An empirical study on the commercial adoption of digital currencies

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Abstract
Digital currencies are rapidly evolving Internet currencies that have been increasingly attracting academic, governmental, banking, and business interest. This paper aims to present the commercial perspective towards the adoption of digital currencies as a means of daily transactions. Considering digital currencies as a pioneering technological innovation, this study proposes a research model that combines the Innovation Decision Process Model (IDPM) with the Technology Acceptance Model (TAM), adding the construct of perceived security in order to investigate the factors that affect the actual use of digital currencies. The collected data from 254 respondents, derived from an online questionnaire-based survey addressed to commercial users, were further analyzed by using Structural Equation Modeling (SEM). The findings of this research have significant implications for academics by bridging the gap in the literature about the factors affecting digital currencies' commercial adoption and for practitioners concerning decision-making on their adoption and use. More specifically, this study stresses the role of perceived security and the fact that managers need to build their policies regarding transactions in digital currencies on the basis of security. Perceived usefulness was also found to be a significant factor, meaning that commercial users should be aware of the advantages of digital currencies regarding businesses. Moreover, compatibility with existing values and practices affects indirectly the actual use of digital currencies, implying that managers need to perceive that the use of digital currencies should be compatible with existing practices.

Keywords Digital Currencies · Cryptocurrencies · Innovation Decision Process Model · Technology Acceptance Model · Structural Equation Modeling

1 Introduction

Digital currencies' mainstream adoption is a critical issue. Cryptocurrencies are the most representative type of digital currencies (Mallqui and Fernandes 2019). Today, there are more than 2,120 cryptocurrencies and the total market capitalization is greater than $130 billions (CoinMarketCap 2019). Bitcoin is the first decentralized peer-to-peer payment network (Nakamoto 2008) and the dominant cryptocurrency, while over 100,000 businesses in the world accept bitcoins[2] (Mallqui and Fernandes 2019). The sooner the commercial users understand how digital currencies affect global commerce, the better they will be prepared for a rapidly evolving financial landscape.

Digital currencies represent online means of payment that differ significantly from the traditional ones, such as cash, cheques, debit/credit cards and bank transfers (Pîrjan et al. 2015). Digital currencies are decentralized (they are not issued or controlled by a central bank or institution). They are based on cryptography and consensus

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[2] According to the website bitcoin.org, the term Bitcoin with capital "B" is used when describing the concept of Bitcoin or the entire network itself, while the term bitcoin with lower-case "b" is used to describe bitcoin as a unit of transaction (https://bitcoin.org/en/vocabulary#bit)

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(Antonopoulos 2014); hence, they are considered as a disruptive technological innovation (Folkinshteyn and Lennon 2016). Despite the rising market capitalization, digital currencies have not become mainstream yet. According to Barry Silbert, the CEO and founder of the Digital Currency Group, the global consumer adoption phase will only occur if, (i) the companies' innovations facilitate consumers to transact and invest in Bitcoin, (ii) the trade volume increases so much, that payments in Bitcoin start to be accepted by large merchants, and (iii) the awareness about Bitcoin expands (Maudlin 2014). However, the payment network closer to Bitcoin is considered to be Western Union rather than Visa, MasterCard or Discover, because Bitcoin is a network that is used more for remittances instead for consumption (Folkinshteyn and Lennon 2015; Tasca 2016).

So, what is the meaning of these growing transfers of money in digital currencies from person to person, when they cannot be widely used for payments in daily life? Will more commercial users follow this trend and adopting digital currencies as a means of transaction eventually lead to their mainstream use? These are the fundamental questions that motivated this research and led to the main research question: what are the factors that affect the commercial adoption of digital currencies?

In the IT/IS field, there has been growing interest in digital currencies (Oshodin et al. 2016). Literature about digital currencies covers mostly technological, theoretical, economic, and regulatory issues. However, in the research topic of commercial adoption of digital currencies, there is lack of empirical research. Until now, studies have been addressed mainly to individual users of Bitcoin in general, mostly consumers and investors (Smyth 2013; Bohr and Bashir 2014; Glaser et al. 2014; Silinskyte 2014; Kumpajaya and Dhewanto 2015; Abramova and Böhme 2016; Bashir et al. 2016; Catalini and Tucker 2016; Gao et al. 2016; Krombholz et al. 2016) and very few have dealt with organizations and e-commerce (Connolly and Kick 2015; Polasik et al. 2015).

To address this gap, this study focuses on the commercial users, i.e. the particular type of end-users' category of the digital currencies network (Folkinshteyn and Lennon 2016) and sheds light to the factors that affect their decision towards the adoption of digital currencies. Thus, this approach suggests a new perspective that extends prior research and could contribute to the understanding of how commercial end-users act and think about digital currencies, as well as to assist commercial users to adapt better and sooner to the new digital financial reality.

The remainder of the paper is organized as follows: Section 2 presents the theoretical background and Section 3 describes the methodology followed. Section 4 analyzes the results including descriptive statistics and SEM, while Section 5 discusses the theoretical and managerial implications of the study; finally, Section 6 summarizes the conclusion, limitations, and future research directions.

2 Theoretical background

2.1 Overview of digital currencies and related work

Digital currencies could correspond to email and are encountered as the Internet of money. Besides, blockchain technology is compared to the early Internet and is considered the most exciting technology since the World Wide Web appearance (Antonopoulos 2014; Folkinshteyn et al. 2015).

Digital currencies are mostly used in electronic commerce transactions (European Central Bank 2012; Polasik et al. 2015; Redžović and Novaković 2016). Digital currencies offer benefits to both companies and consumers, such as lower transaction fees (Brito and Castillo 2013; Dion 2013), instant and global transactions, simplified payment processes (Folkinshteyn et al. 2015b; Ciaian et al. 2016), private pseudo-anonymous transactions, no counterfeiting, and no intermediaries (Ciaian et al. 2016; Ermakova et al. 2017). The greatest advantage for e-business is that there are no chargebacks, meaning that digital currencies transactions cannot be reversed arbitrarily by the sender, i.e. consumers, as debit/credit card chargebacks can, thus avoiding chargeback frauds and rolling reserves kept by card companies (Ron and Shamir 2013; Bashir et al. 2016; Folkinshteyn and Lennon 2016; Gao et al. 2016). Digital currencies can be used in all countries, thus there is no need to exchange currencies (Saito 2015). By accepting digital currencies, businesses can reach consumers in every part of the world. This can increase their revenue and mitigate economic fluctuations in any local area (Dwyer 2015; Folkinshteyn and Lennon 2016).

Literature, so far, focuses on technological issues (Decker and Wattenhofer 2013; Meiklejohn et al. 2013; Ron and Shamir 2013; Sompolinsky and Zohar 2013; Vasek et al. 2014; Andrychowicz et al. 2015; Eyal and Sirer 2018), theoretical issues (Moore 2013; Teigland et al. 2013; Karlstrøm 2014; Saito 2015), economic aspects (Becker et al. 2013; Chowdhury and Mendelson 2013; Iavorschi 2013; Kroll et al. 2013; Moore and Christin 2013; Dwyer 2014; Van Alstyne 2014; Wang 2014), as well as regulatory aspects (Stokes 2012; Dion 2013; Shadab 2014; Luther 2015).

Few studies have dealt with organizations and e-commerce (Connolly and Kick 2015; Polasik et al. 2015), as aforementioned in the preceding section. Connolly and Kick (2015) selected randomly 30 companies from the list of organizations provided by usebitcoins.info and compared these adopters' IT readiness, innovativeness, and social media presence to other 30 non-adopters companies. According to this study, the adoption by organizations is more important than the adoption by consumers because consumers cannot use cryptocurrency if organizations do not accept them as a payment method. This study is based on the characteristics of the five-user groups in the DOI theory (see Section 2.2) and implies that organizations can use the results to compare themselves to Bitcoin adopters and non-adopters in order to identify their own level of readiness to adopt Bitcoin. Polasik et al. (2015) investigated both Bitcoin price formation and e-commerce adoption, in order to understand the factors driving prices and inform vendors for the most favorable circumstances to adopt Bitcoin in online transactions. They found that business features, use of other payment methods, customers' knowledge about Bitcoin, and the size of both the official and unofficial economy are significant determinants in the formation of the proportion of sales attributed to Bitcoin. This study was based on the network externality theory and Rogers's concept of innovation diffusion and was addressed to merchants who had adopted Bitcoin in their e-business.

2.2 Diffusion of Innovations Theory and Innovation Decision Process Model

Diffusion of Innovations (DOI), proposed by Everett Rogers (1962), explains how innovation is accepted and diffused within a social system. Rogers demonstrated five categories of adopters according to their innovativeness that embrace technological innovation at different rates: Innovators, Early Adopters, Early Majority, Late Majority, and Laggards. According to Rogers, innovativeness is the grade at which a person or another unit of adoption is relatively previous in the adoption of new ideas than other members of the social system. In IT, innovativeness is the "willingness of an individual to try out any new information technology" (Midgley and Dowling 1978; Flynn and Goldsmith 1993). Hence, in the technology acceptance domain, innovativeness could be freely interpreted as the degree of interest in trying a new thing, a new concept or innovative product or service (Zarmpou et al. 2012).

Rogers (1995) described the process through which an individual or another decision-making unit passes from the five stages, as depicted in the Innovation Decision Process Model (IDPM) (see Fig. 1).

IDPM was based on communication theory and is encountered as the adoption part of the DOI model by Rogers (Seligman 2000). Innovation diffusion uses an approach in which the decision to adopt new technology is mainly based on perceptions of the technology within the decision-making unit (Rogers 1995; Tatnall and Burgess 2004). As depicted in Fig. 1, Rogers (1995) has identified five attributes that provoke the diffusion of innovation: 1) relative advantage, 2) compatibility with existing values and practices, 3) complexity, 4) trialability, and 5) observability. Potential adopters evaluate an innovation based on these innovation attributes.

