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Blockchain for Development: Preliminary Insights from a Literature Review

Completed Research Full Papers

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Abstract

Blockchain is considered a disruptive technology with the potential to cause socioeconomic transformation in developing and emerging economies. In this preliminary study, we conducted a review of papers dealing with Blockchain for development published by 2019. These were issued in various outlets such as journals, conference proceedings, and professional magazines. We also caught some gray literature, such as press releases and reports. Initially, we found 288 papers, but after an evaluation of relevance and removing duplicates, we ended up with 35 articles. We examined the research focus taking into consideration such aspects as understanding of development, Blockchain use, type of contribution, and themes investigated in the papers. We also analyzed the research scope understood as country or region of inquiry. Based on the analysis, we discerned opportunities and challenges of Blockchain for development and gaps and opportunities for future research.

Keywords

Blockchain, Development, Literature review

Introduction

Since its debut in enabling a peer-to-peer electronic cash system called Bitcoin (Nakamoto 2008), Blockchain has been garnering attention. A cornerstone of this technology is its ability to promote trust among participants of a transaction without requiring a third party (e.g., a notary or a bank) that traditionally fulfill that role. That is due to its underlying distributed ledger, where transactions are registered by consensus in a network of peers, using cryptographic mechanisms that render the records tamper-evident, and, in more recent implementations, to smart contracts that execute automatically given the previously agreed-upon terms (Themistocleous et al. 2020; Yaga et al. 2019).

The transparency, auditability, and resilience associated with Blockchains lead to experiments in multiple areas beyond cryptocurrencies (Christodoulou et al. 2020). Some use cases hold vast potential for development in general and emerging economies in particular, fostering more democratic mechanisms and helping to fight corruption. Examples are secure and lean ID mechanisms, the reduction of the number of unbanked, preventing voting fraud and tax evasion, improving government management of public benefits, reducing commissions on remittances of emigrants, controlling donations and charity initiatives, or ensuring integrity of public records (e.g., property registrations) (Kshetri 2017). Of course, deploying Blockchain-based systems also carries risks, such as the significant amount of energy consumed by the consensus mechanisms of some public permissionless systems, or the possibility of a coalition of malicious actors dominating more than 50% of the network and, thus, gaining full control over it, to cite just a few.

Equally important is that we are still only beginning to understand the potential of this technology. Much like what happened with the introduction of the World Wide Web, now and then, few could predict the

extension of the disruptions that the new technology would cause (Mougayar 2016). Thus, unlike what happened with previous technologies, such as the ERP, where developing and emerging economies lagged in adoption when compared with developed counterparts (Roztocki et al. 2020), the opportunity now exists for them to timely address afflicting areas and even leapfrog established solutions in advanced countries. To understand how close we are to that reality, we formulated the following research question:

RQ: *What is the current state of the art in the use of Blockchain for Development?*

We organized the paper as follows. In the next section, we describe our research method, which is followed by the presentation of results. We then discuss our findings, explain implications, and close the study with concluding remarks.

Method

To answer our research question, we executed a thorough literature review, taking into account guidelines proposed by Webster and Watson (2002) and by Kitchenham (2004). Using the classification of Paré et al. (2015), it can be classified as a descriptive review. After some preliminary experiments to tune the search keywords, we decided on the set presented in Table 1.

| Search Expression | Search Expression |
|--|---|
| Blockchain AND development AND countries | "Distributed Ledger Technology" AND Development |
| Blockchain AND development AND economies | "Distributed Ledger Technology" AND countries |
| Blockchain AND developing AND countries | "Distributed Ledger Technology" AND economies |
| Blockchain AND developing AND economies | "Distributed Ledger Technology" AND developing |
| Blockchain AND emerging AND countries | |
| Blockchain AND emerging AND economies | |

Table 1. Search Expressions

We aimed for a diversified and balanced set of databases, spanning managerial and technical, as well as sources known for publishing research on Development. We also included some aggregators. The inclusion criteria were documents written in English, but not restricted to academic papers. New experiments with Blockchain technology emerge at a fast pace, meaning that peer-reviewed literature may not be up to date with the most recent developments. Researchers in A-level conferences have acknowledged this fact and defended the inclusion of gray literature in studies of state-of-the art, given the appropriate caution. No specific starting publication date was specified to constrain the database searches, although it was expected that nothing would be found prior to late 2008, when Satoshi Nakamoto published the paper on Bitcoin, considered the first successful implementation of Blockchain technology (Nakamoto 2008).

