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Working Paper

Blockchain – A potential technological revolution for increasing efficiency in cross-border trade processes?

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This paper provides an evaluation of whether blockchain can contribute to the facilitation of international trade processes. Therefore, a specific case analysis on the African Northern Corridor route from Mombasa to Kampala is conducted and its issues in the context of blockchain are analysed. The goal of this paper is to provide insights into which areas of trade issues blockchain can be applied to in order to increase overall efficiency in cross-border trade.

Challenges in international trade

Within the last 50 years major technological developments and new innovations have significantly shortened distances between countries globally and allowed international trade flows to expand on a global scale. Not only did these improvements facilitate the interaction between major developed economies, but also enabled other, more distant and underdeveloped countries to engage in the international exchange of goods and services. However, even though trade costs have declined significantly, their impact on cross-border trade still remains large (Anderson & Van Wincoop, 2004; Moïse & Le Bris, 2013).

Hereby, research has shown that most of the costs are generated through paperwork and bureaucracy, even despite major technological innovations and improvements during the past decades in informational technology and communication (Green, 2017). This resulted from an analysis of different export procedures, which was based on data obtained from Worldbank questionnaires completed by freight-forwarding companies as well as port and customs authorities (Djankov, Freund, & Pham, 2010). Hence, additional technological improvement in these areas still bear a lot of potential for further reducing trade costs and increasing efficiency in international trade processes.

One of such technological innovations having the potential to reduce these cost aspects is blockchain, a distributed ledger-based technology. By utilizing such distributed ledgers as a middleware in cross-border trade processes, encrypted and cross-validated data can be shared across supply chain members simultaneously (Green, 2017) without requiring a central trusted intermediary or authority (Hofmann, Strewe, & Bosia, 2017). Therefore, integrating the factor of blockchain into research and developing specific use cases is vital for a critical evaluation of the technology's potential in the area of international trade.

This research paper is an effort to fill this gap by assessing the technology's potential impact in international trade. In particular, this research provides an analysis on whether blockchain can increase trade efficiency in cross-border trade and thereby reduce trade costs. For this purpose the geographic region of the African Northern Corridor has been chosen. The relevance of this region for a use case is given for two reasons: On the one hand there is a strong institutional environment in place in the region, focusing on enhancing trade efficiency along the corridor in order to increase its competitiveness (EAC, 2017; NCTTCA, 2018). On the other hand, relevant studies illustrate the time losses across the Northern Corridor due to various infrastructural and bureaucratic challenges and thereby emphasise the relevance an increase in efficiency in cross-border trade could have in this region (Djankov et al., 2010; Eberhard-Ruiz & Calabrese, 2017).

Blockchain – its routes and main principles

Distributed databases with the possibility of having multiple users being granted writing access have already been used in practice for decades, with the most famous example being Wikipedia. Such distributed systems are constructed out of independent data storage devices which are not connected and managed by a main processor but are storing and processing information on their own (Lipton, 2017). Thereby, these records saved by the distributed devices can also be organized in blocks in order to increase efficient usage of memory. The name blockchain has also been derived from this aspect.

The initial goal of blockchain, when introduced by Satoshi Nakamoto in 2008 was to guarantee safe financial transactions between two parties while eliminating the possibility of double spending and intermediaries such as banks (Nakamoto, 2008). And while the financial industry is slowly starting to implement transaction solutions driven by the technology, other industries are also starting to realize which benefits blockchain could bear concerning creating trusted, transparent data chains without intermediaries charging transaction costs (Satyavolu & Sangamnerkar, 2016). Referred potentials are based on two main novelties which blockchain technology introduces to conventional distributed ledger networks. These are cryptographic and game theoretic components, which guarantee data consistency next to the distributed structure of the network. These two novelties are incorporated in generating a unique personal signature key and a cryptographic consensus mechanism which are together ensuring the validity of the blockchain and its data (Gramoli, 2017).