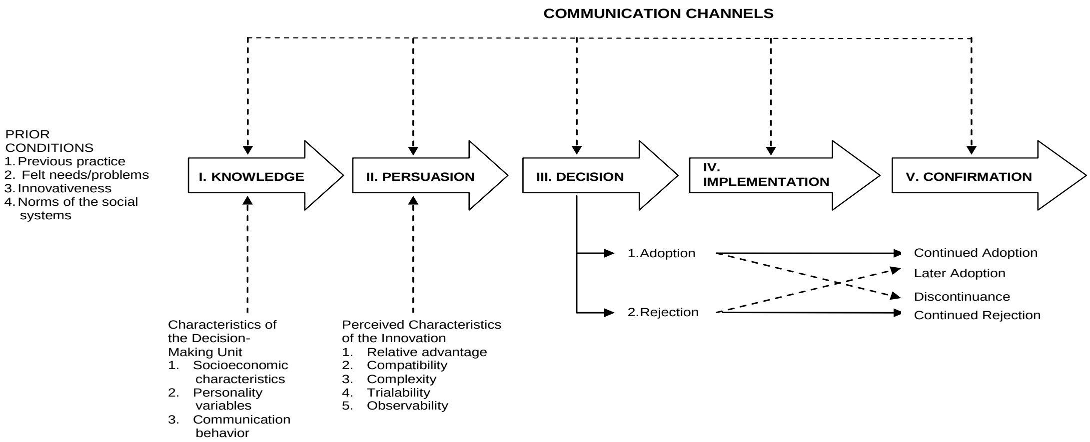

Fig. 1 Innovation Decision Process Model (IDPM) (Rogers, 1995)

The concept of digital currencies involves a series of innovations: the peer-to-peer decentralized network, blockchain (the public register of transactions), mining (the mathematical system for issuing the currencies), the proof-of-work or proof-of-stake methods, and the decentralized system of transaction verification based on consensus, digital signatures, and timestamps. All these underpinned technologies have created a wave of innovation in currencies and marked the beginning of a new era for innovations in financial services, economics, distributed systems, voting systems, corporate governance, and contracts (Antonopoulos 2014; Pîrjan et al. 2015).

Most innovations in the last few years are technological, due to the evolution in IT/IS field. Diffusion of Innovations has been successfully employed in numerous IT studies (Hoffer and Alexander 1992; Moore and Benbasat 1996; Karahanna et al. 1999), in the adoption and diffusion of innovations in digital environments (Rangaswamy and Gupta 2000), e-banking (Kolodinsky et al. 2004; Gounaris and Koritos 2008), digital mobile technology (Kauffman and Techatassanasoontorn 2005), e-government (Carter and Bélanger 2005), and e-commerce (Eastin 2002; Pease and Rowe 2005); even in Bitcoin adoption in organizations and the relevant MIT students' experiment (Connolly and Kick 2015; Catalini and Tucker 2016). Hence, DOI theory is related to the topic of this study and the use of IDPM, as a base model for studying the diffusion of the technological innovation of digital currencies and explaining their commercial adoption, is expected to be a valuable contribution.

2.3 Technology Acceptance Model and extensions

Technology Acceptance Model (TAM) was developed by Fred Davis (1985) and is the most well-established model in predicting IT adoption. It is used to explain users' behavior about adopting technology and is extensively applied to IS research. TAM was derived from the Theory of Reasoned Action (TRA) (Fishbein and Ajzen 1975; Ajzen and Fishbein 1980), which explains consumer-purchasing behavior and is considered the most influential extension of TRA in the literature. TAM uses two main factors: 1) perceived usefulness (PU), i.e. the grade at which the user believes that the adoption of technology will enhance his job performance and 2) perceived ease of use (PEOU), i.e. the grade at which the user considers that the use of a system requires zero effort, as depicted in Fig. 2.

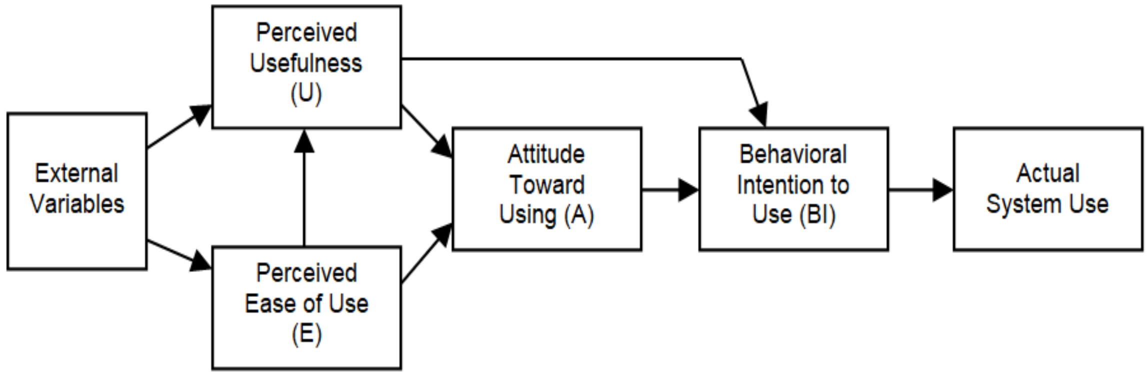

Fig. 2 Technology Acceptance Model (Davis et al. 1989)

TAM was successfully used by numerous studies dealing with the acceptance of the World Wide Web (Fenech 1998) and Web-based related technologies, such as the use of the wireless Internet (Lu et al. 2003; Venkatesh and Ramesh 2006), email (Gefen and Straub 1997), e-learning (Roca et al. 2006), healthcare IT (Hu et al. 1999; Chismar and Wiley-Patton 2003; Holden and Karsh 2010), Internet and online banking (Gounaris and Koritos 2008; Lin et al. 2015), mobile technologies (Schwarz et al. 2004; Zarmpou et al. 2012), online shopping (Vijayasarathy 2004), e-government (Carter and Bélanger 2005), and e-commerce (Pavlou 2003). Since TAM has been successfully employed in analyzing all aspects of Web-based technologies and end-users acceptance, it is a highly reasonable approach that TAM can be used as a base model for studying the use of the technological innovation of digital currencies and the commercial end-users acceptance.

TAM2 (Venkatesh and Davis 2000) and TAM3 (Venkatesh and Bala 2008) were proposed as the extensions of TAM in order to address some gaps of the original model. TAM was negatively criticized by many researchers for ignoring social and external influences, and not to be applicable to large groups of users, where the use of technology was obligatory. However, in this study, the original TAM was used rather than TAM2 or TAM3 for the following reasons: first, the two basic constructs of TAM - perceived ease of use and perceived usefulness - are considered as major constructs in literature and constantly related to the decision making, rather than the determinants of TAM2 or TAM3. Also, the basic TAM allows other factors to be incorporated easily into its original framework (El-Kasheir et al. 2009). Second, TAM2 and TAM3 are based on longitudinal research and the data collection was made between different times, with at least one month gap. Between these gaps, training, incentives, and peer support were offered, in order to address implementation problems of the new technology. Findings of TAM2 and TAM3 showed that increased experience, gained in these gaps, mediates the relationships between some of the models' determinants and perceived usefulness or perceived ease of use, accordingly.

Subsequently, TAM2 and TAM3 would not be appropriate models for this study, because the online survey ran at a specific time period, with no gaps or interventions; hence, there is not any increased experience of the respondents to evaluate. Finally, TAM2 and TAM3 determinants would not fit into a study of digital currencies. For example, TAM2 social influence determinants are not expected to have a valuable contribution in a digital currencies study, because digital currencies are based on consensus and voluntary peer-to-peer networks. Previous studies (Smyth 2013; Silinskyte 2014) indicate that individuals use digital currencies based on other motives, rather than being influenced by other social important people, nor want to improve their image and status. Specifically, social factors are not expected to influence commercial users to adopt digital currencies. Besides, some TAM3 anchor determinants (i.e. computer self-efficacy and computer anxiety) are not so contemporary anymore, as the use and familiarity with computers have increased since the appearance of TAM3.

2.4 Integration of the two theories and relation to this research

Digital currencies are based on pre-existing IT innovative achievements. When users adopt and use digital currencies, in essence they adopt and use technology and innovation; hence, firstly, from a conceptual point of view, the combined application of IDPM and TAM is justified. Secondly, previous studies have successfully integrated the two theories, producing good results (Sigala et al. 2000; Chen et al. 2002; Kolodinsky et al. 2004; Wu and Wang 2005). IDPM and TAM have many common constructs, while complement and reconfirm each other's reliability and validity in order to investigate the adoption of IT/IS (Chen et al. 2002; Lee et al. 2011). Researchers indicate that the constructs used in TAM are a subset of the Perceived Characteristics of the Innovation of IDPM. However, in a meta-analysis by Tornatzky and Klein (1982), the only IDPM's constructs that were found to be consistently related to innovation adoption are relative advantage, compatibility, and complexity (Agarwal and Prasad 1998; Kolodinsky et al. 2004). Also, these are the most influential determinants of continued usage decisions (Moore and Benbasat 1991). The constructs of relative advantage and perceived usefulness, as well as complexity and perceived ease of use, are considered to have a complementary relationship (Moore and Benbasat 1991). Relative advantage and perceived usefulness are used interchangeably in the literature. According to Wang et al. (2011), they are conceptually different constructs, but they are measured with similar items; their use depends on the subject of the research since relative advantage is preferable when multiple technologies are available to the potential adopters and a comparison between them is investigated. In the research model of this study, perceived usefulness is more appropriate to be used as a construct than relative advantage since the focus of the study is not to compare. Finally, compatibility is the only innovation characteristic from IDPM that is not included in TAM (Chen et al. 2002) and will be regarded as a distinct construct in the proposed research model of this study.

3 Methodology

3.1 Research hypotheses and proposed model

Regarding digital currencies as technological innovation, a research model that combines the Innovation Decision Process Model (IDPM) with the Technology Acceptance Model (TAM), adding the construct of perceived security, is proposed. The research hypotheses and the model are presented below.

3.1.1 Perceived ease of use, perceived usefulness, and actual use

TAM is considered the most influential theoretical framework in explaining IT/IS adoption (Lu et al. 2003) and has been successfully employed by a great number of studies, as aforementioned in Subsection 2.3. If digital currencies are easy to use, it is more probable for users to conduct transactions (Kumpajaya and Dhewanto 2015) with them. Besides, when Information and Communication Technologies are perceived as useful, individuals have the intention to use them (Wang et al. 2011).

