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Factors influencing blockchain adoption in the tourism industry: an empirical study

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ABSTRACT

The adoption of blockchain technology is gaining trends, leading to the need for investigations into the reasons that persuade the intention to adopt it by companies. However, empirical studies in the tourism industry are still scarce. This investigation aims to design a new adoption model that combines Human-Organisation-Technology-Fit (HOT-fit), Technology-Organisation-Environment (TOE) and sustainability dimensions. The model is validated using new empirical evidence in a relatively understudied geographic context, with a sample of 210 Portuguese tourism companies. The information was examined utilising Partial Least Squares Structural Equation Modelling (PLS-SEM). The outcomes indicate that reasons such as sustainability and competition intensity significantly impact the objective to adopt blockchain. The work provides practical implications for businesses, governments and society. Additionally, this paper offers a pioneering study of blockchain adoption by tourism companies in Portugal, which may help future researchers extend their study of this field to other sectors and regions.

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Blockchain; tourism business; strategy; sustainability

1. Introduction

Blockchain technology is considered a distributed, secure and encrypted record of digital transactions (Turk and Klinc 2017) that has excellent potential for the business world (Morganti, Schiavone, and Bondavalli 2018), addressing transparency and visibility issues companies face (García-García et al. 2020). Blockchain can also support sustainability by enabling the creation of sustainable business models (Mangla et al. 2022), optimising energy usage (Rana et al. 2019), reducing transaction costs, improving data security and accelerating transactions (Rashideh 2020).

Researchers are interested in the prospective benefits of blockchain for various sectors (Gatteschi et al. 2018), including the automotive (Fraga-Lamas and Fernández-Caramés 2019), banking (Gan, Keung, and Hong 2021), electronic commerce (Treiblmaier and Sillaber 2021) or hospitality and tourism industries (Kizildag et al. 2020). The tourism industry requires emerging technologies like blockchain to enhance efficiency and reduce costs (Melkic 2020). More and more airlines using cryptoassets to develop digital marketing strategies (Sakas et al. 2021). Despite the potential benefits, investigation on implementing blockchain in tourism is insufficient, with factors such as uncertainty and lack of trust affecting adoption (PWC 2022).

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Empirical studies on adoption factors are crucial (Tham and Sigala 2020). Previous works indicate the need to investigate how technologies like blockchain are adopted in tourism (Nuryyev et al. 2020; Önder and Gunter 2022), considering sustainability (Erol et al. 2022) and extending models like Technology Acceptance Model (TAM) and TOE (AlShamsi, Al-Emran, and Shaalan 2022) in different European tourist destinations (Dadkhah, Rahimnia, and Filimonau 2022). This research is the pioneer in mixing the TOE framework, HOT-fit model and sustainability dimensions to analyse key factors influencing blockchain adoption in tourism companies in Portugal, which is a crypto-friendly country suitable for empirical study (Chandler 2022), and the interest in adopting blockchain is increasing (Lacapra 2023).

This paper highlights the valuable contribution to practitioners and policymakers with a better comprehension of the challenges and benefits when managers integrate blockchain into their business models. Although there is great interest in adopting this technology, the adoption is limited in Portugal. The study addresses these research questions: How do adoption factors related to technology, organisation, environment and human factors affect blockchain uptake by Portuguese companies in the tourism sector?, and to what extent does concern for economic, social and environmental sustainability influences blockchain adoption by Portuguese tourism companies?

A survey is conducted to validate a model on the factors that influence blockchain adoption in tourism companies in Portugal using PLS-SEM statistical method. Section 2 establishes the literature review about blockchain and the gap. Section 3 describes the theoretical framework, including hypotheses. Section 4 details the study methodology with the questionnaire, data collection and variables. Section 5 displays the findings of the econometric model, and the final parts discuss the implications, conclusions and investigation trends.

2. Literature review

Blockchain provides an immutable and traceable public ledger (Werner et al. 2021), which can positively influence the tourism company's competitiveness (Tham and Sigala 2020), approaching substantial benefits like cost reduction, improved traceability, and transparency, reduced risks, better customer service (Nam et al. 2021). Although blockchain has advantages, some entrepreneurs find it difficult to adopt it due to the scarcity of rules (Sharma et al. 2021), insufficient support to implement it (Koster and Borgman 2020) or lack of perceived benefits (Clohessy and Acton 2019) including those related to sustainability (Polas et al. 2022).

