Title

**Blockchain Technology in supply chain management**

Introduction

Since the early 1980s, most of the fundamental concepts of blockchain have been arisen [1], while after presenting Bitcoin by an anonymous person, Satoshi Nakamoto, the blockchain was introduced [2]. Based on [3] and [4], Blockchain Technology (BCT) has several explanations. Therefore, by combining different definitions in literature, Blockchain is a decentralized ledger shared in a peer-to-peer distributed network with no central authority. According to [5], Although BCT has some main characteristics such as anonymity, traceability, decentralization, immutable, etc., it has some restriction by nature, including confidentiality, immutability, scalability, regulation, legacy system integration, and authenticity. There are several fields such as healthcare, Internet of Things (IoT), agriculture, finance, education, supply chain, etc., in which BCT has been applied. One of these fields, which has recently become popular in both academic and practical context, is Supply Chain Management (SCM) [5] [6] [7].

SCM can be defined as a system to manage (1) relationships between a firm and interdependent organizations, (2) all activities from sourcing to logistics [3]. Moreover, it involves some processes to facility flows of produce, finances, and information among all parties in Supply Chain [4]. Traditional SCM has inefficiency with delay, errors, and being costly, which are caused by the lake of traceability and transparency. By applying BCT to SCM, traditional relationships in this field are reconfigured. In other words, by applying smart-contract operations, all intermediaries eliminate. As a result, there are several benefits such as transparency, authenticity, cost reduction, improve trust and security, intermediation, and increase transaction process speed, which BCT brings to SCM [8]. Research studies show that implementation SCM by using BCT can be reached to maximize performance considered some technologies such as using IoT and smart-contract [3] [5]. Among all fields in SCM, the [5] reported that agriculture-related research (i.e. Agribusiness and Food SCM) and environmental-related research are the potential areas to explore.

By using shared, secured, distributed, and permissioned transaction ledger, BCT has an ability to enhance and address some issues in various industry sectors [9]. Since blockchain has several features helped improving many aspects in different sectors, if it is applied correctly in SC, can bring several benefits. There are so many applications implemented blockchain in SCs of different industries, including financial services, management systems, shipping industry, healthcare, agriculture and food, aviation, construction, E-commerce, education, entertainment and tourism, spacecraft, postal services, and sustainability management. There are some companies for each application in real world [8]. Moreover, according to [10], there are some applications of BTC in SCM derived from startup. These focus on fashion, retail, and pharmaceuticals.

Based on the systematic review [11], traceability,the strongest characteristic for SCM [5], has been noticed more as a main topic among 20 thematic categorization. After this, Supply Chain information security and Supply chain finance are noteworthy in the second and the third place, respectively. The large portion of research thematics in existing research area is about designing and blockchain-based framework and model. To summarize, traceability, efficient managing information, and reduce transaction cost are the main benefits of BCT-based solutions proposed to combat SC barriers.

As it mentioned before, while using BTC in SC brings several benefits such as visibility increased, human errors reduction, transparency enabled, security data enhancement, etc., there are several challenges for blockchain adoption to SCM. According to [8] [12], it can be possible to classify challenges for implementing blockchain in SC in three category including organizational challenges, technical challenges, and operational challenges.

**Q1: What are Organizational Challenges?**

Based on [8] and [12], this category is inclusive intra-organizational barriers, and inter-organizational barriers for adoption in large scale. To mention what factors are influenced adoption, lake of management, lake of expertise, changing organizational culture, hesitation to convert to new system **(intra-organizational)**, culture differences, information policies between parties, lake of customer’s awareness **(inter-organizational)** aresome barriers in Organizational Challenges.

**Q2: What are Technical Challenges?**

For implementing blockchain in SC, there are several technical issues that will be explained in follow. The performance and efficiency of blockchain can be affected due to size block and increasing number of blocks. Therefore, improvement of storage for handling big data will be required in this field [8] [12]. Another challenges mentioned by [12] is immutability of information. In blockchain, it is not possible to edit or delete information without consensus. Therefore, falsifying and adulteration is not possible in SC.

*Scalability*, *Privacy*, *Interoperability*, *Product* *provenance*, and *Latency* are some technical challenges reported by [13] [14]. Moreover, *Auditing, Visibility* and *Disintermediation* are some other features of blockchain which are need to monitor carefully [8].

**Q3: What are Operational Challenges?**

To have an effective implementation of blockchain in SC, it is required that various parties (i.e. operational efficiency, maintenance costs, big data management, and IT support) *are taken part* *with each other properly*. In addition, there is no certain, explicit government policies and regulations on cryptocurrency, and how to use blockchain technology for business objective. Also customers’ behavior and demands are not specified clearly. The other issues reported are uncertain market, lake of awards and encouragement programs, and organizations' lack of preparation, which has been received less attention from scholars [8] [12].

Technical and operational challenges could be adequate area for a Ph.D. thesis. There is a need to find out how different parties must be act with each other to attain an applicable supply chain. Moreover, there is a need to peruse mentioned technical challenges to apply BTC to SCM.

Methodology

In this Ph.D. thesis, to deal with each challenges mentioned recently, it is required to have two different strategies for each challenge. Since supply chain is an extensive research area, it seems that choosing a specific field in SC can make research smoother and more straightforward. As mentioned before in introduction section, Agriculture and Food SCM is one of the research area which has potential to study.

**Operational Challenges:**

1. Perusing more and detailed about each party policies and regulations
2. Having interview with expertise in each parties, involving in SC, to find out more information not mentioned in papers.
3. Integrating information that obtain from two previous steps
4. Analyzing information and review in terms of qualitative and quantitative values (Firstly, it is required to specify quantitative and qualitative criteria, then based on extracted criteria select appropriate data for next step)
5. Designing a model for a comprehensive rules

**Technical Challenges:**

1. Perusing more and detailed about each technical issue in real existing projects (Study area should be not only on papers but also on media, news, and projects‘ white-paper)
2. Perusing more and detailed about frameworks and model implemented BTC in SC
3. Analyzing information, gained in previous step, to derive compatible technical features
4. Analyzing and review tools and framework for blockchain implementation
5. Choosing best framework to develop a new model for blockchain-based SC by considering the model, designed in operational part, and enhancing technical feature selected in step 3.

From my perspective, it is require to select some graduate students in other fields including economy, agriculture or food industry, and marketing to complete the *operational challenges* part.

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