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Taxonomy Development of Blockchain Platforms: Information Systems Perspectives

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Abstract. Blockchain platform has given information system scholars research opportunities in understanding dynamics of convergence of technology and social context. The information system research issues are complex and require taxonomies to understand the similarities and uniqueness among objects. Developing taxonomies is a complex process that needs systematic approach. This paper is a research-in-progress. We proposed taxonomy for Blockchain platform using existing method of developing taxonomies in information systems. With the unprecedented growth led to several companies to develop the varieties of Blockchain platforms. The complexity in the implementation and understanding the technical protocols leading to difficulty face by researchers and practitioners to access their full potentials. To bridge the gap, we proposed a taxonomy of Blockchains distributed ledger platforms in order to provide a mechanism for researchers and practitioners to understand the phenomenon. Final of taxonomy contains five (5) dimensions with fifteen (15) characteristics. Our analysis discovered Blockchain platforms are designed with specific goals, which prescribe its features, i.e FinTech Blockchain platforms for financial domain.

Keywords: Blockchain, Distributed ledger technology, Proof-of-work, Proof-of-Stake, Taxonomy, Taxonomy development

INTRODUCTION

Blockchain platform offer unprecedented business opportunities and intend to disrupt varieties of wide range of industries such as global financial systems, transportations etc due to its openness, open protocol and standard. Blockchain is a decentralized transaction and data management technology developed first for Bitcoin cryptocurrency by anonymous person or group of person [1] . The interest in Blockchain technology has been increasing in recent times. The reason for the interest in Blockchain platform is its central attributes that provide security, anonymity and data integrity without central clearing house or entities, and therefore it creates interesting research areas, especially from the perspectives of platform challenges and its limitations [2]. However, it perhaps a digital platform based on cryptographic mechanism, which regulates the generation, verification and transaction recorded in an open and distributed public digital ledger between two or more parties without central clearing house as in case of traditional financial system eg. Bank Negara Malaysia and Central Bank of Nigeria [3].

However, recent use of Bitcoin Blockchain for developing new Blockchain applications, to enable registering and transfer of custom assets, such as smart property, coupons, movie tickets, or financial assets such as stocks, bonds, etc. Blockchain open protocol and standard contains capabilities to support independent and *spontaneous* innovations. For instance, bitcoin developers are free to introduce innovative applications to augment the bitcoin network without any central entity [3]. Similarly, Bitcoin platform for example and its underlying core platform Blockchain technology realized disruptive market capabilities [4]. Despite it difficult to accept and understand by larger society it give rise to a number of cryptocurrency companies (e.g., Bitcoin exchanges) which are embedded within an interconnected but

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decentralized innovation ecosystem [5]–[7]. Cryptocurrencies digital currency is inevitably present itself as a new digital artifact that offer significant research opportunity to IS scholars due to its multifaceted technological and social contexts that led to the urgent need to structure the knowledge and classify the field in order to provide ways in understanding the similarities and differences among various perspective under the field of Blockchain platform ecosystem artifacts.

Although, a great deal of research in developing a taxonomy from IS scholars has been done due to complexity of information system field. However, literature shows that classifying objects under study of interest into taxonomies is a complex process and still remain an underlying problem [8]. According to [9] reveals that taxonomies and classification frameworks are considered as an established instrument in information systems and other research disciplines to create foundation to structure knowledge and classify objects belonging to specific domains. Scholars of many discipline has undergo process and development. For instance, in Biology [23] and [10] and many more. Taxonomy development of cryptocurrencies platform in the field of information system is scanty.

Therefore finding a suitable method to develop taxonomy of this young field of research in information point of view is important and will surely serve as a basis for identifying new potential research directions. This paper is research–in-progress is aim to present and to demonstrate an ideal taxonomy for cryptocurrencies platform ecosystem. Cryptocurrencies has continued to raise a lot of attention across the globe due to its unique characteristics of decentralization and distributed nature without intermediary as against the traditional digital currency system that poses central entity. The development of cryptocurrencies platform ecosystem has continued to increase complexity due to open source leading to emergent of many developers in the ecosystem. Therefore, cryptocurrencies community such as consumers, investors, developers and researchers need to understand and analyze the complexity of the Bitcoin platform ecosystem.