Attributes of blockchain in an international trade context

Trust in data. Even though blockchain is still away from commercial usage certain functional aspects and benefits are already identifiable. One of these major benefits of blockchain is that it provides mutual trust into data. Guaranteeing the integrity of data while providing transparency and traceability as well as auditability of information can be vital in an international trade environment in which there is often a lack of trust in participating parties (Chatterjee, 2018; Swan, 2017). With these attributes blockchain bears the potential of reducing barriers resulting from insecurities as well as costs imposed by policies, especially as a foundation for reducing non-tariff barriers. Some blockchain-projects have already been successfully launched with the goal of providing trust and thereby reducing the addressed areas of trade costs. Examples for already existing use cases in international trade with the goal of enabling trust into information are Blockverify, tackling the issue of counterfeit drugs by tagging pharmaceuticals (Hulseapple, 2018) or Everledger's blockchain-platform, verifying the provenance of rough cut diamonds (Kshetri, 2018).

Trust in decentralized authority. The second major benefit blockchain provides is the decentralization of authority. Thereby, the complex cryptographic consensus mechanism in combination with the distributed network of ledgers deals as a substitute for a central governing authority. In an international trade context such a concept offers the potential of reducing trust issues across trade

participants and authorities, and thereby creates a platform for sharing only one single “true” version of information between all authorized parties (Goyal & Varghese, 2017; Swan, 2015). Consequently, the decentralization aspect can mainly reduce information barriers as well as costs imposed by the environment and policies. An example for a use case in this area is the joint venture between IBM and Maersk which is focusing on digitizing supply chains on the blockchain. The newly formed company pursues the goal of reducing time and costs spent on paperwork at border crossings by making information transparently available to all participants without needing one central authority governing the system (Tirschwell, 2018).

Self-enforced contracting. Lastly, the blockchain’s attribute of self-enforced smart contracts further offers the potential of reducing trade costs, especially in the area of administrative procedures. In international trade such smart contracts offer the possibility of reducing trade costs by mitigating contracting costs to a minimum as no intermediary is required for setting up and verifying the validity of the contract (Goyal & Varghese, 2017). Example use cases for self-enforced blockchain contracts in trade transactions are the transaction completed between the banks ING and HSBC on shipping soybeans (Chatterjee, 2018) or the Ethereum based platform ETHlend which allows lenders and borrowers to establish loan terms and collaterals wrapped up in a smart contract (Kulechov, 2018).

Methodology of analysis

Choice of use case. For this specific use case analysis a region with a weak competitiveness rating¹ and an institutional environment which is proactively engaging in enhancing economic engagement across its region has been chosen. Therefore, the African Northern Corridor fulfils both of these criteria, namely the low competitiveness criteria with an average country ranking of 104² out of 137 on the Global Competitiveness Index (GCI) (World Economic Forum, 2018) and has a strong institutional backbone supporting the economic development in the region (EAC, 2017; NCTTCA, 2018). Additionally, studies indicate that the region lacks bureaucratic process efficiency (Djankov et al., 2010; Eberhard-Ruiz & Calabrese, 2017) which is an area in which research identifies the largest impact on trade costs and at the same time the biggest potential for blockchain on increasing trade efficiency. Moreover, the focus of this paper is narrowed down to one specific trading route in the corridor as reports suggest that the region is not homogenous in its challenges (TTCA, 2017). The choice of the specific route is made based on its significance for regional trade, the importance of the mean of transport operating on this route, data availability and the requirement to have all trade hindering physical obstacles along the route which occur in the Northern Corridor. Specifically, these obstacles are border crossings and weighbridges. In alignment with these criteria and a literature review on the region’s performance, this paper chooses to analyse the route from the port of Mombasa to Kampala, which is operated by trucks, the most important mean of transportation along the corridor³ and meets all other criteria addressed (TTCA, 2017).

Data collection. Data on the region’s main weaknesses and strengths is collected in a triangular way by summarizing primary and secondary data. Primary data for the study has been collected by conducting semi-structured interviews as well as by collecting written responses from experts. Experts on the selected trading route have been chosen based on their geographic location, area of responsibility, and organizational background. This implies that all experts providing primary information are located in either Uganda or Kenya, work in organizations related to either roads, borders or ports and the sample contains experts from the public and the private sector. Moreover,

¹ In reference to the connection of trade costs being an indicator for the competitiveness of economies (OECD/WTO, 2015).

² Excluding South Sudan, as the country is not listed in the GCI ranking.

