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A Study on the Acceptance Towards Blockchain-Based Access to Biobanks' Services Using UTAUT2 With ITM and Perceived Risk

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Abstract. The blockchain technology offers reliability, decentralization, security and credibility. Blockchain solutions can be based on smart contracts and on the use of utility tokens which may represent a utility of a company like limited fashion items, cars, car parts or even human biological samples stored in biobanks. However, decentralization comes with responsibilities: people must take care of storing those tokens in a safe place (commonly denominated as "wallets") knowing that losing a wallet or wallet key means losing the owned tokens. This concept is still new to people and might sound scary. The success of such services relies on the extent of customers intending to adopt them and very few studies target this intention.
The current research proposes a model combining of the unified theory of acceptance and usage of technology (UTAUT2) with the initial trust model (ITM) and the perceived risk construct in order to evaluate the factors affecting the behaviour and use intention of people towards a blockchain technology that enables access to biobank services. An online questionnaire was built and sent to swiss university students. The 72 results showed that simplifying the access to blockchain-based technologies will facilitate inclusion, enabling people with lower digital literacy to access these technologies.

Keywords: Blockchain, Biobanks, UTAUT2, ITM.

1 Introduction

A biobank is a stock of biological samples, i.e., stem cells or blood, and associated information, i.e., height or weight; the samples are stored for research, diagnostic and therapeutic purposes. Every biobank has its own goal; therefore, the types of the collected specimens and the offered services vary accordingly.

The blockchain technology's transaction ledger is public, decentralized, encrypted and constantly audited; therefore, all the network's participants (miners) can make sure the data is correct. Miners have a stored copy of the blockchain's past data so any modification or inconsistency is immediately detectable, adding data traceability and

immutability. The technology also allows the deployment of smart contracts, adding autonomy and accuracy, making biobanks' services safer, more transparent and more accessible. We believe that increasing the acceptance of blockchain-based technologies is a first step to increase their accessibility and, consequently, the inclusiveness of the services provided via this technology.

The goal of this study is to propose a model that evaluates the factors affecting the intention toward the adoption of blockchain-based technologies facilitating access to biobank services and to get a first understanding about its acceptance. Many hypotheses were suggested for every construct of the model, regarding its impact on the behavioural intention and use behaviour. Each hypothesis was represented by questions and then validated or rejected based on the answers.

2 Theoretical Background

2.1 UTAUT and UTAUT2

The unified theory of acceptance and use of technology (UTAUT) was forumlated by [1], with the goal of combining the schemes provided by a wide range of models like TAM (Technology acceptance model), TPB (Theory of planned behaviour), TRA (Theory of reason action), IDT (Innovation diffusion technology). Its goal is to interpret the factors affecting users' acceptance and use of a new technology.
The UTAUT's four key constructs are [1]:
Performance expectancy (PE) representing the extent to which the use of the technology lets the user achieve gains and improvements in some tasks.
Effort expectancy (EE) expressing the intuitiveness associated by the consumer to the technology's use. Given the blockchain's complexity, effort expectancy could be important in establishing the intention to use.
Social influence (SI) is to what degree the consumer suppose that friends and close relatives will think that he/she should use the technology.
Facilitating conditions (FC) represents the consumer's beliefs in the availability of needed resources and help to support the use of the technology.

The objective of UTAUT2 [2] is to broaden UTAUT's scope by taking into consideration the consumer use context due to the variance of the answer between the customers and organization context.

UTAUT2 appends three constructs to UTAUT:
Hedonic motivation (HM) is illustrated by the feeling of fun derived from the technology usage.
Price Value (PV) is the "consumer's cognitive trade-off between the perceived benefits of the application and the monetary cost of using it". The price value is positive when the benefits of using the technology are perceived to be greater than the associated monetary cost and such price value has a positive impact on intention. This construct was excluded from the questionnaire because the participants didn't know about the cost of the technology.

Habit (HB) represents the learning curve and the extent to which learning automates tasks to be done with the technology [3]. It is also equated to automaticity by [4]. Blockchain technologies currently require some technical background so it is expected that habit affects intention to use and adopt positively.
The defined constructs are expected to be moderated by the variables: age, gender and experience; with experience being the occasion to use a technology that varies since the system was used for the first time ([4], [1]).

