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Decision Making on Introducing of Blockchain Technology in Croatian Public Administration

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Abstract

Blockchain technology has many features enabling great potential to transform every aspect of life. In this paper, we consider application of Blockchain in public administration sector. We utilize the Value Measuring Methodology (VMM) for the purpose of the profitability assessment of introducing Blockchain into the public administration. This process is conducted by multi criteria decision making with a group of experts. Results of cost-effectiveness analysis and AHP analysis, which are part of VNM, indicated direct user value as the largest benefit, followed by operational value for the State. Potential risks are identified along with the costs summarizing an analysis.

Keywords: Blockchain technology, public administration, value measuring methodology, effective public administration.

1. Introduction

"The most efficient way to produce anything is to bring together under one management as many as possible of the activities needed to turn out the product" (Drucker, 2003). Peter Drucker's quote describes exactly the idea behind the implementation of Blockchain technology in the Public Administration sector. Why? Public Administration is a complex system. It is centralized in terms of the responsibility for managing and providing of public services, yet fragmented in terms of the organizational structure and the ability to share information. Blockchain technology has the potential to simplify the confidential information management, to provide an easier access to information to government agencies, as well as to protect the security of such information. Government agencies have much to gain by experimenting with such technology and developing it through pilot projects. Blockchain can help agencies turn paper records into electronic ones and manage them through a safe infrastructure, as well as enable them to turn some of such records into the "smart" ones. IT departments within government agencies should create rules and algorithms that will allow for an automatic information sharing in Blockchain with third parties once the specific prerequisites are met. In the long run, this technology could enable individuals and organizations to take direct control over the information the Government keeps on them. Blockchain is a distributed ledger (Vacca et al., 2020). This means

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that data is not stored in a central database as in traditional data system architecture, but is maintained over a distributed network. Blockchain confirms new transactions based on a set of pre-defined rules. Blockchain stores a transparent and immutable record of all the transactions made. Some Blockchain features make this technology an attractive solution to specific issues the public service agencies are facing. Those features are given in an addition. First one is increased efficiency. Blockchain provides both the process and organization efficiency. Transactions for processing (be it a financial or information-related transactions are less error-prone and are simpler. For the public sector, Blockchain represents a specific opportunity to provide conventional services (Alketbi, Nasir & Talib, 2018), which were previously in paper format only, in the electronic form (Estonia, for instance, provided health care records in Blockchain). Second, data integration. The chain immutability through Blockchain protects it from being changed or removed. It provides a transparent structure and a visible transaction trace, which prevents unauthorized record tracing and provides a more secure network. Third one is reduced risk. It provides an opportunity to reduce and eliminate corruption. For instance, in the area of social assistance distribution, tax process management and land registry management. Some of the most advanced applications of Blockchain in the public sector are e-services in Estonia (Sullivan & Burger, 2017) and the Dubai initiative (Bishr, 2019) aimed at providing all the public services to its citizens through Blockchain.

This research paper provides the analysis of the existing examples of the implementation of Blockchain technology in the Public Administration of different countries all over the world, based on what it presents a proposal of the implementation of Blockchain to the Croatian Public Administration. The central part of the paper describes and implements the Value Measuring Methodology (VMM) for the purpose of the profitability assessment of introducing Blockchain into the Public Administration. Expert judgements play an important role in decision making, especially in expensive and innovative IT projects implementations. Building predictions and performing expert examinations in are among the tasks requiring experts' involvement in decision-making processes. We have taken expert knowledge into account to conduct expertise and obtain valuable insight into perception of Blockchain implementation potential in public sector.

The paper is organized as follows. In the second chapter, the Value Measuring Methodology implementation is described step-by-step. The third chapter provides ideas for the introduction of the Blockchain technology into the Croatian Public Administration with fourth chapter, assessing their cost-effectiveness. The conclusion provides the VMM framework for the cost-effectiveness assessment and the value assessment results carried by applying the AHP method.

