



## Conference Paper

# Bitcoin Security and Privacy: A Study of Users Experiences

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## Abstract

The digital currency (Bitcoin) is evolving and spreading quickly over the Western world. However, this currency comes with many doubts in terms of its security and validity. This makes investigating the user's experience and awareness in our region (The Kingdom of Bahrain and The Eastern Province "Dammam and Khobar" in KSA) a highly interesting topic. The main purpose of this article is to explore the users' experience and awareness and to address the factors that could affect users' experience to use Bitcoin. To achieve this purpose, a quantitative approach was conducted using an online questionnaire; the questions in the questionnaire were extracted based on many factors: (i) Bitcoin usage and management, (ii) security, privacy, anonymity and backup behaviour, and (iii) risk perception. The results showed that most users are aware of Bitcoin, however, the minority are using it.

**Keywords:** Bitcoin, Digital Currency, User Experience, Security and Privacy

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## 1. Introduction

A few years ago, the world has begun to evolve and change its way of living towards new tendency known as smart cities. A smart city is about the full connectivity of many devices and sensors that allow observing, identifying and understanding the world without a user intervening as the "Internet of Things" (Lopez, 2013). This city operates innovatively in order to improve the lifestyle of citizens, and it covers six dimensions: economy, environment, government, people, mobility, and living.

With this unprecedented evolution and prosperity, and as these cities are moving towards a smart infrastructure that is built on the basis of Internet of Things (IOT), a new smart digital currency known as **Bitcoin** was introduced. **Bitcoin** are basically "a digital/virtual currency which is utilized through peer to peer electronic payment system that is based on cryptographic proof" (Satoshi Nakamoto, 2008). The transaction of Bitcoin performed directly between the sender and the receiver using a Bitcoin address without involvement of any central authority. All the transactions details

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and history are stored in a chronological order in a single digital file (a public ledger) referred to as the Blockchain (Barcelo, 2007).

Bitcoin can positively contribute to the growth of smart cities, where all its dimensions utilize online services and engage in the digital space. However, despite the fact that Bitcoin have innumerable benefits, any new technology would counter some issues and difficulties in its initial and developing stages. One major challenge is security, even though, the Bitcoin transactions are performed in a secure and private manner, there are still many concerns and ambiguities about the strength of its encryption, and the confidentiality of the personal data and transaction details. Another challenge is people's awareness, people are used to deal with the traditional banking systems. Thus, it is a challenging task to convey their customary understanding towards a new decentralized and digitalized currency system. Consequently, the success of any technology is highly depending on the end-users' expectations and needs, where in this case they expect transparency, facilitation and high level of security while utilizing the digital currency (Bitcoin) and performing these transactions.

This paper is interested in studying the behaviour of Middle East citizens towards Bitcoin. Thus, it discusses the security and privacy issue of Bitcoin, and studies the public awareness of the Bitcoin. In addition, it examines the end user's experience of using Bitcoin in terms of security, privacy, anonymity and risk. The results were produced through an analysis of an online questionnaire that was distributed among different groups in the Kingdom of Bahrain and The Eastern Province (Dammam and Khobar) in KSA.

The rest of the paper is organized as follows; a review of literatures and various research papers related to the topic is presented in section II. The methodology and data collection are presented in Section III. Section IV presents the findings. Section V represents the analysis and discussion. Then, the conclusion and the recommendations are presented in section VI.

## 2. Literature Review

This section reviews and examines valuable and beneficial research papers related to the proposed topic.

## 2.1. Introduction to smart cities

The concept of smart city was initially introduced in the 1990s, and it was mainly focusing in acquisitioning an effective objective; the perceived value of new technologies and how these technologies are contributing to the cities' modernistic infrastructure (Nam et al., Page 14 of 85 2011). Few years later, this concept has become more popular in both the scientific and academic fields.

Presently, smart city concept is rapidly growing, where it is expected that by the 2025, 40% of the world's population will live in smart developed cities (Frost & Sullivan, 2014). Smart cities are built on the basis of Internet of Things (IoT), which is defined as "connecting a number of devices through a wireless internet connection with the ability to communicate and understand each other's and to be managed from a computer device without human intervening" (Lopez, 2013).

## 2.2. Smart cities dimension

A complete integration of a city's different systems and areas such as (transportation, energy, education, health care, buildings, physical infrastructure, food, water, and public safety) is importantly essential where they will effectively contribute to the process of creation an intelligent/smart city, like that of cities, no system can operate in isolation (Dirks and Keeling, 2009). In Smart cities' six main dimensions were introduced in a recent work conducted by the Centre of Regional Science at the Vienna University of Technology as: *smart economy, smart mobility, a smart environment, smart people, smart living, and smart governance* (Giffinger and Gudrun, 2010). Each dimension is utilizing that concept of smart city to function effectively to produce and generate smart and modern output, and to build advanced cities that facilitate human life and meet their needs, Smart economy dimension is also utilizing this concept to contributes to the development of its economic status.