2.2 Initial Trust Model

The functional goals of our application allow it to be brought closer to a mobile banking or e-banking design. Given the fact that blockchain technologies are still relatively new to the market, consumers tend to be cautious and that the offered service might seem risky. To consider this aspect, we propose to extend UTAUT2 with ITM (Initial trust model) and add perceived risk as an additional key construct. **Initial trust (IT)** does not rely on experience or knowledge, it reflects the willingness of a person to take risks to accomplish a certain task [5]. Trust has an important role in determining customers' intention to adopt mobile banking technologies [6], [7], [8]).

ITM's three main constructs are:
Structural assurance (SA) in the form of documents helping building trust in the service
Personal propensity to trust (PPT) represented by the tendency of the person to rely on others in various situations [9].
Firm's reputation is also an important construct of the model; however, we chose to discard it given that, in our study, the participants did not know the company offering the service.

2.3 Perceived Risk

Perceived risk (PR) is represented by the perceived potential loss due to using the offered solution [10]. It is commonly used as extension of the UTAUT model [11]. This construct will also be moderated by experience.

3 Hypotheses and Methodology

The proposed model is a combination of the UTAUT2 model with the ITM model and the perceived risk construct. Our model is shown in Fig.1

3.1 Hypotheses

In our model, a hypothesis represents the influence of a latent variable on another.
H1, H2, H3, H4a, H5, H6a, H10: PE, EE, SI, FC, HM, HB and IT will have a positive effect on behavioural intention.
H7: PR will have a negative influence on behavioural intention.

H8, H9: SA and PPT will have a positive influence on initial trust.
H4b, H6b, H11: FC, HB and behvaioural intention will have positive effects on use behaviour.

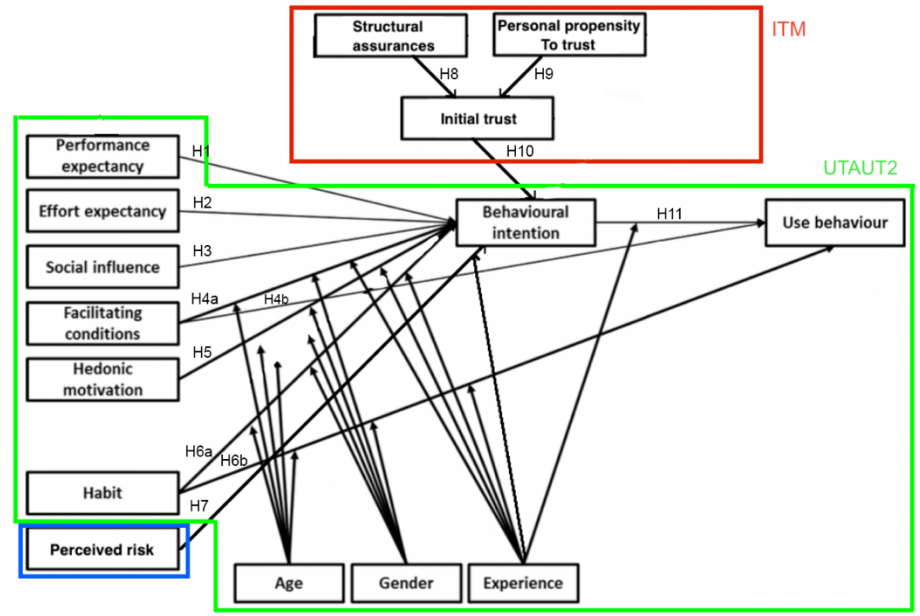

Fig. 1. Our research model showing the UTAUT2 (without the price value variable), ITM (without the firm's reputation variable) and the perceived risk construct

The questionnaire was distributed to university members in Switzerland (students, employees and professors). Qualtrics [12] was the chosen platform on which the questionnaire was created and hosted. The broadcast was done via email. Some questions were eliminated (either due to unrelatedness to our technology or due to lack of knowledge available on the participants' side).

4 Results

We had a total of 82 participants, 10 questionnaires had been disregarded due to missing answers. The majority was masculine (between 18 and 40 years) and most of the participants held a bachelor degree or a master. The fact that most of the contributors had higher education does not directly correlate to their digital literacy or their understanding of blockchain-based technologies. In this concern, participants were asked about their experience with crypto-currencies and e-banking. 19 participants had less than a year of online banking experience. Only 2 participants considered themselves very familiar with crypto-currencies and interaction with the blockchain, 11 participants had previously bought crypto-currencies while the rest had no prior interaction with such a technology.