Previous research are focused on the typical technology adoption models like the Unified Theory of Acceptance and Use of Technology (UTAUT) (Wamba, Queiroz, and Trinchera 2020), TOE (Clohessy, Acton, and Rogers 2018), TAM (Liu and Ye 2021), or HOT-fit model (Miyachi and Mackey 2021), or in diverse sectors (Prisco et al. 2022), like halal food (Ali et al. 2023), healthcare (Kabra 2023), logistics supply chain (Ganguly 2022) or education (Liu and Ye 2021). There is still little blockchain adoption in the tourism sector (Jain et al. 2023). To fill this research gap, our paper is based on previous investigations in tourism (Chang et al. 2022) integrating the HOT-fit model with TOE (Alizadeh et al. 2020; Sallehudin et al. 2019) and sustainability (Polas et al. 2022).

3. Theory and hypotheses

Although initially the HOT-fit model was used in the field of health, this model is utilised in different sectors and contexts, and it began to see its application in the tourism sector (Yadegaridehkordi et al. 2018) and technologies like blockchain (Miyachi and Mackey 2021). HOT-fit allows us to show that human factors influence technology adoption (Yusof et al. 2008), and the TOE framework is an appropriate model to study technology adoption theoretically (Tornatzky, Fleischer, and Chakrabarti 1990). To achieve a holistic analysis framework, this adoption model framework that includes human, technology, organisation, environment and sustainability, will help companies

in the tourism sector's decision-making process by assessing diverse challenges upsetting blockchain adoption, making our model broader and complete to successfully predict technology adoption (Lian, Yen, and Wang 2014)

In this research, to understand the causes impacting blockchain adoption, it formulated these hypotheses were derived from these models (Figure 1).

The HOT-fit model, in which human and organisational factors play a relevant role in Information Systems (IS) (Yusof et al. 2008) has its basis in earlier models, e.g. the IS Success Model (DeLone and McLean 2004) and the IS Organisational Fit Model (Scott-Morton 1991).

Given the importance of the human factor in the implementation of any IT project (Xu and Lu 2022), previous research has shown the importance of the role of the CIO in supporting the digital transformation of businesses and helping them to transform and adopt new technologies (Parra and Guerrero 2020). The CIO's innovativeness significantly influences IT adoption (Alshamaila, Papagiannidis, and Li 2013; Yusof et al. 2008) and could be considered a driver for the motivation to implement a new technology (Agarwal and Prasad 1998). However, this influence needs to be investigated beyond the manufacturing sector, with particular interest in the service sector (Lian, Yen, and Wang 2014).