The paper structured as follows: Section II we conduct a literature review on taxonomy development. Section III we discuss research method. Section IV we develop the cryptocurrencies taxonomies by using existing taxonomy development method. Finally section V we demonstrate the importance of the taxonomy by analyzing a range of Blockchain platforms ecosystem and make suggesting for the future research.

REVIEW OF TAXONOMY DEVELOPMENT IN INFORMATION SYSTEM

Literature confirmed that classification of objects will help scholars and practitioners understand and analyze complex domains, because it reduce the complexity and improved identification similarities and differences among objects which is the most important aspect of taxonomies [8] and [30]. Similarly, suitable taxonomies will play important role in guiding scholars and practitioners understand the relationship among objects in a particular domain, thereby knowledge obtain can be used as a basis for future exploration of the phenomenon [11]. Before we adopt the method to develop taxonomy of Blockhain platform architecture we need to review the existing literature on the subject. But, to the best of our knowledge we observed that cryptocurrencies Blochchain platforms taxonomies research is scanty only very few taxonomies have been proposed in the literature [3], [12] this proved to an insufficient taxonomy knowledge of cryptocurrencies Blockhchain platforms. According to [13] proposed taxonomy of Blockchain digital business models of Bitcoin companies based on value creation as dimensional classification. But emphasis only on core Bitcoin platform and does not take into account of complementors or modules that add functionalities within Bitcoin ecosystem. According to [12] present taxonomy of decentralized consensus systems they focused on technical protocols and implementations perspective. Infrastructure of decentralized consensus system taxonomy contains moderate number of six dimensions and easy to understand characteristics we consider the taxonomy to be concise and easy to use as was intended.

RESEARCH METHOD

In this research work design science research method was deployed and we systematically adopt taxonomy development method by [8]. According to [8] described his method or approach based on Bailey's model. The [30]

three-level indicator model was used as the most appealing for the development of taxonomies in the information systems field [8]. The sole objective of this work is to address new knowledge about Blockchain platform ecosystem. Design science research was characterized by two important processes as follows: building an artifact and finding suitable mechanism for evaluating the artifact [14].

This method was chosen to develop new taxonomy for Blockchain platform which we consider an appropriate considering that, the foundation behind the method is based on design science research method that informs our justification of adoption the method. We rely on the method proposed by [8]; we further evaluate the method by adopting it to develop a new taxonomy that classifies and explain existing and own going Blockchain platform projects. The unprecedented growth of Blockchains platforms and due to its technological and societal context it continues to raise public attention in recent times. Similarly, the used of Blockchain-enable technology is gaining research attention in information system domain, it is necessary to appraise existing research coverage and identify areas for future exploration [15].

Our search are based our on secondary data, which we extensively identify an existing and also ongoing Blockchains (digital ledger technologies) projects since the introduction of the legacy Blockchain platform by [1]. We focused on information system basket of knowledge (AISeL, higher ranked IS conferences PACIS, AMCIS, ICIS ECIS and other IS related journals and conferences). First initial list of about 100 Blockchains identified in the first search, but excluded some due to lack of clear purpose and do not have enough information available about their architecture. After extensive reading we carried out filtering process and twenty four (24) Blockchains (distributed ledger technologies) were selected for this study, we proceeded to a new search to find out more about their dimensions and characteristics of each selected Blockchains platforms.

