Students Expectations Towards New Technologies: A Case of Blockchain

Completed Research

Introduction

Blockchain technology (BC) concept and implementation was presented by Nakamoto (2008) as a distributed digital ledger, consisting of digital blocks connected into chains, being the backbone of the cryptocurrency Bitcoin. This solution allowed to realize payments in peer-to-peer networks. Invention of blockchain and Bitcoin is perceived as an answer of the IT community to the financial crisis of 2008.

BC properties such as (Xu et al. 2019): decentralization, persistency, anonymity and auditability make this technology suitable for application in the Information Technology for Development context as it can contribute to the improvement of quality of life and eliminating poverty. There are numerous examples of blockchain-based systems in developing countries and emerging economies that include: providing services for excluded, unprivileged, and underserved areas – finance (Schuetz and Venkatesh In Press; Ghatpande et al. 2019), healthcare (Dhagarra et al. 2019), and eliminating poverty (Kshetri 2017); establishing e-government initiatives (Khan et al. 2019); providing secure land registry systems (Lemieux 2016); enabling record-keeping functionality in education (Bore et al. 2017); implementing FinTech applications – cryptocurrencies (Mazambani and Mutambara 2019), money transfer in general (Westhuizen 2016) and loan management systems for small and medium-sized enterprises (Kinai et al. 2017); understanding the future of work (Bhattacharyya and Nair 2019); designing intelligent water management systems (Dogo et al. 2019). However, people's related issue connected with this technology diffusion, especially among the young generation, remains to be investigated.

It should be noted that in literature there are numerous well established models and frameworks describing user behaviour in the context of acceptance and adoption of a new technology and/or information system (Taherdoost 2018). The most prominent include: Diffusion of Innovations (DOI) (Rogers 1962), Social Cognitive Theory (SCT) (Bandura 1986), Theory of Reasoned Action (TRA) (Fishbein and Ajzen, 1975, Ajzen and Fishbain 1980), Theory of Planned Behavior (TPB) (Ajzen 1985; 1991), Technology Acceptance Model (TAM) (Davis 1989; Davis et al. 1989) and The Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al. 2003). However, to the best of our knowledge, the issue of perception of new technologies by young people still requires investigation.

We would like to investigate to what extent the young generation of IT workers are ready to use new technologies and what are their expectations towards them. This issue is of utmost importance taking into account the fact that they will shape business decisions in the immediate future. They will be to decide which technology should be applied. We focused our attention on BC as an example of a new technology. In order to investigate the above mentioned issues in depth, we conducted research among students of universities in Cracow, Poland, that aimed at answering the following research questions:

RQ1: Does the use of certain types of information sources impact knowledge or usage of BC?
RQ2: Are there any relationships between knowledge and usage of BC?
RQ3: Are there any relationships between students' knowledge and their expectations towards BC?
RQ4: Are there any relationships between technology usage and expectations concerning BC?
RQ5: Are there any relationships between the use of information sources and expectations concerning BC?

The research is an extension of a preliminary study presented in (Authors 2019). In particular, in the current study we analysed a greater student population that allowed us to conduct a more detailed analysis of relationships between factors and also to propose a research model.

The paper is organised as follows. The next section presents the research background that is followed by the description of the research method. Then the results of empirical research are presented and discussed. The main research outcomes are summarised in Implications and Conclusion sections.

Research Background

Blockchain

Blockchain technology may be defined as "an emerging digital technology that combines cryptography, data management, networking, and incentive mechanisms to support the checking, execution, and recording of transactions between parties" (Xu et al. 2019, p. 3). Nowadays BC has an over 10-year history. BC applications dominate in the financial and banking (FinTech) industries but also are present in other domains such as technology, media, telecommunications, life sciences and health care, and government (Deloitte 2019). In particular, BC may be used for digital currency exchange, digital content management, registration of patents, organizing e-voting, execution of smart contracts, implementing supply chains, and establishing blockchain states (Boucher at al. 2017).

