Enineering Economy (MS-391)

Project Report

Blockchain-Based Academic Certificate Verification

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Contents

1 Abstract

This engineering economy project suggests that HEC of Pakistan should implement a blockchain based degree verification system to counter credential fraud while reducing operating expenses. Using a survey administration with 50 participants, the study assesses the economic practicality and technical possibility for the integration of distributed ledger technology for academic credentials' attestation. The identified cost-saving benefits reflect virtually limitless opportunities for saving administrative overhead, as well as the potential for improving credential validity, as seen in the cost-benefit analysis In addition to this, the engineering assessment highlights scalability and sped difference compared to conventional methods of verification. The study suggests that this blockchain solution is indeed feasible and affordable in the context of the country to address the challenges in the academic verification system of the country and bring an efficient change it it.

2 Introduction

Higher education in Pakistan during the last decade has been equally confronted with formidable obstructions in establishing the reliability and effectiveness of the academic accreditation system. The HEC act of Pakistan is the major one that is accountable for checking, yet it follows the traditional simple and old model of checking that has become inefficient. This entrenched culture has led to students being locked out of any chance of further education or employment locally as well as in other countries for as long as weeks to sometimes several months.

The current system not only results in a great many delays but also brings innumerable inconveniences and additional complexities. There are cases where students have challenges in managing their requests for verification and thus, they end up feeling insecure to visit different HEC offices with high costs and time wastage. Also, the system as a whole is operated manually and is very vulnerable to fraud where cases of forging and doctoring of documents are on the increase and are becoming more complex as time goes on. Such issues question the solidity of the educational framework of Pakistan.

Using blockchain is a transparent and effective solution to many of these challenges in verifying certificates. According to Forbes, blockchain technology is a decentralized, tamper proof, transparent solution that guarantees authenticity of credentials. Paper certificates can be easily forged and would require day light to be accessed and verified while certificates on a blockchain can be verified in real-time, thereby greatly reducing the risks of document fraud.

However, implementing the system using the blockchain model is not without its problems. The most outstanding is the case of blockchain gas fees where the gas fees refer to the prices of performing various activities on the network. They can be, however, expensive with high fees affecting its adoption especially in regions where resources are limited. Also, the establishment of the blockchain offers great challenges such as the initial investment to create an effective infrastructure to support the solution in addition to technical know-how, which HEC may encounter.

Nevertheless, the benefits of blockchain-based verification far outcompete the prob-

lems associated with it. In this context of specificity, of coherent and focused goals and objectives and following a rigorous methodology and epistemology, blockchain technology therefore has the capability and capacity to transform the credibility and efficiency of academic accreditation from Pakistan and make it competitive and comparable with international standards.

3 Methodology

3.1 Research Setting

This study falls within the higher education sector of Pakistan and more particularly regarding the authentication activities of the HEC. The study was conducted in the academic year 2024/2025 involving different stakeholders within the academic arena.

3.2 Objectives

The goals of this study were therefore to; Determine the applicability of blockchain verification system for HEC Pakistan, to establish the level of technology adoption among the stakeholders and To examine a cost analysis of the shift from conventional verification method towards blockchain verification system. Secondary objectives were to examine possible implementation difficulties and to define the efficient strategy of system development in terms of cost.

3.3 Sample Selection and Size

The study aimed at identifying and selecting the respondents from the key organization stakeholder categories using purposive method. The participants included university administrators, recent graduates, employers and HEC officials. While not immensely large, this sample did afford enough data for the initial appraisal of stakeholder perceptions and the overall characteristics of the system as it pertains to an engineering economy project.

3.4 Data Collection

The primary data was collected by Google Form survey where respondent had to answer questions in a prescribed format. The questionnaire was both closed and open-ended, and they asked respondents about their awareness of block chain, readiness to accept new verification solutions, and benefits and risks. Questions were developed to elicit detailed information concerning the users' expectations, possible economic effects, and implementation choices.

3.5 Blockchain Solution Providers Analysis

This comprised evaluation of existing blockchain solution providers in the academic verification market. Some of which include: MIT's digital credential initiative, TrueRec by Sony Global Education and BlockCerts. These case studies proved to be helpful to identify the realistic costs of implementation, requirements for maintenance and possible GRR. Information provided from such sources was used to determine other systems development and operation costs.

