Blockchain Adoption in Rural Area: The role of Internet Penetration

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***Abstract*—This paper investigates the role of internet penetration on the adoption of blockchain for rural application. Areas of rural adoption includes financial services, agricultural product supply chain and election. This work first analyzed the factors affecting rural adoption, such as corruption, illiteracy, and lack of network infrastructure. Then we narrowed it down to network related factors. To emphasize on the importance of internet availability, we analyzed data from ITU to see how rural areas are disadvantaged by lack of internet. We also analyzed factors that affect internet penetration. And finally suggested possible solution which include the implementation of private to public transactions and the use of tokens. These are expected to argument the deficits of the current internet infrastructure, hence facilitate rural adoption.**

***Index Terms*—Blockchain, rural adoption, offline transactions,**

I. Introduction

At the advent of blockchain with Bitcoin as the first known implementation, it promised financial services to all. But to this day, blockchain implementation has been mostly in the urban areas [1] [2]. The promise of banking the unbanked by blockchain is yet to be realized. As the adoption of this new technology is moving on fast, it is also timely and important to examine factors impeding the adoption of blockchain in rural areas and proffer solutions. The scope of this paper is to:

- Survey the general problem associated with the adoption of blockchain in rural areas.
- Survey the network related limitations of rural areas.
- And suggest possible solutions.

The rest of this article is arranged as follows: section II presents the sectors that will most likely require adoption of blockchain for rural scenario. Section III presents the general factors associated with blockchain adoption in this target system. Network related limitations are presented in section IV. The suggestion of possible solutions to these open issues are presented in V, and finally the conclusion and future work is in section VI.

II. Areas of Rural Adoption

The use of blockchain can be important in many ways but this paper will consider three areas. Namely: Financial, electoral, and Agricultural supply chain. This is based on the assumption that they are the most crucial application that will yield the most benefit for rural dwellers.

A. Financial

Cryptocurrency has emerged to create a decentralized banking system, where no financial institution will control the money. It is a virtual currency that uses cryptography system to protect transaction [3]. The foremost application of blockchain is the Bitcoin for financial purpose [4]. Today, many cryptocurrencies are used in different parts of the world [5]. Example Bitcoin, Ethereum, litecoin, Bitcoin cash etc. Despite the blockchain's success in the financial idusry, rapid adoption of blockchain for financial transaction is difficult to replicate in the underdeveloped socialites. [6] explored the use of hardware to create a wireless mesh connection, with other device user to overcome the problem of poor or no Internet connection, for Bitcoin transaction. In their proposal, several equipment are need to complete the setup. A block stream satellite receiver is installed to download block chain data from the satellite. This device is bulky and mostly stationary. To extent the connection from the satellite receiver, a GoTenna mesh is used to create a mobile connection within a limited range. This approach succeeded in extending connection to fixed areas without internet access. But it has the limitation of cost and mobility, because the hardware is costly, must be at a certain range from other users to function and considerably bulky for mobile use

B. Elections

The use of blockchain for voting is a concept that has not enjoyed much attention, but yet holds a lot of promises for the future. While some countries have adopted electronic voting system, it has struggled to meet up with expectation especially in terms of its reliability and security [8] [9]. Though electronic voting has faced some criticism, the application of blockchain has resulted in commendable results [10]. The use of blockchain for voting are considered more in the developed countries which in most cases has functional electoral system than the underdeveloped and developing countries. It is imperative to apply this new technology for rural environment.