The *Global Blockchain Survey* 2019 by Deloitte (2019) indicates that last year introduced a change in the way BC is considered by companies. The surveyed companies shared the recognition that BC is a real and pragmatic solution for various organizational needs. The opinion that BC constitutes one of the top five critical strategic priorities for the organization increased by 10% from the previous year and accounts for 53%. On the other hand, only 3% of organizations stated that BC is not relevant for their organizational needs. This last figure dropped by 1% from the previous year. The organizations admitted in 82% share that "blockchain technology is broadly scalable and will eventually achieve mainstream adoption" (p. 5).

According to many authors, BC is considered, similarly as Internet in the '90, to be a disruptive technology (Frizzo-Barker et al. In Press; Woodside et al. 2017). It is, however, a relatively immature academic concept as it is mainly analyzed from theory rather than practical perspective. The study done by Frizzo-Baker with colleagues (In Press) indicates that 83% of papers concentrate on conceptual issues whereas 17% focus on the empirical side and conclude that BC research is at the earliest stage of scholarly endeavour.

The majority of BC scholarly literature focuses on the technology and ignores the organizational complexity of technology implementation. However, academic literature on BC adoption is emerging and includes among others: studies of conceptual frameworks for adoption of BC including complex relationships between institutional, market and technical factors (Janssen et al. 2020), eliminating financial exclusion of rural areas in India (Schuetz and Venkatesh In Press), supply chain on an individual level in India and USA (Queiroza and Wamba 2019), and Malaysia (Wong et al. In Press).

Site of Research

Our research was conducted in Cracow, Poland. It should be noted that today Cracow is considered to be the 6th best outsourcing destination in the world according to (Tholons, 2018). There are numerous shared service centres, business process outsourcing firms, IT services and R&D (research & development) companies including brands such as: Akamai, Capgemini, Cisco, Google, HCL, HSBC, IBM, Motorola, Nokia, Sabre, Samsung, and UBS, to mention the most prominent. A good climate for business investment is undoubtedly fostered by the public activities which are expressed by the creation of the Special Economic Zone and the Cracow Technology Park. This allows companies to optimize their investments and helps organize business actions especially at the beginning of their activity.

Another key factor that contributes to the growth of business environment is Cracow 's academic heritage. Today there are more than a dozen universities supplying a significant number of alumni ready to be employed by the businesses. A vast part of this number are IT specialists. The four main universities are the following: AGH University of Science and Technology, Cracow University of Economics, Cracow University of Technology, and Jagiellonian University. These universities constitute the target group of our research. They offer various IT studies (e.g. programming, software engineering, web applications development, databases, networking, IT management) at undergraduate and graduate levels.

Research Method

In order to answer the research questions we developed a survey that includes a mix of closed-ended (including multiple-choice) and open-ended items (see Appendix for the list of survey items relevant to

the current study). The survey was implemented using the G Suite Google Cloud package which provides Computerized Self-Administered Questionnaire functionality and was available online between April and June of 2019. It was directed to IT students of major Cracow universities. The link to the survey was distributed via email to heads of relevant departments with a request to distribute it among students. The estimated number of IT students at these universities is approx. 1500. As the number of returned questionnaires is 257, the response rate of our research reached 17,1%. After the analysis, their number was reduced to 256.

The respondents' characteristics are presented in Table 1. Respondents came from three types of universities: business (Cracow University of Economics, focus on IT in organizations), technical (AGH University of Science and Technology and Cracow University of Technology, focus on technical and programming issues), and academic (Jagiellonian University, broader focus on theoretical aspects).

Variable	Category	No.	%
Gender	Female	41	16
	Male	215	84
Form of study	Full-time	224	87
	Part-time	32	13
University type	Business	105	41
	Technical	93	37
	Academic	58	23

Table 1. Respondents' structure

Respondents were characterized on the basis of two indicators that we have developed: a knowledge factor (KF) that captures respondents' general knowledge related to BC and a usage factor (UF) that captures the previous experience and readiness to the use of BC solutions by respondents.