The expressions presented in Table 1 were used to search the databases in the title, abstract, and author keywords of the articles. Small variations existed, since the user interfaces and available options differ. The search was completed in January 2019. Originally, we obtained an aggregated 288 papers from all queried databases. The breakdown of results is presented in Table 2. Since some journals and conferences are indexed by multiple engines, 86 duplicates existed among the results and were discarded, leaving 202 papers to be examined.

| Database | # of Papers | Database | # of Papers |
|----------------|-------------|-----------------------------|-------------|
| ACM | 14 | ScienceDirect | 23 |
| AISeI | 25 | SpringerLink | 6 |
| EBSCO | 169 | Taylor & Francis* | 0 |
| Google Scholar | 8 | Wiley Online Library | 8 |
| IEEEExplore | 35 | Note: *search by title only | |

Table 2. Breakdown of Results by Database

The next step consisted of analyzing the papers to decide which ones were relevant, by reading their titles and abstracts. To increase validity and decrease biases, we resorted to researcher triangulation (Denzin 1970; Jick 1979). The full set of papers was divided by the three authors, who, independently, classified

each in one of three categories: 0 – irrelevant/discard; 1 – maybe relevant/discuss; 2 – relevant/keep. After that round, each author classified the papers analyzed by the other two. Disagreements in the classifications were resolved in Skype calls, where arguments were presented and discussed. Upon conclusion, 40 documents remained, whose full text needed to be analyzed. Of these, 4 documents could not be retrieved: two gray reports, one chapter, and one book. An academic paper was deemed out of scope when reading its full text. The final number of relevant full texts was 35. Around 54% were academic papers and the remaining ~46% were gray literature. All data was processed using Microsoft Excel to maintain full traceability of the process.

In conducting our review, we followed the framework shown in Figure 1, adapted from Roztocki and Weistroffer (2012, 2015). Therefore, we categorized the papers by research focus and research scope. Research focus includes the understanding of the concept of development, type of Blockchain use, type of contribution, and themes discussed in papers. Research scope applied to the country or region of inquiry. As a result, we were able to discern opportunities and challenges of Blockchain for development and gaps and opportunities for future research, which are explained in the section “Discussion and Implications”. The categories and subcategories of various issues analyzed in the papers were obtained through the triangulation of classifications made by the authors. These emerged from a bottom-up coding based on the topics discussed in the manuscripts and were refined in live Skype calls.

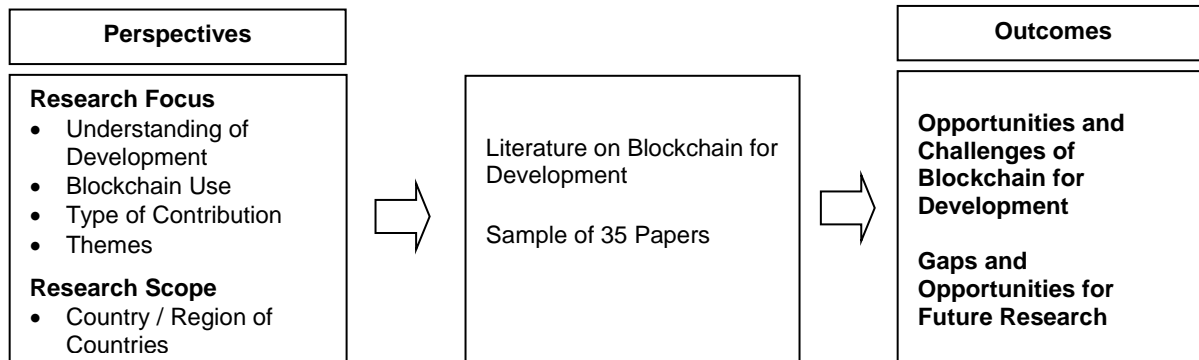


Figure 1. Research Approach / Analytical Framework (adapted from Roztocki and Weistroffer (2012, 2015))

