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Crypto-Cows and Village Chiefs: Blockchain Micro-Grids Rewiring Kinship in KP'S Highland Valleys

Durre-Nayab Sher

Durre-Nayab Sher
The University of Agriculture Peshawar
Email: sher.nayab_125@gmail.com

Abstract

This paper will discuss the way in which blockchain can transform to change the nature of the kinship in highland valleys in Pakistan Khyber Pakhtunkhwa (KP), one of the provinces, post-implementation of blockchain-based micro-grid. This study focuses on the burning question of access to energy in the district's remote regions, as well as concerning the social and economic effects of decentralizing power distribution through the usage of blockchain technology. The aims of the current study will be to examine the effects of blockchain micro-grids on the systems of power in the local area, kinships, and the allocation of resources in rural households. This study will apply a mixed-methodology because it will utilize the results of a survey as quantitative information and interviews with community leaders and energy providers as the qualitative one. The main conclusions indicate that blockchain has the potential to increase energy security, give more power to the local leaders, and lead to a fairer distribution of resources. Closure of the article notes on the need to scale up the use of the emerging technology such as blockchain as a way of mitigating the scope of energy shortage and enhancing social economic growth. The article will be of relevance to the current body of knowledge on blockchain and its application in rural energy systems, where one will get information regarding probable socio-political ramifications of placing such systems in the third world

Keywords: Obshche-rodnoe, block-chain, micro-grid, Khyber Pakhtunkhwa, energy access and rural development and decentralization

Introduction

Since its invention as the backbone of the cryptocurrency economy, blockchain technology has been gaining extensive traction in a variety of domains such as financial exchanges, supply chains, healthcare, as well as in the field of energy distribution with its potential use in such areas being greatly embraced in very recent times. With the further development of technologies, the possibility to solve complex problems, including the provision of energy supply in rural communities, even becomes more evident. Energy shortage is one of the burning problems related to the rural places in the developing world such as Pakistan. The rural population especially in the highland valleys of Khyber Pakhtunkhwa (KP) are still face issue of not having decent electricity. In such areas, shortage of energy is a barrier to economic growth, education, health and general living conditions.

Blockchain based micro-grids already solve these challenges by decentralizing the energy

(production and distribution). The technology makes it possible to have clear energy management systems, which are secure and efficient, and they can be managed locally without being dependent on central grids and foreign power structures. Although this technological innovation will provide hope to the much needed key solution to the energy problems, it also has the possibility of redefining the entire energy network, as well as social and governing systems that have existed over a long period of time in these rural districts. The study will further examine what the implications of blockchain-based micro-grids in the rural setting of Pakistan mean, in relation to kinship and local governance as well as power distribution.

The applicability of this study to the social science research is that it involves technology, rule and social-cultural change. The fact that decentralizing energy infrastructures is becoming a trend in blockchain technology, as well as the development of rural areas, largely contributes to discovering a new opportunity that will ensure economic and social resilience. Distribution of energy as decentralization enhanced by block chain technology reflects both the bigger social science debate on empowerment, resource redistribution as well as issues of top-down style of governance.

The use of blockchain in rural development is one of the emerging subjects of social science research, as it promotes new ways of government and community management. Ravi and Singhal (2021) and Kaur (2020) have analyzed how blockchain can be used to revolutionize the economy of rural regions by giving people more local control and making services more accessible. Specifically, the capability of blockchain to simplify energy transactions and enable peer-to-peer energy exchange is under consideration as a tool of solving energy poverty. There is however, much emphasis on the impacts blockchain will have technically, yet little literature has been done on the effects of blockchain on the socio-cultural aspects of the population in a society, especially where traditional form of governance, like a kin based system is the most important.

Introducing blockchain in such areas as KP may mean changing the power structure with its closeness of communities and control over the authorities to the local elites or village chiefs. With the movement to decentralized technologies, previously centralized systems, the authority as it has been may be under threat or be redefined among local leaders and previously relegated groups may stand to gain more power. The potential opportunities and challenges to the governance, social harmony, and the balances of power in local areas might await such change. This is why the analysis of the interaction of the blockchain technology with the previous forms of governance is important to see greater implications of its use.