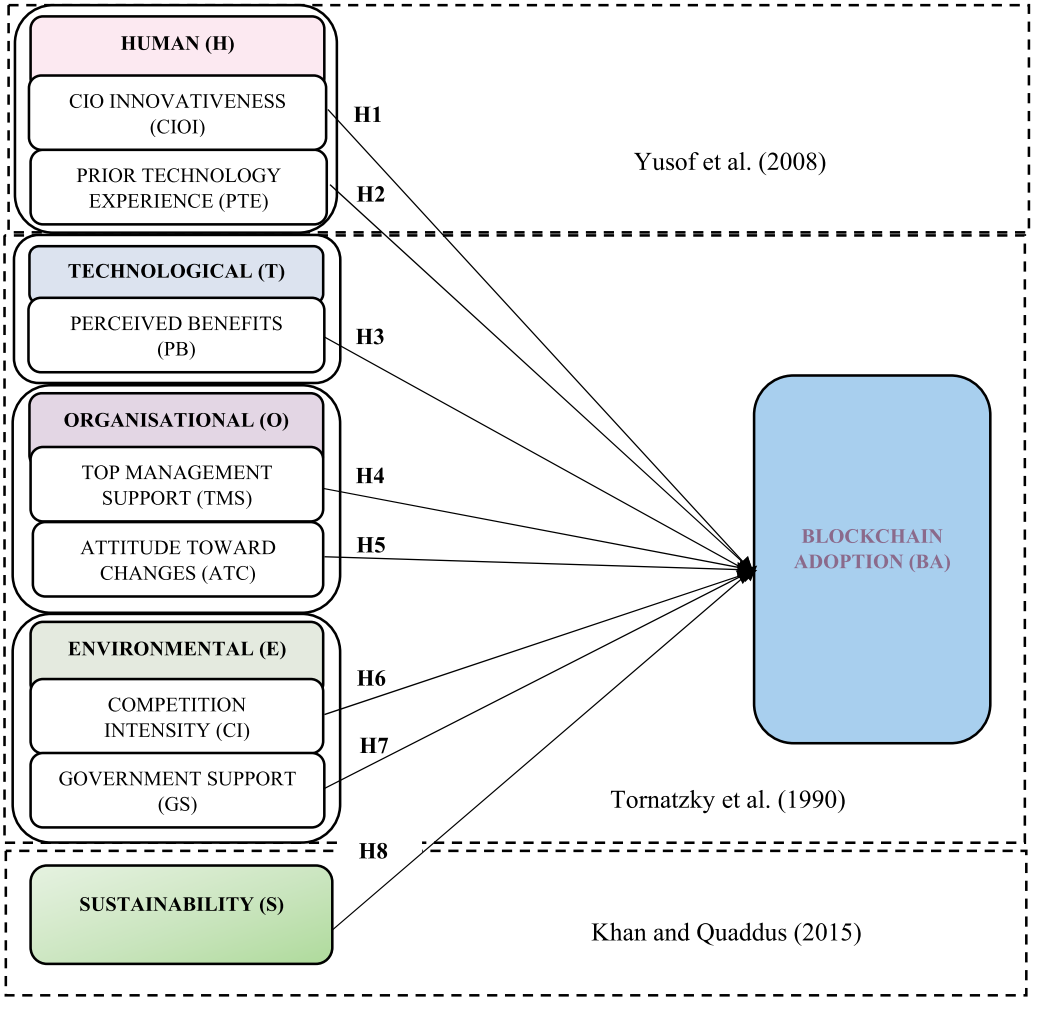

Figure 1. Proposed Model. SHTOE Factors influencing Blockchain Adoption (BA).

Hypothesis 1 (H1): CIO Innovativeness (CIOI) positively influences blockchain adoption (BA) by companies.

The human resources involved in the process must have certain skills and abilities to implement the change (Nathasit, Phensoame, and Vatananan 2010). Key among these skills is those related to the technology being implemented. Previous technology expertise by IT employees influences IT acceptance within the business (Lian, Yen, and Wang 2014). Thus, the success of blockchain implementation requires human capital with specialised blockchain skills (Helliar et al. 2020). In addition, certain demographic or cultural characteristics may condition this success. Young workers can better adapt and adopt new technologies because they have a major predisposition to learn them (Weinberg 2004).

Hypothesis 2 (H2): Prior Technology Experience (PTE) positively influences blockchain adoption (BA).

Research considers the employment of strong models for innovative technologies, such as the TOE Framework (Tornatzky et al. 1990), which applies to companies examining its three primary contexts.

The TOE Framework includes the technological factor with variables like complexity, relative advantage, security, privacy and compatibility that could influence the acceptance of actual or new technologies (Rogers 1995), and other factors like cost reduction (Rana et al. 2019), increasing efficiency and productivity (Korpela, Hallikas, and Dahlberg 2017). Benefits perceived by customers and education regarding blockchain's use in other industries are crucial in increasing its adoption (OECD 2020). Companies perceive benefits from implementing technology when they expect it to benefit their organisation (DiMaggio and Powell 1983). Blockchain technology generates positive company benefits (De Castro, Tanner, and Johnston 2020).

Hypothesis 3 (H3): Perceived Benefits (PB) positively influence blockchain adoption (BA).

Organisational vision implies the heart aspects of an organisation like previous experience in technologies, innovation, support of senior management, organisation dimension, information intensity and organisational inclination (Wang, Wang, and Yang 2010).

Top management support facilitates organisational leadership (Kouhizadeh, Saberi, and Sarkis 2021). Top Management Support is an important part of companies' decisions when adopting new technologies and is recommended to establish blockchain (Clohessy and Acton 2019). The leadership of senior management supplies the necessary resources (De Castro et al. 2020); if leadership support is scarce, the prospects of implementing innovative technologies like blockchain are reduced (Koster and Borgman 2020).

