Optimal Blockchain-based Cryptocurrency Selection for Remittance Transaction: An MCDM Approach

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Abstract--- As blockchain technology becomes trendy in different industries, its application in banking industry is of utmost importance too. Banks in different countries attempt to utilize this technology in wide variety of banking functions. By considering that there are millions of migrants living in far distance than their own countries. The regularly send money to their families. However, current banking and money transfer services are costly and timely, which particularly affects those who send low amount of money in weekly or monthly basis. Blockchain technology with a particular emphasis on the development of cryptocurrencies related to remittance transactions become a solution for both banks and people. This research uses MCDM with an inclusion of AHP and TOPSIS methods to select the most ideal cryptocurrency to solve the remittance transaction problem. Based on the three criteria, namely underlying technology, recognition, and external impact (cost), it is found that Ripple (XRP) is considered the most optimal cryptocurrency by experts who are knowledgeable in both conventional banking process and blockchain technology. Sensitivity analysis is also performed to ensure the validity of the finding, and Ripple (XRP) remains the optimal cryptocurrency in remittance transaction.

Keywords--- Blockchain Technology, Cryptocurrency, Remittance Transaction, Conventional Banking.

I. Introduction

Conventional banking sector is reluctant in utilizing up-to-date and advanced technologies.[1]Recent technologies, especially blockchain transforms everything in the financial sector, such as from payment transactions. It has attracted the global attention in recent years (Tang et al., 2019). It is described as a distributed digital ledger that is upheld by a group of computer nodes, while at the same time is not based on the mutual trust of the nodes (Dinh et al., 2017).

Bitcoin is considered the first blockchain-based digital currency (cryptocurrency), created by Nakamoto (2008), which further led to the rapid advancement of blockchain technology as well as the cryptocurrencies. The first generation of blockchain technology is called Blockchain 1.0, which is mainly about digital currency with the use of mining, hash functioning, and public registrar as well as the underlying protocol (e.g., software that enables transaction of digital currency) (Efanov & Roschin, 2018). Starting from 2017, blockchain technology was applied in various fields, such as Internet of things (IoT), economics, and medicine (Sun et al., 2016; Huckle et al., 2016; Yue et al., 2016). With a presentation of Turing-complete programming language, blockchain technology transformed into Blockchain 2.0 era powered with smart contracts. Ethereum is the locomotive of Blockchain 2.0, which refers to decentralized platform running on smart contracts and without the interferences of third-parties (Ethereum blockchain app platform, 2014). Major applications of Blockchain 2.0 include economic and financial domains with payments and financial transactions. Ethereum is not a pure digital currency, while it is a blockchain-based platform, where blockchain-based projects can be deployed with their own protocols, tokens, or cryptocurrencies. Smart contract is the computer program, which is designed to automatically perform the terms of a certain contract (Efanov & Roschin, 2018). Hence, the parties involved in contract can make transaction and get paid in most transparent way (Crosby et al., 2015).

Regardless the increasing popularity of blockchain technology as well as digital transactions through bitcoin and other cryptocurrencies, bank sector is still resistant to utilize this technology. As such, JPMorgan Chase CEO Jamie Dimon emphasized referred Bitcoin as "*a fraud*" and added that it will end up soon.[2] Why banks are still resistant or afraid of blockchain technology utilization? The simplest answer to the question is that the transactions are highly reliable and certifiable, while at the same time they are cost-efficient by considering the passive involvement of third-parties compared to the conventional transactions (Park & Park, 2017). The new transaction mechanism is also called "*peer-to-peer*" transaction.

[1]https://www.netobjex.com/how-blockcghain-could-possibly-disrupt-banking/
[2]https://www.reuters.com/article/legal-us-usa-banks-conference-jpmorgan/jpmorgans-dimon-says-bitcoin-is-a-fraud-idUSKCN1BN2PN

DOI: 10.5373/JARDCS/V11SP11/20192923
ISSN 1943-023X
Received: 10 Sep 2019/Accepted: 10 Oct 2019

In addition, transaction-related benefits of peer-to-peer transaction outnumber the conventional transaction. Bitcoin and Ethereum operate with consensus algorithm, referred as proof of work (POW) that is relatively less efficient and retains small transaction per second (TPS). On the contrary, there are more advanced public blockchains that are aimed to have higher TPS (Tang et al., 2019). They are based on proof of stake (POS) consensus algorithm, delegated proof of stake (DPOS), and practical byzantine fault tolerance (PBFT) (Larimer, 2014; King & Nadal, 2012; Castro & Liskov, 1999). Moreover, the advanced blockchain technology and digital transaction mechanisms make transactions more efficient, fast and secure, which can ultimately help people, especially in poor and developing countries, to transfer money rapidly, with less transaction costs, and without the attendance of third parties.