## 2.3. Smart economy dimension

A smart economy is one of the smart city dimensions that contributes in the cities prosperity, increases the development of new products and services, and gives better opportunities to the local entrepreneurs, business processes developments, and overall cities status (Alcatel-Lucent, 2013). It was described as "innovative spirit, economic

image & trademarks, productivity, flexibility or labour market, international embeddedness and ability to transform” (Pellicer et al, 2013). And since those cities are connected with a wide spread internet services all over its area the Central Policy Unit Hong Kong (2015) confirms that the smart local economy is closely connected with the global economy, thus verifies that the local economy is highly being affected by the global trends and initiatives of the smart economy that is sweeping the worlds currently such as the digital currencies (**Bitcoin**).

## 2.4. Overview of Bitcoin

A Bitcoin is a digital currency defined as pure peer-to-peer online payment transactions that occur between the sender and the receiver directly without third party or central authority intervening. Bitcoin currency has no physical representation where all the transactions are performed digitally over the internet network (Nakamoto,2008). Bitcoin contains of three items: the wallet, Blockchain, and the miner. Each item has a specific role that contributes in performing the Bitcoin transactions. Bitcoin wallet is responsible for holding the Blockchain copies, whereas the Blockchain acts as a bank ledger and it is available on the network. Bitcoin miner is responsible for preventing the Bitcoin double spending and provide a security for the transaction processes over the network (Wanda and Nicholas, 2017). However, due to the lack of the physical representation of the Bitcoin, many doubts are spreading everywhere that concerning the source of the Bitcoin and the ability to use and adopt this currency in terms of its validity and security. In addition, most recent researches have shown that Bitcoin raises a number of privacy and security concerns due to the fact that all of the transactions are publicly announced in the system (Conti, Kumar and Ruj, 2017).

## 2.5. Privacy and security of Bitcoin

User’s privacy could be affected by different factors such as the public ledger (Blockchain) that keeps all transactions available, where a recent paper has shown that a user’s Bitcoin transactions can be linked to reveal user information and the risk of this leakage increases when the Bitcoin addresses are reused for multiple times (Barcelo, 2014). In addition, the success of Bitcoin has raised the risk of attracting fraudsters to exploit the operational insecurity and transaction irreversibility of Bitcoin (Moore& Christin,2013). Moreover, cybercriminals find Cryptocurrency system is an easy way to fraud the transactions (Conti, Kumar and Ruj, 2017). Another study has

studied and evaluated the privacy of Bitcoin by a process of analysing the Bitcoin system using a simulator that imitate the use of Bitcoin. The results have shown that 40% of the people's addresses can be exposed even when users follow privacy measures recommended by Bitcoin.

## 2.6. Anonymity of Bitcoin

There are some confusions and misconception about the anonymity of Bitcoin which is addressed also as a complicated issue and one of the most debatable concerns about Bitcoin.

According to (Reid and Harrigan,2013), in the Bitcoin system "users are identified only by public-keys and an attacker wishing to de-anonymize users will attempt to construct the one-to-many mapping between users and public-keys, and associate information external to the system with the users". Whereas, in a different research paper, (Miers et al, 2013) have introduced a cryptographic extension to Bitcoin named: Zerocoin, this Cryptocurrency boots the protocol to provide complete anonymity in currency's transactions. Zerocoin uses intelligent cryptography system and promise for powerful anonymity and incorporates the anonymity at the protocol level while different anonymity-enhancing technologies just add anonymity on top of the core protocol (Narayanan et al,2016).

## 2.7. People awareness and acceptance towards Bitcoin

The utilization of Cryptocurrencies is correlated with consumer awareness and different economic and demographic characteristics.

According to the results of the Survey of Consumer Payment Choice (SCPC) that was conducted in 2014-2015, 50% of United States consumers were aware of virtual currencies. However, most of these consumers who are aware of digital currencies didn't have a deep knowledge about them and they struggled to give an accurate answer to questions related to these currencies. In addition, about 1% only of the consumers in the United States have previously owned a virtual currency and use them in purchasing from a person or a merchant (Schuh & Shy,2016).

Another survey was conducted during the summer of 2016 to investigate the motivations and barriers that either motivate or prevent consumers from using the Bitcoin. The analysed findings classified the consumers into two categories. First, consumers who use Bitcoin due to technological curiosity. While the second category includes

the majority of people who state that they are waiting for others to start using the digital currencies, as they question the value and security problems (Presthus and O'Malley,2017).

In addition, a large-scale survey was conducted to examine end-users awareness of Bitcoin system in terms of security, privacy and anonymity. After analysing the survey's results, it was founded that the majority participants didn't take any security steps to protect their Bitcoin tools and they have misunderstanding on how to maintain their privacy within this system. while 22% of the users have lost money due to security violations or self-induced errors (Krombholz et al,2017).

## 2.8. Reflection

Based on the reviewed papers, we found that Bitcoin is highly spreading and being used in the western world. However, a large percentage of people who were aware of Bitcoin were not motivated to use it due to some concerns about the privacy, security, validity, and source of this Cryptocurrency. In addition, we found that the majority of Bitcoin's consumers didn't take any security measures to protect themselves from security violations or cybercriminals.