Hypothesis 4 (H4): Top Management Support (TMS) positively influences blockchain adoption (BA).

Attitude towards change enables organisations to realise the potential of blockchain technology (Rashideh 2020). Workers increasingly have a positive attitude toward adopting emerging technologies (Yeboah-Boateng and Essandoh 2014). So, the individual's desire to engage in change is fundamental, but it requires that this motivation is accompanied by the organisation's direction in implementing the change (Nathasit, Phensoame, and Vatananan 2010).

Hypothesis 5 (H5): Attitude Toward Changes (ATC) positively influences blockchain adoption (BA).

The environmental factor includes variables that affect a company's business strategies, like competitive industry dynamics, government collaborations and legislation (Lippert and Govindarajulu 2006).

Competitive or external pressure to remain forward the competition and access the technology despite its high cost or minimal degree of entrance into the industry is a challenge for companies (Farooque et al. 2020). This competitive pressure conditions their corporate strategies in both direction and method, in a trial-and-error attempt to achieve rapid adaptation or change (Howells and Hine 1991). Competition Intensity is the competitive pressure group in which organisations are afraid of losing their competitive advantage and is considered an essential variable when it comes to embracing blockchain. Therefore, competitive pressure stimulates companies' decisions to implement blockchain (Wong et al. 2020).

Hypothesis 6 (H6): Competition Intensity (CI) positively influences blockchain adoption (BA).

Government support is defined as those policies, initiatives and government incentives that encourage the implementation of technology like blockchain (Koster and Borgman 2020). In those cases where the Government does not show enough support, the reception of blockchain is impossible (De Castro et al. 2020), so the support of the Government is essential (Wong et al. 2019). Even the application of this technology in e-administration can help to meet social needs and public values (Ølnes, Ubacht, and Janssen 2017). Government support is necessary and the lack of legislation is a barrier (Sharma et al. 2021).

Hypothesis 7 (H7): Government Support (GS) positively influences blockchain adoption (BA).

Sustainability involves ideas and solutions that address global climate change through its three dimensions: economic – productivity gains through Industry 4.0 technologies that reduce production costs and generate income (Spangenberg 2005), social – use of natural resources without injuring the environment and reducing greenhouse emissions (Bai et al. 2020) – and environmental – entails ethical business practices that achieve workplace justness develop human capital and improve participation of the community (Shdifat, Kozanoglu, and Erfani 2021), including fair wages, healthcare and employee–employer relations (Alhaddi 2015). 'The path towards sustainability requires business strategies that ensure profitability, analysing how the combination of transition management, adaptive planning and socio-technical approaches can contribute to an effective implementation of sustainability-oriented innovations in the business context' (Almeida and Melo 2017, 395).

Hypothesis 8 (H8): Sustainability (S) positively influences blockchain adoption (BA).

4. Research methodology

PLS-SEM is employed to analyse the relationship between variables. This quantitative technique is recommended to analyse the complex framework (Hair et al. 2017). Compared to CB-SEM, PLS-SEM is robust even with a small sample, especially in business research, and it accommodates higher-order constructs, both reflective and formative (Hair et al. 2017). In addition, 'both the average variance extracted (AVE) and composite reliability (CR) values are higher in the PLS-SEM method, indicating higher reliability and construct validity' (Dash and Paul 2021, 121092). SmartPLS 4 is the software utilised to check the measurement and the structural models (Ringle, Wende, and Becker 2022).

4.1. Sample and data collection

It selected companies in the tourism sector of Portugal as the target population. Portugal is composed of 74.560 tourism firms (Portugal Bank 2022). It used Orbis and Sabi Databases to find the public target, where around 18.000 tourism firms appeared. To send the email to these enterprises, we used simple random sampling. The questionnaires were sent in Portuguese, so we translated the English items into Portuguese. The investigation intended to comprehend how these challenging aspects would impact blockchain adoption. The questionnaire had one question to see the knowledge of this technology. According to the data collection, we emailed our questionnaire and contacted the Chief Executive Officers (CEO) or senior IT staff by phone. A pilot study is realised utilising data from 30 fulfilled surveys to confirm the validity and reliability. It collected the data from September 2022 to December 2022, getting a representative sample of 210 results. Hair et al. (2017) consider an appropriate sample between 200 and 400.