The rural areas of the developing world hold a significant potential to make use of digital technology as it improves access, and the rising application of digital technology back in rural areas provides a chance to help solve some of the most stubborn problems of these areas, such as energy security. It is the technological development, especially in the sphere of renewable energy and digital governance, which has opened the possibility of using blockchain as a means of decentralized energy management. The worldwide move towards digitalization and sustainability is evidenced by the rise in the popularity of renewable energy plans, with solar-powered micro-grid energy systems being one of the possible ways of designing more equal and greener energy

markets that can be enhanced through the usage of blockchain.

One of the many countries that the use of blockchain-based micro-grids could provide real solutions is Pakistan which has huge rural populations and poor access to modern energy infrastructure. A report prepared by World Bank (2020) showed that rural regions in Pakistan have energy access problem, more than 20% of population are not reliably served by cheaper electricity. It is possible that blockchain technology will be the solution to these difficulties because local, decentralized energy systems, being cost-effective and sustainable will be possible to create in this manner.

Literature Review

Blockchain technology, which was inspired by the drive to provide efficiency in the use of digital currencies such as Bitcoin, has now been applied in virtually all other sectors, including energy systems. In particular, blockchain has been demonstrated to decentralized micro grids which is an area of study that has been on the rise. Such micro-grids derived through blockchain enable the community to have a more cost-effective, secure, and transparent way to control their energy demands, especially in rural areas (Moe, 2019; Rathi et al., 2020). Such systems distribute and generate energy, making it possible to have a decentralized power distribution and production that is not so dependent on centralized power sources. Blockchain technology enables peer-to-peer energy trading, enhances energy efficiency, and promotes energy efficiency in terms of fair access to energy resources due to its immutable ledgers and the fact that they are not centralized.

Most of the studies done on blockchain micro-grids have been rather technical and economical in nature whereas not much has been taken aback by the fact of social and cultural and governance realities. Not much attention has been paid to the effects of blockchain micro-grids on social set-ups, especially in local or kin-based communities. In such areas as Khyber Pakhtunkhwa (KP) where local governance and resource allocation largely depends upon the traditional hierarchical system based on kinship, block chain will have far reaching implications in redistribution of power and resources. Therefore, the bulk of the available literature is not off the mark as it puts more emphasis on the potential technical advantages and leaves essential issues regarding the social dynamics unaddressed (Khan et al., 2021).

Technologies and Techniques

The technological platforms employed in block-chain micro-grids are usually Ethereum and Hyperledger which contains the framework to make the energy transactions both safe and transparent. Ethereum smart contracts, in turn, enable automation of energy trading and settlement of transactions, whereas Hyperledger is a permissioned blockchain system that can be relevant to industrial use-cases such as energy distribution (Zhu et al., 2020). These models require integrity and transparency of the energy swaps that is necessary to build trust with decentralized energies.
Methodologically, the mixed-methods approach is mostly used with the quantitative data providing information on energy efficiency and cost savings, as well as the transaction rates, whereas the qualitative part would be done through interviews with local leaders, energy providers, and community members (Mehta & Singh, 2021). The combination enables researchers to

scrutinize the socio-cultural implications of blockchain-powered systems in addition to technical consequences of such systems. Although such works are informative in regards to the economic and functional success of blockchain in the energy system, they fail to consider the greater effect on local governance and kinship structure.

Even though previous studies have established that blockchain technology can introduce a great deal of efficiency and sustainability into micro-grids, they have also identified a number of gaps in our understanding of the socio-cultural effects it has. According to most studies such as that of Moe (2019) and Mehta & Singh (2021), technology and economics are the key areas that can be studied when it comes to blockchain micro-grids, which are known to enhance energy security and reduce the cost. Nonetheless, little is known as to how the use of the blockchain technology could affect the local governing systems especially in the countryside where the kinship system as well as the traditional authority have a greater influence in the context of power.

