.000	1.000	1.000	0.758
FC	0.999	0.999	0.997	0.427
PE	1.000	1.000	1.000	0.197
SI	0.999	1.000	0.998	0.074
Sec	1.000	1.000	1.000	0.347
Trust	1.000	1.000	1.000	0.165

Table H5: MICOM (Step 3a) Mean Results for Age

	Original difference	Permutation mean difference	5.0%	95.0%	Permutation p value
AW	-0.011	0.000	-0.167	0.166	0.461
BI	0.102	0.001	-0.169	0.167	0.161
EX	0.059	-0.001	-0.169	0.167	0.275
FC	0.022	0.000	-0.166	0.168	0.421
PE	0.102	0.001	-0.165	0.164	0.163
SI	0.007	0.000	-0.164	0.167	0.470
Sec	0.112	0.000	-0.165	0.168	0.135
Trust	0.139	0.002	-0.165	0.171	0.091

Table H6: MICOM (Step 3b) Variance Results for Age

	Original difference	Permutation mean difference	5.0%	95.0%	Permutation p value
AW	-0.146	-0.001	-0.194	0.191	0.110
BI	0.070	-0.001	-0.349	0.347	0.377
EX	0.007	0.000	-0.205	0.207	0.474
FC	0.034	0.000	-0.217	0.227	0.400
PE	-0.274	-0.001	-0.208	0.205	0.014
SI	0.151	-0.002	-0.184	0.177	0.080
Sec	-0.148	-0.001	-0.201	0.195	0.111
Trust	-0.327	-0.003	-0.208	0.197	0.004

Table H7: MICOM (Step 2) Results for Job Types

	Original correlation	Correlation permutation mean	5.0%	Permutation p value
AW	1.000	1.000	0.999	0.807
BI	1.000	1.000	1.000	0.118
EX	1.000	1.000	1.000	0.426
FC	1.000	0.999	0.997	0.728
PE	1.000	1.000	1.000	0.955
SI	0.999	0.999	0.998	0.148
Sec	1.000	1.000	1.000	0.107
Trust	1.000	1.000	1.000	0.290

Table H8: MICOM (Step 3a) Mean Results for Job Types

	Original difference	Permutation mean difference	5.0%	95.0%	Permutation p value
AW	-0.044	0.002	-0.172	0.170	0.331
BI	-0.235	0.000	-0.170	0.171	0.011
EX	-0.220	0.001	-0.173	0.171	0.016
FC	-0.169	0.001	-0.175	0.172	0.056
PE	-0.111	0.002	-0.169	0.176	0.138
SI	-0.196	0.000	-0.170	0.172	0.028
Sec	-0.042	0.001	-0.169	0.173	0.340
Trust	-0.048	0.001	-0.171	0.173	0.317

Table H9: MICOM (Step 3b) Variance Results for Job Types

	Original difference	Permutation mean difference	5.0%	95.0%	Permutation p value
AW	-0.265	0.003	-0.197	0.207	0.012
BI	-0.033	0.005	-0.351	0.356	0.431
EX	0.040	0.005	-0.199	0.216	0.386
FC	-0.128	0.002	-0.219	0.229	0.174
PE	0.121	0.001	-0.215	0.222	0.189
SI	-0.053	0.005	-0.179	0.193	0.308
Sec	-0.072	0.007	-0.195	0.217	0.266
Trust	0.080	0.006	-0.194	0.211	0.269

Table H10: MICOM (Step 2) Results for Experience

	Original correlation	Correlation permutation mean	5.0%	Permutation p value
AW	1.000	1.000	0.999	0.839
BI	1.000	1.000	1.000	0.145
EX	1.000	1.000	1.000	0.829
FC	1.000	0.999	0.997	0.602
PE	1.000	1.000	1.000	0.683
SI	1.000	1.000	0.998	0.946
Sec	1.000	1.000	1.000	0.844
Trust	1.000	1.000	1.000	0.311

Table H11: MICOM (Step 3a) Mean Results for Experience

	Original difference	Permutation mean difference	5.0%	95.0%	Permutation p value
AW	0.170	0.000	-0.163	0.167	0.047
BI	0.230	0.001	-0.160	0.166	0.009
EX	0.089	0.000	-0.162	0.161	0.189
FC	0.124	0.000	-0.165	0.165	0.111
PE	0.331	0.001	-0.165	0.166	0.001
SI	0.252	-0.003	-0.164	0.162	0.004
Sec	0.178	-0.001	-0.165	0.163	0.035
Trust	0.157	0.000	-0.168	0.166	0.060

Table H12: MICOM (Step 3b) Variance Results for Job Types

	Original difference	Permutation mean difference	5.0%	95.0%	Permutation p value
AW	-0.173	0.000	-0.193	0.195	0.070
BI	-0.073	0.000	-0.339	0.335	0.365
EX	-0.178	-0.003	-0.201	0.197	0.075
FC	0.086	0.000	-0.216	0.224	0.256
PE	-0.300	-0.001	-0.212	0.210	0.011
SI	0.020	0.001	-0.184	0.188	0.422
Sec	-0.134	0.002	-0.194	0.203	0.132
Trust	-0.393	-0.001	-0.197	0.196	0.000

Appendix I: Comparisons between Complete Results and Subsamples

Table I-1: Comparisons of the Direct and Moderating Relationships between Complete and Subsample Results