C. Agricultural supply chain

The production of most agricultural products are done in the rural areas. But because of the way most supply chains are structured the middle men take significant part of the farmers profit. Farmers would want to make as much profit from their

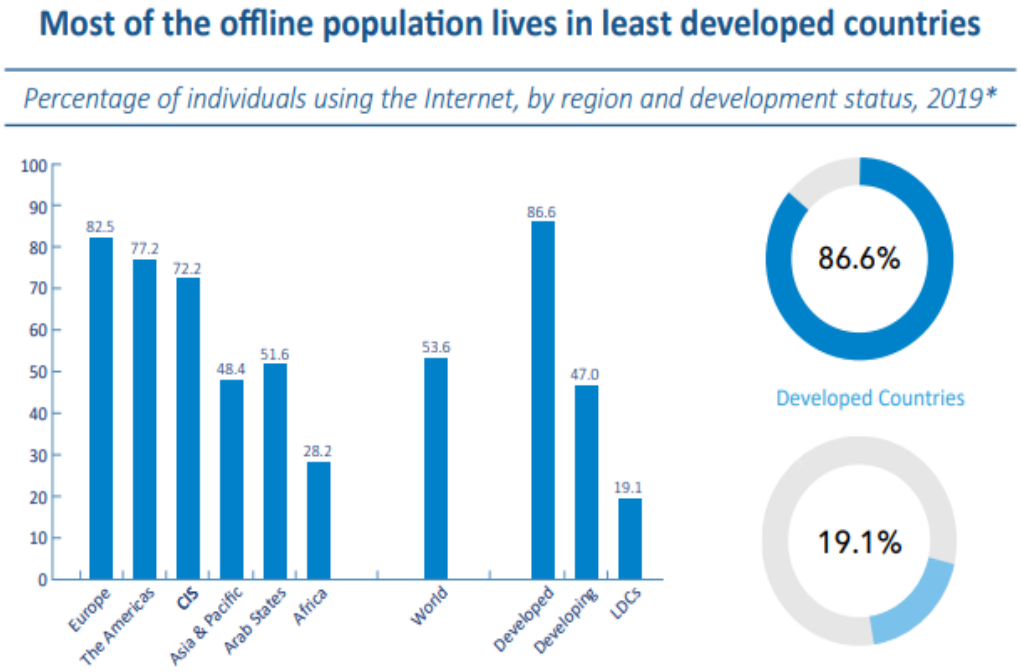

Fig. 1. This chart shows the level of Internet usage in different regions of the world. It can be seen that the least developed countries (LDCs) are lagging far behind in terms of Internet usage. [7]

produce as possible. Hence the adoption of blockchain will be rapid. The adoption of blockchain in Agro-food industry has been surveyed in [11][12].

III. Factors that affect Blockchain adoption

The blockchain creation has been juxtaposed with general purpose inventions like steam engine, electricity, internet and computer with prospects of globally affecting social structure and economies. While there are many merits of using blockchain, its success depends on its level of adoption. The following factors peculiar to the rural environment are factors that work to inhibit its adoption.

A. Illiteracy and awareness

There must be an educated population in any society that wants to embrace the blockchain technology. Awareness is equally important as understanding the general purpose of the technology is necessary, because its concepts are complicated and needs interest to learn [13] [14].

B. Corruption

Blockchain with it's smart contract feature is a technology that is geared to fight corruption, and eliminate fraudulent claims of transacting [14] [15]. But it is also the same reason why it may be difficult to be adopted in a corrupt society. According to authors in [16] corruption is mostly found where a small group or individuals cause considerable share and that rural areas are particularly prone to corruption.

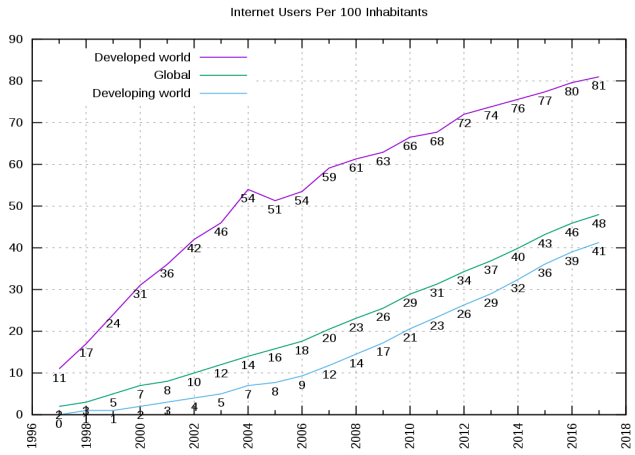

Fig. 2. Developed world, developing world and global Internet usage[18]. This graph demonstrates the gap between the percentage use of Internet in these scenarios. It can be seen that the global Internet use is close to that of developing societies.