This makes addressing the user awareness and experience in using the Bitcoin in the middle east an interesting topic, where we can examine the behaviour of middle east citizens towards the Bitcoin and compare the final results with the ones we have found. In addition, this will provide a contribution to the knowledge body of digital currency and shed light on the Kingdom of Bahrain and Saudi Arabia.

## 3. Methodology and Data Collection

In this paper, a quantitative approach was conducted to collect the data, where an online questionnaire distributed based on a purposive sampling that mainly targeted the financial industries and other organizations. The questionnaire was designed to gather the necessary data based on the stated factors that were: (1) Bitcoin usage and management, (2) security, privacy, anonymity and backup behaviour, (3) risk perception, and each factor has a number of questions derived from: *"The Other Side of the Coin: User Experiences with Bitcoin Security and Privacy"* paper by (Krombholz et al, 2017),that serve the paper goal.

The online questionnaire was designed using Google Forms, where it was distributed over a purposive sample of users whether they were: Self-employed, employed (Government Sector), employed (Private Sector), student, retired, unemployed citizens or residents in Kingdom of Bahrain and The Eastern Province in KSA. This questionnaire was distributed online among users that concerning with the use of the Bitcoin and was active from 2<sup>nd</sup> until 9<sup>th</sup> of January, and to control the respondent’s responses the questionnaire questions classified as follows: Awareness section, Usage section and the User Experience section where the purpose of the classification is to classify the those users who are aware, use and then have an experience with the Bitcoin in order to gain a clear and accurate data where the users that do not use the Bitcoin will not continue and solve the User Experience section that contribute in investigating how users experience the Bitcoin system in terms of security, privacy, anonymity and risk depending on the questions as Table1 represent.

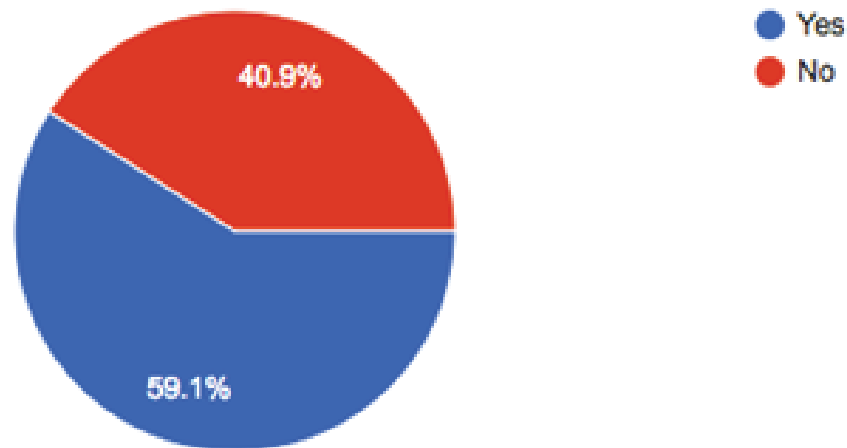
TABLE 1: The factors questions.

Factor	Questions
<b>Bitcoin Usage and Management</b>	- I started using Bitcoin from.
	- I am performing Bitcoin transactions.
	- What motivate me to use the Bitcoin is.
	- the services or products I pay for with Bitcoins is/are.
	- The most likely risk associated with Bitcoin.
	- the crypto currencies I’m holding or using besides Bitcoin.
<b>Security, Privacy, Anonymity and Backup behaviour</b>	- The greatest benefit of Bitcoins is.
	- wallets currently that I’m using is/are.
	- Is this wallet password protected ?
	- Is this wallet encrypted ?
	- Is this wallet backed up ?
	- Bitcoin usage is anonymous.
	- It is possible to follow your Bitcoin transactions.
	- I am using a software protection for Bitcoin.
- I am taking additional steps to ensure my privacy using Bitcoin.	
<b>Risk perception</b>	- The risk of monetary loss for Bitcoin compared to credit cards is.
	- The risk for malware that steals your Bitcoins is.
	- The risk of monetary theft in case the device gets lost or stolen is.
	- The risk of a strong fluctuation in the Bitcoin exchange rate.
	- The security incidents that I have been affected by is/are.
	- I Have lost my bitcoins or Bitcoin keys before.
	- The reason behind the key/Bitcoin loss is/are.
- I have been able to recover my keys.	

## 4. Findings

This part represents what the distributed questionnaire yield, where 203 people filled and answered the questions from Kingdom of Bahrain and The Eastern Province in KSA during around 30 days. The findings addressed in terms of Bitcoin usage and management, security, privacy, anonymity and backup behaviour, risk perception and the demographic data.

### 4.1. Users awareness and use of Bitcoin



**Figure 1:** Percentage of people awareness of Bitcoin.

The Fig 1 above shows percentage of people awareness of Bitcoin in Bahrain and The Eastern Province (Dammam and Khobar) in KSA, where most the respondents were aware with a 59.1% while only 40.9% were not aware.

Fig 2 represent the people usage percentage of the Bitcoin, where most them do not use the Bitcoin, while a small percentage use the Bitcoin currently with a 28.3%.