3.6 Data Reliability

Several strategies for the validation of responses were integrated within the survey so as to ensure the accuracy of the results; self-checks and crosses used in order to detect cases of discrepancy. In this case, the statistical techniques were used to check on the accuracy and consistency of the collected data as well as to create statistical confidence in the conclusions made in the course of the research.

3.7 Ethical Considerations

Emphasis was placed to the ethical research principles and procedures in conducting this research. All participants agreed to participate in the study after being fully informed on matters of the study and their subsequent rights and were informed that their identification data would remain anonymous and their ability to withdraw from the study at any time was fully endorsed. Participants' identity was also upheld by observing right data storage and use procedures, and participants were informed on how their answers would be used in the research. It is pertinent to mention here that the study had no ambiguities and uncertainties in terms of purpose and procedure and that there were no undercurrents of bias at any step of data gathering and interpretation. All these ethical issues were crucial to preserve the academic research credibility besides observing the participant rights.

3.8 Study Limitations

Some important limitations must be taken into consideration while analyzing the outcomes of this investigation. Despite the fact the total number of participants is moderate being fifty it is appropriate for preliminary investigation although the number does not reflect all the stakeholders in higher education in Pakistan. Views gathered in this research may not be easily generalized in rural environment since this investigation is more specific to Urban environment.

Due to time constraints, the data collection and analysis was somewhat restricted. Some of the respondents lack sufficient technical knowledge on the topic to best describe blockchain technology since some responses were basically self-reports. Furthermore, few comparable cases of implementing such a framework in similar economic structures somewhat supported the number of direct benchmarking options for cost analysis. However, all these limitations, were found not to degrade the value of the study very much but add value by outlining areas of improvement for future research efforts and strategies for applying the findings.

4 Results of Survey

The results of the study, derived from the methods are presented below:

4.1 Role of Participants

80.9% of the respondents were in the age group of students. Others were university administrators following them at 22.5 % then employers at 8.5 % among the total respondents.

This distribution indicates that the survey received mainly the students' perception of blockchain-based degree verification that is consistent with their mandate as the major consumers of the adopted blockchain model for degree validation.

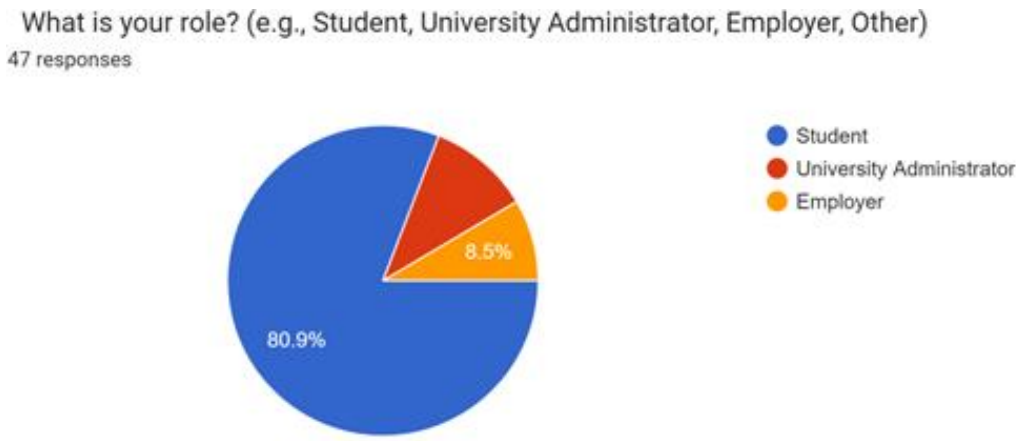

Figure 1: Role of Participant

4.2 Experience of Participants with HEC

The data indicates that a significant majority (68.1%) of respondents have prior experience interacting with HEC or similar organizations for certificate verification purposes. This high percentage of experienced users strengthens the reliability of the survey responses, as these participants can provide informed perspectives on the current verification system's challenges and the potential benefits of a blockchain-based solution.