C. Internet penetration

Internet penetration indicates the percentage of Internet users in any country. Internet/network infrastructures are aspects that affect the adoption of blockchain in rural/underdeveloped and developing societies. According to [17], there are about 4.6 billion estimated Internet users out of 7.8 billion people in the world. While many developed countries are close to 90% internet penetration, many underdeveloped and developing countries are less than 20% internet penetration [18]. See Fig. 1 and Fig. 2.

IV. Factors that affect Internet penetration

The relationship between internet penetration and various factors of development, such as economic, social, and political factors are necessary. Using seconding data, [19] found that a society's internet penetration mostly depends on telecommunication infrastructure, GDP per capita, urbanization, and political stability. See Table I

Indicators of national development like urbanization, literacy and per capita income signify a well-developed media infrastructure according to a study by UNESCO [19]. Therefore the following hypothesis were made:

H1: Countries GDP is directly proportional to it's Internet penetration.

H2: A country's population literacy rate is directly proportional to Internet diffusion.

H3: Higher urban population will likely result to faster Internet growth.

H4: English proficiency is directly proportional to Internet penetration in a country. As most content on the internet are in English language, countries with high English proficiency has strategic advantage to use the resources on the Internet.

H5: A country with a well established telecommunication infrastructure is likely to be connected with high spread rate of internet. Research to determine the chief inhibiting factor in providing Internet connectivity indicates that poor telecommunication infrastructure.

H6: Political freedom is directly proportional to internet growth. In countries with strong political control the Internet is likely to face resistance. The government considers the internet a source of risk to its political control.

H7: Fast Internet development is promoted in countries with political stability. Investment in telecommunication tends to lead to achievement in a long term. Hence societies with political instability will have a government which wants to show a quick result to its citizens.

TABLE I
Correlation between Internet Penetration and Various Factors [19]

Variable	1995	1998	2000	2002
Telecom	0.84**	0.93**	0.95**	0.97**
GDP	0.86**	0.91**	0.92**	0.92**
Urbanization	0.74**	0.81**	0.82**	0.83**
Political stability	0.63**	0.64**	0.62**	0.61**
Literacy	0.36	0.40	0.45*	0.45*
Political freedom	-0.15	-0.22	-0.38	-0.38
English Level	0.19	0.17	-0.02	-0.13
* Correlation is significant at the 0.05 level (2–tailed)				
** Correlation is significant at the 0.01 level (2–tailed)				

- **Rural area adoption**

V. Suggested solutions

The current blockchain architecture requires Internet access to perform its transaction. This constant depedency of blockchain on contineous connection to internet is a major factor determining where and where not blockchain technology can be used. To overcome this, our paper suggests two possible solutions.

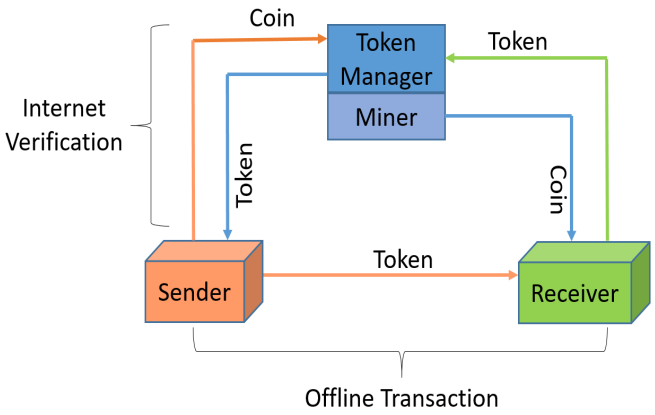

Fig. 3. Architecture for token enabled off-line blockchain transaction.