In TAM, the two key factors, i.e. perceived ease of use and perceived usefulness, affect indirectly the dependent construct of the actual use of the system (Davis et al., 1989). Similarly, perceived ease of use and perceived usefulness are considered as a subset of the Perceived Characteristics of the Innovation of IDPM (see Subsection 2.4), which also have an indirect effect on the decision stage (3rd stage) (Rogers, 1995). At the same time, perceived usefulness affects directly behavioral intention to use (BIU), deviating attitude towards using (ATU). According to Davis et al. (1989), this deviation is due to that, in organizational environments, individuals form intentions towards behaviors they believe will increase their job performance and the subsequent consequences (i.e. pay increases, rewards or promotions) of using the system, regardless of their positive or negative thinking or feelings towards these behaviors. Besides, in TAM2 the construct of ATU has been removed because it has proven unable to reliably predict both the BIU and actual use of the system. This is consistent with prior research findings (Taylor and Todd 1995a, b). Moreover, according to Taylor and Todd (1995a), prior experience affects the behavior of IT users differently. Findings indicate that inexperienced users tend to rely primarily on perceived usefulness rather than intentions, while they may firstly focus on perceived ease of use because they have no gained knowledge from past behavior that would help them to shape their intentions.

Consequently, the examination of the direct effect of perceived ease of use and perceived usefulness on the actual use of digital currencies is proposed for the following reasons: first, digital currencies are fairly new in today's economy, especially in the business world; hence, any particular experience in digital currencies by commercial users is not expected. Therefore, there is no gained knowledge from past behavior to form commercial users' intentions. Second, commercial users are regarded as an integral part of the company they represent. It is argued that in business settings, ATU and BIU are not expected to affect the actual use of digital currencies, because companies, as decision making units according to IDPM, may take a decision that is not always aligned to the personal thoughts, feelings, and intentions of their personnel. Commercial users are asked to comply with the company's decision, but their perceptions about usefulness and ease of use will define the actual use of digital currencies. Third, this work investigates the factors that affect the commercial adoption of digital currencies. Since the use of digital currencies has started to increasingly spread nowadays, the emphasis should be given to the 3rd stage of IDPM, the stage of decision, i.e. the adoption or not of digital currencies as a means of transaction. Therefore, the research hypotheses are formulated as below:

H1 A commercial user's perceived ease of use positively affects the perceived usefulness of digital currencies.

H2 A commercial user's perceived ease of use positively affects the actual use of digital currencies.

H3 A commercial user's perceived usefulness positively affects the actual use of digital currencies.

3.1.2 Perceived security and actual use

Due to their nature, digital currencies are mostly used in e-commerce. According to Pavlou (2001), some unique dimensions of e-commerce, such as the implicit uncertainty of using Internet technologies, are not included in TAM. This uncertainty is more a consequence of people's perceptions and not so much of inadequate security mechanisms. This situation also happens in digital currencies, though encrypted technology offers adequate security mechanisms. Digital currencies are considered as the Internet of money (Antonopoulos 2014) and Internet transactions are associated with two risk possibilities: (a) privacy loss and (b) monetary loss (Pavlou 2001). Digital currencies can guarantee that the first risk does not exist thanks to blockchain, but the second risk exists, due to high price instability.

For commercial users, perceived security of digital currencies has two dimensions: (a) the security they perceive that the use of digital currencies offers to their business and (b) the security they perceive that the use of digital currencies offers to their customers. First, the use of digital currencies can help to reduce fraud and theft costs, which are two major economic drains for businesses (Coffin 2003). Also, there are no chargebacks, which eliminate e-business's risk of chargeback fraud and rolling reserves (Ron and Shamir 2013; Bashir et al. 2016; Folkinshteyn and Lennon 2016; Gao et al. 2016). However, the prices of digital currencies exhibit high volatility and since the legal and fiscal framework is also unclear in many countries, they are considered risky from a financial perspective. Monetary loss due to digital currencies' price instability is a major real threat, as well as possible troubles that could be evoked by governmental or tax authorities (Bitcoin Foundation 2014; Ermakova et al. 2017; Rapoza 2017). Also, loss of digital wallets keys or hacking of a digital wallet could be some other threats that would lead to money loss; nevertheless, digital wallets are considered safer than traditional wallets full of cash or debit/credit cards (Antonopoulos 2014).

Second, the use of digital currencies can protect from identity theft, while offers alongside enhanced privacy (Antonopoulos 2014; European Banking Authority 2013; Gao et al. 2016; Halaburda and Sarvary 2016; Dabrowski and Janikowski 2018). Unlike traditional e-transactions via banks and debit/credit cards, personal information is not stored on any computer systems, thus providing greater security to a business's customers from hackers and cyber attacks (Antonopoulos 2014). Since no middlemen are required, transactions can remain anonymous to third parties (Gao et al. 2016). Sensitive information is not compromised, because none of the consumer's personal information is attached to transactions with digital currencies (Antonopoulos 2014; European Banking Authority 2013; Gao et al. 2016; Dabrowski and Janikowski 2018). Problems with perceptions of online customers about the lack of privacy and security are among the main obstacles to the development of e-commerce (Chou et al. 1999; Furnell and Karweni 1999; Dong-Her et al. 2004) because of the possibility that financial data might be intercepted and put to fraudulent use (Jones et al. 2000). In order to attract and retain online customers, their perception of security has to be enhanced (Chellappa and Pavlou 2002; Stroborn et al. 2004; Tsiakis and Sthephanides 2005; Linck et al. 2006; Kousaridas et al. 2008). Thus, commercial users perceiving that digital currencies are secure and allowing customers to pay in digital currencies conduce to the enhancement of the customers' perception of security of the payment methods used by the businesses (Kolsaker and Payne 2002;

Flavián and Guinalíu 2006; Hartono et al. 2014). This would be a plus for businesses towards the actual use of digital currencies because it will increase their clientele and revenues.

On the grounds of the above and since this study investigates the factors that lead commercial users to the adoption of digital currencies and not the factors that prevent them, the construct of perceived security is proposed to be examined, instead of perceived risk. If commercial users perceive the level of security that digital currencies offer both to them and their customers, this will affect them positively towards their decision to adopt digital currencies in daily transactions. Thus, the following research hypothesis is formulated:

H4 A commercial user's perceived security positively affects the actual use of digital currencies.

3.1.3 Prior conditions, perceived ease of use, perceived usefulness, and perceived security

According to IDPM, there are some prior conditions that influence the knowledge stage (1st stage). These prior conditions are previous practices, the need to be fulfilled or the problem to be solved, the innovativeness of the decision-making unit, and the norms of the social systems (Rogers, 1995).

For example, if commercial users already use e-payments (i.e. previous practices) in the company they represent, they will find easier to transact in digital currencies. Moreover, when their company faces problems with high transaction fees, counterfeiting, chargeback frauds, rolling reserves, institutional restrictions, and governmental capital controls (i.e. previous practices, the need to be fulfilled or problem to be solved), they will find more useful and secure to transact in digital currencies, rather than via traditional ways of online transactions. In the same vein, when commercial users feel that they belong to a group among Innovators and Early Majority (i.e. innovativeness of the decision-making unit), then their degree of perceived ease of use, usefulness, and security of digital currencies will be greater than that of Late Majority or Laggards, and it is more probable that they will use digital currencies. Finally, when the business network or competitors have already adopted digital currencies or customers request transactions in digital currencies (i.e. norms of the social systems), this will positively influence the perceptions of commercial users towards usefulness, ease of use, and security of digital currencies, finally conducing to the actual use of digital currencies. Prior conditions are expected to affect indirectly the actual use of digital currencies, but directly and positively perceived ease of use, perceived usefulness, and perceived security. Therefore, the research hypotheses are formulated as below:

H5 Prior conditions positively affect a commercial user's perceived usefulness of digital currencies.

H6 Prior conditions positively affect a commercial user's perceived ease of use of digital currencies.

H7 Prior conditions positively affect a commercial user's perceived security of digital currencies.

3.1.4 Compatibility with existing values and practices, perceived ease of use, perceived usefulness, and perceived security

Compatibility is the only characteristic of IDPM's Perceived Characteristics of the Innovation, which is not included in TAM and is regarded as a distinct construct in this survey, as aforementioned in Subsection 2.4. Technologies that are perceived to be compatible with various aspects of an individual's experiences and working styles are more likely to produce feelings of familiarity for the new technology and result in a faster rate of adoption (Agarwal and Karahanna 1998; Chen et al. 2002; Schwarz et al. 2004). According to Kumpajaya and

Dhewanto (2015), perceived compatibility affects the user's intention towards Bitcoin. In the case of digital currencies, compatibility with existing values and practices for commercial users would be the perceived familiarity of the use of digital currencies with existing work practices (i.e. payment/revenues practices of the company), company's systems (i.e. business functions, IT infrastructure, software), transaction rules and taxation (i.e. chargebacks, rolling reserves, V.A.T.), and existence of governmental/institutional legislation. For example, if commercial users are able to sell their products or services by using the IT infrastructure that their business possesses, then the commercial users' perceived ease of use of digital currencies is enhanced. Furthermore, when selling products and services in digital currencies conduces to the augmentation of the clientele and to lower transaction fees, then this practice enhances the commercial users' perceived usefulness of the digital currencies. Besides, when commercial users can pay their providers or employees with digital currencies, then the commercial users' perceived usefulness of digital currencies is also enhanced. Finally, when selling products and services in digital currencies is harmonized with legislation and taxation, then the commercial users' perceived security about digital currencies is increased.

According to Oh et al. (2003), perceived usefulness and perceived ease of use mediate the effects of compatibility to customers' intended use. Individuals who feel compatible with a new technology are in a better position to evaluate the usefulness of the new technology and they are expected to find it easier to use. However, potential customers would not adopt a new service only because of its compatibility. In the same vein, Crespo et al. (2013) resulted in the positive influence that perceived compatibility has on perceived usefulness and perceived ease of use of e-commerce. Therefore, compatibility is expected to affect directly the perceived usefulness and perceived ease of use and indirectly the actual use of digital currencies. Finally, according to Rogers (1995), compatibility reduces uncertainty. This suggests that compatibility would also have a positive direct influence on perceived security. Therefore, the following research hypotheses are formulated:

H8 Compatibility positively affects a commercial user's perceived usefulness of digital currencies.