The knowledge factor was calculated on the basis of answers to questionnaire items 3, 4 and 5 in the following way: question 3 answers scored from 0 to 11 points, one point for every correct answer; question 4 answers were scored from 0 to 6 points, one point for knowing the consensus method and two points for being familiar with its algorithm, and additionally one point for the correct indication of other algorithms; question 5 answers were scored from minus two to plus four, the lowest value assigned to the worst answer, the highest to the best answer. The weighted sum of points obtained from questions 3, 4, 5 was calculated; the weight being one with an exception to question 3, to which a weight of three was assigned because it was the most complex question. Finally, the achieved result was normalized and expressed as a percentage of the maximum value. Based on the value of KF, the following three levels of the respondents' technological knowledge were distinguished: low (L) indicating poor knowledge of BC ($KF < 30\%$); medium (M) indicating an occasional/random knowledge of BC ($30\% \leq KF < 50\%$); high (H) level indicating good knowledge and understanding of the technological aspects of BC ($KF \geq 50\%$).

The usage factor was assessed on the basis of the assumption that in a student population experience and readiness to use BC is reflected in usage of cryptocurrencies (the first item in the questionnaire), since the most widespread and popular use of BC are cryptocurrencies. UF was calculated as a normalized value of the sum of the points achieved by respondents (one point for knowing the listed cryptocurrency, two points for its usage, and additional two points for pointing out other cryptocurrencies) and expressed as a percentage of the maximum points available, i.e. eight. Based on the value of the UF, three groups of respondents were distinguished: low usage (L) covering respondents who have not had contact with cryptocurrencies ($UF < 25\%$); medium usage (M) comprising respondents whose contact with cryptocurrencies is sporadic or narrowed to practically one cryptocurrency ($25\% \leq UF < 50\%$); high usage (H) which includes respondents actively using cryptocurrencies ($UF \geq 50\%$).

To analyse the respondents' expectations towards BC, the answers to question 6 were assigned to one of three categories:

- Technological Evolution (TE) – the most modest expectations, treating BC as one of many new technologies that will in time find their applications in accordance with their characteristics

(Relevant questionnaire answer: "BC used as one of many available database technologies utilized to solve specific problems in an innovative way"),

- Social Evolution (SE) – expectations that BC will influence society functioning but this process will be stretched over time as solutions based on this technology will be implemented (Relevant questionnaire answer: "Public registers in various areas (administration, judiciary, science, medicine) where high level of confidence is desired"),
- Social Revolution (SR) – expectations that BC will change society functioning in a revolutionary way (Relevant questionnaire answer: "Creating of new values (concepts), e.g. cryptocurrencies which can have a revolutionary impact on the society").

In order to investigate the relationships among different factors that may influence the students' expectations we propose a research model that is presented in Figure 1.

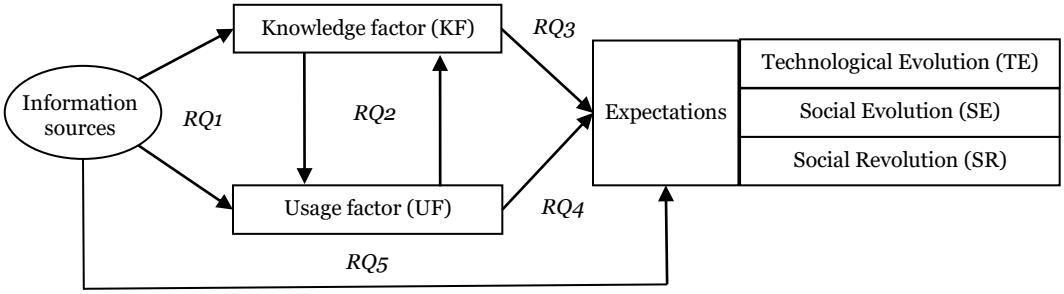

Figure 1 Research model

Results

Information Sources versus Knowledge or Usage (RQ1)

Table 2 presents the distribution of information sources used by respondents in relation to their KF and UF. The information sources in the table are ordered accordingly to their credibility. The least reliable were the traditional media and popular internet portals, which often present information in a selective manner, focusing on creating the so-called "media hype", and do not provide reliable and complete information. The most reliable are scientific articles and classes conducted as part of studies, which by definition should present detailed and verified facts. Other sources, i.e. specialized sources and conversations with other people fall between these two groups.