Table 1. Validity and reliability of the latent variables

	Item	Factor loading	Indicator reliability	Fiability composite	AVE	Rho_A
BI	BI1	0.935	0.877	0.938	0.883	0.871
	BI2	0.944	0.891			
EE	EE1	0.570	0.324	0.786	0.557	0.693
	EE2	0.873	0.761			
	EE3	0.765	0.585			
EXP	EXP1	0.971	0.943	0.971	0.943	0.940
	EXP2	0.971	0.942			
FC	FC1	0.820	0.671	0.871	0.628	0.803
	FC2	0.799	0.638			
	FC3	0.780	0.608			
	FC4	0.770	0.592			
HB	HB1	0.752	0.565	0.836	0.721	0.797
	HB2	0.933	0.875			
HM	HM1	1	1	1	1	1
IT	IT1	0.931	0.866	0.928	0.763	0.907
	IT2	0.948	0.899			
	IT3	0.848	0.719			
	IT4	0.754	0.568			
PE	PE1	1	1	1	1	1
PPT	PPT1	0.903	0.815	0.665	0.415	0.779
	PPT2	0.759	0.576			
	PPT3	0.516	0.265			
	PPT4	-0.023	0.0005			
PR	PR1	0.865	0.748	0.944	0.849	0.976
	PR2	0.946	0.894			
	PR3	0.951	0.905			
SA	SA1	0.528	0.278	0.732	0.597	0.719
	SA2	0.956	0.914			
SI	SI1	0.947	0.896	0.929	0.867	0.880
	SI2	0.916	0.838			
USE	USE1	0.833	0.694	0.832	0.625	0.778
	USE2	0.845	0.714			
	USE3	0.684	0.467			

5 Discussion

The results showed that simplifying the access to blockchain-based technologies will facilitate inclusion, enabling people with lower digital literacy to access these technologies. We have noticed that a significant part of the answers was neutral (neither agree nor disagree). This is probably due to the complexity and novelty of the pre-

sented technology: The blockchain concept is still unclear. Most of the participants were quite confident that they could understand and use our solution and they found that this technology facilitates the access to biobank services. About 25% intends to use the technology.

The questionnaires were collected and analyzed using the partial least squared method (PLS) based on variance-based structural equation modeling by using the SmartPLS software [13]. A representation of the model was made on SmartPLS in order to analyze the factors that influence the willingness to use and adopt the technology.

In order to ensure the reliability and validity of the latent variables, their external loads, their composite reliability, the extracted mean variance and its square root are studied (these data are calculated and exported via SmartPLS). The conditions that these indicators must meet are as follows:

- Indicator reliability is acceptable if it's above 0.7, it is considered acceptable if it's an exploration context and its value is above 0.4.
- Internal consistency reliability is acceptable if it's above 0.7 or above 0.6 in case of exploratory research.
- Convergent validity is acceptable for values equal to 0.5 or higher

There are 4 elements below the acceptable limit level (0.4) for indicator reliability (EE1, PPT3, PPT4 and SA1). The personal propensity to trust has a mean variance greater than 0.4 which is acceptable if the reliability component passes the threshold of 0.6 [14]. All items pass the threshold for the reliability component and the rho_A (Table 1).

Table 2. Discriminant validity. This picture shows the correlation between variables and the square root of the AVE (in bold)

	USE	BI	EE	EXP	FC	HB	HM	IT	PR	PE	PPT	SI	SA
USE	**0.791**												
BI	0.543	**0.939**											
EE	0.603	0.673	**0.747**										
EXP	0.608	0.807	0.688	**0.971**									
FC	0.54	0.612	0.754	0.606	**0.792**								
HB	0.495	0.799	0.653	0.613	0.658	**0.85**							
HM	0.402	0.342	0.474	0.414	0.586	0.456	**1**						
IT	0.556	0.592	0.632	0.588	0.688	0.606	0.54	**0.874**					
PR	-0.295	-0.234	-0.335	-0.289	-0.422	-0.236	-0.297	-0.516	**0.922**				
PE	-0.112	-0.174	0.06	-0.118	-0.068	-0.165	-0.046	-0.136	0.047	**1**			
PPT	-0.235	-0.244	-0.424	-0.288	-0.318	-0.299	-0.441	-0.408	0.363	-0.11	**0.644**		
SI	0.569	0.688	0.758	0.528	0.761	0.754	0.494	0.723	-0.307	-0.164	-0.429	**0.931**	
SA	0.416	0.403	0.358	0.375	0.399	0.453	0.21	0.631	-0.395	0.156	-0.261	0.395	**0.772**

Discriminant validity is established by checking that the square root of the average variance extracted (AVE) (in bold on the diagonal in Table 2) is greater than other correlation values between latent variables. We include experience in the chart because a strong moderating effect was noticed.