H9 Compatibility positively affects a commercial user's perceived ease of use of digital currencies.

H10 Compatibility positively affects a commercial user's perceived security of digital currencies.

Based on the above analysis, the proposed conceptual and structural research model is depicted in Fig. 3:

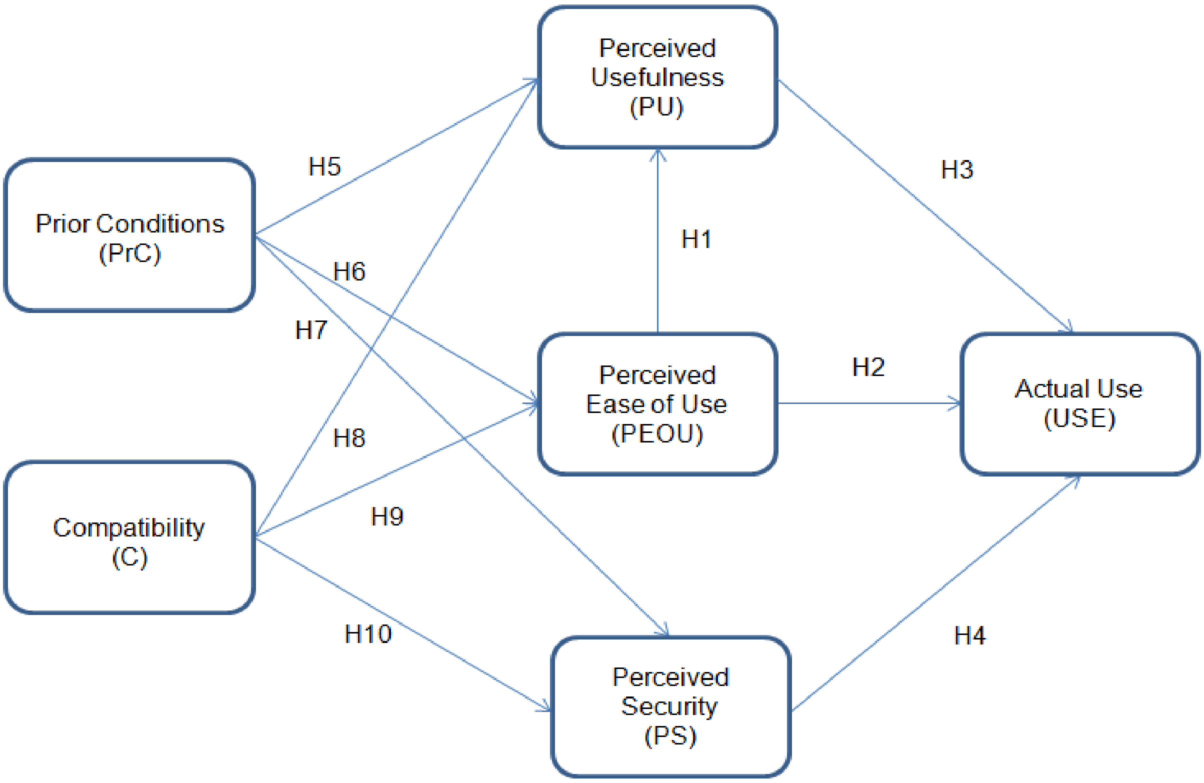

Fig. 3 Proposed research model for commercial acceptance of digital currencies

The proposed research hypotheses led to the construction of a questionnaire, which refers to all digital currencies in general, consisting of four sections; this was used in the context of a survey targeting to commercial users. The data collected were further analyzed by employing Structural Equation Modeling (SEM).

3.2 Sample and data collection

In total, 254 responses were gathered. The survey was conducted online for 9 months and was completed in early 2017. The questionnaire was circulated globally, emphasizing on the European Union (EU), as although Bitcoin was launched from the USA and the variables that affect its value are associated with the American economy (van Wijk 2013), the financial crisis in Europe is the one that brought digital currencies to the forefront (Saito 2015). Fig. 4 shows, in the first row, the world map of venues, i.e. places that accept Bitcoin at two periods of time: in April 2016, when the survey was launched and in March 2019, when this paper was submitted. This collation helps to realize the commercial adoption pace of Bitcoin worldwide. The colors show the progressive increase in venues that accept Bitcoin, in countries like India and South America; however, the vast majority of adoption is still in the USA and Europe. In the second row of Fig. 4, the world maps of nodes of Ethereum and Ripple[3] are illustrated, showing that the geographical spread for other cryptocurrencies is similar to Bitcoin, nevertheless smaller.

April 2016: 7.300 venues approximately	March 2019: 14.440 venues approximately

[3] Bitcoin, Ripple, and Ethereum are the top three cryptocurrencies in terms of market capitalization (CoinMarketCap 2019)

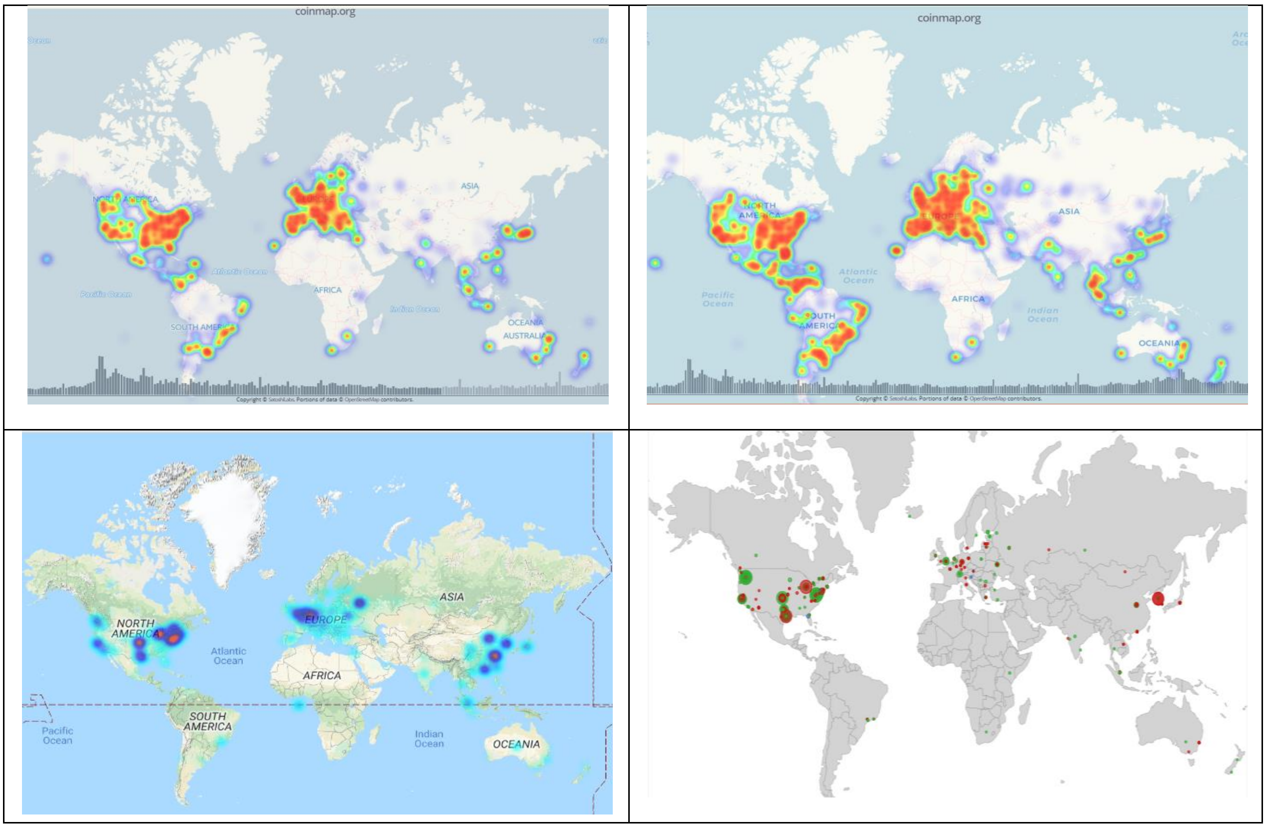

Fig. 4 World maps of places and nodes that accept Bitcoin, Ethereum, and Ripple (https://coinmap.org/#/world/50.06419174/14.58984375/2; https://www.ethernodes.org/network/1; https://xrpcharts.ripple.com/#/topology)

Reaching all the companies globally or even in the EU and achieving a random and truly representative sampling was impossible (Groves 1989); however, efforts were made to gather an appropriate sample size.

At first, the link of the questionnaire was planned to be sent selectively to mailing lists from EU companies among all sectors *(total 10,762 recipients)* collected from Business Chambers, Professional Associations, and websites. Having specified the sampling frame, the link of the questionnaire was sent to the above recipients via the Google Forms application, two Gmail accounts, two MailChimp accounts, and contact forms of companies' websites gradually and in parallel.

Additionally, the link was posted on Social Media *(Twitter, Reddit, selected LinkedIn Groups, Google+ Communities, Facebook Communities)* and forums related to the topic *(Bitcoin Forum*[4]*, European Digital Currency and Blockchain Technology Forum (EDCAB)*[5]*, Pureoverlock Forum*[6] *and Diginomics Forum*[7]*)*. Thus, worldwide dissemination was achieved.

The structured questionnaire consisted of 31 questions (13 five-point Likert scaled, 8 multiple-choice, 8 checkboxes, 1 drop-down list, and 1 dichotomous). The respondents were asked to complete either 29 questions in the case of adoption of digital currencies or 24 questions in case of non-adoption[8]. The questionnaire consisted of

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[4] https://bitcointalk.org/
[5] http://edcab.eu/
[6] http://forums.pureoverclock.com/forum.php
[7] http://forum.diginomics.com/
[8] In the 2^{nd} section of the questionnaire, the respondents had to choose between two alternative cases: the case that the company which they represented had adopted the digital currencies as a means of transaction and the case that

four sections: the 1st section aimed to obtain general information about the company; the 2nd section to record the company views about digital currencies (it is the main section); the 3rd section to record the respondent's views about digital currencies, and the last one to see the prospects of digital currencies. The total of the variables derived from the coding of the questionnaire was 199.

