IDENTIFICATION OF CRITICAL SUCCESS FACTORS
FOR THE IMPLEMENTATION OF THE BLOCKCHAIN PROJECTS
IN THE SMART CITIES

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Abstract: The primary objective of this paper is to conduct a systematic literature review to analyse contemporary scientific literature to determine a list of blockchain IT system implementation critical success factors. Scientific literature is available for the critical success factors that are impacting implementation for IT projects in general; however, it is of scientific and practical importance to whether these factors and their influence change when it comes to blockchain projects and even to determine does some additional critical success factors impact the success of the blockchain information system implementation in the smart cities.

Keywords: Blockchain, Smart city, Project management, Information systems, Sustainability.

1. INTRODUCTION

Blockchain is one of the most popular buzzwords at the end of the decade. The hype associated with crypto currencies made blockchain technology worldwide famous. The positive aspect of the hype was that many new startups and ideas revolving around the implementation of the blockchain technologies arose. However, this hype did a lot for the blockchain technology spread but also caused a lot of damage to the understanding the nature of this technology and the way it can revolutionize entire business models through improvement of the information systems. Viewed from the information technology point of view, the blockchain is a new way of data layer organization, not some magical new paradigm that will change everything and make everything else obsolete. Storing data in encrypted, anonymised, append-only, distributed, a peer-to-peer database that has computer algorithm for deciding what truth instead of arbitrary central authority is a revolutionary leap, but it has to be viewed as an important part of current information technologies and systems not per se. Blockchain projects are already implemented in many areas, including information systems in smart cities. They are implemented by IT projects managers and perceived as IT project which they are. The goal of this paper is to attempt to identify some additional project implementation success factors that are native to the blockchain projects within smart cities or the blockchain projects in general in case that data on blockchain projects is scarce. Since blockchain theory is the novel subject of the scientific literature, practical example and use cases are even more scarce, the authors of these papers will attempt to find and examine all available source of information including non-scientific articles and data available on the internet.

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2. BLOCKCHAIN TECHNOLOGY IN THE SMART CITY
CRITICAL SUCCESS FACTORS

The authors analysed the available scientific literature and other available literature to find any additional CSF related to blockchain projects specifically or to determine the deviation of strength for any CSF in the list.

| Architecture – Technology | Software engineers should define criteria for selecting the most appropriate blockchain implementation, evaluating the adoption of sidechain technology, or the implementation of an ad-hoc blockchain (Porru, 2017). Enhancements in blockchain design are needed to improve scalability by reducing latency, increasing throughput and enhancing security. Progress in this domain will expand the technology’s adoption (Schatsky & Muraskin, 2015). Integration in IT architecture, In-house/ internal development, Flexible infrastructure (Holotiuk & Moor-mann) |
| Blockchain size – throughput | As the blockchain adoption increases, blockchains will grow exponentially, commonly referred to as blockchain bloat (Swan, 2015). To become a mainstream technology, blockchains of the future must be scalable and fast (Schatsky & Muraskin, 2015). The size of the blockchain ledger is already more than the capability of some of smaller devices and may lead to making a vast part of the public unable to participate or delays in processing transactions (Inno-value, 2015). The blockchain technology is still in the early stages of development and faces several technical limitations such as throughput (a theoretical current maximum number is seven transactions per second), latency (each block takes 10 min to process which means at least 10 min needed for your transaction to be confirmed), and size and bandwidth (long time needed to download the entire blockchain) (Wang et al, 2017). Increased efficiency is anticipated, as “transaction costs are expected to decrease” (with blockchain) (Ølnes et al, 2017). |
| Business model | Traditional business models might not seem applicable to the blockchain, since the whole point of decentralized peer-to-peer models is that there are no facilitating intermediaries, whereas most of the businesses are formed around the concept of intermediation (to reduce total transaction cost for the customer while earning a fee for themselves) (Prasad et al, 2018). However, there are many worthwhile applications of blockchains even in a traditional business (Swan, 2015). One factor that drives the interest in distributed ledger-based methods is the ease with which they can be added to existing workflows and data processing lifecycles (Anjum et al, 2017). |
| Cloud services integration | A key success factor for blockchains in an enterprise is middleware – integration of blockchains with each other and with many other systems in real-time, using different technologies and communication protocols (Everest Group, 2016). |
| CASE Tools | Creation of software tools for smart contract languages. The implementation of Smart Contract Development Environments (SCDEs) – the blockchain-oriented declination of IDEs – might be pivotal for the building and diffusion of expertise (Porru, et al, 2017). |
| Cost-effectiveness | Therefore, blockchain-based cloud services must be highly cost-efficient, even while scaling up and wasting many computational resources (mining) by design (Swan, 2015). Not all blockchain projects result in a reduction of costs and blockchain is just one part of a complete solution (Robben & Verslype). |
| Energy efficiency | Blockchain mining draws an enormous amount of energy, estimated to be $15m per day or even more, to compute and verify transactions securely and with trustworthiness (Swan, 2015). There have been some work and proposals to improve energy efficiency through economic models (Wang & Liu, 2015), more efficient block design (Paul et al, 2014) and faster Bitcoin mining through the simultaneous usage of CPUs and GPUs (Anish, 2014). |
| Industry collaboration | Blockchain will be successful if a strong community and value-creating network can be formed (Prasad et al, 2018). This will need shared solutions and shared solutions will require governance and consensus around technology choices. Industry leaders must collaborate to design the right solutions and should form consortia and work with regulators early on (McKinsey, 2015). |
| Legislation – Regulatory clarity | Regulatory clarity (or lack thereof) will decide whether the blockchain industry will develop into a full-fledged industry (or not). Multiple countries have banned or continued to deliberate cryptocurrency-related issues (Swan, 2015). Recently, the Union Budget of India 2018 declared cryptocurrencies to be illegal tender but supported exploration of blockchain technology (Mathur, 2018). Forthcoming regulation is likely to influence the future of blockchain as the technology can store substantial amounts of sensitive data, including payment information and customer data (Holotiuk & Moor mann). |
| Metrics | Due to the distributed nature of the Blockchain, specific metrics are required to measure complexity, communication capability, resource consumption (e.g. the so-called gas in the Ethereum system), and overall performance of blockchain systems (Porru et al, 2017). |
Modelling languages