The results of the measurement model indicate good consistency reliability, indicator reliability, convergent validity and discriminant validity, ensuring distinction and usefulness of the latent variables for testing the structural model.

The model explains 86% of the variation in behavioural intent and 51.4% of the utilization behaviour. It also indicates that social influence (0.258), habit (0.351) and experience (0.526) are strong predictors of behavioural intention while the rest do not really affect it. The same is true for facilitated conditions (0.245), habit (0.161) and experience (0.430) for use behaviour.

According to the results analysis, the suggested model reached acceptable levels in terms of fitness, reliability and validity. The effect of added constructs like perceived risk or initial trust is not very significant on behavioural intention. The fact that only a small party doesn't trust the technology (less than 15% had negative answers when it comes to trust or propensity to trust) and that experience and habit influence behavioural intention the most shows how important it is that people get familiar with using the technology. Therefore, designers should focus on simplifying the use of blockchain-based technologies to facilitate inclusion.

5.1 Limitations and future research

This study presents some limitations that should be tackled in future research. In particular, the participants have not tested the solution but a video of a prototype was presented with an explanation about the solution and blockchain technology. In addition, the fact that the blockchain technology is very new and was never used before by many participants was a barrier for some of them who perceived this technology as very complex and the goal of the proposed service unclear; this resulted in some incomplete surveys. Finally, the survey was only sent to people with an academic background. A more diversified audience (i) might give more importance to other constructs (ii) and allows generalizing the results to general population.

Finally, it is also important to keep in mind that people will get more and more familiar with the blockchain technology in general and that habit and experience will grow up more and more in this field.

6 Conclusion

The adoption of biobanks services using blockchain technology was studied in this research by suggesting a new model joining UTAUT2, ITM and the perceived risk construct. The additions to the UTAUT2 model turned out to be with negligible influence on the behavioural intention and use behaviour. We found out that the inclusion of such a technology relies on how easy it seems for users. Further studies should maybe let users use the technology for a certain period of time before handing in the questionnaires.

References

1. Venkatesh, Viswanath, et al. "User acceptance of information technology: Toward a unified view." *MIS quarterly* (2003): 425-478.
2. Venkatesh, Viswanath, James YL Thong, and Xin Xu. "Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology." *MIS quarterly* (2012): 157-178.
3. Limayem, Moez, Sabine Gabriele Hirt, and Christy MK Cheung. "How habit limits the predictive power of intention: The case of information systems continuance." *MIS quarterly* (2007): 705-737.
4. Kim, Sung S., Naresh K. Malhotra, and Sridhar Narasimhan. "Research note—two competing perspectives on automatic use: A theoretical and empirical comparison." *Information systems research* 16.4 (2005): 418-432.
5. Kim, Kyung Kyu, and Bipin Prabhakar. "Initial trust and the adoption of B2C e-commerce: The case of internet banking." *ACM SIGMIS Database: the DATABASE for Advances in Information Systems* 35.2 (2004): 50-64.
6. Alalwan, Ali A., et al. "Consumer adoption of Internet banking in Jordan: Examining the role of hedonic motivation, habit, self-efficacy and trust." *Journal of Financial Services Marketing* 20.2 (2015): 145-157.
7. Luo, Xin, et al. "Examining multi-dimensional trust and multi-faceted risk in initial acceptance of emerging technologies: An empirical study of mobile banking services." *Decision support systems* 49.2 (2010): 222-234.
8. Zhou, Tao. “An empirical examination of initial trust in mobile banking.” Internet Research (2011)
9. McKnight, D. Harrison, Larry L. Cummings, and Norman L. Chervany. "Initial trust formation in new organizational relationships." *Academy of Management review* 23.3 (1998): 473-490.
10. Featherman, Mauricio S., and Paul A. Pavlou. "Predicting e-services adoption: a perceived risk facets perspective." *International journal of human-computer studies* 59.4 (2003): 451-474.
11. Williams, Michael D., Nripendra P. Rana, and Yogesh K. Dwivedi. "The unified theory of acceptance and use of technology (UTAUT): a literature review." *Journal of enterprise information management* (2015).
12. Qualtrics Homepage, https://www.qualtrics.com/, last accessed 2021/01/29.
13. SmartPLS Homepage, https://www.smartpls.com/, last accessed 2021/01/29.
14. Fornell, Claes, and David F. Larcker. "Evaluating structural equation models with unobservable variables and measurement error." *Journal of marketing research* 18.1 (1981): 39-50.