### 4.2. Demographic findings

As table1 shows that the respondents group age that contribute in answering the questionnaire, most of them were between 18-25 and 26-35 with 44.3% and 36.9, and the least group was above 55 with a 1.5%. also, most of the respondents were well educated and hold the bachelor certificate with a percentage of 62.6%, whereas



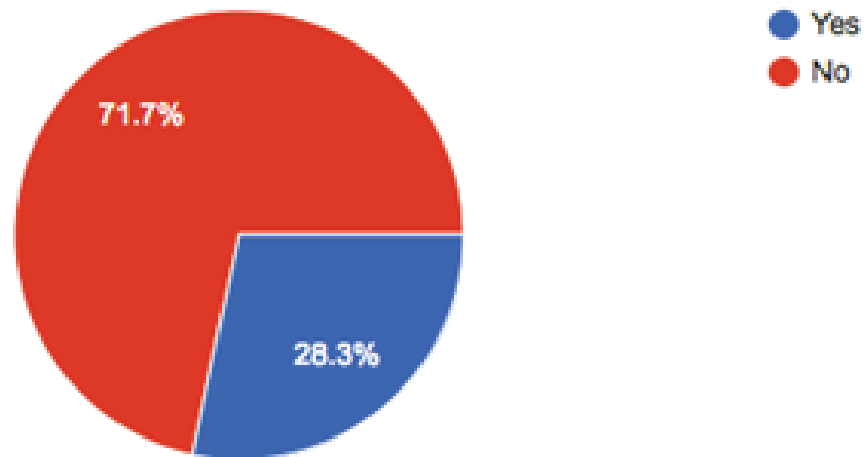


Figure 2: Percentage of people use the Bitcoin.

the users with their occupations, the finding showed a diverse mixture of employed in the private sector that gets the highest percentage, employed the government sector with 16.3%, where the retired gets the least percentage which is 5%.

TABLE 2: Demographic Characteristic of Bitcoin Survey Respondents.

Demographic Factor		Frequency	Percent (%)
<b>Gender</b>	Male	75	36.9
	Female	128	63.1
<b>Age</b>	Below 18	2	1.0
	18 - 25	90	44.3
	26 - 35	75	36.9
	36 -55	32	15.8
	Above 55	3	1.5
<b>Education</b>	Intermediately or less	3	1.5
	Secondary Certificate	23	11.3
	Diploma	29	14.3
	Bachelor Certificate	127	62.6
	Master’s Degree	19	9.4
<b>Occupation</b>	PhD or Higher	2	1.0
	Self employed	26	12.8
	Employed (Government Sector)	33	16.3
	Employed (Private Sector)	59	29.1
	Student	53	26.1
	Retired	1	.5
	Unemployed	31	15.3



Figure 3: Nationality of Bitcoin users.

Fig 3 illustrate the users that have an experience with the Bitcoin from Kingdom of Bahrain and The Eastern Province (Dammam and Khobar) in KSA, where Kingdom of Bahrain and other nationality gets the least percentage with a 39.4% and 7.4% of users experience respectively, and the highest percentage was from the KSA with 53.2%.

### 4.3. Users’ experience in terms of (Bitcoin’s usage and management, security, privacy, anonymity and backup behaviour, and risk perception)

#### 4.3.1. Bitcoin usage and management

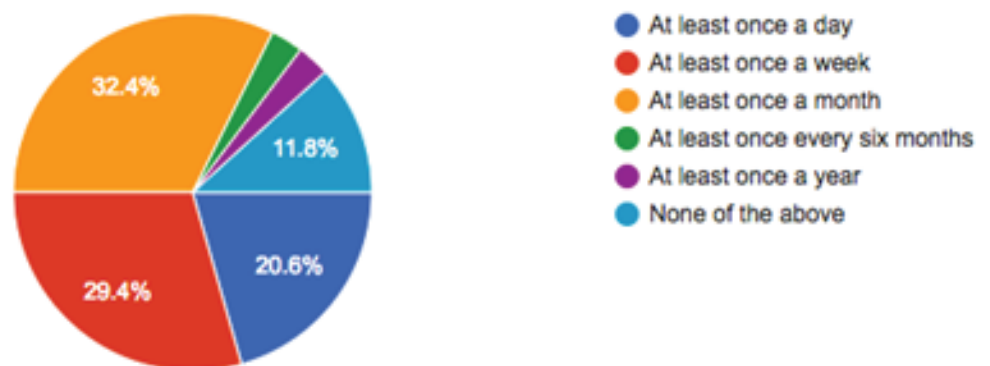


Figure 4: Bitcoin transaction frequencies.

The frequencies of performing a Bitcoin transaction varies between once a week, once a month with 29.4% and 32.4%, and at least once a day with 20.6% whereas none of the above at the last rank with 11.8% as Fig 4 shows.