Results

Understanding of Development in the Analyzed Papers

Table 3 displays various aspects of development present in the reviewed papers.

| Economic development | Count | Social development | Count |
|--|--------------|---------------------------|--------------|
| economic issues | 9 | well-being | 2 |
| growth | 6 | freedom | 2 |
| access to capital | 5 | fraud prevention | 2 |
| wealth | 2 | health | 2 |
| easy transfer of money | 2 | environmental issues | 1 |
| government participation in building financial infrastructure / cryptocurrency | 2 | social development | 1 |
| business opportunities | 2 | poverty alleviation | 1 |
| employment | 1 | corruption prevention | 1 |
| | | education | 1 |
| | | peace | 1 |
| | | political participation | 1 |
| Total | 29 | Total | 15 |

Note: In 4 papers, no conceptualization of development has been found

Table 3. Understanding of Development

Our analysis revealed that the prevailing understanding of development among the reviewed papers relates to the economic aspects. That perspective is present in virtually all reviewed papers discussing the concept of development, while 4 papers out of 35 analyzed did not report any discernible conceptualization. The most popular views of development refer to general understanding of economic development, which is followed by growth and access to capital. The latter is also associated with easy transfer of money. Social aspects of development were less popular among the examined papers and included a number of individual mentions of ideas associated with people's well-being, legal, political, and environmental issues. The multi-faceted conceptualization of development, focusing on both economic and societal aspects, appears generally missing in the analyzed works. Only a few papers (5) followed the dual (socioeconomic) meaning of development, and most of such works were reviewing studies conducted among multiple countries. Interestingly, the only exception was the study conducted in Ukraine.

Blockchain use in the Analyzed Papers

Table 4 illustrates various ways of Blockchain use reported in the reviewed papers. The most popular category of the Blockchain use reported by the analyzed papers includes financial and economic issues, mainly associated with access to money and support for cryptocurrencies. The next most popular categories include public administration, logistics, and transparency-related initiatives. Blockchain was also reported as an underlying technology for data management. It should be noted that the majority of Blockchain uses refer to people's well-being and social and financial inclusion, with purely technical and business-oriented uses being much less popular. In 9 papers, no specific Blockchain use has been reported.

| Use Category | Use | Count |
|--|---|-------|
| Financial and economic | money transfer | 11 |
| | financial services | 9 |
| | basis for cryptocurrencies | 8 |
| | payments | 6 |
| | remittances | 2 |
| | lending to SMEs | 2 |
| Legal / public administration services | identity management | 5 |
| | land registry | 3 |
| | real estate | 2 |
| | public finance management | 2 |
| | social security | 1 |
| Logistics / Supply chain | cross-border trading | 5 |
| | supply chain | 5 |
| Legal issues and transparency | money laundering prevention | 6 |
| | tracking donations and aid | 2 |
| | fraud detection | 2 |
| Underlying technology | transactions recording | 6 |
| | Blockchain software description | 3 |
| | as a database | 1 |
| Utilities | water management | 2 |
| | renewable energy | 2 |
| Financial inclusion | financial services for the unbanked / financial inclusion | 2 |
| Environment | climate finance flows | 1 |
| Health | healthcare | 1 |
| N/A | | 9 |
| Total | | 95 |

Table 4. Blockchain use

Types of Contribution of the Analyzed Papers

Table 5 breaks down the type of contribution we found in the papers.

| Type of Contribution | # of Papers |
|--|-------------|
| Description of a system idea not implemented yet | 15 |
| Raising awareness about Blockchain | 15 |
| Implemented Blockchain system that is in operation | 9 |
| Proof of Concept of a Blockchain system | 3 |
| Implementation of a Blockchain system | 2 |
| Examples of Blockchain use | 2 |
| Literature review on Blockchain | 2 |
| Discussion of Blockchain challenges | 1 |
| Regulatory aspects | 1 |
| N/A | 4 |

Table 5. Types of Contribution

Most manuscripts are still focused on raising awareness of the opportunities for using Blockchain, beyond the initial realm of Bitcoin. About the same number discuss ideas for systems that could be implemented. Somewhat surprisingly, a very high number already discuss systems in operation. It is interesting that we

already found mentions of challenges to the use of Blockchain and also discussions of regulatory aspects. In the case of 4 papers, no specific type of contribution was discerned.