In order to confirm the overall structure of the research model, the Structural Equation Modeling (SEM) technique (McQuitty and Wolf 2013) was applied, as it is analyzed in Section 4. The Structural Equation model used four items per construct (except one of them) for avoiding potential underidentification problems; thus, only 19 items were chosen out of 198 as independent variables and tested in order to confirm their effect on the dependent variable (v199) that concerns the Actual Digital Currencies Use (see Appendix 1). In order to evaluate the fit of the proposed model, two set of indices were examined; the overall fit indices: Goodness of Fit Index (GFI), Adjusted Goodness of Fit Index (AGFI), Standardized Root Mean Square Residual (SRMR), Root Mean Error of Approximation (RMSEA), and Normed Chi-square (χ^2), as well as the incremental fit indices: Normed Fit Index (NFI), Comparative Fit Index (CFI), and Tucker-Lewis Index (TLI). The suggested analysis was conducted using the lavaan (version 0.5-23.1097) open source R software package (Rosseel 2012) and the Maximum-Likelihood (ML) estimation method.

3.3 Validity and reliability

Validity verifies that the survey measures what it is supposed to measure. There are several different types of validity. In order to secure the content validity of the measurement instrument, the questionnaire was reviewed by Faculty members and a translation expert. The questionnaire was also tested by means of a pilot survey conducted among a few Greek enterprises. Construct and convergent validity were confirmed by applying SEM and the results are presented in Tables 6 and 7 of Section 4.

Reliability is the ability of the research tool to reproduce the survey results. The internal consistency was measured by Cronbach's alpha coefficient, which is a statistical tool that is frequently being used to estimate the internal consistency among the questions of a survey. The value obtained was 0.937, which indicates a high level of internal consistency of the total survey.

4 Results

4.1 Descriptive characteristics

Tables 1 and 2 present the business sector and the years of operation of the businesses represented by the respondents in the sample, in conjunction with their response about the adoption or not of digital currencies as a means of transaction.

Table 1 Descriptive characteristics: business sector

it had not. Depending on their choice, the respondents were asked to complete a different set of questions in the same section of the questionnaire. Sections 1, 3, and 4 of the questionnaire were common for all the respondents

Actual use of digital currencies as a means of transaction	The company has not adopted digital currencies		The company has adopted digital currencies		Total	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Information Technology	30	11.8%	36	14.2%	66	26.0%
Consulting Services	14	5.5%	16	6.3%	30	11.8%
Retail	14	5.5%	8	3.1%	22	8.7%
Manufacturing	12	4.7%	4	1.6%	16	6.3%
Health	7	2.8%	8	3.1%	15	5.9%
Insurance	12	4.7%	3	1.2%	15	5.9%
Construction	9	3.5%	4	1.6%	13	5.1%
Tourism and Leisure	5	2.0%	7	2.8%	12	4.7%
Marketing and Advertising services	7	2.8%	3	1.2%	10	3.9%
Energy	5	2.0%	3	1.2%	8	3.1%
Logistics	5	2.0%	3	1.2%	8	3.1%
Wholesale	3	1.2%	3	1.2%	6	2.4%
Other[a]	11	4.3%	7	2.8%	18	7.1%
N/A	11	4.3%	4	1.6%	15	5.9%
Total	145	57.1%	109	42.9%	254	100.00%

[a] Some answers about other Business Sector were Agriculture, Charity, Culture, Design, Education, University, Photography, and Sports.

The results presented in Table 1 show that the majority (26%) of businesses belong to the Information Technology business sector. Also, it is shown that the majority of business sectors like Information Technology, Consulting Services, Health, Tourism, and Leisure have adopted the digital currencies as a means of transaction, while the majority of Retail, Manufacturing, Insurance, Construction, Marketing, Energy, and Logistics have not.

Table 2 Descriptive characteristics: years of operation

Actual use of digital currencies as a means of transaction	The company has not adopted digital currencies		The company has adopted digital currencies		Total	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
10-25 years ago	40	15.7%	16	6.3%	56	22.0%
5-10 years ago	35	13.8%	20	7.9%	55	21.7%
In the last 2 years	19	7.5%	34	13.4%	53	20.9%
2-5 years ago	19	7.5%	32	12.6%	51	20.1%
>25 years ago	32	12.6%	7	2.8%	39	15.4%
Total	145	57.1%	109	42.9%	254	100.0%

The results presented in Table 2 show that the majority (22%) of the businesses that responded to this survey operate 10-25 years. Also, it is shown that the majority of the young businesses that operate less than 2 years (13.4%) and 2-5 years (12.6%) have adopted the digital currencies as a means of transaction, while the businesses that operate 10-25 years (15.7%), 5-10 years (13.8%), and >25 years (12.6%) have not.

In Table 3, the results are further analyzed according to the country region in which the headquarters of the businesses are located. The majority of respondents represent businesses, whose headquarters are located in the Southern EU (42.1%), and most of them in Greece (30.3%); thus, the results in detail are presented separately.

Table 3 Descriptive characteristics: country region in which headquarters are located

Actual use of digital currencies as a means of transaction	The company has not adopted digital currencies		The company has adopted digital currencies		Total	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Southern EU [a]	75	29.5%	32	12.6%	107	42.1%
Greece	62	24.4%	15	5.9%	77	30.3
rest Southern EU	13	5.1%	17	6.7%	30	11.8%
Outside EU[b]	29	11.4%	28	11.0%	57	22.4%
Northern EU[c]	22	8.7%	24	9.5%	46	18.2%
Central EU[d]	19	7.5%	25	9.8%	44	17.3%
Total	145	57.1%	109	42.9%	254	100.0%

[a] The majority of the respondents were from the Southern European Union. This is reasonable as the survey started to diffuse among Greek businesses (due to the nationality of the authors), which have responded with a high rate (30.3%) participating in a survey held by a Greek university. The other countries that are included in the Southern EU are Bulgaria, Croatia, Cyprus, Italy, Malta, Portugal, Romania, and Spain.

[b] The majority of the responding countries Outside EU were USA (10%), followed by Australia (3%), Canada (2%), and with a smaller percentage Mexico, Serbia, Switzerland, Russia, Azerbaijan, Belize, Brazil, Guatemala, Hong Kong, Iceland, India, Japan, Nigeria, South Africa, and Ukraine.

[c] The countries that are included in Northern EU are Denmark, Estonia, Finland, Ireland, Latvia, Lithuania, Sweden, and United Kingdom.

[d] The countries that are included in Central EU are Austria, Belgium, Czech Republic, France, Germany, Hungary, Luxembourg, Netherlands, Poland, Slovakia, and Slovenia.

The results presented in Table 3 show that the majority of businesses with headquarters in Southern EU (29.5%) and Outside EU (11.4%) have not adopted digital currencies as a means of transaction, while the majority of businesses with headquarters in Northern EU (9.5%) and Central EU (9.8%) have adopted digital currencies as a means of transaction.

The descriptive results are further analyzed according to the business size, in terms of employees in Table 4 and in terms of annual turnover in Table 5.

Table 4 Descriptive characteristics: business size regarding employees

Actual use of digital currencies as a means of transaction	The company has not adopted digital currencies		The company has adopted digital currencies		Total	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
< 10 employees (micro business)	73	28.7%	75	29.5%	148	58.3%
10 - 49 employees (small business)	36	14.2%	18	7.1%	54	21.3%
50 - 249 employees (medium-sized business)	20	7.9%	8	3.15%	28	11.0%
> 250 employees (large business)	16	6.3%	8	3.15%	24	9.4%
Total	145	57.1%	109	42.9%	254	100.0%

The results presented in Table 4 show that the marginal majority (29.5%) of micro businesses have adopted the digital currencies as a means of transaction, while the majority of small (14.2%), medium-sized (7.9%), and large businesses (6.3%) have not. Interpreting this result, it is concluded that the majority of the overall sample that actually use digital currencies comprise micro businesses.

Table 5 Descriptive characteristics: business size regarding annual turnover

Actual use of digital currencies as a means of transaction	The company has not adopted digital currencies		The company has adopted digital currencies		Total	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
< 2 million €	87	34.2%	81	31.9%	168	66.1%
2-10 million €	30	11.8%	18	7.1%	48	18.9%
10-50 million €	15	5.9%	6	2.4%	21	8.3%
> 50 million €	13	5.1%	4	1.6%	17	6.7%
Total	145	57.1%	109	42.9%	254	100.0%

The results presented in Table 5 show that the majority (34.2%) of businesses with annual turnover < 2 million € have not adopted the digital currencies as a means of transaction, while the same applies for the majority of businesses with a bigger annual turnover. Thus, it is deduced that the result is opposite to the previous result in Table 4 with regards to small-sized businesses.

For this reason, in Table 6 the results about the actual use of digital currencies by business size are presented both in terms of employees and annual turnover.

Table 6 Descriptive characteristics: business size regarding employees and annual turnover

Actual use of digital currencies as a means of transaction		The company has not adopted digital currencies		The company has adopted digital currencies		Total	
		Frequency	Percent	Frequency	Percent	Frequency	Percent
< 10 employees (micro business)	< 2 million €	69	27.17%	68	26.77%	137	53.94%
	2-10 million €	3	1.18%	6	2.36%	9	3.54%
	10-50 million €	0	0.00%	1	0.39%	1	0.39%
	> 50 million €	1	0.39%	0	0.00%	1	0.39%
	Total	73	28.74%	75	29.53%	148	58.27%
10 - 49 employees (small business)	< 2 million €	13	5.12%	10	3.94%	23	9.06%
	2-10 million €	21	8.27%	8	3.15%	29	11.42%
	10-50 million €	2	0.79%	0	0.00%	2	0.79%
	> 50 million €	0	0.00%	0	0.00%	0	0.00%
	Total	36	14.17%	18	7.09%	54	21.26%
50 - 249 employees (medium-sized business)	< 2 million €	5	1.97%	3	1.18%	8	3.15%
	2-10 million €	5	1.97%	1	0.39%	6	2.36%
	10-50 million €	9	3.54%	4	1.57%	13	5.12%
	> 50 million €	1	0.39%	0	0.00%	1	0.39%
	Total	20	7.87%	8	3.15%	28	11.02%
> 250 employees (large business)	< 2 million €	0	0.00%	0	0.00%	0	0.00%
	2-10 million €	1	0.39%	3	1.18%	4	1.57%
	10-50 million €	4	1.57%	1	0.39%	5	1.97%
	> 50 million €	11	4.33%	4	1.57%	15	5.91%
	Total	16	6.30%	8	3.15%	24	9.45%
Total		145	57.09%	109	42.91%	254	100.00%

The results presented in Table 6 show that the majority of the overall sample (53.94%) are micro businesses with annual turnover < 2 million, out of which the marginal majority (27.17%) have not adopted digital currencies as a means of transaction, while the rest 26.77% have adopted digital currencies as a means of transaction.