The current research aims to make a comprehensive evaluation of blockchain-based cryptocurrencies that can potentially replace conventional banking transactions. The evaluation is based on three criteria: (1) Technology; (2) Recognition; (3) External impact, and their underlying sub-criteria. Multi-criteria decision making (MCDM) method is employed to select the most appropriate blockchain-based cryptocurrency. To be more specific, analytic hierarchy process (AHP) by Saaty (1990) is employed for measuring the weights of criteria in respect with cryptocurrency options. Then, the technique for order preferences by similarity to an ideal solution (TOPSIS) method by Hwang and Yoon (1981) is utilized to select the most optimal cryptocurrency for digital transactions. Finally, sensitivity analysis is performed as there is a possibility that criteria weights might be sensitive to the changes. Hence, AHP criteria weights are adjusted with 10%, 30%, and 50% increase in order to test whether or not the overall criteria weights of the most optimal cryptocurrency change.

II. Banking Sector and Blockchain in GCC

Global migration is an omnipresent reality in the Gulf Cooperation Council (GCC) countries (Gulf Research Centre Cambridge, 2018). For many countries in South Asia, the Arab world and East Africa, migration to the GCC countries is an integral part of the life of millions and a constitutive element of economies and societies. The migrants send money back to the home frequently, although the costs are high.[3] According to Moody's report, Saudi Arabian banks can save nearly US$ 400 million per year by utilizing blockchain software for facilitating cross-border payments.[4] Ripple – One of the most advanced blockchain-based platform that allow real-time cross-border payments, signed the agreement with the Saudi Arabian Monetary Authority (SAMA) to help improving the payment infrastructure.[5] The National Bank of Abu Dhabi also partners with Ripple to cut extra transaction costs and speed up the payments.[6]

As of October 2018, in blockchain-based cryptocurrency market, more than 2,000 crypto coins and tokens were traded in more than 15,000 exchanges, where the top crypto coins are Bitcoin (Market cap: $154,1 billion), Ethereum (Market cap: $30,1 billion), Ripple (Market cap: $19,1 billion), Bitcoin Cash (Market cap: $8,3 billion), EOS (Market cap: $7,4 billion), and Litecoin (Market cap: $7,2 billion).[7] The comparison of the cryptocurrencies (see Table 1) show that altcoins, namely Ethereum, Litecoin, and Ripple have more circulating supply, while at the same time transaction/per second in Ethereum is accounted for 20/per second, in Litecoin 56/per second, and in Ripple 1500/per second, in comparison with Bitcoin (7/per second). Block time is faster Ethereum (15 seconds) and Litecoin (2 minutes and 3 seconds).

Table 1: Comparison of Top Cryptocurrencies

	Bitcoin	Bitcoin Cash	Bitcoin Gold	Ethereum	Litecoin	Ripple
Circulating supply	> 16.8m	> 16.9m	> 16.9m	>97m	>55m	>39b
Maximum supply	21m	21m	21m	Unlimited	84m	100b
Current mining	12.5/per block	12.5/per block	12.5/per block	3/per block	25/per block	1b/per month
Transaction/per sec	7	60	7	20	56	1500
Block time	10min	10min	10min	15sec	2min 3sec	Near instant
Network	N/A	N/A	N/A	Ethereum	N/A	RippleNet
Blockchain size	>185Gb	>159Gb	>163Gb	>337Gb	>14Gb	N/A

[3]https://medium.com/@atiejelmouallem/blockchain-applications-in-banking-with-focus-on-gcc-banks-2af60efc3d5d
[4]https://www.thenational.ae/business/saudi-blockchain-pilot-could-save-banks-up-to-400m-per-year-moody-s-says-1.706414
[5]https://ripple.com/insights/ripple-and-saudi-arabian-monetary-authority-offer-pilot-program-for-saudi-banks/
[6]https://www.incarabia.com/technology/one-of-the-uaes-biggest-banks-is-embracing-blockchain/
[7]https://www.coinmarketcap.com