Themes in the Analyzed Papers

Table 6 displays categories and subcategories of the themes in the analyzed papers discovered during the process of data analysis. The column “Count” illustrates number of mentions across the analyzed papers.

| Theme Category | Theme Subcategory | Count |
|-----------------------------|---|--------------|
| Areas of Blockchain use | banking/finance | 8 |
| | public investment management | 1 |
| | international trade | 1 |
| | climate change | 1 |
| | land registration | 1 |
| | healthcare | 1 |
| | international money transfer | 1 |
| Economic impact | opportunities for developing countries | 6 |
| | reduction of transactions costs | 2 |
| | dark side of Blockchain | 2 |
| | changed role of intermediaries | 2 |
| Adoption considerations | role of government | 2 |
| | trust in Blockchain | 2 |
| | management of implementation | 2 |
| | facilitating conditions for Blockchain adoption | 1 |
| Global impact | global competition | 3 |
| | overcoming stereotypes about countries | 2 |
| | rise in popularity of Blockchain | 2 |
| Addressing financial abuses | fighting corruption | 1 |
| | reducing informal economy | 1 |
| | reducing fraud | 1 |
| Technology-related aspects | Blockchain as a solution for handling shared data | 1 |
| Social considerations | women empowerment | 1 |
| Total | | 45 |

Table 6. Themes in the Existing Literature

As mentioned earlier, the theme categories and subcategories presented in Table 6 emerged from a bottom-up coding and were subject to researcher triangulation. The themes are not meant to be orthogonal, but rather to provide a perspective of the initiatives reported in the literature. For example, more transparent land registration systems supported on Blockchain could also count, in some countries, towards corruption fighting.

It is interesting to notice that, despite the gradual distancing between Blockchain as a technology and its use as the basis for Bitcoin, financial applications still clearly dominate the reported initiatives. The applications, however, are no longer restricted to the cryptocurrency domain, having become more diverse, to include international money transfer (e.g., in remittances and supply chains), micro-credit, micro-insurance, efficiency of traditional banks, among others.

Opportunities for using Blockchain for development, specifically in developing countries, also ranks high in the topics discussed in the papers. And once again, many uses that are singled-out in other themes could count towards that goal, even is not explicitly mentioned in the papers (e.g., uses in healthcare, or even global competition, that ranks third).

Region and Country in the Analyzed Papers

Table 7 provides geographical information about the identified Blockchain for development initiatives, namely which countries (or groups) are mentioned and how often across the 35 papers analyzed in depth.

| Country | Count | Region (declared) | Count |
|---|-------|---|-------|
| China, India | 5 | Developing countries | 6 |
| Russia | 4 | Africa | 3 |
| Kenya, Philippines | 3 | Caribbean islands | 2 |
| Belarus, Indonesia, Pakistan | 2 | Emerging markets in Africa, Asia, and Middle East | 1 |
| Afghanistan, Armenia, Brazil, Cambodia, Ghana, Honduras, Iraq, Jordan, Malaysia, Marshall Islands, Myanmar, Namibia, Nigeria, Papua New Guinea, Peru, Rwanda, Samoa, Singapore, Somalia, Swaziland, Syria, Thailand, Turkey, UAE, Ukraine | 1 | Latin America | 1 |
| | | Middle East | 1 |
| | | Country classification by World Bank | |
| | | Low income | 4 |
| | | Lower middle income | 13 |
| | | Upper middle income | 14 |
| | | High income group | 2 |

Table 7. Existing Literature by Country and Region of Investigation

The first striking fact is that many countries – thirty-three – within the scope of our literature review are considering Blockchain technology for development. Also of note is that they span various regions of the globe, such as Africa, Caribbean islands, Asia, Middle East, and Latin America. The countries most frequently mentioned in the literature are China, India, and Russia. It is interesting that the reported countries are almost equally split between Low + Lower Middle income (~51,5%) and Upper Middle + High-income (~48,5%), according to the World Bank. The High-income group, however, accounts for just ~6%. The development goals for which Blockchain is being leveraged varies a lot, ranging from access to capital to political participation. Note that, although in our search criteria we aimed for developing countries, some papers retrieved in the search discuss groups or a mix of developing and developed. Since some ideas about uses for Blockchain are applicable to countries in both groups, we decided not to omit them.