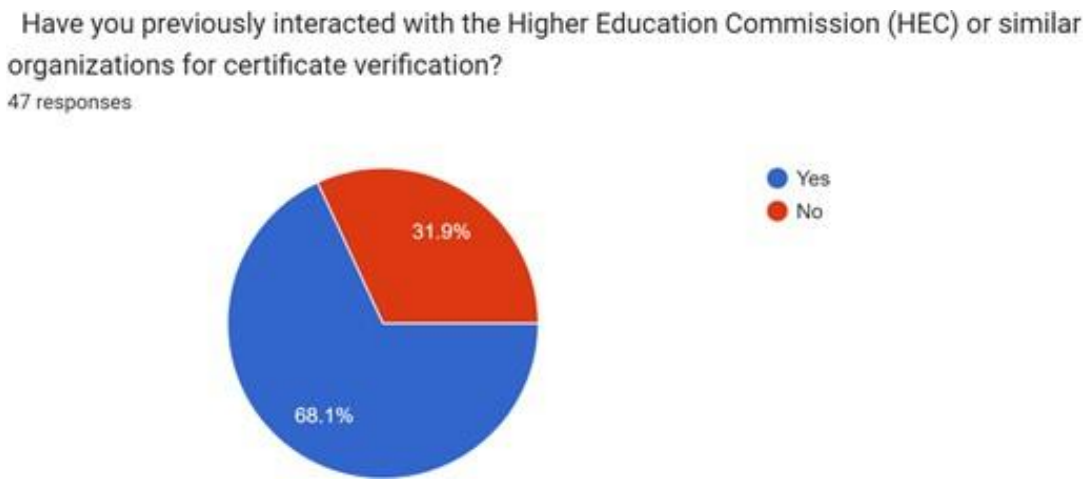

Figure 2: Experience wth HEC

4.3 Challenges faced during Attestation Process

The most significant challenge reported was “Long wait times” at 91.5%, followed by ”High costs” at 34% and ”Lack of transparency” at 31.9%.

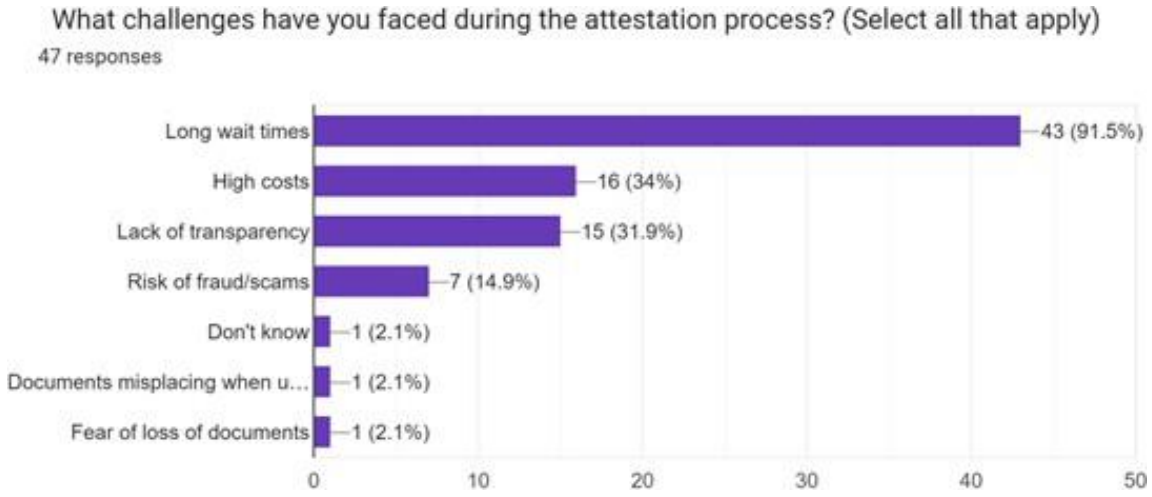

Figure 3: Faced Issues

4.4 Participants Willingness to use Blockchain

This pie chart analyses responses from participants on their willingness to pay extra fees for blockchain based certificate verification that would be quicker and secure. While 61.7% of the respondents affirmed this proposition by choosing “Yes,” 38.3 percent said “No.”