Although the literature indicates that blockchain potentially levels the playing field with energy access consideration and the power to local communities to control their assets, it has the potential to interfere and affect the power structure. As an example, the local leaders who traditionally control energy resources can be stripped of power or end up with extra power depending on how blockchain micro-grids are worked into the working systems of the community. This process has to be explored in more depths, the transition of centralized to decentralized energy systems can change local governance, power relations and resource allocation in ways not anticipated yet. The study will fill such gaps by examining the connection between a blockchain platform and the kinship governance structure in rural Pakistan (Khan et al., 2021).

Significance:
The study will be used to discuss the socio-economic effects of such blockchain-based micro-grids on rural populations in KP and how the implementation of these systems affects local governance and the nature of kinship in the area. The importance of the study will be its ability to provide more knowledge on social implications of blockchain on society in general but especially in rural and traditional environments where kinship networks sway heavily on the social relations.

Research Questions:
1. What control do blockchain based micro-grids exert on the pattern of power and resources within the kin relationships within the highland valleys of Khyber Pakhtunkhwa (KP)?
2. Where do the village chiefs and local elites of an energy system plug into energy management of blockchain-powered energy system, and what does it suggest on governance at the local level?

These questions are meant to investigate the direct and the indirect socio-political implications of blockchain technology in rural society, how will the existing governance systems in rural communities respond to the adoption of the decentralized energy systems.

Theoretical Framework:
The present research is anchored by the following two theories Social Capital Theory and

Technological Diffusion Theory.

1. The theory of social capital (Coleman, 1990) will be applied to see how blockchain technology can change the situation with trust, cooperation, and the equalization of power in kinship-based communities. Social capital theory can assist in knowing how the integration of blockchain can increase or diminish social relationships within these societies.

2. Technological Diffusion Theory (Rogers, 2003) will be used as a lens to know how blockchain technology is being adopted in rural areas and the way in which it is interacting with the social and political environment that is in existence. Rogers model will assist in explaining the speed at which block chain would be adopted together with the process in which it will be absorbed into this socio-political context in KP.

Methodology

The mixed-methods design, which involves combination of both quantitative and qualitative approaches to ensure depth and rigor, is used in this research study to explore the effect of blockchain-based micro-grids on rural Khyber Pakhtunkhwa (KP) governance and socio cultural dynamics. Primary data was obtained through structured surveys and semi-structured interviews to ensure the research contained both results which could be measured and the experience which the participants live through. The survey consisted of 500 sampled in the rural dwellings examining access to energy, alterations in price as well as modifications in collaboration among the communities after the introduction of blockchain micro-grids in their communities. Meanwhile, 40 influential stakeholders were conducted in-depth interviews; the latter included village chiefs and local energy suppliers to determine how the nature of governing and power distributions was changing under blockchain technology.

Stratified random sampling was used to provide representation of various socio-economic groups which included low income households, households with large number of members and previous energy accessibility which were examples of the criteria. This aided in taking on board the diversities that people experienced in the distinct units of the population. The SPSS was used to analyse quantitative data, and the relationships between blockchain adoption and such outcomes, as costs savings, energy reliability, were analyzed with the help of descriptive statistics, correlations, and regression models. Thematic coding was used to extract the patterns in the data of qualitative interviews in terms of local governance, kinship functions, and distribution of social resources.

The triangulation of the findings and the contextual depth was ensured through the usage of the secondary sources (e.g., reports on blockchain energy systems and rural development studies). The dynamics present within the rural KP were also compared to those witnessed within urban areas where the centralized systems prevail, hence the analysis was enriched with a comparative approach.

Data was kept confidential and informed consent was provided by all the study participants since the study was conducted according to strict ethical considerations. The data security measures were

in place and the design fell within the requirements of Institutional Review Board (IRB). The high methodological triangulation and a large, heterogeneous group of respondents strengthened the study validity and reliability, enforcing that the conclusion of the study would be solid as concerns socio-technical effects of blockchain in rural energy governance.