4.2 Structural Equation Modeling

In this section, the Structural Equation Modeling (SEM) technique (McQuitty and Wolf 2013) is applied. A structural equation model is introduced and further examined, in order to confirm the overall structure of the research model.

The proposed SEM model was first examined for multicollinearity, i.e. the situation that is created when there are strong correlations between the independent variables in the multiple regression (Maddala 2001; Gujarati 2003). Interpreting a problem by using multiple regression analysis method is achieved best when the independent variables that were included in the model are unrelated to each other. When there are strong correlations between the variables, it is difficult, if not impossible, to evaluate the actual effect of a particular independent variable on the dependent variable. Thus, the correlations between variables used in the structural model were analyzed using Spearman's correlation coefficient; this is a statistical tool that measures the strength of a monotonic relationship between paired data. In Spearman's correlation, unlike Pearson's correlation, there is no requirement of normality and hence, it was considered more appropriate for the data of this survey. Values can range from –1 to 1, indicating total negative or positive correlation accordingly, while 0 indicates no correlation. Table 7 shows the correlations between all quantified constructs.

Table 7 Correlations between all quantified constructs

Correlations

			PEOU	PU	PS	PrCond	Compat	ActualUse
Spearman's rho	PEOU	Correlation	1.000	-.250	.573	.482	.453	.468
		Sig. (2-tailed)		.000	.000	.000	.000	.000
		N	254	254	254	254	254	254
	PU	Correlation	-.250	1.000	-.555	-.502	-.692	-.740
		Sig. (2-tailed)	.000		.000	.000	.000	.000
		N	254	254	254	254	254	254
	PS	Correlation	.573	-.555	1.000	.694	.763	.822
		Sig. (2-tailed)	.000	.000		.000	.000	.000
		N	254	254	254	254	254	254
	PrCond	Correlation	.482	-.502	.694	1.000	.643	.735
		Sig. (2-tailed)	.000	.000	.000		.000	.000
		N	254	254	254	254	254	254
	Compat	Correlation	.453	-.692	.763	.643	1.000	.874
		Sig. (2-tailed)	.000	.000	.000	.000		.000
		N	254	254	254	254	254	254
	ActualUse	Correlation	.468	-.740	.822	.735	.874	1.000
		Sig. (2-tailed)	.000	.000	.000	.000	.000	
		N	254	254	254	254	254	254

Table 7 indicates that all the independent factors correlate; however, there is no very strong correlation between them. The majority of the correlations are moderate, while the strongest correlation is between Perceived Security and Compatibility (.763). However, the values of all probabilities are 0.000 and the R^2 is 0.908, which implies that 90.8% of the variance in the dependent variable is predictable from the independent variables; thus, it is statistically significant and the problem of multicollinearity is not intense. Also, the strongest correlation coefficient is lower than R^2 (0.763 < 0.908) (Klein 1962). Finally, the Variance Inflation Factor (VIF) and the Tolerance index were checked and the results are given in Table 8. The values of these two collinearity statistics imply that the problem of multicollinearity can be safely ignored in this study. Therefore, all the factors in the research model were kept.

Table 8 Variance Inflation Factor (VIF) and the Tolerance index

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.083	.060		1.374	.171		
	PEOU	-.015	.025	-.014	-.596	.552	.634	1.576
	PU	-.085	.016	-.140	-5.365	.000	.546	1.833
	PS	.099	.026	.158	3.857	.000	.221	4.524
	PrCond	.144	.037	.109	3.862	.000	.470	2.130
	Compat	.300	.020	.642	14.730	.000	.196	5.096

[a] Dependent Variable: ActualUse

In the SEM model of this study, four items per construct (except one of them) were used for avoiding potential underidentification problems, as aforementioned in Subsection 3.2. More specifically, in Fig. 5, the constructs are presented with an ellipse, while the items (Appendix 1) of each factor with a rectangle.

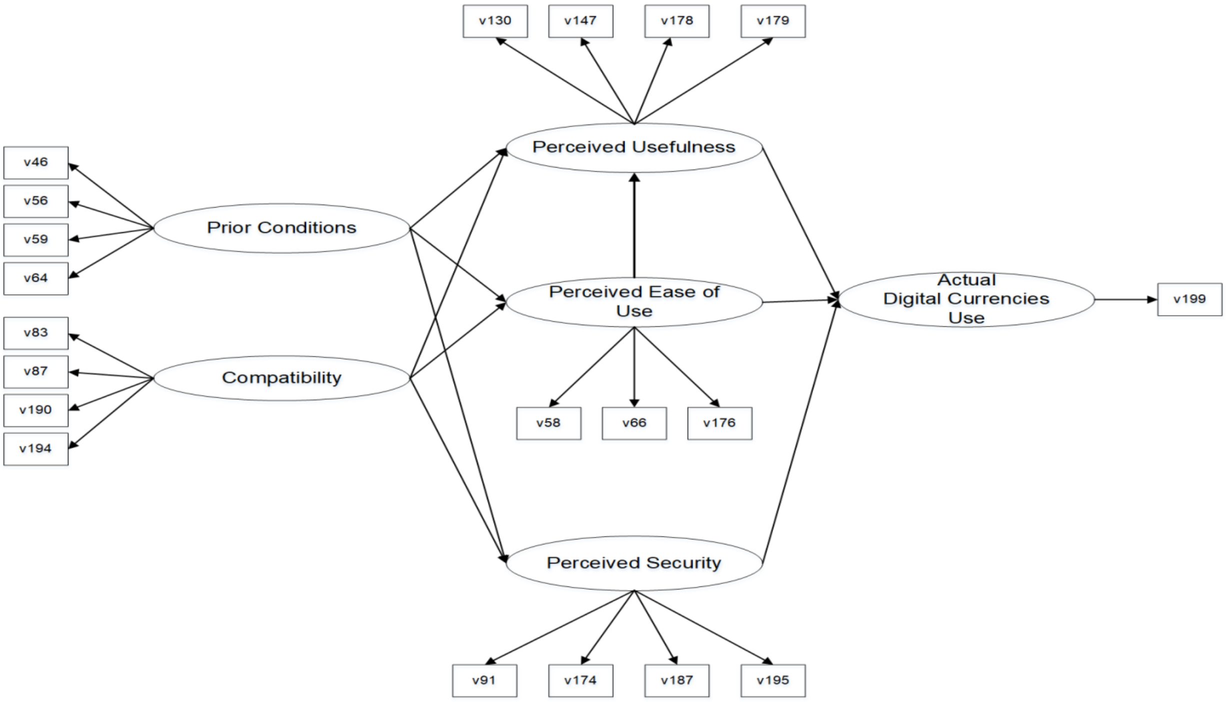


Fig. 5 SEM model

In order to evaluate the fit of the proposed model, various indices are examined presenting a good overall fit of the second order structure. These, overall and incremental, fit indices were checked using commonly accepted cutoff values according to the literature (Hu and Bentler 1999; Hooper et al. 2008; Iacobucci 2010). In Table 7, the measures that were used to examine the fit of the model, their current values, and the acceptable cutoff values are presented. The first set of indices (absolute fit indices) concerns the overall fit, while the second the incremental fit of the proposed model.

Table 9 Overall and incremental fit indices

Chi square (χ^2) = 356.135, Degrees of Freedom (df) = 160, p value < 0.005

	Fit indices	Value	Accepted value
Absolute fit indices	Goodness of Fit Index (GFI)	0.982	> 0.95
	Adjusted Goodness of Fit Index (AGFI)	0.975	> 0.95
	Standardized Root Mean Square Residual (SRMR)	0.062	< 0.08
	Root Mean Square Error of Approximation (RMSEA)	0.069	< 0.08
	Normed Chi square (χ^2)	2.226	$2 < \chi^2 < 5$
Incremental fit indices	Normed Fit Index (NFI)	0.894	> 0.95
	Comparative Fit Index (CFI)	0.938	> 0.95
	Tucker-Lewis Index (TLI)	0.926	> 0.95

The absolute fit indices, presented in Table 9, show an overall very good fit of the model. As it is depicted in Table 9, the GFI and AGFI values are above 0.95, showing a very good fit and also the values of SRMR, RMSEA, and Normed Chi-square (χ^2) are clearly adequate. Thus, the proposed model fits very well the sampled data. Apart from these fundamental absolute fit indices, the incremental (also known as comparative, relative) fit indices show an acceptable fit of the model, as well. The CFI and TLI are above 0.9 and only slightly less than 0.95, and only the NFI is slightly less than 0.9. Besides testing and measuring the overall fit of the model, several tests regarding the reliability of each construct were also conducted. A valid indicator for measuring a construct's consistency is that factor loadings, also known as λ, which should receive values more than 0.7, while average variance extracted (AVE) index should exceed 50% respectively. In Table 10, the proposed reliability measures along with each factor loadings are presented. As it can be seen, the first order structure has a convergent validity since the observed variables' loadings are significant on the corresponding factor (Kline 2011).