The most popular sources of knowledge are popular websites and conversations with other people. Specialized industry-specific Internet sites, papers and scientific briefings were of moderate popularity with an exception of users with high knowledge and usage factors, who appreciate these sources of information at the highest degree. Surprisingly, the lowest attractiveness gain television, radio, media, and university classes and lectures.

Information sources	Total	Knowledge factor			Usage factor		
		L	M	H	L	M	H
Popular Internet portals	63	63	65	60	55	68	62
Television, radio or other media	14	18	12	12	29	11	8
Specialized industry-specific Internet sites	43	31	42	62	17	36	65
Conversations with other people	58	60	53	63	64	63	49
Papers and scientific briefings	43	38	38	46	33	49	43
University classes and lectures	11	10	13	9	10	12	10
Other	7	2	6	14	2	6	10

Note: L, M, H – low, medium, high levels of factors

Table 2 Information sources [%]

The average number of indicated sources of knowledge (among respondents with different levels of KF) in different subgroups fell between 2.22 and 2.66, with more sources being indicated by people with higher KF (respectively: 2.22; 2.35; 2.66; for KF = L; M; H). A similar relationship, although not so visible, has been noticed for UF.

Relationships between Knowledge and Usage (RQ2)

Table 3 shows the distribution of respondents according to their knowledge and usage factors. In general, the values of KF and UF correspond within the groups, i.e. users with low KF are characterized also by low UF and users with high KF have also high UF. Users with low KF are moderately distributed among UF categories, whereas the percentage of users with high KF clearly increases as the UF grows. Contrary to that, users with high UF are evenly distributed within the KF categories and the percentage of users characterized by low UF evidently decreases with the grow of KF.

		Usage factor			
		L	M	H	Total
Knowledge factor	L	12	13	10	35
	M	9	17	14	40
	H	2	10	14	26
	Total	23	39	38	

Note: L, M, H – low, medium, high levels of factors.

Table 3 Respondents' distribution according to knowledge and usage factors [%]

In order to investigate the statistical significance of the relationship between KF and UF the χ^2 test was used because these factors are measured on a nominal scale. Due to the small size of the low category (L) of UF, only two categories of UF are distinguished (L + M, H) for the purposes of the test. The obtained values indicate the existence of a weak relationship between KF and UF (for significance α=0,005 and two degrees of freedom, the border value of the χ^2 test is 10.597 whereas obtained value is 11.530 with Cramer Index V = 0.212).

Expectations and Knowledge and Usage Factors (RQ 3 and RQ4)

Students' expectations towards BC in relation to their KF and UF are depicted in Table 4. Interestingly, respondents with a medium and high KF perceive it primarily as a tool for Social Evolution, whereas respondents with low level of KF see it as a tool of Social Revolution. In the case of UF the results are similar: respondents with a low level of UF perceived it as a tool of Social Revolution.

Expectations	Total	Knowledge factor			Usage factor		
		L	M	H	L	M	H
Technological Evolution	26	24	25	30	20	24	30
Social Evolution	36	20	45	45	38	41	30
Social Revolution	38	56	31	25	42	35	40

Note: L, M, H – low, medium, high levels of factors

Table 4 Students' expectations in relation to knowledge and usage factors [%]

The $\chi 2$ test was used to assess the relationship between expectations and KF. The obtained values indicate the existence of an average relationship between expectations and KF (for significance $\alpha = 0.001$ and 4 degrees of freedom, the border value is 18.47 whereas we obtained the value 21.67, with the Cramer index V = 0.296). However, the relationship between expectations and UF has not been detected.

Information Sources and Expectations (RQ5)

Table 5 presents the distribution of indicated sources of information in relation to their expectations. Column Total shows the percentage of respondents who pointed out the given source, while the columns Technical Evolution, Social Evolution and Social Revolution show the percentage of respondents with a given expectation who pointed out the given source. The expectations of respondents pointing to popular websites as a source of knowledge are most often associated with Social Revolution, while in the group of respondents pointing to other sources, Technical Evolution is the most often indicated. The exception is a source of information described as "Conversations with other people", where the largest group of respondents pointed to Social Evolution.