³ Roads along the Northern Corridor account for around 95% of all trade activities across the region (TTCA, 2017).

secondary data from literature sources and reports relating to strengths and weaknesses of the trading route has been analysed in order to complement the primary data. Overall, the identified strengths and weaknesses have further been summarized into separate categories, namely border procedures, road issues, and policies and regulations.

Structure of analysis. In order to analyse the applicability of blockchain on the identified trade issues in the Northern Corridor a conceptual framework has been designed. This framework has been derived from a thorough literature review on the attributes of blockchain (Mulligan, Scott, Warren, & Rangaswami, 2018; Seebacher & Schuritz, 2017; Wüst & Gervais, 2017) and complemented by primary data collected from experts in the area of blockchain. The according framework is depicted in .

The African Northern Corridor

Located in the eastern part of Africa, the Northern Corridor represents an important trading route linking the countries of Uganda, Rwanda, Burundi, Democratic Republic of Congo (DRC) and South Sudan to Kenya and the port of Mombasa. Along the corridor, the countries are connected with each other through a network of roads, railways, pipelines and waterways, allowing multiple ways for exporting goods from the inland through the port of Mombasa, which represents the major regional gate to international markets. In history, the corridor has been performing poorly due to inefficiencies in administrative procedures at border crossings and the port of Mombasa, as well as due to delays caused by infrastructural shortfalls along the trading route. However, regional efforts in the past years have enabled the reduction in these administrative and infrastructural inefficiencies considerably. Especially, the focus of authorities and trade-fostering organizations on integrating African corridors regionally has strongly contributed to the decrease in inefficiencies along the Northern Corridor (TTCA, 2017).

In the following, this paper highlights identified issues in the areas of border procedures, roads, and policies and regulations. The emphasis on roads is reasoned by the fact that roads in the Northern Corridor account for around 95% of all trade activities across the region (TTCA, 2017).

Issues in border procedures. Multiple issues have been identified by experts and secondary sources. One of the major issues outlined at the port of Mombasa is that procedures still lack coordination and documentation. Moreover, there is yet no system for pre-clearance of cargo while they are still on the vessel and paper-based bills of lading are also still used, which remains a time-costly issue for border procedures. Similarly, a system issue has been identified in the usage of two different platforms by the Kenya Revenue Authority (KRA) and the Kenya Port Authority (KPA) which causes delays in executing orders due to synchronisation delays as payments are made in the KRA system but have not yet arrived to the KPA system. Additionally, after being released by the customs cargo has by law a free period to stay unmoved at the port, using up space and increasing delays after customs release as transporters usually use up this free period. Moreover, the port of Mombasa as well as the border post of Malaba are often struggling with system outages, where at the latter such are even more frequent. Apart from system outages the major issues highlighted by experts at the Malaba border crossing were infrastructural shortfalls as well as unpaid duties for imported goods. Both are causing unnecessary long stoppages of cargo at borders and in further extent traffic jams.

Road issues. Related to roads and weighbridges it has been outlined that many countries have neither upgraded their weighbridges to WIM nor adopted the vehicle load laws defined by the EAC Vehicle Load Control Act. But even in countries such as Kenya, where the related infrastructure and regulatory environment has been adapted, challenges are still existing as for example in the context of a lack of (infrastructural) solutions to pre-weigh goods. Thereby, especially goods originating regionally and regional transshipments are affected, resulting in a financial burden for transporters due to weigh

incompliance at weighbridges. Next to the issues connected to the weighbridges there have also been weaknesses highlighted concerning tracking the cargo itself while on the road. As tracking is done by the authorities, transporters themselves also mount tracking devices on their trucks, causing redundancy and additional costs as various different systems have to be set up and maintained. In contrast to the existence of too many tracking systems, electronic seals are lacking in quantity which disables the further expansion of the tracking system. Apart from these rather technical issues, a general issue highlighted multiple times are the infrastructural shortfalls and regular maintenances causing traffic jams, high costs and crashes along the corridor's roads. Another additional point outlined has been the police harassment on truckers, especially on the Kenyan roads, causing additional delays and eventually unexpected additional costs.