4.2. Instrument and variables

The tool used to carry out the descriptive surveys of this research is a survey based on the Likert score scale from 1 to 7: from totally disagree (1) to totally agree (7). It utilised a 7-point scale to generate

added flexibility and preferences for respondents growing the reliability and accuracy of the investigation finding (Featherman and Pavlou 2003). All the validated items are the following: CIOI is adapted from Alshamaila, Papagiannidis, and Li (2013), PTE from Lian, Yen, and Wang (2014), PB from DiMaggio and Powell (1983), TMS and GS from Koster and Borgman (2020), ATC from Yeboah-Boateng and Essandoh (2014), CI from Wong et al. (2020) and sustainability dimensions from Khan and Quaddus (2015).

5. Data analysis and results

5.1. Demographic data

Concerning the companies' properties, most respondents are micro-small companies (65,21%) with more than 20 years of existence (89,52%), Only 9.05% of organisations are multinationals. Concerning the category most firms are accommodations (40,95%), tour operators (11,90%), travel agencies (10%), restaurants (6,67%) or museums (5,24%).

5.2. Measurement model

The measurement reliability model was examined using the PLS method. It is considered that the minimum appropriate assessments of factor loads, Cronbach's Alpha (CA) and Composite Reliability (CR), must be identical to or more than 0.7 (Hair et al. 2017) and in the case of the Average Variance Extracted (AVE) must be more than 0.5 (Fornell and Larcker 1981). The evaluation demonstrates the credibility of the indicators since they are all above 0.7. Table 1 shows the measurement model outcomes with diverse metrics such as outer loading, CR and CA.

Table 1. Measurement model results.

Constructs	Items	Factor Loading	Composite Reliability	CA	AVE	Validity?
CIO Innovativeness (CIOI)	CIOI1	0.939	0.903	0.887	0.898	Yes
	CIOI2	0.956				
Prior Technology Experience (PTE)	PTE1	0.900	0.723	0.710	0.774	Yes
	PTE2	0.859				
Perceived Benefits (PB)	PB1	0.923	0.973	0.971	0.898	Yes
	PB2	0.950				
	PB3	0.958				
	PB4	0.947				
	PB5	0.959				
Top Management Support (TMS)	TMS1	0.932	0.959	0.948	0.906	Yes
	TMS2	0.970				
	TMS3	0.954				
Attitude Toward Changes (ATC)	ATC1	0.957	0.906	0.906	0.914	Yes
	ATC2	0.955				
Competitive Intensity (CI)	CI1	0.892	0.910	0.904	0.840	Yes
	CI2	0.949				
	CI3	0.907				
Government Support (GS)	GS1	0.955	0.965	0.964	0.932	Yes
	GS2	0.963				
	GS3	0.978				
Economic Sustainability (ECS)	ECS1	0.936	0.986	0.986	0.898	Yes
	ECS2	0.941				
	ECS3	0.930				
Environmental Sustainability (ENS)	ENS1	0.942				
	ENS2	0.945				
	ENS3	0.960				
Social Sustainability (SS)	SS1	0.964				
	SS2	0.956				
	SS3	0.953				
Blockchain Adoption (BA)	BA1	0.961	0.950	0.949	0.908	Yes
	BA2	0.949				
	BA3	0.949				

5.3. Structural model

It verified the path (β) and determination (R^2) coefficients to judge the causal relationship by the data reflected (Hair et al. 2017). Table 2 establishes the demonstration of the hypotheses test develops. The findings specify that all projected hypotheses are not rejected, except for perceived benefits, attitude toward change and government support.

In this section, it describes the *p*-values and β coefficient. The model describes 60.8% of the variation in blockchain adoption. CIOI (H1) accounted for 12.8% (β coefficient = 0.128, $p < 0.05$), PTE (H2) clarifying 16.9% (β coefficient = 0.169, $p < 0.05$), TMS (H4) describes −17,1% (β coefficient = −0.171, $p < 0.05$), CI (H6) explaining 38.6% (β coefficient = 0.386, $p < 0.001$), and sustainability (H8) clarifying 16.8% of the variation in blockchain adoption (β coefficient = 0.168, $p < 0.001$), are not rejected being statistically significant. H1, and H2 are not rejected but with small effect. Evidence gives partial support to. H6 and H8 are not rejected with medium effects. PB (H3) (β coefficient = 0.052, $p < 0.05$), ATC (H5) (β coefficient = 0.023, $p < 0.05$) and GS (H7) (β coefficient = −0.136, $p < 0.05$) are variables not supported.