DOI: 10.5373/JARDCS/V11SP11/20192923
ISSN 1943-023X

Received: 10 Sep 2019/Accepted: 10 Oct 2019

It is necessary to understand the best cryptocurrencies are for international money transfers. Ripple is considered one of the attractive ones for financial institutions (Token insight, 2018), as well as the banks in GCC countries, as mentioned above. Money transferring services, such as TransferWise and PayPal are the most convenient ones with relatively small transfer fees. In addition, when customers sent money, they don't control the money being sent, instead they trust a company to do it for them. However, main challenges for these services are: (1) sending money to countries that face global sanctions and cut off from International banking system (e.g., Iran, Saudi Arabia, Venezuela, Cuba, Tanzania); (2) transactions at risk of being stopped or frozen by these services; (3) Need to send low amount of money to family weekly (e.g., an immigrant sending US$ 50 to family in weekly basis).[8] Litecoin is the solution for cost-sensitive money transactions, which is faster and cheaper than Bitcoin. Although Bitcoin transaction fees skyrocketed before, the average transaction fee is approximately 37 cents, which also makes it a competitive cryptocurrency in International money transfer. According to the comparison between Bitcoin and Ripple, the latter one can settle transactions in less than 4 seconds (Jani, 2018). Dash is another top digital currency with relatively low transaction costs and faster transfer time that may allow migrants to send money globally (see Figure 1).

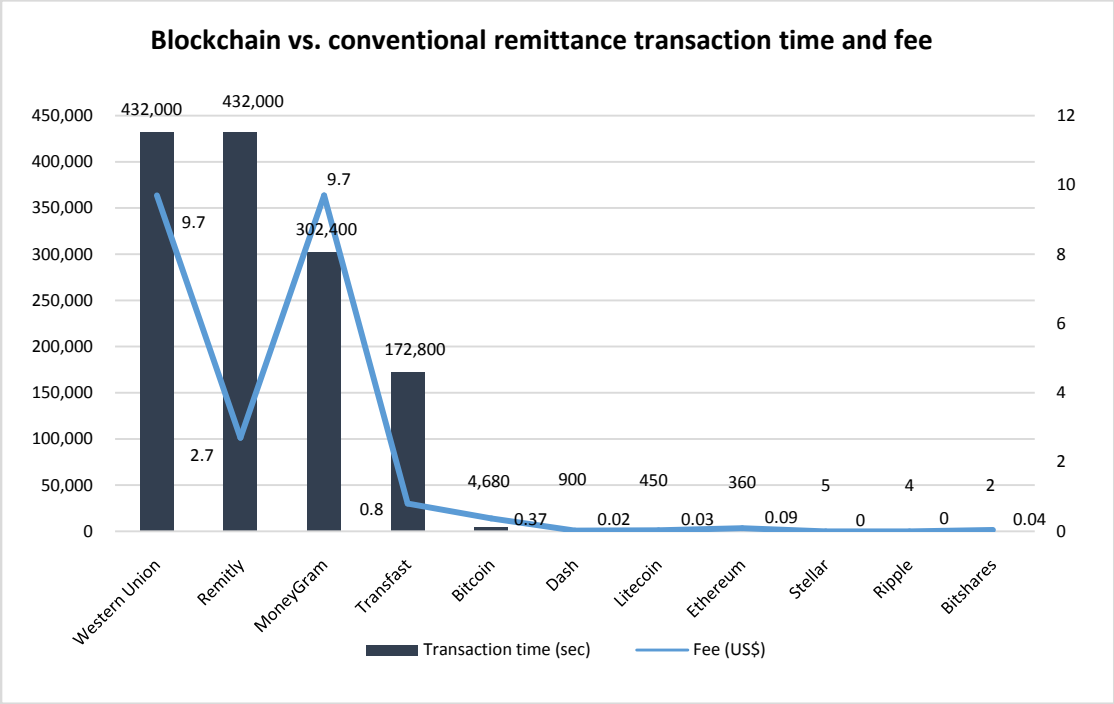

Figure 1: Blockchain vs. Conventional Remittance Transaction Time and Fee

*Source:*https://www.saveonsend.com/blog/bitcoin-blockchain-money-transfer/

According to Block data,[9] blockchain-based remittance service has several advantages compared to conventional remittance service: (1) time stamped, traceable and encrypted transaction vs. central data storage and lost transactions; (2) multiple currencies vs. fiat currency; (3) distributed ledger technology (permissioned and permissionless), open-source vs. legacy banking and SWIFT (international payment system) and others.