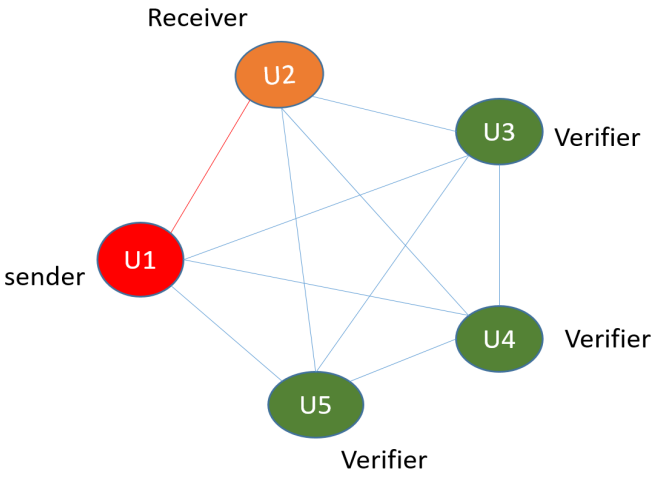

Fig. 4. Private to public transaction. A private transaction which is verified by other participants in the private network is later offloaded on the public blockchain.

1 The use of token: In this process a token is generated using internet connection. The generated token can then be used during an offline period (without connection to Internet) and the token can then be retrieved in the presence of an internet connection. With this method , blockchain transactions can still be done without instant connection to the Internet. see Fig 3.

2 Private to public transaction: This process will enable private network transaction to go on without the instant connection to the internet. In this case, a private network is created by a number of blockchain users within a close proximity. Among these participants a transaction is conducted and will be uploaded to the main blockchain network at a later time, in the presence of an internet connection. For example people inside a flight can conduct transaction if people in that aeroplane connect with Bluetooth, Wi-Fi or any other means then when they come out from the flight the transaction can then be linked to the public blockchain. See Fig. 4. The user1 (U1) and user2 (U2) can conduct transaction without instant

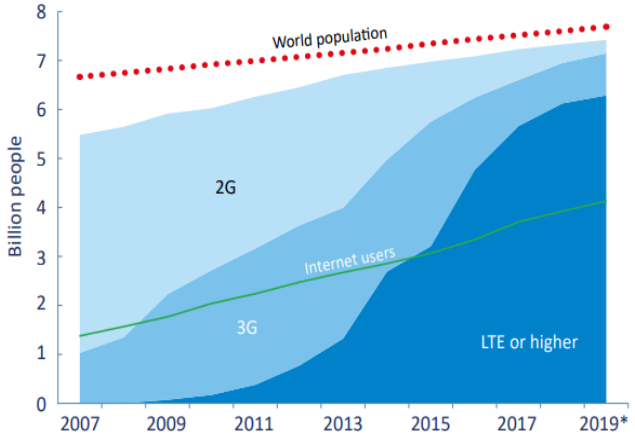

Fig. 5. Graph showing the coverage of different mobile network type from 2007-2019. Almost the entire world population lives within reach of a mobile network [21].

internet connection, and the transaction is confirmed by U3, U4, and/or U5. Later the transaction is uploaded to the public blockchain. A similar concept has been presented in [20]

3 The use of text message for blockchain transaction: According to [21], 2G mobile network covers about 97% of the world's population. Tapping into this, blockchain transactions can be done in rural areas with the use of text message [22]. See Fig 5.

VI. Conclusion

This paper has surveyed the crucial areas of blockchain application for rural dwellers. In this paper we studied the factors affecting the adoption of blockchain in underdeveloped/developing societies. The network related factors was analyzed and solution proposed. The solution include the use of token to enable offline transaction, the creation of private to public transactions and the use of cellular network. In the future , the implementation of these proposed solutions will be the direction of this paper.

VII. Acknowledgment

This work was supported by Priority Research Centers Program through the National Research Foundation of Korea(NRF) funded by the Ministry of Education, Science and Technology(2018R1A6A1A03024003).

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