Policy and regulatory issues. From the point of policies and regulation an issue multiple times outlined is the non-transparency of official and unofficial charges as well as asymmetries in charges which all cause miscalculations among transporters and hence reduce their forecasted profits. A similar issue results from still present visa fees across Northern Corridor countries which violates against article number 43 of the Northern Corridor Agreement on abolishing visa fees (TTCA, 2017). Hence, these fees add additional, often non-transparent costs for transporters. Another issue identified are the regulations concerning cargo insurances across the region which are of importance to transporters in order to reduce their financial burden in case of losses or damages of cargo. In this context, the biggest issue outlined is that insurances across the region are not recognized in every country and hence transporters need separate insurances for every country they pass in transit or they take the risk of losing the whole cargo without getting reimbursed. Next to the issues of various charges and fees, the issue of informal trade has been raised, causing losses in revenue for authorities as well as price dumping regionally.

Facilitating trade in the Northern Corridor with blockchain

Based on the issues identified in the Northern Corridor and the framework designed, this research paper analyses in following the applicability of blockchain on targeting these issues and thereby increasing trade efficiency. Furthermore, following section sheds light on the reasons why certain issues cannot benefit from the usage of blockchain.

Results. Overall, the analysis evaluated that seven out of the seventeen respective issues identified can be mitigated by applying blockchain technology. The results of the analysis and the respective areas of issues are summarized in .

The displayed findings suggest that blockchain could mainly be applied in improving efficiency of border procedures, which is also the area in which most issues have been identified. These can be mostly allocated to **lacking transparency of documents** across parties as well as **insufficient coordination** of procedures at border posts. The latter refers to the aspect that procedures by different parties cannot be conducted simultaneously, hence often causing redundancies in checks when multiple authorities are involved in the process. In this context, blockchain would allow creating a trusted tamper proof platform which would be simultaneously accessible by multiple parties and would at the same time allow better coordination of procedures as well as transparency of documentation. At the same time the system would not require a trusted central governing authority which is an important aspect in interactions between different countries where trust issues are not uncommon.

Apart from border procedures, the analysis found that there are issues present in the area of **tracking cargo** and **re-tracing goods to their origin**. Even though there is currently a cargo tracking system in place, in many cases freight forwarder and authorities use separate devices and systems in order to

track goods. This causes not only additional costs for both sides but also redundancies in terms of tracking data and re-tracing cargo to its origin. Blockchain in combination with IoT applications connecting the tracking devices to the platform would not only allow reducing these redundancies but would create a single point of truth which would be shared across all the parties involved. Also in this case the distributed ledgers of the blockchain would allow sorting out conflicts of interests without requiring a central governing authority.

However, the analysis also finds that not all of the issues identified can be mitigated with the usage of blockchain. This is mostly due to the fact that their nature is unrelated to any digital context but rather to a lack of infrastructure and policies in place, which both cannot be directly influenced by implementing a blockchain.

Table 1

Results of the applicability analysis of blockchain on identified trade issues

Issues in border procedures	x	Regular customs-system outages at the border posts.
	✓	Delays of payments and their display in different systems.
	✓	The usage of two different platforms by the KRA and the KPA causes delays in executing orders due to synchronization delays.
	x	Due to system downtime and infrastructural challenges trucks take up to 12h to cross at Malaba even though the distance to cross the border is not large.
	✓	Coordination and documentation of procedures in which multiple different agencies interact (e.g. at OSCs) is still a major challenge at numerous border posts.
	✓	Unavailability of mechanisms for pre-clearance of goods while still on the vessel and paper-based bills of landing are a time-costly issue at the port of Mombasa.
	x	The free period for cargo at the port makes importers leave their cargo for this period unmoved at the port, while using up space and increasing delays after customs release.
Road issues	x	Infrastructural road shortfalls and regular maintenances cause traffic jams, high costs and crashes.
	x	Many countries have neither upgraded their weighbridges to WIM nor adopted the vehicle load laws defined by the EAC Vehicle Load Control Act.
	x	A lack of (infrastructural) solutions to pre-weigh goods originating regionally as well as varying vehicle loads due to regional transshipments result in a financial burden for transporters due to weigh non-compliance at weighbridges.
	x	Police road blocks cause delays as well as potential unexpected additional costs.
	✓	Authorities and transporters all mount their own tracking devices on the vehicles/cargo leading to redundancy as various different system have to be set up and maintained instead of one single system.
	x	The occasional lack of e-seals hinders the further expansion of the tracking system. Currently tracked cargo is selected based on a risk matrix, which means that only risky cargo is tracked.
Policy and regulatory issues	x	Visa fees across Northern Corridor countries add to additional costs for transporters.
	✓	Non-transparency of official, unofficial as well as asymmetric charges cause miscalculations among transporters reducing their forecasted profits.
	✓	The issue of informal trade deludes the origin of goods and in further advance causes losses in revenue for authorities as well as price dumping regionally.
	x	Insurances across the region are not recognized in every country which can result in a large financial burden for transporters in case of losses of cargo (due to accidents, etc.).