Fig 5 illustrate the most services and products that the Bitcoin used to pay for, the majority was for the online shopping with 47.1% followed by medium for currency

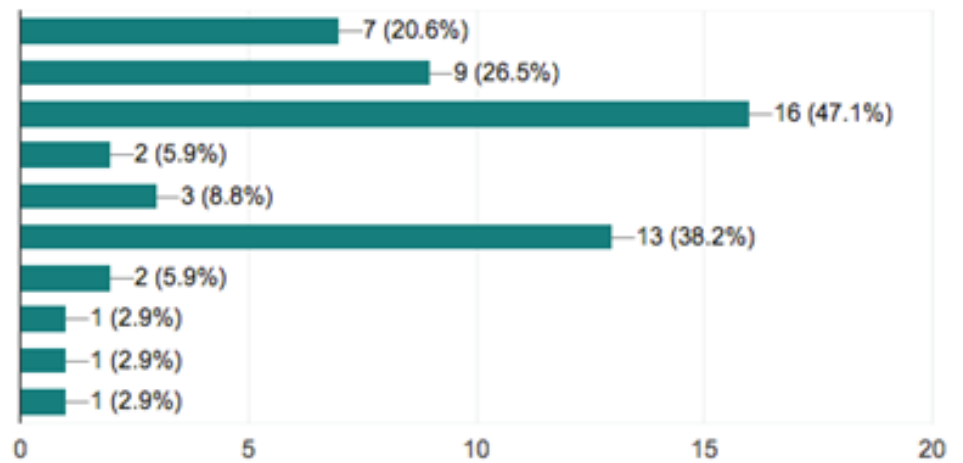


Figure 5: Services and Products paid using Bitcoin.

exchange with 38.2% whereas physical store did not use it yet, and gain money/buy and sell considered the minimum with a 2.9%.

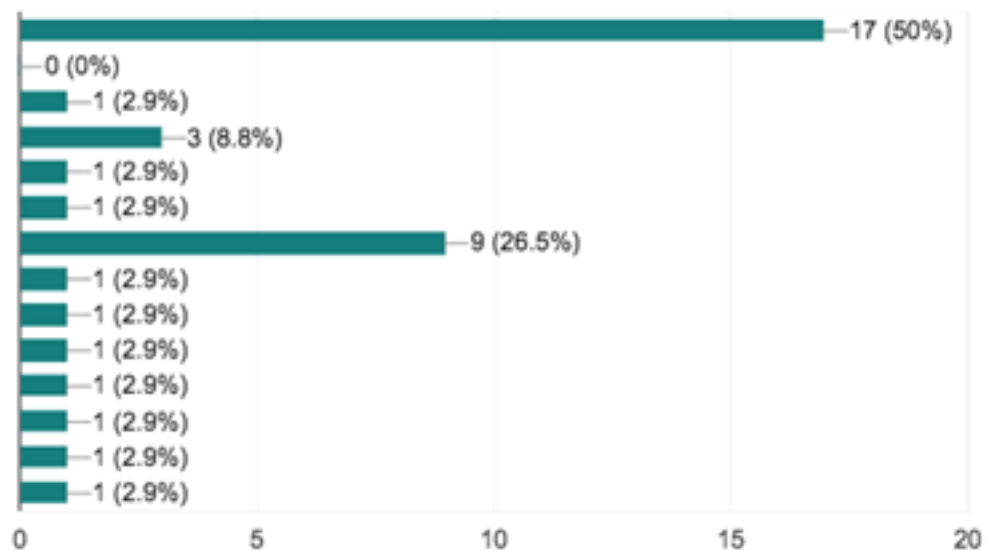


Figure 6: Other digital currencies used.

The other digital currencies used as a substitute for the Bitcoin are listed in Fig 6, where half of respondents specified that they do not use another digital currency with 50%, however the mostly used currency was Litecoin with a 26.5%. Most of the remaining currencies ranked at the least with 2.9%.

### 4.3.2. Security, privacy, anonymity, and backup behaviour

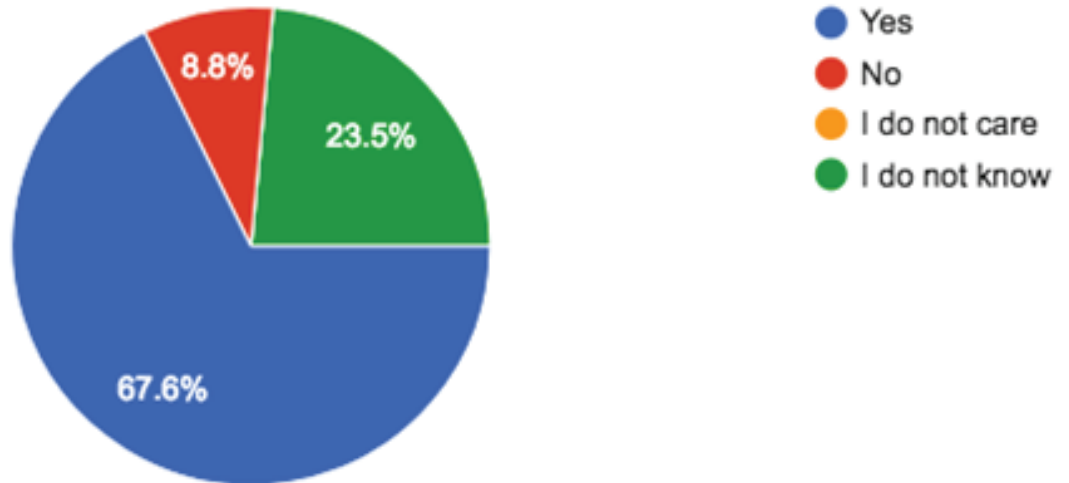


Figure 7: Percentage of encrypted Bitcoin wallet.