2. Methodology

The Value Measuring Methodology (VMM) defines four steps which need to be performed for the purpose of the assessment of cost-effectiveness. The four methodology steps are the following (Mataracioglu, 2015):

(1) Developing a Decision Framework;

(2) Defining the Alternatives;

(3) Analysing the Alternatives;

(4) Documentation and Communication.

The methodology inputs are the requirements. The first step output is the decision-making framework. The second step output are the alternatives with estimated values, costs and risks. Here, we have used experts' viewpoints to build reliable model. Main premise was, if a

person is considered to be an expert in the given domain, his estimates are credible and close to the real values. The third step output is the comparison of values, costs and risks. The end result is the guideline supporting the decision-making on the implementation.

There are four tasks to be completed in the first step (VMM, 2018), which are the following:

(i) Identify and define value structure;

(ii) Identify and define risk structure;

(iii) Identify and define cost structure;

(iv) Begin documentation.

As a result of the completion of the aforementioned tasks, we get a value structure with priorities, the list of risk factors and the cost structure. The value structure consists of the five following factors: direct customer value, basic/operational value for the State, strategic/political value, financial value for the State and social/public value. Those factors are described as follows (VMM, 2019): (i) Direct Customer Value: Benefits directly realized by the customer or a group of customers. The customers can be government employees, government agencies, citizens, etc; (ii) Basic/Operational Value for the State: Improvements of the current government operations and processes; (iii) Strategic/Political Value: Benefits which bring the organization closer to achieving its strategic goals; (iv) Financial Value for the State Financial benefits (cost reduction); (v) Social/Public Value.

Benefits which are not directly related to the Customer but to the society as a whole.

Value structure describes the benefits through two different layers. The first layer consists of the five aforementioned factors that must be analyzed in order to identify the opportunities for the creation of value for the society, government and individuals. The second layer includes the measures defining such values within a quantitative framework.

Following step-by-step algorithm is performed:

(i) Numerous of alternatives defined and five experts involved in evaluating those alternatives;

(ii) Individual pair comparisons performed by experts are modelled;

(iii) Individual pair comparisons are aggregated using a geometric mean method with individual expert competence considerations;

(iv) Alternative weights are calculated as eigenvalues of aggregate pair comparison matrices built with expert competence consideration;

(v) Results are discussed.

As part of risk identification, risk factors must be identified, as well as the risk occurrence probability and the risk impact. The list of costs records the expenses associated with the defined values. This methodology assesses the return on investment through a sort of a compromise between the value (benefits), costs and risks (VMM guide, 2018). Therefore, the assessment based on this model includes a multidimensional analysis of value, such as the direct customer value, social/public value, financial value for the State, operational/basic value for the State and strategic/political value. The aforementioned values are measured through a set of elements. Accordingly, it becomes possible to make a decision for each element. This method is not just about achieving the benefits or reducing costs; both aspects are included in an objective way. Such a VMM model allows for a comparison of different values. Moreover, it provides qualitative data to decision and policy makers who support the assessment of potential benefits of using specific services.

3. Assessing the cost-effectiveness of introducing Blockchain into the Croatian Public Administration

Blockchain is a technology providing the Internet values: it is a new, distributed ledger which can help us transform the business world and change the old order of people's jobs for the better. When considering the potential application of the Blockchain technology in the Public Administration, the three essential Blockchain values provide the potential solutions. Those values are the following: record keeping, value transfer and smart contracts. Wherever there is a need for one of the three values, the Blockchain technology must be considered as a potential solution.

3.1 *Identity management*

Digital identity is a trigger allowing for the integration of the remaining Blockchain elements. Whether it is about cryptocurrency or a car, each property must be electronically stored in order for it to be included into a Blockchain transaction. In doing so, the owner or the person who is carrying out the transaction needs a digital identity so as to be involved in the transaction. The importance of this challenge has been recognized by the participants in the public sector worldwide, where one-fifth of the population lives with no officially recognized identity.