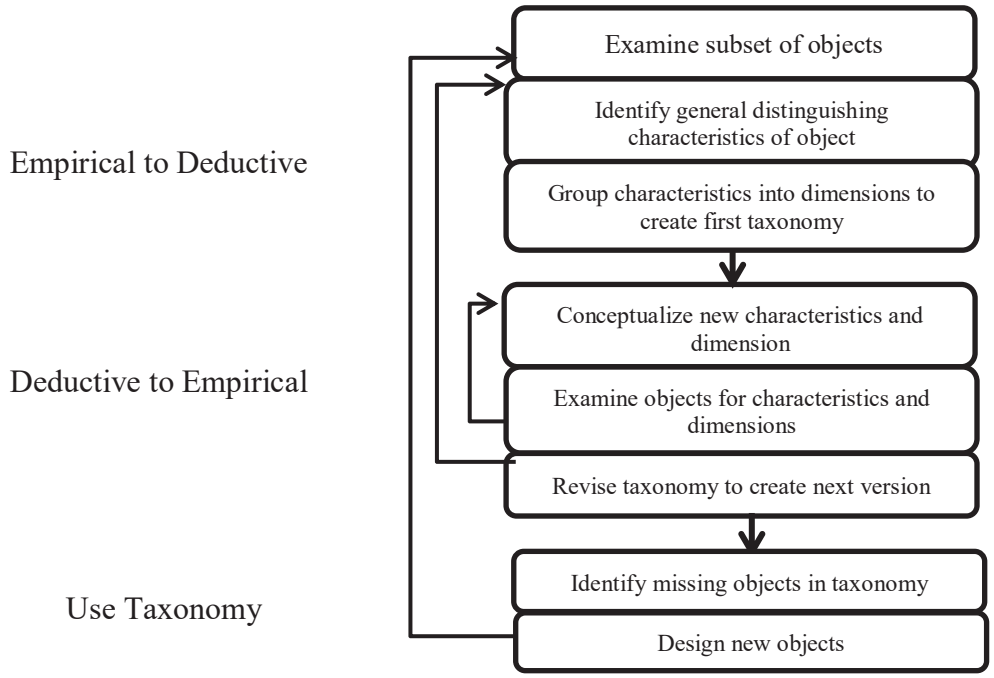

FIGURE 1. Taxonomy development method (Source: [8])

DEVELOPMENT OF TAXONOMY OF BLOCKCHAIN ARCHITECTURE

With the above background we adopt the above method to propose taxonomy of Blockchain architectures. In order to successfully develop the taxonomy the above method by [8] was carefully validated. First, we conceptualized the

term Blockchain as a subset of database platform. We want the taxonomy that classify and identify Blockchain platform based on access right .The meta-characteristics is virtually Permissioned and permissionless architectures how developers interact with the core Blockchain platform with different architecture. The main purpose of our taxonomy is to distinguish among Blockchain platform based on how developers interact with different distributed decentralized platform.

This taxonomy is expected to help us identify whether types of architecture is actually influence developers perspectives in their development effort. The meta-characteristic for this proposed taxonomy development in actual interaction between developers and different distributed architecture platforms. We start by finding the some existing Blockchain platform, but because of time constrain, we cannot exhaustively provide the entire existing Blockchain platform. We are not interested in the user behavior characteristics rather we are interested in platform characteristics such as access right, transaction validation, algorithm used etc. The purpose of this taxonomy is to distinguish among platform based on the dimensions.

We begin by developers access grant to the platforms. Different Blockchain platforms have a different mode of operation, platforms does allow developers and any other person can access them openly are refer to as Permissionless they are completely open access to everyone and no permission is required from any authority to become a participant in the network. According to [16] emphasized that participants are unknown to each other and trust emerges from game-theoretical incentives. While, Permissioned refer to an idea behind permissioned ledgers is no more complicated all the participants in the network are known and can be trusted to vote honestly, there is no need to introduce the artificial incentives to ensure that co-operation will take place.

At this level we have identified some distinguishing characteristics, we finally groups the characteristics in to the following dimensions: Mode of operation dimension and Visibility dimension.

- Mode of operation dimension-contains (Permissionless and Permissioned ledger).
- Visibility dimension (Public and Private)

The above classification of characteristics, the first taxonomy was achieved using an empirical to deductive approach according to [8]. We also observed that some Blockchain architecture are generic while others are for specific purpose, this led to have another dimension called “Task”. Ethereum and Eris are a great example of Blockchain platforms designed for a general purpose, which allow users to write their own programs to be stored on the Blockchain and automatically executed in a distributed manner.