Drawing from the discussion above, the top blockchain-based cryptocurrencies, which are considered effective in international remittance transactions, are selected for further analysis.

III. Proposed Evaluation Model

As blockchain popularity is growing, its underlying technology is also advancing. Technology is an important indicator to evaluation blockchains (Tang et al., 2019), while at the same time population and global recognition is another factor that determine the mass adoption. Bitcoin ranks 18th, according to the CCID's (2018a) Global Public Blockchain Technology Assessment Index, whereas it is still one of the trendiest blockchain platforms.

[8]https://www.keysheet.io/guides/best-coin-for-international-money-transfer/
[9]https://download.blockdata.tech/blockdata-remittance-market-blockchain-technology.pdf

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Therefore, in the proposed evaluation model, the Underlying technology (A_1) and Recognition (A_2) are employed as first level criteria. Another criterion is External factors (A_3). This criterion is mainly comprised of cost-related second level factors, namely price of the coin, transaction cost, and energy cost/transaction (see Figure 2).

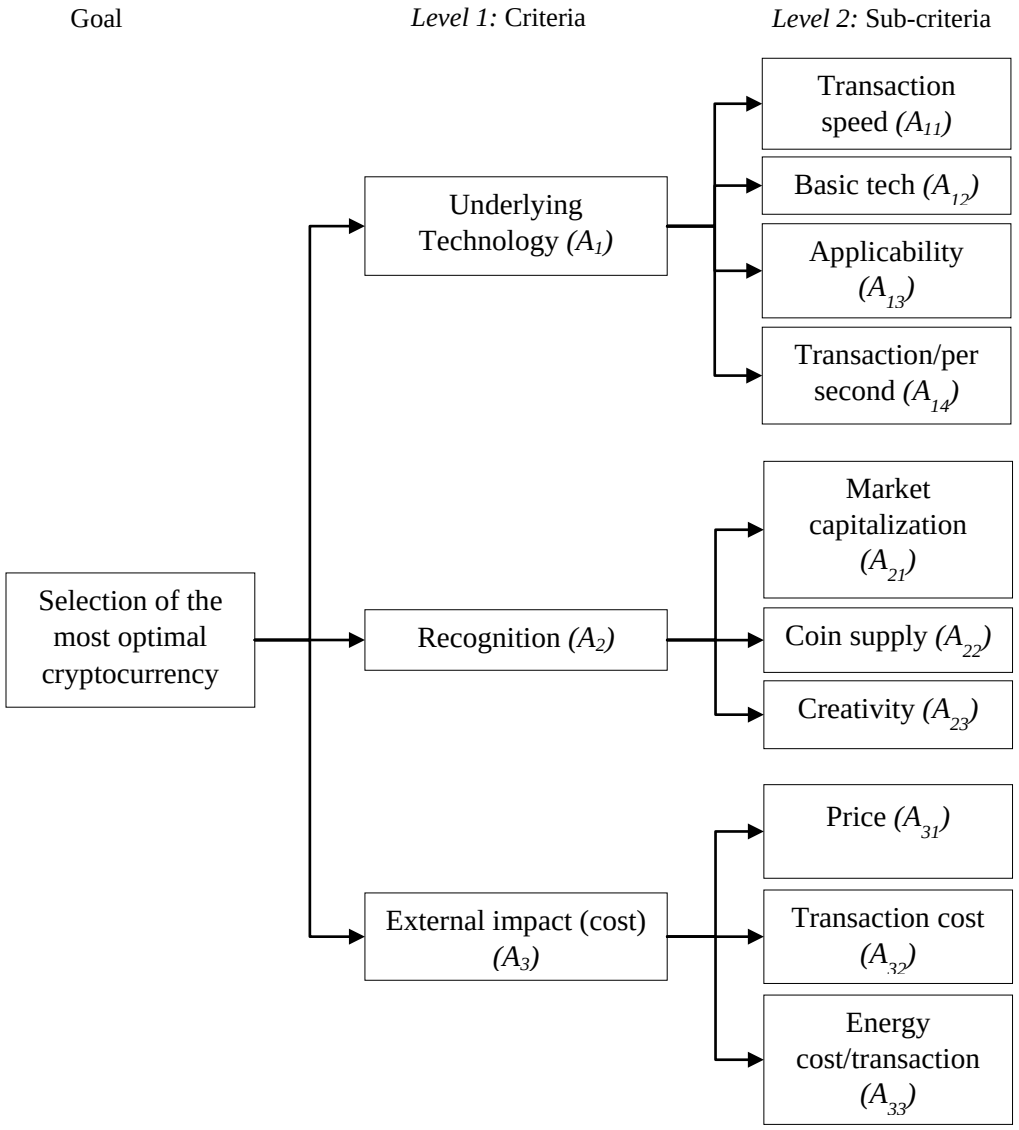

Figure 2: AHP Hierarchy of the Optimal Cryptocurrency Selection Decision-making

3.1. Underlying Technology

This criterion contains of four sub-criteria, namely Transaction speed (A_{11}), Basic tech (A_{12}), Applicability (A_{13}), and Transaction/per second (A_{14}). As CCID (2018b) already included A_{12} and A_{13} in assessment index, this study adopts their scoring results. In addition, Tang et al. (2019) employed A_{14} in the context of public blockchain, the current study uses it in the context of blockchain-based remittance transaction. Finally, A_{11} is adopted from an external source.[10] Hence Technology mainly examines the overall performance of a cryptocurrency, its safety, degree of centralization, and ease of use (CCID, 2018b).

3.2. Recognition

The three second-level sub-criteria assess this criterion. They are Market capitalization (A_{21}), Coin supply (A_{22}), and Creativity (A_{23}). A_{21} refers to the outcome of the price of a blockchain company's stock in the exchange market

[10]https://cointelegraph.com/ripple-101/ripple-vs-bitcoin-key-differences#difference-in-utilizing

DOI: 10.5373/JARDCS/V11SP11/20192923
ISSN 1943-023X

Received: 10 Sep 2019/Accepted: 10 Oct 2019