Potential challenges are: (i) lack of standards necessary to establish a digital identity, and (ii) different types of verification procedure hinder the economic engagement and may obstruct the provision of public sector services.

Potential values are: (i) a safe identity could provide efficient transactions within a wide range of different types of assets, and (ii) individual and explicit control over the purpose into which the elements of identity are divided.

3.2 *Land registration*

A reliable property records can be created by ensuring a unique and non-corrupted record on Blockchain and evaluating the record status changes among the owners. The purchase of houses and/or land and their transfer through a safe system would serve as a basis for investment and economic growth. Potential challenge lies in licenses and registration procedures which are based on paper and are fragmented. It makes them expensive, inefficient and vulnerable to unauthorized handling. Potential values are: (i) a decentralized and standardized land registration system could reduce the number of the required intermediaries, increase the degree of confidence in the identity of parties involved in the transaction, increase the efficiency of the procedure and reduce the time and costs of process implementation; and (ii) the recording of proprietary rights through Blockchain would significantly reduce the costs.

3.3 *Voting*

The voting activity is a common topic when it comes to the application of Blockchain. Potential challenges with this one are: (i) cyber-attacks could compromise the election results, and (ii) delayed results or inefficiencies associated with remote voting. Potential values: (i) Reduced costs through voting enabled by Blockchain, (ii) Increased voting safety, (iii) Higher voter turnout, and (iv) Increased transparency.

Accordingly, this paper suggests applying Blockchain in the public sector for the following purposes.

3.4 *Blockchain types*

Blockchain are divided into two main categories: public and private. Public Blockchain allows participants to read it and use it to carry out transactions, and to participate in the process of creating the consensus (Guegan, 2017). There is no central register, nor a trusted third party. Public Blockchain works with a coin or token. Blockchain is private (or mixed) if the consensus process can only be achieved by a limited number of participants. The private Blockchain doesn't have to use mechanisms based on cryptography (Guegan, 2017). Private and mixed Blockchain are faster and consume less energy because there is lower number of transaction checkpoints. The public are completely democratic and open, but slower and more energy demanding.

In the context of selection of Blockchain for public administration, only a private type of Blockchain is suitable for public administration because all rights to conduct transactions on the network and information belong to the state. Users, citizens or organizations, have access to the system with a key.

3.5 *Purposes of Blockchain implementation*

There are numerous purposes of Blockchain implementation: identification, registers, payments assuming responsibility, and automation.

The days when identity checks had up to a few dozen steps are over. With digitized birth certificates and ID documents Blockchain provides a single personal identifier. It is a completely new and reliable member identification method which includes both the identification of citizens and government agencies, providing all sorts of services from electronic voting to confidential legal dispute settlement.

Blockchain provides the digitalization of land registry, vehicle registration and medical records registration, and more. Once recorded, the documents become digital evidence, available, for example, for a reliable utilization in legal battles. This reduces the printing and tracking costs, with smart contracts that can automate the specific activities. For instance, by introducing the electronic driver's license, the owner can receive a notice of the expiry or can simply renew the license through the automatic debit payment from the owner's bank account.

There is a great potential for the use of Blockchain and cryptocurrencies by the existing financial institutions. Blockchain technology has a huge potential for fraud elimination and for eliminating the possibility of tax evasion owing to the transparent and reliable built-in protocols. Social security benefits, supports, tax returns and cross-border payments can be automated and accessible to the public.

Blockchain enables one to assume responsibility in all the sectors. Financial development and cash flow can be permanently recorded and tracked; the results of votes can be updated online in real time. Public services can be easily accessible to the citizens, owing to a new degree of transparency.

The performing of processes related to application submission, payments made and received, issuing visas and license transfer can be simplified compared to previous years. Blockchain is particularly useful in the development of the market the existing infrastructure of which could not accept the radical change otherwise.