While, Special purpose designs, such as Bitcoin and Hyperledger do not allow users to deviate very far from their originally designed. However, they are optimized for a specific task, such as tracking assets and transferring value. Therefore, we add another dimension called Task dimension with generic and specific characteristics. Then secondly, we review the taxonomy again and again using deductive to empirical and vice versa approach in order to obtain another brand of taxonomy, we finally hypothesize and deduce that, distributed ledger technology platforms varies in their transaction speed, Temper-Proof, Energy saving and Easy to Scale [17]. So went ahead an identify these importance characteristics. For instances Ripple has a higher transaction speed while Ethereum has low because is permissioenless Blockchain requires the miners to compute a large number of hashes until they produced a winning hash or mining for that particular block has ended this may cause latency [18]. Perhaps, in a nut shell permissioned Blockchain do not require mining effort for transactions. Thus we review the existing taxonomy at this level by including yet another dimension called design architecture with the following characteristics: (transaction speed, temper-proof, energy saving and easy to scale). This led to a new form of taxonomy; we keep this process as we said earlier by discovering and adding new dimension and its characteristics which eventually led to yet another version of taxonomy that is inclusive and comprehensive. According to [8] argued that it is highly subjective to decides or predicts when to finally stop the development of taxonomy of any kind.

PROPOSED TAXONOMY OF BLOCKCHAINS PLATFORM

This proposed taxonomy of Blockchain platform is based on meta-characteristics of mode of operation of some selected Blockchains platforms. Although the platform used in this study is not exhaustive [19]–[28].

TABLE 1. Characteristics of selected Blockchains (DLTs) Platforms

s/n	Blockchains Platforms	Mode of operation		Visibility			Task		Design Architecture					Consensus Mechanism			
		Permissionless	Permissioned	Public	Private	Hybrid	Generic	Specific	Easy to Scale	Censorship Resistance	Speed	Temper-Proof	Energy saving	POW	POS	Hybrid POS/POW	Others
1	Blockchain	√	-	√	-		-	√		√	-	√	-	√	-	-	-
2	BigChainDB	-	√	√	√		√		√	-	√	-	√	-	√	-	-
3	Chain Core	-	√	-	√		-	√	√	-	√	-	√	-	√	-	-
4	Corda	-	√	-	√			√	√	-	√	-	√	-	√	-	
5	Credits	-	√				√	-	√	-	√	-	√	-	√	-	√
6	Domus Tower Blockchain	-	√	-	√				√	-		-	√				
7	Elements Blockc Platform				√									√	-	-	-
8	Eris:db	-	√	-	√			√	√	-	√	-	√				
9	Ethereum	√	-	√	-		√	-	-	√	-	√	-	√	√	-	-
10	HydraChain	-	√						√	-	√	-	√		-	-	√
11	Hyperledger Fabric	-	√	-	√			√	√	-	√	-	√	-	-	-	√
12	Hyperledger Iroha	-	√	-	√			√	√	-	√	-	√				
13	Hyperledger Sawtooth Lake	-	√	-	√			√	√	-	√	-	√				
14	Multichain	√	√	√	√			√	√	-	√	-	√	-	-	-	√
15	Openchain	-	√	-	√		√	√	√	-	√	-	√	-	-	-	√
16	Quorum	-	√						√	-	√	-	√				
17	Stellar	√	-	√	--				-	√	√	√	-				
18	Symbiont Assembly				√			√									
19	Ripple	-	√	√	-				√	-	√	-	√	-	-	-	√
20	Counterparty	√	-	√	-				-	√	-	√	-	√	-	-	-
21	Nxt	√	-	√	-				-	√	-	√	-	-	√	-	-
22	Codius	√	-	√	-				-	√	-	√	-				
23	Bitshares	-	√	√	-				√	-	√	-	√	-	√	-	-
24	BlockStack	-	√	-	√				√	-	√	-	√	-	-	-	√

IMPORTANCE OF BLOCKCHAIN TAXONOMY

The importance of any taxonomy development process is to guide in understanding and analyze the object under the study. For the purpose of this study the selected Blockchains platform in the table1 above although the list is not an exhaustive data guide us to identify dimensions and characteristics of each Blockchain platforms (distributed ledger technologies).