Diagrams such as the Use Case Diagram, Activity Diagram, and State Diagram could not effectively represent the blockchain environment (Porru et al., 2017). Currently, the industry is not providing sufficient use cases which present potential applications within the organization (Ølnes et al., 2017). Focus on the customer when designing use cases (Holotiuk & Moormann).

Organisational Structure

The successful adoption of blockchain requires a lot of organisational support in various forms. In all cases, the blockchain adoption is widely supported by the top management and considered important enough to invest in the adoption (Holotiuk & Moormann).

Privacy

There are studies to show experimental evidence on the lack of anonymity in the Bitcoin network and possibility to do transaction linking to IP addresses (Moser et al., 2013; Koshy et al., 2014; Feld et al., 2014). The success of the Estonian medical record blockchain project will depend upon its ability to keep medical records private while at the same time widely available to medical providers and insurance companies (Heston, 2017). Loss of privacy, trust and confidentiality (Bhargava et al., 2013).

Project management

The project management teams are responsible for organisational tasks concerning blockchain (Holotiuk & Moormann).

Rich ecosystem

Blockchains include several different types of participants as a business network, and its real value is achieved when these business networks grow (IBM, 2017).

Security

A Blockchain must guarantee data integrity and uniqueness to ensure Blockchain-based systems are trustworthy. The same group of authors, recommend software review as additional development methodology (Porru et al., 2017). Blockchain, especially public ones, has some potential security issues (Swan, 2015). An improved security perception will be a CSF of blockchain (Prasad et al., 2018; Riggins & Wamba, 2015).

Sidechain Development

Development of sidechains, alternative blockchains with additional features but still linked to Bitcoin, could be a CSF for the broader adoption of blockchain technology (Bogart & Rice, 2015).

Standardisation

Industry Standards will need to emerge for better enterprise adoption of blockchain technologies (Everest Group, 2016). There are many types of blockchain available on the market. Consequently, experts are unsure “if blockchain will become a standard in the banking industry.” (Ølnes et al., 2017).

Team skills

The Blockchain sector will need professional figures with a well-defined skills portfolio comprising finance, law, and technology expertise. Skilling up current resources and/or hiring blockchain skills will be a CSF for better returns on blockchain investments and, therefore, increased blockchain adoption (Porru et al., 2017). Enterprises will need a smart contracts talent pool that can connect legal text to business logic and convert that to a programmed smart contract on blockchain (Everest Group, 2016). An acute shortage of available talent for blockchain industry jobs has been reported as a major problem preventing wider growth and use of the technology (Castillo, 2017). Skilled experts in the area of blockchain that may fill existing knowledge gaps are currently expensive and rare in the market (Holotiuk & Moormann).

User control of data

User control on data will be an important driver for the success of blockchain-based cloud services, as that will help assuage user’s privacy concerns with a decentralized system with multiple (and potentially unverified) nodes (Bogart & Rice, 2015; Swan, 2015).

User engagement

User engagement is one of the primary success factors defining the success of blockchain technology (Prasad et al., 2018). Blockchain is still an emerging technology for most construction people. Lack of awareness and understanding prevents the diffusion of this technology. There are many issues to be resolved before individuals would feel comfortable storing their personal records in a decentralised manner with a pointer and possibly access via the blockchain (Wang et al., 2017).

3. CONCLUSION AND FURTHER RESEARCH

The currently available scientific literature on critical success factors for the software development projects can be compared to the list of CSF (critical success factors) authors created. Authors in the scientific literature did extensive analysis and created a scientific viewpoint on the subject of critical success factors for the project implementation (Sudhakar, 2012; Müller & Jugdev, 2012; Ram & Corkindale, 2014). G. Sudhakar (2012) in an extensive literature review identified 35 critical success factors based on the past empirical and theoretical studies that increase the project success. Software development and implementation CSF will be compared to the factors found in this research to detect the overlap of CSF related to blockchain and
CSF related to software development and implementation projects. The overlapping CSF is Architecture – Technology, Business model, Cost-effectiveness, Cloud services integration, Organisational structure, Project management, Team competence and User engagement. The rest of the factors are primarily associated with the blockchain technology as a factor. Blockchain specific CSF are as follows: Blockchain size – throughput, blockchain development and testing CASE Tools, Energy efficiency, Industry collaboration, Legislation – Regulatory clarity, Metrics, Modeling languages, Privacy, Rich ecosystem, Security, Sidechain Development, Standardization, User control of data.

In this work software, development and implementation are viewed holistically because of their inseparable nature (no software is developed not to be implemented, and successful implementation is the successful result for any software development project). The created list is just a literature review of the available literature and has no pretensions to be considered as final and whole. This list is a starting point for further research. Additionally, the research gathered results from many areas that contribute to smart city components, e.g. supply chains that contribute to the mobility of the smart cities but was also broadened by all other available resources related to the CSF of the blockchain projects.

Further research should tie blockchain CSF more tightly and specifically to the blockchain projects in the smart cities and also try to use the scientific method to extract knowledge from domain experts that are not researchers.

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