multiplied by asset value, profitability value, as well as growth value (Tang et al., 2019). The more market capitalization means wider use of the cryptocurrency globally. Therefore, it is selected as one of the major indicators of Recognition. A_{23} is adopted from CCID's assessment index, while A_{22} is adopted from external source, as it can help for a comprehensive assessment of cryptocurrencies. It is assumed that prospective growth of blockchain-based remittance transaction may require the increase in coin supply as well. Therefore, it is added as the indicator of Recognition.

3.3. External Factors (Cost)

This criterion is assessed with three sub-criteria, namely Price (A_{31}), Transaction cost (A_{32}), and Energy cost/per transaction (A_{33}). These are mainly cost-related indicators. As discussed in Section 2, the transaction cost makes cryptocurrencies more attractive compared to the conventional remittance services. Therefore, the current study utilizes A_{32}. Price is also important due to the volatility of financial exchange markets. The same applies to the cryptocurrency exchange markets as well. For instance, Bitcoin price dropped from US$ 18,737 in December 2017 to US$ 8,144 in February 2018. Recently, 1 Bitcoin costs US$ 8,710. The growth trend of the top cryptocurrencies is similar. Hence, A_{31} is added as one of the major assessment indicators in this study. Finally, $A_{33}$is considered because cryptocurrencies require electricity consumption for each transaction. For instance, Ethereum requires approximately 23 KWh, while Bitcoin requires 250 KWh. Hence, this might be the major concern in terms of mass adoption of remittance transactions. The overall data of each cryptocurrency regarding the criteria and sub-criteria is given in Table 2.

Table 2: The Comparison of Cryptocurrencies

Cryptocurrency alternatives		A_1				A_2			A_3		
		A_{11} *(sec)*	A_{12}	A_{13}	A_{14}	A_{21} *(US$)*	A_{22} *(Coin)*	A_{23}	A_{31} *(US$)*	A_{32} *(US$)*	A_{33} *(KWh)*
Bitcoin	B_1	4,680	43.7	16.3	7	151,243	17,738	36.0	8,526	0.37	250
Dash	B_2	900	53.6	21.0	21,000	1,433	8,846	9.9	161.97	1.62	0.798
Litecoin	B_3	1,800	50.1	10.3	56	6,977	62,057	13.4	112.43	0.11	0.530
Ethereum	B_4	360	79.4	28.8	20	28,027	106,334	28.3	263.57	0.30	25
Stellar	B_5	5	70.1	20.0	3,000	2,613	19,327,249	9.8	0.135	0.01	0
Bitcoincash	B_8	60	48.9	20.3	27	7,673	17,817	10.2	430.64	0.22	0
Bitshares	B_7	2	88.2	12.6	100,000	181	2,723,020	9.5	0.066	0.07	0
Ripple	B_8	4	72.1	12.9	1,500	18,709	21,181,995	9.9	0.444	0.03	0.034