Our decisions to identify and group the dimensions and characteristics for each of the platform in the above table are however, based on our understanding of the mode of operation and the purpose of the platform. However, some

platforms may be of dual purpose, public and private used. For instance, Bitcoin based platforms for the transfer of custom assets using the Bitcoin Blockchain, FinTech Blockchain platforms targets to disrupt applications within the global financial system and smart contract platforms that principally focus on applications that require reasoning conducted or assessed according to strict principles of validity that are beyond just demonstrating account balances or balance transfers as in the case of cryptocurrency transfers.
From the taxonomy we however observed the following:

a) There are a lot of existing and ongoing Blockchains platform projects (distributed ledger technologies) disrupting variety of wide range of industries.
b) We discovers five (5) dimensions and fifteen (15) characteristics that we consider at this level to explain various types of Blockchains distributed ledger platforms
c) There is growing number of Permissioned Blockchains platform compare to Permissionless in this taxonomy. Therefore, there is need for more research on why development of permissioned is higher than Permissionless.
d) There are ten (10) public Blockchain platforms in this taxonomy while thirteen (13) private platforms this shows that more private platforms are likely to emerge in future. The overwhelming number of private Blockchain platforms could be as a result of security and trust concern by users. There is likely the increase in the number of Blockchains platform with private characteristics in future.
e) Permissioned Blockchains platform ledgers are having higher transactions speed compare to permissioneless platform with energy saving as well.
f) We also observed that Blockchains platforms are designed with specific goals, which prescribe its features such as Bitcoin is based transfer for custom assets, Blockchain platforms for financial applications known as FinTech Blockchain platforms, this category specifically targets applications within the financial domain.
g) Others are smart contract platforms that focus on applications that require complex logic beyond account balances, enterprise platforms which focus enterprises, in a controlled manner. These also typically use a distributed consensus protocol, getting completely rid of PoW and mining and finally sidechain platforms for faster innovation without polluting the main Bitcoin Blockchain

CONCLUSION AND FUTURE WORK

This research in-progress paper described how we can use information system method of taxonomy development to classify technology under study. The method was based on empirical to deductive back to empirical. This process will be continue over and over again until when we believe that the taxonomy has reach attributes of comprehensiveness and inclusiveness in scope the entire underlying premise.

We further use development process to evaluate the existing method of taxonomy development in information system with five (5) dimensions: Mode of operation, Visibility, Task, Design Architecture and Consensus Mechanism. While we also further found fifteen characteristics under those five dimensions in the taxonomy which are useful by analyzing some selected existing Blockchain distributed ledger platforms. We found that, there are a more number of private Blockchains platforms compared to public platforms. Our analysis of Blockchains platforms architecture using information system taxonomy development method which is underpinned by design science paradigm shows an important taxonomy which may be useful mechanism for researchers and industry players for analyzing current and future Blockchain distributed ledger platforms.

We however, end this paper by proposing future research could follow several possible directions by adding several other dimensions that we have not covered here such as Cryptographic guarantees, Pseudonymity, immutability, Shared Read and Write, Auditability and Transparency, Blockchain domain, source code, native token, API and Wallet supports. This may lead to evaluate the efficiency of the taxonomy by categorizing more Blockchains platforms.

REFERENCES

[1] S. Nakamoto, "Bitcoin: A Peer-to-Peer Electronic Cash System," *Www.Bitcoin.Org*, p. 9, 2008.

[2] J. Yli-Huumo, D. Ko, S. Choi, S. Park, and K. Smolander, "Where is current research on Blockchain technology? - A systematic review," *PLoS One*, vol. 11, no. 10, pp. 1–27, 2016.

[3] E. Kazan, C.-W. Tan, and E. T. K. Lim, "Value Creation in Cryptocurrency Networks: Towards A Taxonomy of Digital Business Models for Bitcoin Companies," *PACIS 2015 Proc.*, pp. 1–15, 2015.

[4] C. M. Christensen and J. L. Bower, "Customer Power , Strategic Investment , and the Failure of Leading Firms Author (s): Clayton M . Christensen and Joseph L . Bower Published by : Wiley Stable URL : http://www.jstor.org/stable/2486845 Accessed : 23-04-2016 08 : 20 UTC Your use of the JST," *Strateg. Manag. J.*, vol. 17, no. 3, pp. 197–218, 1996.