Table 10 Loading estimates and Average Variance Extracted (AVE) for each construct

Construct (η)	Variable	Standardized factor loadings (λ)	Reliability measures
Perceived Ease of Use of digital currencies (PEOU)	v58	0.683^{***}	AVE 17.34%
	v66	0.473^{***}	
	v176	0.365^{***}	
Perceived Usefulness of digital currencies (PU)	v178	0.311^{***}	AVE 55.65%
	v179	0.126^{*}	
	v130	-0.916^{***}	
	v147	-0.760^{***}	
Perceived Security (PS)	v91	0.972^{***}	AVE 71.72%
	v174	0.542^{***}	
	v187	-0.145^{**}	
	v195	-0.017	
Prior Conditions	v46	0.517^{***}	AVE 34.08%
	v56	0.246^{***}	
	v59	0.824^{***}	
	v64	0.631^{***}	
Compatibility with existing values and practices	v83	0.962^{***}	AVE 89.11%
	v87	0.960^{***}	
	v190	-0.079	
	v194	-0.179^{***}	

***, **, and * indicate 1%, 5%, and 10% level of significance respectively

Loadings can range from –1 to 1. Loadings close to –1 or 1 indicate that the factor strongly affects the variable. Loadings close to zero indicate that the factor has a weak effect on the variable. According to Table 10, the constructs Perceived Usefulness, Perceived Security, and Compatibility seem to have a strong consistency due to high AVE values. Furthermore, as far as the construct's loadings to each item are concerned, all loadings seem to be in good levels except for v190 and v195. Regarding AVE indices, it can be concluded that the constructs examined are well formed, as the majority of the values are above the accepted levels. The proposed structural equation model, not only successfully converged, but also produced a proper solution without Heywood cases, i.e. warnings of negative error variances.

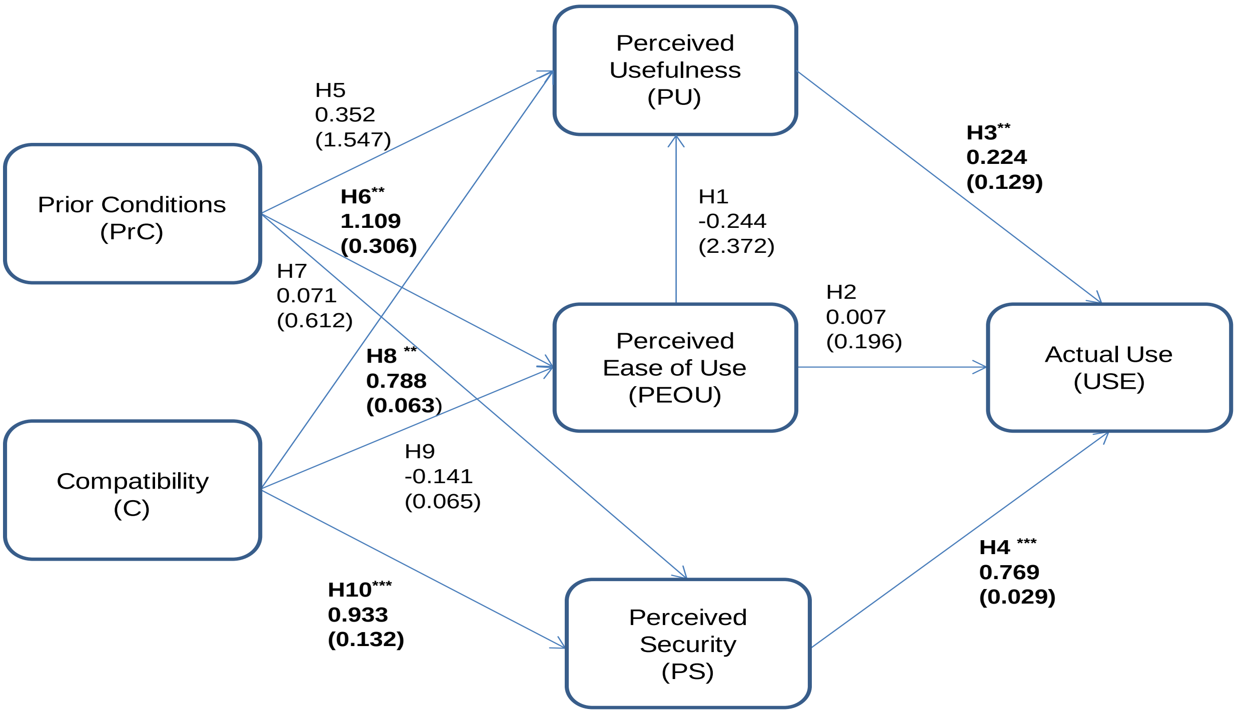
In Table 11, the results regarding hypotheses, derived by SEM, are presented:

Table 11 The hypotheses results

Hypotheses	Latent Variable Effects	Standardized factor loadings (λ)	Statistical significance P(>|z|)	Results
H1	PEOU ⇒ PU	-0.244	0.900	Not Supported
H2	PEOU ⇒ USE	0.007	0.951	Not Supported
H3	PU ⇒ USE	0.224	0.011**	*Supported*
H4	PS ⇒ USE	0.769	0.000***	*Supported*
H5	PrC ⇒ PU	0.352	0.876	Not Supported
H6	PrC ⇒ PEOU	1.109	0.042***	*Supported*
H7	PrC ⇒ PS	0.071	0.613	Not Supported
H8	C ⇒ PU	0.788	0.048**	*Supported*
H9	C ⇒ PEOU	-0.141	0.779	Not Supported
H10	C ⇒ PS	0.933	0.000***	*Supported*

*** and ** indicate 1% and 5% level of significance respectively

In Fig. 6, the structural model that includes the standardized path coefficients is presented. The values in parentheses represent standard errors. Hypotheses that are supported are represented in bold. Fig. 6 also depicts the convergence validity of the second order structure, regarding the relations between exogenous and endogenous factors. Finally, in Fig. 6, the regression results regarding R^2 are reported.



Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.953[a]	.908	.906	.152

[a] Predictors: (Constant), Compat, PEOU, PU, PrCond, PS

*** and ** indicate 1% and 5% level of significance respectively

Fig. 6 Structural Model for commercial acceptance of digital currencies

The results of the SEM indicate that the constructs perceived security, perceived usefulness, and compatibility were found to be strongly consistent to the proposed model (AVE > 50%: PS = 71.72%, PU = 55.65%, and C = 89.11%); thus, the majority of the examined constructs are well formed. Nevertheless, in the proposed research model not all of the initial hypotheses are verified.

The results of the empirical research demonstrate that the most significant factor that affects the actual use of digital currencies by companies is perceived security (H4: $\lambda = 0.769$, $p < 0.01$), followed by perceived usefulness (H3: $\lambda = 0.224$, $p < 0.05$). This means that security is the main priority for commercial users towards the adoption of digital currencies and usefulness is the next significant factor that both will lead to the actual use of digital currencies. The more commercial users feel secure and find useful digital currencies, the more the commercial adoption and use of digital currencies increases. On the contrary, if commercial users feel insecure and find no usefulness in digital currencies, they are not anticipated to use digital currencies. These findings support the two original hypotheses (H4 & H3) as predicted and are in line with prior literature (Taylor and Todd 1995a; Salisbury et al. 2001; Wang et al. 2011).

Contrary to what was assumed, perceived ease of use does not have a significant effect on perceived usefulness (H1: $\lambda = -0.244$, $p = 0.900 > 0.1$), neither to actual use (H2: $\lambda = 0.007$, $p = 0.951 > 0.1$); thus, H1 & H2 are rejected. These findings are not consistent with studies that focused on non-professional target groups (Davis 1989; Davis et al. 1989); however, they are in line with findings of prior studies that were addressed to professionals (Hu et al. 1999; Chau and Hu 2002; Chismar and Wiley-Patton 2003). This could be explained because nowadays commercial users have either more IT skills or rely on their computer specialized staff support; hence, they are not interested if digital currencies are easy to use, but they are interested if they are secure and useful as a means of transaction. Besides, the majority of the respondents in the survey activated in the Information Technology business sector, while in tandem they represent micro and small businesses – probably startups, which mean that they are more familiar with technology and therefore they lend less weight to ease of use in relevance with usefulness and security of digital currencies. According to Keil et al. (1995), "no amount of EOU (ease of use) will compensate for low usefulness", meaning that usefulness is more important than ease of use. Consequently, this study contributes to the literature regarding digital currencies in general and the literature regarding digital currencies' commercial adoption, in specific by providing indications that commercial users use digital currencies if they perceive them as secure and useful rather than easy to use.

Furthermore, the prior conditions affect positively more the construct of perceived ease of use (H6: $\lambda = 1.109$, $p < 0.05$) rather than perceived usefulness (H5: $\lambda = 0.352$, $p = 0.876 > 0.1$) or perceived security (H7: $\lambda = 0.071$, $p = 0.613 > 0.1$). Consequently, H6 is accepted, while H5 and H7 are rejected. This means, firstly, that as the commercial users feel that some previous practices and norms of the socio-economic system may pose a problem to them (e.g. control by central organizations, high cost of transactions and other bureaucratic and complicated procedures and norms), so they perceive that the use of digital currencies is easier than other traditional means of transactions. Secondly, it means that as the commercial users feel technologically innovative, so it is easier for them to perceive the use of digital currencies. This finding is in line with the previous finding of this research about the perceived ease of use.

Finally, the construct of compatibility affects positively more the constructs of perceived security (H10: $\lambda = 0.933$, $p < 0.01$) and perceived usefulness (H8: $\lambda = 0.788$, $p < 0.05$) rather than perceived ease of use (H9: $\lambda = -0.141$, $p = 0.779 > 0.1$). Consequently, H10 & H8 are accepted, while H9 is rejected. These findings are in agreement with prior literature (Rogers 1995) and partially in line with other studies (Oh et al. 2003; Crespo et al. 2013). This could be explained by the previous finding that indicates that perceived ease of use is not a significant factor towards perceived usefulness and actual use of digital currencies for commercial users. These findings mean that the more compatible with existing values and practices the commercial users find digital currencies, the more they feel secure and consider digital currencies useful for commercial transactions.