Information sources	Total	Technical Evolution	Social Evolution	Social Revolution
Popular Internet portals	63	59	62	67
Television, radio or other media	14	21	9	13
Specialized industry-specific Internet sites	43	46	45	40
Conversations with other people	58	59	65	50
Papers and scientific briefings	43	52	40	38
University classes and lectures	11	16	12	6
Other	7	5	1	12

Table 5 Sources of knowledge in relation to expectations [%]

Analysis and Discussion

As far as RQ1 is concerned (relationships between information sources and knowledge and usage factors), firstly, it should be noted that the Internet sources which include popular and specialized Internet portals, and conversations with other people are among the types of information sources the most frequently used by respondents. This indicates a significant interest in the subject and the desire to independently acquire knowledge and to share and verify this knowledge during contacts with other people. Secondly, analyzing the data broken down into groups of respondents depending on the value of KF and UF coefficients, it can be seen that there is a visible difference in the types and number of sources of information indicated. This is particularly transparent if we consider the "Specialized industry-specific Internet sites", which should be considered as one of the most reliable sources; respondents with a high level of KF indicated twice as often this information source than those with a low level of KF (62% vs. 31%), and in the case of UF the difference in the frequency of indication is even greater (65% for UF = H and 17% for UF = L). In terms of

the number of indicated sources, respondents with higher KF and UF rates indicate on average more sources, which also indicates that as they increase their knowledge or willingness to use technology, they are looking for additional sources of information. Surprisingly, the role of traditional media and formal education in the enhancement of knowledge and usage of BC is negligible. The low percentage of students who indicated classes as a source of information may indicate that students who start their studies already have some knowledge acquired on their own, so classes and lectures are not perceived by them as the basic source of knowledge, competing with other sources.

The results of investigation into RQ2 concerning relationships between KF and UF indicate that there is a relationship between these coefficients, although this relationship cannot be directed in the sense of causality. This relationship can be interpreted in two ways: (1) people with greater knowledge (higher KF) are more likely to use BC (higher UF) or (2) people with greater propensity to use BC want to know as much as possible about it (higher KF). Based on the research, it is impossible to decide which interpretation is correct: (1) or (2) or maybe both, because it can depend of an individual/respondent.

As far as RQ3 and RQ4 are concerned, it can be seen that Social Revolution is the most frequently indicated expectation class pointed out by respondents with a low level of both KF and UF. It is also visible that respondents with high level of KF the least often indicated Social Revolution as their expectation, leaning rather like respondents from the group of the medium level of KF to recognize that BC has and will have an impact on society functioning, but this impact will rather have the nature of a lengthy process (Social Evolution). Interestingly, in none of the groups of respondents does the view dominate that BC only has a technical aspect (Technological Evolution), which means that they perceive the existence of the potential impact of this technology on the functioning of society, differing only in the assessment of the scale and speed of this impact. On the other hand, analyzing expectations in the group of respondents with a high level of KF, it might be observed that as knowledge increases, and hence the knowledge of technical aspects and properties of BC technology, expectations for its potential impact on the functioning of society decrease (which would explain why in this group more people indicate Technical Evolution than Social Revolution as their expectation towards BC).

Comparing the sources of information with the expectations towards BC (RQ5), it is difficult to clearly indicate the occurrence of some dependencies. Analyzing the difference between the frequency of indications of a given source for all respondents from a given category of expectations, only fluctuations of several percentage points can be seen. These results indicate that there is no direct relationship between information sources and expectations. This may be due to the fact that all sources of information are perceived by respondents through the prism of their own knowledge, and thus their direct impact on expectations may be difficult or even impossible to detect.

Implications

The paper has a number of implications both for theory and practice. As far as theory is concerned we proposed a new research model that might be useful in investigating factors that influence the embracing of new technologies (not only BC) by students. To the best of our knowledge this model encompasses factors that have not been revealed before.