Discussion and Implications

The quality of the research published in the examined time frame varies considerably. Some papers are very superficial or demonstrate a shallow knowledge of how Blockchain technology works. Future research proposing Blockchain-based solutions should include an explanation of which specific characteristics of this technology are being used (e.g., being tamper-evident or the ability to dispense with trusted third parties), to what end, and how they are being assured (e.g., avoiding node collusion or dealing with the Oracle Problem). Very few papers were published in top-tier journals, although this situation seems to be improving.

The interest in Blockchain is not limited to a narrow geographical location, much less to developed countries. Most papers address development from an economic perspective, so additional effort is warranted in matters related to social development. Among the socio-economic areas defined by Tibben (2015), law and order appear to be the most popular category of Blockchain application in developed countries. Other areas, such as health, education, job creation and young people, and families seem to be underdeveloped. Nevertheless, they represent important aspects of socioeconomic development and thus illustrate opportunities for application and research. If analyzed from the perspective of societal issues in ICT4D research defined by Walsham (2017), it appears that preventing war and terrorism has the lowest potential to be supported by Blockchain. On the contrary, the mainstream use of Blockchain applies to economic well-being and this area appears fruitful for future application and research. At the same time, there are some areas that, at the moment, appear underdeveloped and under researched, but with great

potential to be supported by Blockchain. These are systemic poverty, equality for women, health, and humanitarian crises. There is also potential for using Blockchain in environment and to address climate change.

Concrete examples of using Blockchain in support of humanitarian aid are very cogent. At a time when fraud and misuse of donations threatens to drive benefactors away, the technology can be used to increase transparency and traceability from donor to beneficiary, reduce middleman fees, and even dispensing with intermediaries altogether (e.g., as in directly topping-up prepaid electricity meters for schools in Africa). That said, well-being appears to be underdeveloped in the context of Blockchain-related initiatives, and a greater focus on the individual is also needed. Empowerment and basic needs like healthcare are only briefly mentioned.

Although transparency has been a selling point of Blockchain, namely when used as a single source of truth in an ecosystem, there is also a dark side to the technology, namely when anonymous cryptocurrencies are used to fund criminal activities, such as, for example, terrorism or money laundering. The interplay between trust, regulation, and technology needs further research. Some exciting initiatives will be unfeasible unless enabling legislation is approved, while some careless uses of Blockchain can run counter to existing rules, namely the General Data Protection Regulation and its right to be forgotten. This also means that awareness should be kept on the agenda, but in a more balanced manner, discussing opportunities, but also realistically addressing roadblocks and limitations.

Practitioners may learn from our study that there is a need to carry out Blockchain-based projects to support socioeconomic development. In particular, as Blockchain is a complex technology which is at an early stage of development, but is moving at a very fast pace, it would be important that some time is dedicated to pilot projects that can serve to validate ideas before launching them at a larger scale.

Conclusion

We have performed a thorough literature review to find out the extent to which Blockchain technology is being used for economic and social development, with an emphasis on more fragile countries. The search in 8 databases produced a total of 202 unique papers, of which 35 were deemed relevant and read in full. The results show that the topic is receiving attention, although uneven across sub-areas. Hence, we have identified several avenues for further research. The main limitations of our study are associated with the timeframe and depth of an analysis. This paper presents preliminary insights from a literature review and conclusions are drawn for a given timeframe, as explained earlier. It should be stressed that we took due care over the conducted literature review; nevertheless, the Blockchain field is moving very fast and a constant attention is needed while examining the state-of-the-art.

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Appendix (List of 35 Papers in our Sample)

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