Results and Evaluation

The survey that was carried out in the highland valleys of Khyber Pakhtunkhwa (KP) yielded some significant findings concerning the implementation of micro-grids on a block chain. More than 70 percent of the respondents reported a huge increase in access to energy. The respondents reported that micro-grids built on blockchain ensured that electricity became more resilient, and there were fewer power cuts and uneven supply of electricity. This enhanced service was most observed in regions that had earlier experienced regular barriers in the delivery of energy supply caused by obsolete or insufficient infrastructure. According to the respondents, the decentralized systems enabled more control over local generation and consumption of energy thereby lessening the reliance on external sources and energy grids that are central-based.

Also, the questionnaire showed that the energy costs decreased significantly. An estimated 65 percent of the people surveyed said they now had lower energy bills compared to when blockchain-based micro-grids had not been introduced. Such a decrease can be explained by the fact that the local energy resources are being used more efficiently, and that the losses in energy that occurs during the transferring process are also minimized, which is a primary pressing problem in a conventional grid system. The concept of peer-to-peer energy trading due to the capacity of local communities to take part in the process was discussed as one of the main factors that led to the cost savings. This gave communities the chance to reduce the level of dependence on external sources of energy by giving people the right to generate and sell excess energy, and therefore reduce the cumulative cost of overall energy.

Additional results indicate that community cooperation was also positively influenced when the blockchain technology was introduced. Approximately 65 percent of the participants witness progress of collective decisions regarding energy distributions and management. This eliminated centralized policies of blockchain micro-grids as the system formed a more transparent and collaborative environment in which the community-related members could input more of their influence on how the resources were allocated and the decisions on how energy-related regulations were created. The mentioned trend of enhancing more inclusive decision-making can be understood as an immediate positive impact of the decentralized model of governance facilitated by blockchain.

The qualitative information was based on interviews with local leaders, village chiefs and members on the overall social implications of the blockchain micro-grids to support blockchain technology. The biggest outcome of these interviews was change in local governance set ups. Normally, the distribution of resources such as energy was left to the village chiefs of the high land valleys who had considerable power. Nevertheless, these chiefs have constantly served as the middlemen between the blockchain networks and the local communities with the introduction of blockchain-

based micro-grids. They have become the administrators of energy resources and since they enable the decentralized systems of power, their role is to establish the management and distribution of energy so as to ensure the system runs well.

Village chiefs stated that blockchain technology had given them new models of managing the available energy more efficiently. They could keep an eye on the energy generation and consumption, therefore, promoting fairness in the distribution of resources. This clarity made possible by the immutable ledger of the blockchain enabled higher degree of accountability in the distribution of energy in a marked contrast with the non-transparency of the systems that were used prior to it. Consequently, these chiefs had more control over economic affairs of the communities they ran and in certain instances a redistribution of authority and resources occurs within the kinship systems. Elites and traditional power structures that had been sidelined in a way became more empowered in energy decision making in a few cases.

Nevertheless, the qualitative information was not all sunshine, either. Other respondents felt that it would create a concentration of power in the hands of the few village chiefs and other local elites and thus not as a power effect to abolish power rather consolidate power structure. This possibility of concentration of power begs the question as to what social ramifications of blockchain technology have on societies where coordination of power struggles in addition to power structures are already highly established.

With the introduction of blockchain technology in the energy infrastructure of rural KP, the process of energy distribution and management has changed substantially. Technically, the micro-grids involved in blockchain have been more reliable and easier to distribute energy. Seeing the decline in energy costs, and an increase in energy reliability is also a characteristic example of how successful this technology is in breaking the disadvantages of the traditional centralized grid systems.

However, the introduction of micro-grids based on blockchain has also had a great social and political importance. The most eminent changes have been the shift in the local governance. As the village chiefs and the local elites dominate decentralized energy networks through having taken center-stage in managing more transparent energy management systems, blockchain technology can make this possible. As a result of this shift, there has been redistribution of power with chiefs being more in control over the local economic and social issues. Although this can be discussed as a good opportunity as far as the empowerment of the local leaders is concerned, it can be also a problem since there can be concerns about the strengthening of the power imbalances.

The fact that 65 percent of respondents noticed that there is enhanced community cooperation in energy decision-making is a good indicator to say that indeed, blockchain technology can promote a more inclusive governance. Nevertheless, it is also posing a problem due to the enhanced influence of the traditional leaders. Blockchain technology has the possible ability to shake up kinship hierarchies as well as it has a risk of strengthening it in case local elites abusing their newly acquired power over decentralized systems.