IV. MCDM Approach

4.1. AHP Method

AHP solves a wide variety of problems involving the complex decision-making need (Saaty, 1990). It is very useful in a situation, where evaluation criteria formulation is difficult, while at the same time it enables quantitative evaluation (Chen & Ke, 2016). Decision problem is initially outlined in AHP process, followed by adding the target, main criteria, and sub-criteria and the alternatives.

The decision problem in the current study is to find the most optimal blockchain-based cryptocurrency for remittance transaction offered by ten cryptocurrency alternatives. Following that, the criteria-to-alternative interaction is defined, while at the same time its hierarchical framework is built. Based on the 9-point assessment scale (see Table 3), proposed by Saaty (1990), criteria and alternatives are compared, leading to the comparison matrices construction. AHP process includes the consistency ratio measurement based on the consistency index (*CI*)/random index (*N* = number of criteria). CI is computed as follows:

DOI: 10.5373/JARDCS/V11SP11/20192923
ISSN 1943-023X

Received: 10 Sep 2019/Accepted: 10 Oct 2019

$$CI = \frac{\lambda_{max} - N}{N - 1} \quad (1)$$

Where λ_{max} is the maximum eigen value of matrix, and the *CI* value must be $CI \leq 0.1$. As there are three criteria in the current study (N = 4), the consequent value is 0.58 (Saaty, 1990) (see Table 4).

Table 3: AHP Pairwise Comparison Index based on 1-9 Scale

Importance scale	Denotation
1	Equally important
3	Moderately important for one on another
5	Strongly important for one on another
7	Very strongly important of one on another
9	Extremely important of one on another
2, 4, 6, 8	Intermediary scores
Reciprocals	Opposite comparison

Table 4: R.I Values based on N Number of Attributes

N	1	2	3	4	5	6	7	8	9
R.I	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45

In the current study, the data collection process involved seventeen decision-makers (DMs) who are experts in the blockchain technology and both traditional and blockchain-based international remittance transaction process.

4.2. TOPSIS Method

Hwang and Yoon (1981) proposed TOPSIS method, where the most optimal alternative needs to be located at the shortest distance from the positive-ideal solution in order to maximize benefit and minimize cost, whereas needs to be locate at the farthest distance from the negative-ideal solution that minimizes benefit and maximizes cost.

In TOPSIS, the decision matrix in accordance with performance values of cryptocurrency alternatives is calculated with respect to each criterion as follows:

$$r_{ij} = \frac{X_{ij}}{\sqrt{\sum_{i=1}^{n} X_{ij}^2}}, \forall i, j \quad (2)$$

Then, performance values of cryptocurrencies are multiplied by the weights of criteria gained from AHP as follows:

$$v_{ij} = w_j r_{ij}, \forall i, j \quad (3)$$

In the next step, positive as well as negative-ideal solutions are calculated with reference to the best and worst cryptocurrencies as follows:

$$A^* = \{v_1^*, \dots, v_m^*\} = \{(v_{ij} \mid j \in C_b), (v_{ij} \mid j \in C_c)\} \quad (4)$$

$$A^- = \{v_1^-, \dots, v_m^-\} = \{(v_{ij} \mid j \in C_b), (v_{ij} \mid j \in C_c)\} \quad (5)$$

Where, C_b is benefit, whereas C_c is cost.

Each alternative's distance from the positive- and negative-ideal solution is calculated in equations 6 and 7 as follows:

$$S_j^* = \sqrt{\sum_{j=1}^{m} \left(v_{ij} - v_j^*\right)^2}, \forall i \quad (6)$$

$$S_j^- = \sqrt{\sum_{j=1}^{m} \left(v_{ij} - v_j^-\right)^2}, \forall i \quad (7)$$

Finally, cryptocurrencies are given ranking in accordance with their closeness to the ideal solution as follows:

$$R_i^* = \frac{S_i^-}{S_i^* + S_i^-}, \forall i \quad (8)$$

Where, the value of $RC_j^* RC_1^*$rangesbetween 0 to 1. Here, if the value is higher, it means that an alternative will be closer to the positive-ideal solution.