The F^2 measurement is analysed to indicate if the concept is significant. It implies a substantial influence if F^2 is more than 0.350, a moderate influence if F^2 is between 0.350 and 0.150, or a little influence if F^2 is between 0.150 and 0.020 (Costa et al. 2016). In this research, all hypotheses are positive except for TMS and GS, and all are significant except for PB, ATC and GS. Concerning impact, sizes are all small except for CI and GS with a medium size (Figure 2).

6. Discussion

This work aims to find the aspects influencing Portuguese tourism companies' intention to adopt blockchain. For this purpose, the model is constructed on the TOE, the HOT-fit and the sustainability magnitudes.

The human factor is measured by CIOI and PTE. Both have a positive effect on the intention to adopt blockchain. Those companies whose CIO are more innovative, and staff have more technology experience are more likely to adopt technologies (Yusof et al. 2008). In previous studies, CIOI does not positively influence technology adoption (Lian, Yen, and Wang 2014). The same occurs in the case of PTE. The reason could be the time of execution decisions. Managers are not interested in adopting the technology (Alharbi, Atkins, and Stanier 2016) cause of the insecurity of creating benefits with this innovative technology in the early stages.

Table 2. Path coefficient analysis.

Hypotheses	Relationship	f^2	Effect Size	*P*-Value	β^	Results	Decision
H1	CIOI -> BA	0.029	Small	0.008 ($p < 0.05$)	0.128	Positive Statistically Significant**	Supported
H2	PTE -> BA	0.060	Small	0.038 ($p < 0.05$)	0.169	Positive Statistically Significant**	Supported
H3	PB -> BA	0.002	Small	0.514 ($p < 0.05$)	0.052	Positive Statistically Non-Significant **	NS
H4	TMS -> BA	0.019	Small	0.038 ($p < 0.05$)	−0.171	Negative Statistically Significant**	PS
H5	ATC -> BA	0.000	Small	0.787 ($p < 0.05$)	0.023	Positive Statistically Non-Significant **	NS
H6	CI -> BA	0.150	Medium	0.000 ($p < 0.001$)	0.386	Positive Statistically Significant***	Supported
H7	GS -> BA	0.030	Small	0.054 ($p < 0.05$)	−0.136,	Negative Statistically Non-Significant**	NS
H8	SUST -> BA	0.168	Medium	0.000 ($p < 0.001$)	0.168	Positive Statistically Significant***	Supported

Notes: ** significant at $p < 0.01$; *** significant at $p < 0.001$. NS = Not Supported; PS = Partially Supported – significant but negative.