Fig 7 shows the percentage of encrypted Bitcoin wallet, where 67.6% of the respondents encrypt their wallet while 23.5% do not know if their wallet is encrypted, however 8.8% did not encrypt at all.

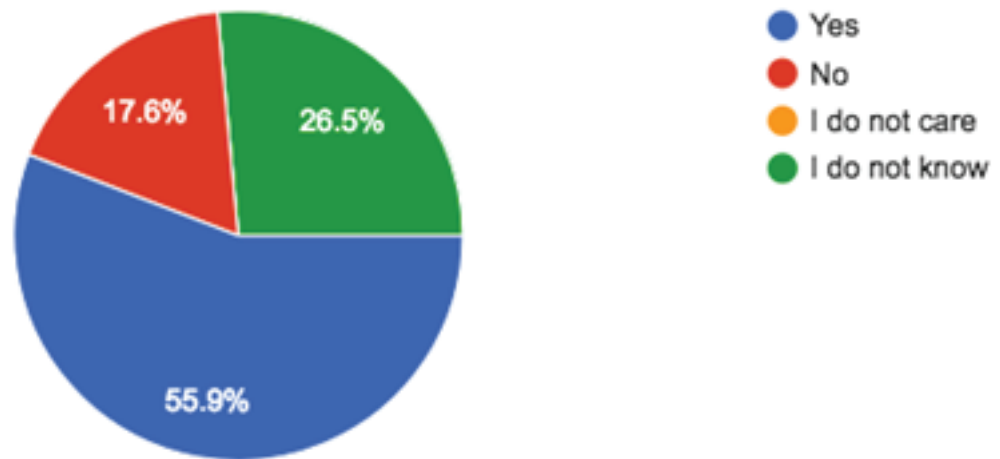


Figure 8: Percentage of backed up Bitcoin wallet.

As Fig 8 illustrate that 55.9% of the respondent's backup their Bitcoin wallet and 17.6% do not do a backup, while 26% do not know if their wallet is backed up or not.

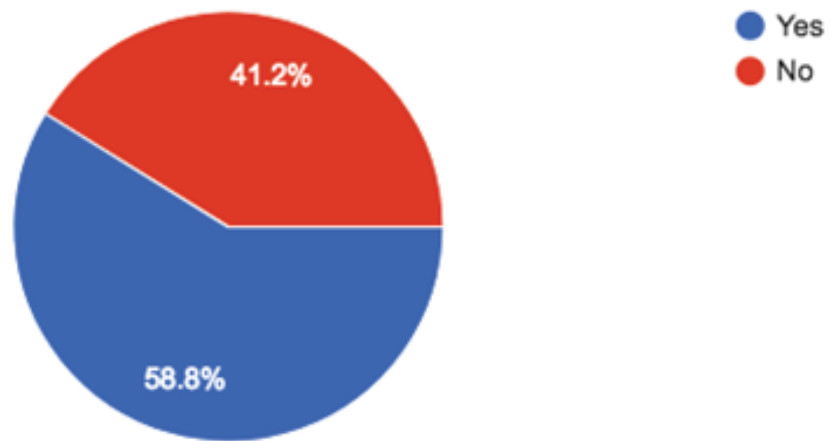


Figure 9: Percentage of Bitcoin that protected by a software.

Around half of respondents specify that they used a software to protect their Bitcoin with a 58.8%, whereas 41.2% did not use a software to protect their Bitcoin as Fig 9 represent.

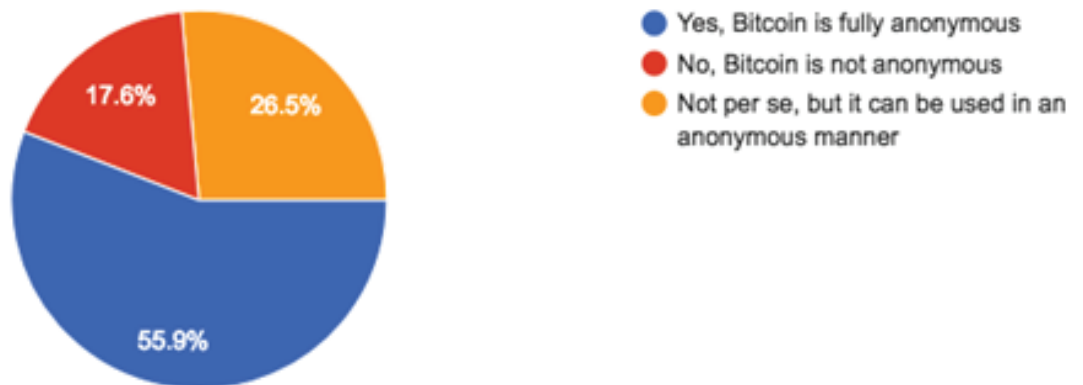


Figure 10: Bitcoin usage anonymity.