5. Discussion

5.1 Theoretical implications

Considering digital currencies as technological innovation, this study integrates IDPM with TAM and perceived security, in order to highlight the significant factors with regard to the actual use of digital currencies from a commercial perspective. While prior studies are mainly concerned with individual users, mostly consumers and investors (Smyth 2013; Bohr and Bashir 2014; Silinskyte 2014; Kumpajaya and Dhewanto 2015; Abramova and Böhme 2016; Bashir et al. 2016; Catalini and Tucker 2016; Gao et al. 2016; Krombholz et al. 2016), this study extends the research in IT/IS by focusing on commercial users within the actual commercial environment. Also, this study differs from the most related ones of Connolly and Kick (2015), and Polasik et al. (2015), for the following reasons: i) it has a different target because it investigates the factors that affect commercial adoption of digital currencies, ii) it is based on a combination of theories, iii) it applies a different methodology by running an online survey which is addressed to all commercial users, both adopters and non-adopters, and iv) it is not limited to Bitcoin. The research tool of the study was an online questionnaire, which was addressed to commercial users to illuminate their views about digital currencies. The data collected through the survey were analyzed using Structural Equation Modeling (SEM) technique. The results of this research answer to the main research question of this study, by revealing the importance of perceived security, followed by perceived usefulness, in affecting the decision making of the commercial end-users towards adopting digital currencies as a means of transaction. This study also strengthens prior studies (Hu et al. 1999; Chau and Hu 2002; Chismar and Wiley-Patton 2003) about commercial users by finding that, in a commercial setting, the perceived ease of use is not a crucial factor towards adopting digital currencies as a means of transaction. The results also indicate the indirect effect of compatibility with existing values and practices on actual use of digital currencies, by implying that commercial end-users, like individual end-users, would not adopt digital currencies only because of their compatibility (Oh et al. 2003). The results of this study imply that understanding the key factors, which lead businesses to adopt digital currencies, sheds light to their rapid movement from the early adoption stage to the early majority stage.

5.2 Managerial implications

The knowledge of the factors that contribute to commercial adoption and actual use of digital currencies helps the commercial users in that topic to adapt better to the upcoming global consumer adoption phase (Maudlin 2014). Managers and business executives in every business sector could take into account the findings of this study while organizing their work, forming their decisions, and updating business strategies.

First, the results indicate the significant role of perceived security onto the actual use of digital currencies by businesses. This finding implies that a basic step for commercial users towards the actual use of digital currencies is to feel safe about their participation and transactions in digital markets. To achieve this goal, they should apply sound practices in order to mitigate any potential risk and benefit from a secure experience while using digital currencies. Prior works (European Banking Authority 2013; Moore 2013; Moore and Christin 2013; Antonopoulos 2014; Vasek et al. 2014; Folkinshteyn and Lennon 2016; Krombholz et al. 2016) suggested some technical practices that managers and business executives should develop and apply in order to protect their business funds and customers' privacy. Additionally, given the high price volatility of digital currencies, managers should act vigilantly and watch the fluctuation of digital currencies' prices on a constant basis, in order to make the right financial decisions concerning the funds of their businesses. Prior works (Luther 2015; Ciaian et al. 2016; Cermak 2017) presented ways in order to protect end-users from digital currencies' volatility risk, which the commercial users should take into consideration (for example, convert the received cryptocurrencies into traditional cash or swap them).

Second, the results highlight the important role of perceived usefulness concerning the managers' decision about the adoption of digital currencies as a means of transaction. This finding implies that commercial users need to be aware that digital currencies could offer advantages to their businesses. But, in order to benefit from the actual use of digital currencies, appropriate information and a necessary preparation are required to start receiving and sending payments in digital currencies. Prior works (Antonopoulos 2014; Pirjan et al. 2015; Ciaian et al. 2016; Folkinshteyn and Lennon 2016; Gao et al. 2016; Halaburda and Sarvary 2016; Ermakova et al. 2017) indicate the usefulness of digital currencies and there is a lot of information on the Internet, which could help to understand the advantages and disadvantages, as well as what is needed to get started. Commercial users should facilitate their transactions in digital currencies and provide secure and user-friendly solutions to meet the users' growing demand for transactions in digital currencies. In this way, they will be able to realize the usefulness of the adoption of digital currencies, by expanding their customer base, while minimizing fees by choosing to use services and partners that transact in digital currencies.

Third, the results indicate that compatibility with existing values and practices affects indirectly the actual use of digital currencies by businesses. This finding implies that commercial users should develop techniques and plan actions to enhance their familiarity with the use of digital currencies in order to perceive that it should be compatible with existing work practices, systems of the company, and transaction rules. Also, managers should pay attention to regulations, legislative and fiscal regime of their country, in order their commercial transactions to be compatible with existing accounting and taxation practices (Swartz 2014; Luther 2015; Ciaian et al. 2016). To achieve this goal, managers and the staff of their company should be trained on the use of digital currencies (Kumpajaya and Dhewanto 2015). Training will strengthen their feeling of compatibility and subsequently their perceptions about security and usefulness of digital currencies.

6 Conclusion

This study responds to a research need, set by the rapid evolution of digital currencies, for understanding the factors that affect the commercial adoption of digital currencies as a means of transaction in everyday life. Results stress that perceived security and usefulness are the main factors that directly affect the commercial adoption of digital currencies, while compatibility with existing values and practices has an indirect effect. The sooner the commercial users understand how to adapt to this new financial landscape, the better they will counterbalance the pros and cons, aiming to be in readiness when digital currencies will be a globally accepted method of transactions.

Attention should be paid to the following limitations of this study: first, the sample was not equally distributed with regards to the business size and the location of the business headquarters. The reason why we had in the sample micro and small-sized businesses is due to that, probably startups, dealing with digital currencies, replied to the questionnaire. This explanation is also supported because the majority of the respondents represent businesses that activate in the IT sector; hence, it is expected that they are more interested in a specialized issue, such as digital currencies. Furthermore, micro and small-sized businesses are more flexible to answer than large businesses. As far as the region is concerned, there are several Greek businesses in the sample. At the kick-off of the survey, we also wanted to see the current status of digital currencies' adoption in our country, thus the questionnaire was disseminated among Greek businesses, which at the end of the survey resulted in 30.3% of the sample. Specifically, the micro Greek businesses represent 23.2% of the sample. Hence, a separate analysis according to size, turnover, and the region was made, in order to illustrate the adoption status of digital currencies in every portion of the sample (Tables 3, 4, 5, and 6). Moreover, in Table 3, the separation that was made concerning Greece intended not to distort the image of the rest Southern EU. Moreover, given that the research is a Web-based survey, it is possible that non-online responses by a mailed survey, telephone calls or face-to-face interviews would result in a different set of findings. Also, it is acknowledged that the job position of the respondent that participated in the survey was not asked, so, the consistency of the individual's responses with the perceptions and strategies of the company that they represent may be different. It is always possible that representatives of companies who did not participate in the survey to have different beliefs and perceptions from those who filled in the questionnaire.

Apart from the economic and commercial effects of the use of digital currencies, blockchain technology is expected to impact many business sectors (Folkinshteyn and Lennon 2016). Furthermore, a new trend is that central banks consider issuing their own digital currencies, based on blockchain technology, which may lead to a new situation in digital transactions (Bank for International Settlements 2018; Mancini-Griffoli et al. 2018). Therefore, blockchain adoption interests many institutions, nowadays. Future research could focus on the effects of the evolution of the use of digital currencies and blockchain technology in certain business sectors. Research in a specific country or business sector would be valuable and probably data collection would be easier, as face-to-face interviews could be conducted. Additionally, further surveys from the stakeholder's perspective should be conducted using different sampling schemes and data collection methodologies. Digital currencies constitute a continuously evolving theme and open up the road for future studies in various disciplines, apart from technology, economy or entrepreneurship, such as legislation, taxation, ethics, sociology and so on, where different theories could be applied depending on the subject area.

Appendix 1 Description of the items/variables for each construct used in SEM

Construct	Item/variable	Description	Question of the survey
Perceived ease of use	v58	Ease of use	13. In case your company has adopted digital currencies as a means of transaction, which were the main reasons for adopting digital currencies?
	v66	Speed of transactions	13. In case your company has adopted digital currencies as a means of transaction, which were the main reasons for adopting digital currencies?
	v176	Perceived ease of use	25. How easy do you think the use of digital currency is?
Perceived usefulness	v130	Ignorance about its further utilization	19. In case your company has NOT adopted digital currencies as a means of transaction, to what extent did the following reasons affect your company's decision?
	v147	Not widespread to the general public	20. In case your company has NOT adopted digital currencies as a means of transaction, specifically which features of digital currency affected your company's decision?
	v178	Future of digital currency regarding its acceptance and use	27. In your opinion, what will the future of digital currency be, regarding its acceptance and use?
	v179	Future of digital currency as a means of transaction	28. What do you think the future of digital currency as a means of transaction will be?
Perceived security	v91	Money loss due to price instability	15. In case your company has adopted digital currencies as a means of transaction, to what extent have the following problems arisen?
	v174	Trust of digital currency as an effective means of transaction	23. To what extent do you trust digital currency as an effective means of transaction?
	v187	Rate stabilization between digital and traditional currency	29. In what ways do you think the use of digital currency could be more widespread?
	v195	Providing greater security from cyber attacks	30. Which of the following factors do you think that the creators of digital currency should take into account in order to establish it as a means of electronic payment?
Prior conditions	v46	Innovativeness	11. When your company is informed about a relevant technological innovation, how does it usually act?
	v56	Control avoidance	13. In case your company has adopted digital currencies as a means of

		by central organizations	transaction, which were the main reasons for adopting digital currencies?
	v59	Freedom in payments	13. In case your company has adopted digital currencies as a means of transaction, which were the main reasons for adopting digital currencies?
	v64	Low cost of transactions	13. In case your company has adopted digital currencies as a means of transaction, which were the main reasons for adopting digital currencies?
Compatibility	v83	Compatibility issues with some of the company's systems	15. In case your company has adopted digital currencies as a means of transaction, to what extent have the following problems arisen?
	v87	Governmental restrictions	15. In case your company has adopted digital currencies as a means of transaction, to what extent have the following problems arisen?
	v190	Decreasing connection with computer science (cryptography, etc)	30. Which of the following factors do you think that the creators of digital currency should take into account in order to establish it as a means of electronic payment?
	v194	Providing digital currency services through banks	30. Which of the following factors do you think that the creators of digital currency should take into account in order to establish it as a means of electronic payment?
Actual Digital Currency Use	v199	Adoption or not of digital currency as a means of transaction	Please select one of the following: ❑ The company has adopted digital currencies as a means of transaction ❑ The company has NOT adopted digital currencies as a means of transaction

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