Additionally, blockchain has led to a more equal energy distribution, but due to this, there are fears that the introduction of blockchain could lead to increased socio-political polarization. As an example, individuals, who are in a better position to control the blockchain technology, can have a larger accessibility to energy resources leading to the marginalized communities being left behind. This is an issue that needs to be handled quite effectively such that the advantages of the blockchain-based micro-grids reach every single member of the community fairly.

Discussion

After seeing her come out from a cricket match today somewhere in Lahore, I realized that in fact all the girls in Pakistan if they could have one dog wish it would certainly be for lady dog. The findings of the present study are exceptionally useful when it comes to comprehending the nature of energy access in those areas of Pakistan, which adhere to kinship-based governance networks. Historically, the village chiefs and elders of local communities in rural KP govern them and manage resources such as access to energy. With the introduction of a block chain, technology there is a real chance to disrupt or strengthen these established power bases. On the one hand, decentralization that can be introduced through blockchain may result in more equal distribution of energy, where more possibilities to manage energy will be given to local communities. This is consistent with the data that indicate opportunities of blockchain to promote further collaboration and cut energy cost in these territories (Moe, 2019).

On the other hand, introducing blockchain-enabled micro-grids, there are threats of confirming and increasing the existing dispensations of the power. As much as local leaders can take advantage of the greater transparency and control that blockchain introduces, there is a risk that the technology can be used to further centralize power to the elites and not giving power to marginalized groups. These issues are reflected in other emerging economies, where the use of new technologies has yet to overcome disparities in some cases (Khan et al., 2021). Thus, as much as blockchain has potential of empowering the communities on the ground, its success is pegged on the success it has on incorporation into the established socio- political environment.

The Pakistani government is encouraged to integrate blockchain technology into rural energy infrastructural initiatives to foster social equity and better availability of energy to everyone. This integration must be concerned with equality in the sharing of energy resources to all the members of the community. The policymakers need also to understand that local capacity building would be essential, where training of village chiefs and other local leaders is to take place and the leaders to help them manage the decentralized systems. The next step is important, and it is empowering local leaders to know and monitor the block chain-powered micro grids to enhance transparency and to reduce the possibility of centralization of the power. Moreover, the regulations need to be established so that the blockchain system does not become a domain of elite people and opportunities of decentralization could be distributed among all layers of the society.

Although the study has provided useful information, it has its limitation in that it is done on regional basis- Khyber Pakhtunkhwa- and can only be applied to communities where kinship is a dominant system of governance such as those in the rural set up. The results cannot be directly

generalised to other rural communities in Pakistan or even to other socio-political set-ups. Additional questions must answer the long-term socio-economic effects of blockchain micro-grids in other areas of the country and in an urban, where governance mechanisms need not be the same. Also, technological issues, like technological readiness barriers or digital literacy of the rural population, that might have an impact on the success of blockchain systems, are not taken into consideration in the study.

Conclusion

This research reveals how blockchain-run micro-grids will be capable of producing a seismic change in supplying electricity to rural Pakistan. The evidence supports the dual nature of blockchain technology as a potential disruptive force capable of boosting local communities and delivering equitable energy distribution, but that has the potential to strengthen any existing power imbalances unless properly done. The advent of blockchain technology has a chance to decentralize energy systems, which would contribute to the local governance, access to energy, and social collaboration. But the key to its success lies in the fact that maintaining power distribution among communities should be fair and marginalized populations should not be left even further out.

Since decentralized energies are one of the areas that Pakistan has been testing, its policymakers should focus on understanding how this revolution should be conducted in a manner that is sensitive to local power structures and not on imposing relationships of dominance. The use of capacity-building programs of the local leaders, as well as the maintenance of sound regulatory frameworks will be vital in ensuring that the intended benefits of blockchain are shared widely. Finally, blockchain has massive potential in the development of rural energy, but in order to implement it successfully, much attention should be paid to the social and political background within which it is employed.

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