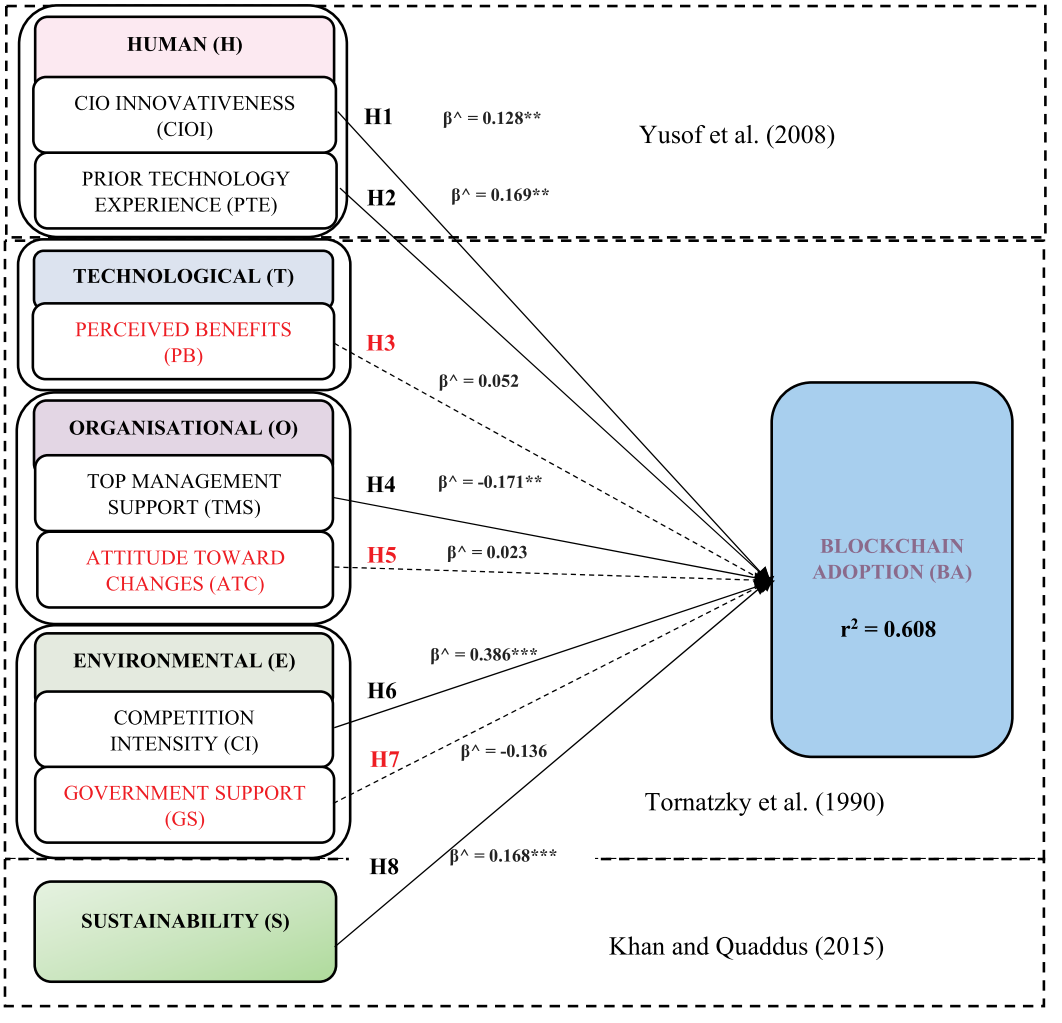

Figure 2. Blockchain Adoption (BA) explained by STHOE model. ** significant at $p < 0.01$; *** significant at $p < 0.001$.

The technological factor is represented by PB. PB has a negative influence on adopting blockchain. Previous studies consider blockchain companies perceiving greater benefits, saving costs and increasing service quality (Korpela, Hallikas, and Dahlberg 2017). However, in this research, most companies perceive that application blockchain application does not increase the benefits. This factor is probably derived from a current increase in the number of tourists in Portugal in 2022 in which Gross Value Added (GVA) reached levels of 2019 (8.1% GVA), before the pandemic (OECD 2022). It could suppose a lack of initiative to adopt blockchain since enterprises consider it unnecessary and would not bring them more benefits. Contrariwise, other works consider that PB positively impacts blockchain adoption (Malik et al. 2021) because managers are conscious of the potential blockchain advantages.

The organisational component is measured by TMS and ATC. TMS has a negative effect on adopting blockchain; conversely, the ATC has a positive result. Other studies determine that TMS impacts blockchain adoption (Kabra 2023), considering a low adoption without TMS (Orji et al. 2020). However, in our results, workers' lack of trust in blockchain could cause a scarcity of confidence in what the TMS. Previous studies consider the shortage of influence of the TMS, too (Wong et al. 2020). It is established that a good ATC incentivises blockchain adoption (Rashideh 2020). For this

reason, ATC impacts technology adoption in line with previous research (Yeboah-Boateng and Essandoh 2014). We do not find other studies focused on the impact of ATC on blockchain adoption. TMS has a negative effect on blockchain adoption. The reasons could be the perception of support as pressure, inadequate communication and a lack of user involvement.

The environmental factor is represented by CI and GS. CI has a positive force in blockchain adoption, and GS negatively affects blockchain adoption by Portugal companies. Firms do not feel pressure and are not afraid of losing a competitive advantage. This may be due to the current context, in which there is a remarkable absence of information about the blockchain concept and a bear market in the investment markets and crypto assets that do not accompany it. Probably if the situation were reversed there would be greater adoption of blockchain. Previous studies have considered that adopting blockchain is relevant for companies to remain competitive (Wong et al. 2019, 2020).