[5] R. Adner and R. Kapoor, "Value creation in innovation ecosystems: How the structure of technological interdependence affects firm performance in new technology generations," *Strateg. Manag. J.*, vol. 31, no. 3, pp. 306–333, 2010.

[6] M. Iansiti and R. Levien, "Keystones and dominators: framing operating and technology strategy in a business ecosystem," *Harvard Bus. Sch. Work. Pap.*, pp. 3–61, 2004.

[7] S. Nambisan and M. Sawhney, "Orchestration Processes in Network-Centric Innovation: Evidence From the Field.," *Acad. Manag. Perspect.*, vol. 25, no. 3, pp. 40–57, 2011.

[8] R. C. Nickerson, J. Muntermann, U. Varshney, and H. Isaac, "Taxonomy development in information systems: Developing a taxonomy of mobile applications," *Eur. Conf. Inf. Syst.*, pp. 1–12, 2009.

[9] W. H. DeLone and E. R. McLean, "Information systems success: The quest for the dependent variable," *Inf. Syst. Res.*, vol. 3, no. 1, pp. 60–95, 1992.

[10] S. Alter, "rl-Alter-Taxonomy.pdf." 1977.

[11] S. T. March and G. F. Smith, "Design and natural science research on information technology," *Decis. Support Syst.*, vol. 15, no. 4, pp. 251–266, 1995.

[12] F. Glaser and L. Bezzenberger, "Beyond Cryptocurrencies - A Taxonomy of Decentralized Consensus Systems," *ECIS 2015 Complet. Res. Pap.*, pp. 1–18, 2015.

[13] E. Kazan, "The Innovative Capabilities of Digital Payment Platforms: A Comparative Study of Apple Pay & Google Wallet," *Int. Conf. Mob. Bus.*, pp. 1–12, 2015.

[14] J. F. N. Jr., A. R. Dennis, J. S. Valacich, and D. R. Vogel, "Information Technology for Negotiating Groups : Generating Options for Mutual Gain," *Manage. Sci.*, vol. 37, no. 10, pp. 1325–1346, 1991.

[15] O. Oshodin, A. Molla, and C. Ong, "An Information Systems Perspective on Digital Currencies: A Systematic Literature Review," *Business.Uow.Edu.Au*, 2016.

[16] S. Tetsuya, "Association for Information Systems AIS Electronic Library (AISeL) Altcoins as Alternatives for What? ALTCOINS AS ALTERNATIVES FOR WHAT?," 2016.

[17] J. Mattila, "THE BLOCKCHAIN PHENOMENON The Disruptive Potential of Distributed Consensus Architectures," *Notes Rec. R. Soc. J. Hist. Sci.*, vol. 70, no. 4, pp. 393–395, 2016.

[18] D. A. Baliga, "The Blockchain Landscape," *Mastering Bitcoin*, 2014.

[19] B. Gmbh, "A BigchainDB Primer," no. May, pp. 1–9, 2017.

[20] T. Mcconaghy *et al.*, "BigchainDB : A Scalable Blockchain Database," 2016.

[21] M. Valenta and P. Sandner, "Comparison of Ethereum, Hyperledger Fabric and Corda," no. June, pp. 1–8, 2017.

[22] R. Creighton, "Domus Tower Blockchain (DRAFT)," 2016.

[23] J. (DragonChain) Roets, "Dragonchain Architecture," no. September, 2016.

[24] H. A. W. G. (WG), "Hyperledger Architecture , Volume 1," vol. 1, pp. 1–15, 2017.

[25] G. Greenspan, "MultiChain Private Blockchain - White Paper," pp. 1–17, 2013.

[26] F. Charlon, "Openchain Documentation," 2017.

[27] CSCC, "Introduction to Blockchain Technology and Hyperledger," no. May, 2017.

[28] C. Kuhlman, D. Middleton, B. Bollen, and S. Davis, "Hyperledger Burrow Proposal," p. 9, 2017.

[29] Sokal, R. R. (1963). The principles and practice of numerical taxonomy. *Taxon*, 190-199.

[30] Bailey, K. (1994). Numerical taxonomy and cluster analysis. *Typologies and Taxonomies*, *34*, 24.