In this context, Blockchain could represent the key step in the implementation of applications of public interest:

- The implementation of a digital identity online for the purpose of e-services;
- Creating the online voting (e-voting) platform;

- Improving public registers and notarial services;
- Improving the land registry system;
- Increasing transparency and assuming responsibility in the financing of political campaigns and political parties;
- Creating new intellectual property licensing, copyright collection and management systems, less dependent on intermediaries;
- Preparation of certificates of origin for physical products, such as wood, preventing marketing from illegal areas;
- Creating a complete IoT platform (Internet of Things);
- Creating a new certificate layer in Agriculture, encouraging green and environmentally friendly practices.

4. Research results

For the afore-mentioned application examples, the cost-effectiveness analysis is performed by group of experts through the VMM methodology steps, which is given below. Blockchain values in the Public Administration System were identified as follows:

Direct (for users)

- Simple approach to services (license renewal, bill payment services): in terms of the effort invested into locating and obtaining services;
- Faster services: in terms of the time required for service delivery and/or reducing of waiting time, faster execution of transactions;
- Better services: in terms of the quality and added value of service characteristics (such as service delivery process transparency);
- Increasing users' satisfaction with the services;
- Increased transaction safety.

Basic/operational for the State

- Increasing the volume of service provision: in terms of the number of administrative transactions and the number of service users;
- Improved, shared infrastructure;
- Increased employee productivity: redistribution of a large number of hours of economic productivity in the reduced document processing time;
- Elimination of redundant procedures;
- Increased public sector efficiency: providing paperless transactions.

Strategic (political)

- Building international relations: strengthening international business relations, selling services worldwide;
- Strengthening the economy – through additional revenue generated by the companies providing products and services (such as bank accounts, postal services, etc.) – leads to the increasing of the Croatian GDP;
- Improving the State's image: with no investment in marketing;

- Creating new business opportunities in the private sector;
- Increasing the level of trust from the citizens;
- Financial for the State;
- Reduced service provision costs (such as reduced costs of holding elections);
- Reduced internal operating costs due to the reduced:

  (a) costs associated with paper production and distribution,

  (b) human resources performing manual tasks, such as paperwork handling,

  (c) form sending and processing, all as a result of the electronic provision of services.

Social (public)

- Reduced CO_2 emissions: due to reduced traveling;
- Increased participation of citizens in political processes: higher voter turnout;
- Increased confidence in the Government's ability to authenticate users: leading to an increase in the citizens' safety;
- Reduced number of identity theft frauds.

The analysis of the values of Blockchain leads to the conclusion that the implementation would bring more administrative transactions and clients due to an increased visibility and availability of services. At the same time, it would enable the citizens and business partners to establish new companies using technology. The State would make multiple financial savings through the reduction of costs in terms of distribution, as well as human resources. The last but not the least, there is a number of non-quantifiable benefits, such as the feeling that the State contributes to strengthening business and international relations through this initiative.

4.1 *Value analysis*

Analytic Hierarchy Process (AHP) methodology has been previously used in strategic decision making (e.g. Oreški, 2012) and decision making in government (e.g. Đurek, Kadoić & Oreški, 2021). The application of AHP is given below. It is used for the purpose of determining the weights of specific values and groups of values. Previous research papers suggest (Glass, 1999; Procaccino et al., 2002) that experts' opinions have deep divergence between managers/users/members of the development team regarding importance and risks of involved factors, as well of different levels of management. Whereas managers/users focus their attention on budget and business objectives, the members of the development team mainly pay attention to technical aspects. Thus, in this work, different views were taken into account. Five experts were included consisting of: deputy mayor of a county, deputy mayor of a city, deputy mayor of municipality, user/vice dean of IT faculty, Member of Parliament.

The goal is to obtain the experts' perceptions of different decision-making levels about the importance of values in order to establish a rank among them. It is a valuable effort, since different levels of management have significantly different perceptions on such projects' success.