The lack of support from governments and institutions and correct legislation do not generate confidence in firms, so they are reluctant to adopt blockchain. When a government shows support, it builds trust in business (Orji et al. 2020). Other works confirm that GS impact innovation adoption (Kabra 2023; Oliveira, Thomas, and Espadanal 2014) because GS is essential to show knowledge and educate the population about new technologies (Kabra 2023). It is recommended to know well the existing legislation in the country of application of this technology, as well as the correct knowledge of the terms of blockchain to implement valid legislations that cover the damages caused, in case of generating them, to companies and society in general.

The sustainability dimensions – social, economic and environmental – positively impact blockchain adoption. Enterprises may believe that blockchain is not sustainable due to the high energy cost of Bitcoin when using the Proof of Work consensus mechanism. However, companies should consider another consensus mechanism like Proof of Stake (PoS) to reduce energy costs. Prior research indicates that the influence of competitive advantage on economic sustainability holds a larger significance in digitalisation than its influence on social or environmental sustainability (Hajishirzi, Costa, and Aparicio 2022). Some works consider sustainability a challenge for blockchain implementation (Boakye et al. 2023).

7. Conclusions and implications for theory and practice

Despite Portugal being a country with a high reception of blockchain, the tourism sector is lagging in its adoption. This may be due to a lack of information, innovation, experience, and the necessity to develop reasonable regulations to guarantee benefits in their businesses.

7.1. Theoretical implications

This article expands on the existing works about the relationship between blockchain and companies, contributing to the theoretical framework reducing existing research gaps, and increasing the number of empirical studies related to the topic that show blockchain technology's potential. There are diverse studies on the supply chain. Kshetri (2021) and Leal et al. (2020) consider that blockchain can help address challenges that may arise in the supply chains of developing countries, such as an unfavourable institutional environment, elevated costs, technological supply constraints, inadequate distribution of power between chain partners, and absorbency and opaqueness of value distribution networks. To the best of our knowledge, there is a tiny investigation in the tourism and hospitality field and none that analyses the intention of adopting Portuguese tourism companies. According to the best of our knowledge, it can be seen how this study is distinctive and it tries to explore important research gaps in this area shedding light on those reasons that influence the decision to use blockchain considering sustainability. Since it sees fit to reduce that research gap, no study still integrates all the factors of TOE, HOT-fit and Sustainability dimensions analysing the intention to use blockchain.

7.2. Practical implications

These findings provide constructive insights for tourism sector companies on implementing blockchain technology, particularly on the environmental factor. The paper highlights the relevance of CIOI and PTE in blockchain adoption by companies (Yusof et al. 2008), and the main difference regarding blockchain adoption compared to other technologies is the lack of adoption due to the scarcity of trust in businesses, likely due to absence of information and deficiency of government support (Orji et al. 2020). Successful implementation requires an innovative and knowledgeable staff, an evaluation of available resources, and a cost–benefit analysis. Blockchain offers numerous benefits, such as increasing product quality, supply chain efficiency and productivity (Korpela, Hallikas, and Dahlberg 2017), applying discounts and promotions for consumers and gamification strategies (Makori 2022), and promoting sustainability (Mangla et al. 2022), enabling payment through cryptocurrencies (Rashideh 2020). Companies must learn about technology and adapt to change to achieve these benefits. Firms need to identify the best consensus mechanism for reducing energy costs (e. g. PoS) (Vranken 2017) and using renewable energy sources to make it more sustainable. Companies must also consider factors such as competition intensity (Farooque et al. 2020), government support and regulation for successful implementation (Orji et al. 2020).

8. Limitations and future research

The research contains limitations in terms of the geographic scope, only including Portuguese companies, and future research could expand to other European regions. As blockchain is considered an emerging technology, there is a scarcity of information, financial and human resources, and further research could investigate companies that have already adopted blockchain to identify potential failures. Future studies could also incorporate competitive strategies and consider moderator variables, such as disintermediation and information transparency, to recognise blockchain adoption better. Additional quantitative, qualitative, or mixed-methods studies are needed to offer better results. The relationship between blockchain and sustainability needs more empirical evidence of its ties in its different environmental, social and economic dimensions (Khan and Quaddus 2015), especially in tourism (Kouhizadeh, Saberi, and Sarkis 2021).

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