Discussion. The findings of this analysis suggest that blockchain could be mostly beneficial in improving the efficiency of border procedures, thereby mainly reducing information barriers as well as in further context facilitating the reduction of other non-tariff barriers. The relevance of mitigating these cost-factors in an international trade context has also been outlined by other researches. One of the most prominent ones is the study conducted by Anderson and Van Wincoop (2004) who emphasize the relevance of border-related barriers, estimating the costs resulting from these barriers as high as 44% of the ad-valorem value of a traded good, whereby 6% of these are contributed to information barriers alone. Furthermore, the importance of these border processes compared to the overall time spent on cross-border trade procedures has also been outlined by Djankov et al. (2010) who identify these procedures as one of the most time consuming ones in international trade. Djankov et al. (2010) come to this conclusion based on a cross-country analysis of 146 countries. In another study

Eberhard-Ruiz and Calabrese (2017) concluded similar results for a use case on the route from Mombasa to Kampala on which they identified that more than 50% of the delays are caused by border procedures. In their research, they find that increasing efficiency in cargo clearance by customs at borders could potentially reduce transportation prices alone by already 7%, without considering the aspect of reducing other trade barriers. Following these findings and the results of the analysis of this paper it can be said that blockchain has the potential to increase efficiency of cross-border trade in the Northern Corridor significantly.

However, it should also be noted that the identified issues in this study are based on subjective views of the experts interviewed. Hence, it should not be excluded that there are also other issues along this specific route which have neither been addressed by any of the experts nor any regional report. Apart from that, it should be mentioned that for blockchain to fulfil its full potential in increasing trade efficiency also other factors will play a major role which were not addressed in this analysis. Such include the legal enforceability of the blockchain system, and an approach for incentivizing users to participate and validate data in this system. Hence, the overall success of blockchain in trade processes on this specific route is subject to an implementation project which is outside of the scope of this study.

Conclusion

Inefficiencies in cross-border trade processes and related trade costs in particular are important factors influencing the economic development of a country. Emerging technologies such as blockchain offer an opportunity for enhancing the operating principles of these procedures and potentially reducing associated trade costs. Hence, integrating the factor of blockchain into research and developing specific use cases is vital for further evaluation of the technology's potential.

This research is an effort to fill this gap by assessing the technology's potential impact in international trade. In specific, this paper provides an analysis on whether blockchain can increase trade efficiency in cross-border trade and thereby reduce trade costs. For that, the region of the African Northern Corridor, particularly the route from Mombasa to Kampala has been analysed. From the results of this analysis it can be conclude that there is in particular a large potential for blockchain to increase trade efficiency in the area of border procedures. The findings suggest that blockchain could especially reduce trade costs by transparently digitalizing documents and sharing the data across all authorized peers. Moreover, we conclude that blockchain provides an adequate tamper-proof platform for tracking cargo and enables the re-tracing of goods, as a tool for targeting the issues of informal trade. Hence, this study infers that the technology can mostly contribute to a reduction of information barriers as well as partially mitigate delays occurring along the trading routes, in this context especially at border posts. However, we also find that there are certain issues which cannot be targeted with blockchain, namely infrastructural issues and challenges requiring an adaptation of laws. Nevertheless, we can conclude from our findings that blockchain can contribute to an increase in trade efficiency and thereby reduce costs in international trade.

Kaspar Semerl is a Masters student in International Management at WU Vienna and member of the global CEMS Master in Management program. This working paper is a summary of the findings of his thesis project which he conducted in collaboration with Luvent Consulting and the Blockchain Research Accelerator. You can contact him via LinkedIn.

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Appendix

Figure 1

Framework analysing the applicability of blockchain on mitigating trade issues