DOI: 10.5373/JARDCS/V11SP11/20192923
ISSN 1943-023X

Received: 10 Sep 2019/Accepted: 10 Oct 2019

Table 5 shows the distance of cryptocurrencies to positive- and negative-ideal solutions. Among them, Ripple (B_8) has longer distance to the positive-ideal solution, while has more far distance to the negative-ideal solution.

Table 5: The Closeness of Cryptocurrencies from Positive- and Negative-ideal Solutions

	B_1	B_2	B_3	B_4	B_5	B_6	B_7	B_8
S^*	0.202	0.106	0.042	0.056	0.383	0.835	0.115	***0.023***
S^-	0.845	0.862	0.864	0.862	0.514	0.242	0.813	***0.868***

V. Illustrative Example

Based on the AHP method, initially the pair-wise comparison matrix is formed (Chang et al., 2019), then criteria and sub-criteria in accordance with the most ideal cryptocurrency for remittance transaction are defined. The priority weights are given in Table 6. According to the findings, underlying technology (A_1) ranks first, followed by external impact (A_3), meaning that the technological features of the cryptocurrency is highly important in the application of remittance transactions. Besides that, its cost issues must be taken into consideration too. Such that, cryptocurrency price, transaction cost, and energy cost per transaction are underlying determinants of the cost criteria.

The ranking results in Table 7 indicate that Ripple ranks first, meaning that the experts who are knowledgeable about blockchain and traditional banking think that Ripple can be highly beneficial for both banks and customers in international remittance transactions. Ripple blockchain allows transactions to be performed in just 4 seconds. Based on the CCID (2018b), Ripple's basic tech score is 72.1, following Bitshares (88.2) and Ethereum (79.4). In addition, Ripple has coin supply with over 42 billion XRP, which is higher than other cryptocurrencies. This is a big advantage in remittance transactions. Finally, Ripple is less costly than many other cryptocurrencies as well.

Table 6: Local and Global Weights of Criteria as Well as Sub-criteria

Criterion	Local weight	Sub-criterion	Local weights	Global weight	Criterion rank	Sub-criterion rank
Underlying Technology (A_1)	***0.432***	Transaction speed (A_{11})	0.267	0.115	***1***	2
		Basic tech (A_{12})	0.296	0.128		1
		Applicability (A_{13})	0.212	0.092		4
		Transaction/per second (A_{14})	0.225	0.097		3
λ_{max} = 4.191, CI = 0.064, CR = 0.071						
Recognition (A_2)	0.264	Market capitalization (A_{21})	0.357	0.094	3	1
		Coin supply (A_{22})	0.347	0.092		2
		Creativity (A_{23})	0.296	0.078		3
λ_{max} = 3.024, CI = 0.012, CR = 0.021						
External impact (A_3)	0.304	Price (A_{31})	0.329	0.100	2	2
		Transaction cost (A_{32})	0.355	0.108		1
		Energy cost/transaction (A_{33})	0.317	0.096		3
λ_{max} = 3.061, CI = 0.030, CR = 0.052						

Table 7: Final Ranking of Cryptocurrency Alternatives

Cryptocurrency alternatives		TOPSIS score	Rank
Bitcoin	B_1	0.807	6
Dash	B_2	0.891	4
Litecoin	B_3	0.954	2
Ethereum	B_4	0.939	3
Stellar	B_5	0.573	7
Bitcoincash	B_6	0.225	8
Bitshares	B_7	0.876	5
Ripple	B_8	0.974	1

DOI: 10.5373/JARDCS/V11SP11/20192923
ISSN 1943-023X

Received: 10 Sep 2019/Accepted: 10 Oct 2019

VI. Sensitivity Analysis

The ranking of cryptocurrencies is affected by the weights of pre-defined criteria, which might be sensitive to variations. The two types of sensitivity analyses, namely criteria sensitivity and alternative sensitivity, were performed. In criteria sensitivity analysis, the AHP weights of criteria were adjusted to 10%, 30%, and 50% increase. Figure 3 shows that A_{13}, A_{21}, A_{22}, and A_{23} are less sensitive, whereas A_{11} and A_{12} are more sensitive to the changes in criteria weights. However, ranking results of the criteria did not change. Alternative sensitivity analysis also applied 10%, 30%, and 50% increase in TOPSIS weights and the results show that the ranking did not significantly change (see Table 8). Hence, Ripple remains the most ideal cryptocurrency for the remittance transactions in global level.