Fig 10 shows the Bitcoin usage anonymity, most of the respondents specify that the Bitcoin is fully anonymous with a 55.9%, 26.5% agreed that it can be used in an anonymous manner, while 17.6% said that the Bitcoin is not anonymous.

### 4.3.3. Risk perception

Fig 11 clarify that there are a variety of reasons behind the Bitcoin key loss, the first rank was for self-induced event and hardware failure with a 25%, software failure ranked with 20.8% whereas malicious event was the least with 12.5%.

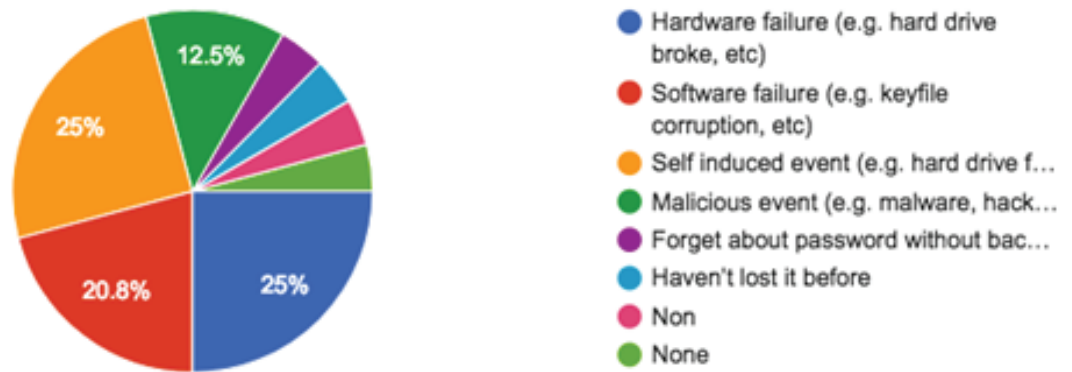


Figure 11: Reasons behind Bitcoin key loss.

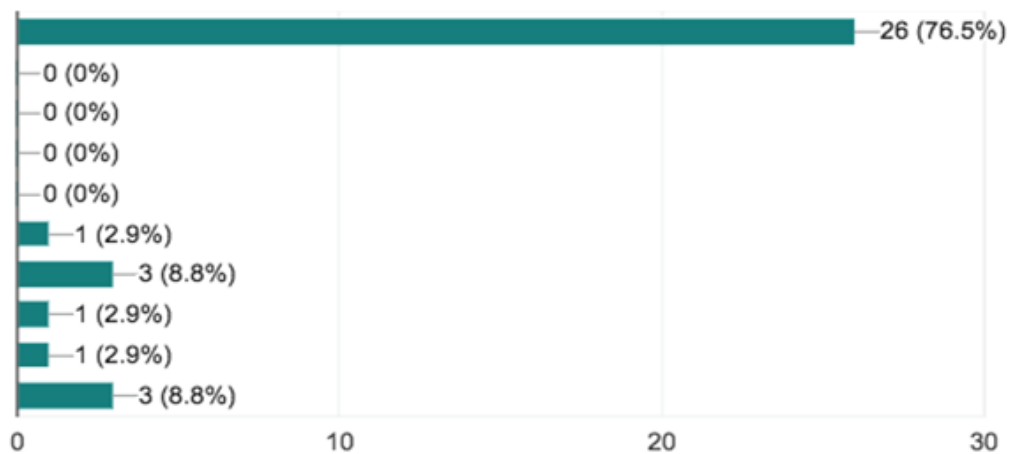


Figure 12: Bitcoin security incidents.

Most of the respondents confirmed that none of the listed incident occurred with them with 76.5% where the mostly occurred incident were Bitcoin exchange scam with an 8.8%. the remaining incident options were the least that were between 2.9% and 0% as Fig 12 illustrate.

Around half of respondents agreed on that the Bitcoin exchange rate fluctuation is strongly high with a 55.9% and 23.5% said that is high where only 2.9% specify that it has strongly low risk as Fig 13 represents.

Fig 14 shows the risk of the Malware on the Bitcoin, 35.3% of the respondents verified that it is strongly high, 11.8% is low where 20.6% was in between. However, no one specified that the Malware has no effect on the Bitcoin.