Implications for practice are mainly related to education. It is difficult to clearly indicate the factors shaping the attitudes and expectations of the young generation towards new technologies. The research, based on the example of BC, shows that these expectations are not clear and depend on the level of knowledge about technology and readiness to use it. It has been shown that these two factors are in a relationship with each other, which means that both by expanding students' knowledge and by encouraging them to use solutions using BC technology, their perceptions and expectations might be influenced. Besides, in order to influence the attitudes of young people towards new technologies (in this case BC), care should be taken of the earlier stages of education.

Conclusion

In the paper a model was proposed that aims to capture the relationships between use of certain types of information sources, knowledge and usage of new technology, and expectations towards new technology. The model was preliminary applied to the case of BC and a survey was conducted on the population of

Cracow IT students to test this model. In total 256 valid responses were obtained that were analysed using qualitative and quantitative methods.

The main results indicate that the use of certain types of information sources does not directly influence expectations towards BC, however they are directly connected with knowledge and usage of BC. Besides, knowledge and usage of BC are interlinked but it is difficult to assess the causal relationship between them. The most interesting outcome of research concerns the detected relation between knowledge, usage and expectations: respondents who do not know a lot about BC and do not experience its usage have higher expectations towards this technology. It might be interesting to investigate whether the same conclusion is valid as far as other new technologies are concerned.

In future research we would like to investigate the relationships between factors present in the proposed model taking into account different respondent characteristics (working/non-working students, type of university: business, technical, academic). Besides, an investigation of these relationships over time might comprise an interesting path for future research. It can be done in two ways: by conducting similar studies on subsequent generations of students or by repeating this survey in the same group of respondents.

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Appendix

Survey items

1. Blockchain technology (BC) is most often associated with the concept of cryptocurrency. Mark one of the following three options against each item: *I do not know; I know; I have used it*.
   Bitcoin; Ethereum; Ripple; Other (please specify)
2. Mark the main sources of information concerning BC.
   Popular Internet portals; Television, radio or other media; Specialized industry-specific Internet sites; Papers and scientific briefings; University classes and lectures; Conversations with other people; Other (please specify)
3. To what extent do the following sentences fit your perception of BC? Mark one of the following three options against each item: *Not applicable to BC; Applicable to BC but not crucial; Crucial for BC*.

It is a distributed system; It is a database; It is a register that resembles an accounting book; Used for cryptocurrency transaction processing; Thanks to cryptography the operations are anonymous; Thanks to cryptography data are persistent; Enables databases with a high level of security; Ensures complete data security; Enables data processing with a higher efficiency than that of traditional methods; Thanks to cryptography frauds are not a threat; Used for processing of banking transactions

4. In the concept of BC, saving the content requires its authorization by specific instances. This authorization is based on various algorithms of the so-called consensus. Indicate which of the approaches listed below are familiar to you and to what extent. Mark one of the following three options against each item: *Not familiar; Familiar but I have not analyzed its mechanism; Familiar with its algorithm.*
   PoW (Proof of Work); PoS (Proof of Stake); PoET (Proof of Elapsed Time); Other (please specify)
5. Mark the best description of the BC application for content storage.
   Can use any database (including commercially available databases, e.g. relational databases); Requires tailored, dedicated database systems customized to its specific forms of collected and stored content; Does not utilize database systems at all, because it relies on other solutions; I do not know how content is stored in BC
6. Which of the BC applications are the most promising according to you?
   Public registers in various areas (administration, judiciary, science, medicine) where high level of confidence is desired; Creating of new values (concepts), e.g. cryptocurrencies which can have a revolutionary impact on the society; BC used as one of many available database technologies utilized to solve specific problems in an innovative way; Other (please specify)
7. Characteristics of the respondent.
   Gender (male / female); Form of study (full-time / part-time); Type of studies (undergraduate, postgraduate)
   Profile of studies (IT, technical, math/physics); Status (student, working student); University (Cracow University of Economics, Jagiellonian University, AGH University of Science and Technology and Cracow University of Technology)