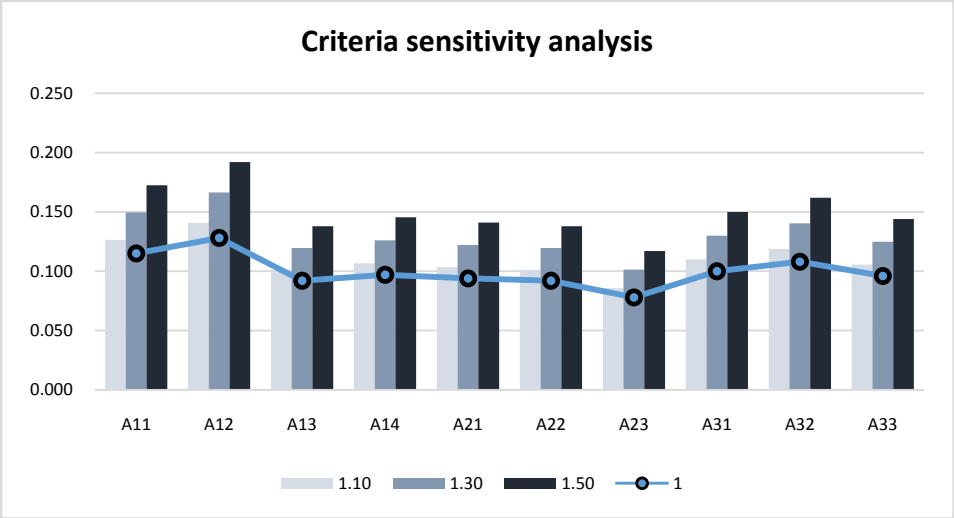

Figure 3: Results of Criteria Sensitivity Analysis

Table 8: Results of Cryptocurrency Ranking Under 4 Scenarios

Rank	Scenario 1 0% change	Scenario 2 10% change	Scenario 3 30% change	Scenario 4 50% change
1	B_8	B_8	B_8	B_3
2	B_3	B_3	B_3	B_8
3	B_4	B_5	B_5	B_5
4	B_2	B_4	B_4	B_4
5	B_7	B_6	B_7	B_6
6	B_1	B_7	B_6	B_7
7	B_5	B_2	B_2	B_2
8	B_6	B_1	B_1	B_1

VII. Discussion and Conclusion

Conventional banking has been leading financial function for quite a long period of time, which is considered a main player in remittance transactions from one to another country. Current money transfer services, such as PayPal, MoneyGram and others are also considered expensive and timely, due to the transactions cost and time. In conventional payment and transaction system, a customer who intends to transact money needs to pay yearly membership fee (or transaction fee) to receiving or making money transactions. Facilitation of transaction is highly important due to the smart phone usage level of world population for shopping or money transactions though mobile banking (Eyal et al., 2016). However, in blockchain technology, peer-to-peer transaction is reliable and verifiable as well as cost-efficient, without the attendance of third parties. Moreover, blockchain-based transactions can be accomplished very quickly without the limitation of physical distance, while cross-borders transactions in a conventional way can be slow. Regarding the security phenomenon, centralized conventional transactions are relatively more vulnerable to data leakage when the managing service is hacked. The recent public blockchains as mentioned in Introduction section, makes it difficult to attack blockchain-based transactions with a strong emphasis on 51% attack concept.

DOI: 10.5373/JARDCS/V11SP11/20192923
ISSN 1943-023X
Received: 10 Sep 2019/Accepted: 10 Oct 2019

The current study uses MCDM approach with an emphasis on AHP-TOPSIS method to select the most optimal cryptocurrency based on the pre-defied criteria and sub-criteria. The evaluation based on technology, global recognition, and cost criterion shows that Ripple is believed to be the ideal cryptocurrency, which can enhance the blockchain system application in banking industry with a particular focus on global remittance transfers. As discussed above, several banks in the Emirates and Saudi Arabian banks utilized Ripple blockchain in banking functions. Hence, its extension across remittance transactions will strongly enable migrants living in either GCC countries or other parts of the World to transfer money to their families easily and more effectively.

Acknowledgment

The author is thankful to the management and staff of Sur University College for their full support and cooperation in getting this research work accomplished in time.

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ISSN 1943-023X

Received: 10 Sep 2019/Accepted: 10 Oct 2019