Paths	Complete	Female	Male	Older employees	Younger	Academics	Admin.	Less Experienced staff	More Experienced staff
PE->BI	**Significant**	Significant	Significant	Significant	Significant	Significant	Significant	Significant	Significant
EX->PE	**Significant**	Significant	Significant	Significant	Significant	Significant	Significant	Significant	Significant
EX->BI	**Insignificant**	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Significant	Insignificant	Significant
SI->BI	**Insignificant**	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
FC->BI	**Significant**	Significant	Significant	Significant	Significant	Significant	Significant	Significant	Insignificant
Trust->BI	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
Trust->PE	**Significant**	Significant	Significant	Significant	Significant	Significant	Significant	Significant	Significant

Trust->EX	**Significant**	Significant	Significant	Significant	Significant	Significant	Significant	Significant	Significant
Sec->BI	**Significant**	Significant	Insignificant	Insignificant	Significant	Significant	Insignificant	Insignificant	Insignificant
Sec->PE	**Significant**	Significant	Significant	Significant	Significant	Significant	Significant	Significant	Significant
Sec->Trust	**Significant**	Significant	Significant	Significant	Significant	Significant	Significant	Significant	Significant
Sec->EX	**Significant**	Significant	Significant	Significant	Significant	Significant	Significant	Significant	Significant
AW->BI	**Significant**	Significant	Significant	Significant	Significant	Significant	Significant	Significant	Significant
AW x PE->BI	**Insignificant**	Insignificant	Insignificant	Significant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
AW x EX->BI	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
AW x SI->BI	**Insignificant**	Insignificant	Insignificant	Significant	Insignificant	Insignificant	Insignificant	Significant	Significant
AW x FC->BI	**Significant**	Significant	Insignificant	Significant	Significant	Significant	Insignificant	Significant	Insignificant

Table I-2: Comparisons of the Indirect Paths between Complete and Subsamples Results

Paths	Complete	Female	Male	Older employees	Younger	Academics	Admin.	Less Experienced staff	More Experienced staff
EX->PE->BI	**Significant**	Significant	Significant	Significant	significant	Significant	Significant	Significant	Significant
Sec->PE->BI	**Significant**	Significant	Insignificant	Insignificant	significant	Significant	Significant	Significant	Significant
Sec->EX->BI	**Insignificant**	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Significant	Insignificant	Insignificant
Sec->Trust->BI	**Insignificant**	Significant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
Sec->Trust->PE->BI	**Significant**	Significant	Significant	Significant	significant	Significant	Significant	Significant	Significant
Sec->Trust->EX->BI	**Insignificant**	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Significant	Insignificant	Significant
Sec->Trust->EX->PE->BI	**Significant**	Significant	Significant	Significant	significant	Significant	Significant	Significant	Significant
Sec->EX->PE->BI	**Significant**	Significant	Significant	Significant	significant	Significant	Significant	Significant	Significant
Trust->PE->BI	**Significant**	Significant	Significant	Significant	significant	Significant	Significant	Significant	Significant

Trust->EX->BI	**Insignifi cant**	Insignifi cant	Insignifi cant	Insignifi cant	Insignifi cant	Insignifi cant	Signific ant	Insignifi cant	Signific ant
Trust->EX->PE->BI	**Signific ant**	Signific ant	Signific ant	Signific ant	significa nt	Signific ant	Signific ant	Signific ant	Signific ant

Appendix J: Blockchain Usage in Existing HEIs

Country	HEI	Purpose of Blockchain
UK	University College London	To store and share data
	Open University	To award badges to users who pass the OU courses
	University of Southampton	To issue and store certificates and diplomas
	Woolf Of University	To improve certificate management, identity verification, tuition fee processing, and educational activities
USA	MIT	To issue and secure verifiable digital certificates.
	University of New Hampshire	To issue and secure verifiable digital certificates.
	King's College	To receive tuition fees
	The University of California	To issue and secure verifiable digital certificates.
	Stanford University	To secure data sharing, manage digital identities, and ensure credential security
Australia	University of Melbourne	To ensure security, enable data sharing, facilitate certificate issuance, and strengthen digital identity management.
Malta	Malta College of Arts Science and Technology	To issue and secure verifiable digital certificates.
Slovenia	University of Maribor	To issue and secure verifiable digital certificates.
Greece	Aristotle University of Thessaloniki	To manage certificates and enhance identification solutions.
	Athens University of Economics and Business	
	Democritus University of Thrace	
China	Zhejiang University	To enhance the protection of intellectual property
	Shenzhen University	
Russia	Synergy University to issue and store certificates based on the blockchain system	To issue and secure verifiable digital certificates. Also, to foster collaboration between students and lecturers.
	The Penza State University	To issue and secure verifiable digital certificates.
UAE	The University in Dubai	
Bahrein	University of Bahrein	
Mexico	Central New Mexico Community College	
Singapore	Ngee Ann Polytechnic	

Saudi Arabia	KAUST
	Taibah University

Appendix K: Sample Size

Method	Suggested sample size	Reference(s)
Sample-to-item ratio	270	Memon et al. (2020)
Sample-to-variable ratio	140	Memon et al. (2020); Nunnally (1978); Hair et al. (2019)
Krejcie and Morgan Table	384	Memon et al. (2020); Krejcie and Morgan (1970)
Ten-times rule	70	Memon et al. (2020); Hair et al. (2022)
Cohen's Power Primer	76	Cohen (1992)
G*power	98	Faul et al. (2009)
The minimum path coefficients	155	Hair et al. (2021)