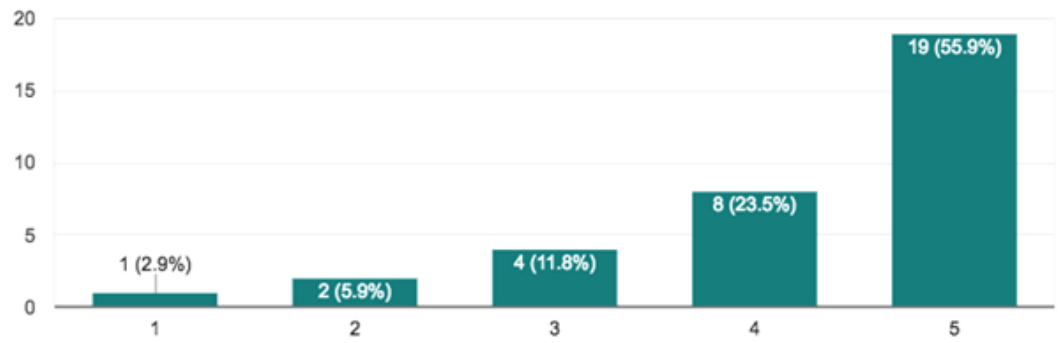


Figure 13: Bitcoin exchange rate fluctuation risk.

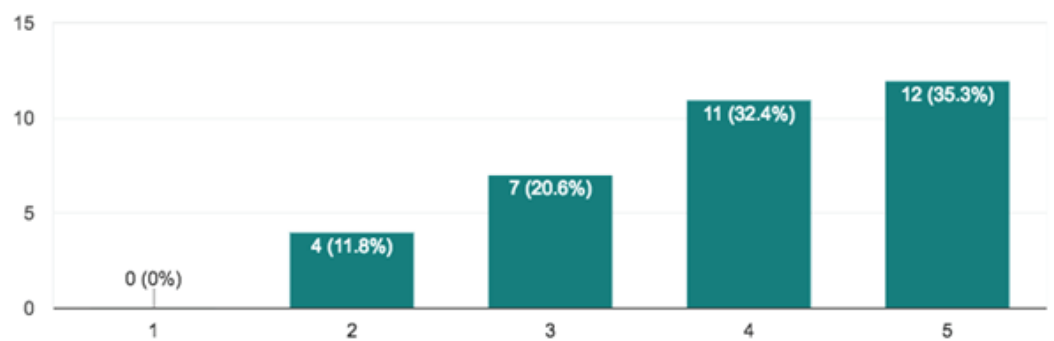


Figure 14: Malware risk on the Bitcoin.

## 5. Discussion

An interesting and surprising results were found after reviewing the analysis’s result of the questionnaire that have been distributed online among different regions in the Kingdom of Bahrain and the Kingdom of Saudi Arabia/Eastern Province particularly in (Khobar Dammam) to study the user’s experience of Bitcoins in terms of security, privacy. 203 people have filled the questionnaire, more than half of them are from Saudi Arabia, while the rest are from Bahrain and different nationalities. The majority of respondents are utilizing Bitcoins are females with a 63.1%, while only 36.9% respondents are males. The majority of the respondents are in their middle age between twenty and forty, while the rest are above the age of 55. Those who answered the questionnaire are mostly self-employed and employed from government and private sectors, and most of them are holding a bachelor’s degree. Thus, the questionnaire was mostly answered by a well-educated people who are aware of bitcoins. However, more than 50% of them are aware of the Cryptocurrency Bitcoin, but only 28.3% are utilizing this digital currency. The result might be due the prohibition of Bitcoin usage in the Kingdom of Bahrain and Saudi Arabia as it was announced recently in reliable

news channels and economic websites that the bitcoins is an illegal currency and it is not accredited in some countries including Bahrain and Saudi Arabia.

Most of the respondents who are utilizing the Bitcoin were motivated by financial gain purposes. Their frequent utilization of bitcoins and different currencies such as Litecoin to perform transactions in different services has varied, where some are using it once a week, others are using it one a month, while the rest are using it once a day. During these transactions, the majority of the users were using password-protected and encrypted wallets in addition to software to protect their Bitcoin tools, while the minority did not take any security measures to protect their transactions. Therefore, a very small percentage of users were affected by security incidents and key losses, while the majority have never been affected by any type of security attacks or loss their keys.

This result shows that most of the Middle East citizens are well-educated in terms of security application and management and they are fully aware on how to secure themselves against security attacks in the cyber space. However, there is a small portion of users who are not fully aware of security measures and do not apply them during the utilization of Bitcoins. Therefore, increasing their awareness in these aspects can be considered critical to have effective and efficient society.

## 6. Conclusion and Recommendations

In conclusion, this paper aimed to examine the people experience in Bahrain and Saudi Arabia in using the digital currencies, in particular (Bitcoin) in terms of security and privacy. In addition, it aimed to study the public awareness of Bitcoins and add to the knowledge body of smart city and cryptocurrencies, since these areas are not sufficiently covered through publications, and as they are still developing and evolving. The literature review section covered the smart city background, its definition and dimensions. In addition, it introduced Bitcoin and its privacy, security and anonymity. Also, it reviewed some papers that studied the people's awareness and acceptance of this Cryptocurrency. The paper used a quantitative method approach through the distribution of an online questionnaire to the residents of the Kingdom of Saudi Arabia (Khobar and Dammam) and Bahrain to measure their experience. Based on the analysed results of the examined questionnaire, this paper can recommend in increasing the citizens' awareness of using Bitcoin while maintaining their security and privacy. In addition, it recommends the citizen of Bahrain and Saudi Arabia to follow the country's cyber security laws and policies.



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