Table 1 in appendix shows the weights for each category. As all experts' opinions were considered to be of the same importance, geometric mean was used as the aggregation method for the calculation of the average weights. It is important to note that consistency ratio associated to the comparison matrices are far below the maximum value, 0.1, suggested by previous research papers (Zahedi, 1986). According to the obtained results, the direct user value has the largest weight, which is followed by the basic, operational value for the State. Strategic and financial

values are of the same weight, while the social values have the lowest pondered value. As shown in Table, more simple approach to services was the most critical factor in the Direct value for category of users. Improved, shared infrastructure was the most critical factor in Basic/operational for State value category.

Creating new business opportunities in the private sector and Increasing the level of trust from the citizens were the most critical factors in the Strategic (political) category. Increased participation of citizens in political processes: higher voter turnout is most important Social benefit.

Reduced service provision costs shown to be more critical than Reduced internal operating costs in Financial for the State category.

4.2 *Risk and cost analysis*

It is difficult to identify the risks and manage them when the final results of such an implementation as well as its implications are still difficult to grasp. However, there are several groups of potential risks which must be pointed out.

Political risks are associated with the Government's consistency which is necessary for maintaining the funding stability and legislative priorities which change frequently with the changing of the coalitions in power. The main political challenge is, therefore, is to maintaining the importance of the project for the coalitions in power, thus enabling the project's sustainability, maintaining the project's independence at the same time in order for the project to attract the support of the people with broad political interest. The other potential risk regards communication and public relations. The idea of using the technological platform to build a global user database is more typical of the business world than of the public administration sector. The third group of risks are technological risks. User safety is the main prerequisite for a successful implementation of such technology in the public administration sector. Further technological risks regarding cyber-attack threats. Today, the protection of digital services and databases supporting them is crucial to national security. Experts have rated those risks probabilities and their possible impacts on project implementation. Results are presented in table 2 in appendix. Experts consider Lack of standards for establishing a digital identity mostly as risk of low or medium probability to occur. Most of the experts see impact of this risk on project as medium. No expert considers this risk as high impact on project. Political risk is recognized as risk of low level by majority of experts. However, there is no consensus among experts regarding impact of Political risks on project implementation, where opinions vary from low to high. According to experts, Communication with citizens seems to be risk of low probability and low impact of Blockchain implementation in public administration, whereas Cost overruns are risk of medium probability. Experts gave software failure risks more place for consideration then hardware failure risks.

Recent research studies (e.g. Sresakoolchai & Kaewunruen, 2020) emphasize importance of proper risk allocation to assure that projects can be run smoothly.

The final task as part of the first step is the cost assessment. In this paper, specific costs are not listed due to prices variation, but groups of costs are identified which will be incurred by such implementation.

System planning and development (Hardware costs, Software costs, Development costs, Analysis costs, Travelling costs).

System implementation (Purchasing costs, Personnel costs, Training costs).

System maintenance (Hardware costs, Software costs, Technical support costs).

This is where we can identify the three basic types of costs, which are the following: the system planning and development, system implementation and system maintenance costs.

5. Conclusion

The literature review has shown a great potential of the implementation of the Blockchain technology in the Public Administration sector. The examples of the good practices of developed countries investing ever more in Blockchain is encouraging and provides an incentive for the implementation of the same system in Croatia. The VMM methodology was used to analyze the values, risks and costs that such an implementation would bring based on experts' opinions.

The main strengths of this paper are two-folds: (i) as far as we know, this research represents first scientific approach to analyze Blockchain in Croatian public administration, (ii) it provides a method for ranking critical success factors of Blockchain implementation in Croatian public administration and it also allows a consistency measure of results.

Here, we have proposed an application of the analytic hierarchy process to rank different critical success factors related to Blockchain implementation. This approach performs better than results based just on qualitative analysis. It is important to note, by using this approach, the level of importance of each factor is compared to the others.

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