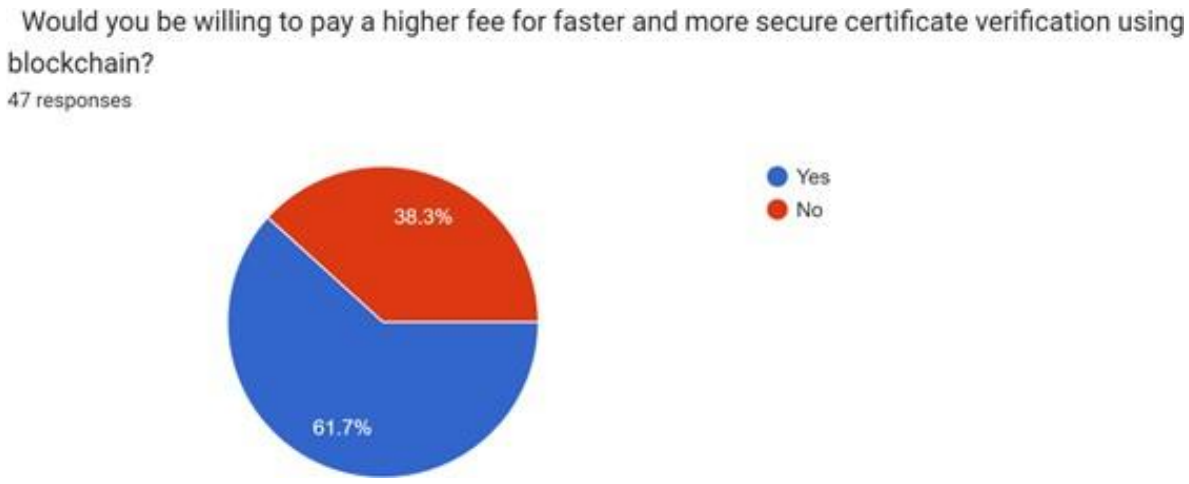

Figure 4: Willingness to use Blockchain

4.5 Payment Preference for using Blockchain

The majority (55.3%) preferred a one-time fee, while 25.5% chose per-verification payment.

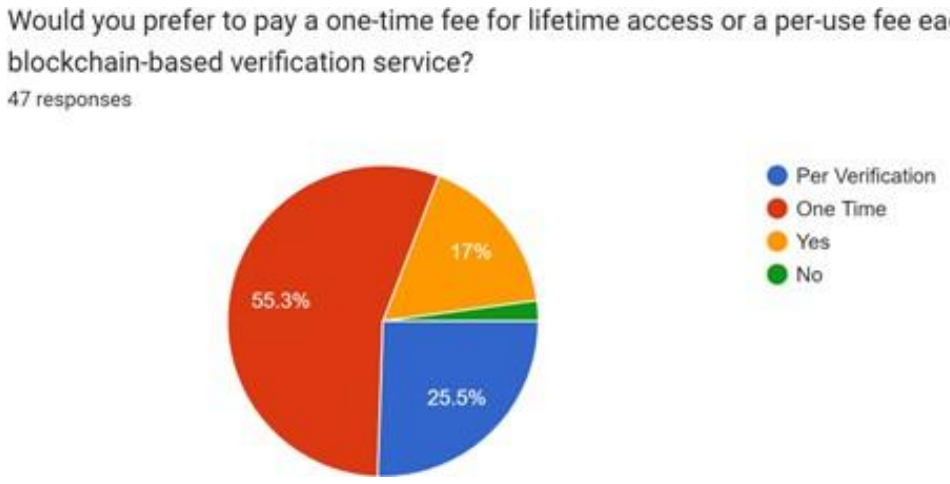

Figure 5: Payment Preference of Participant

4.6 Participants support for Universities Implementing Blockchain

Despite realization, 59.6% of the respondents were willing to support such implementation even if it means having to pay more for semester or graduation fees while only 40.4% would not like the implementation especially when there are high charges for block chain verification.

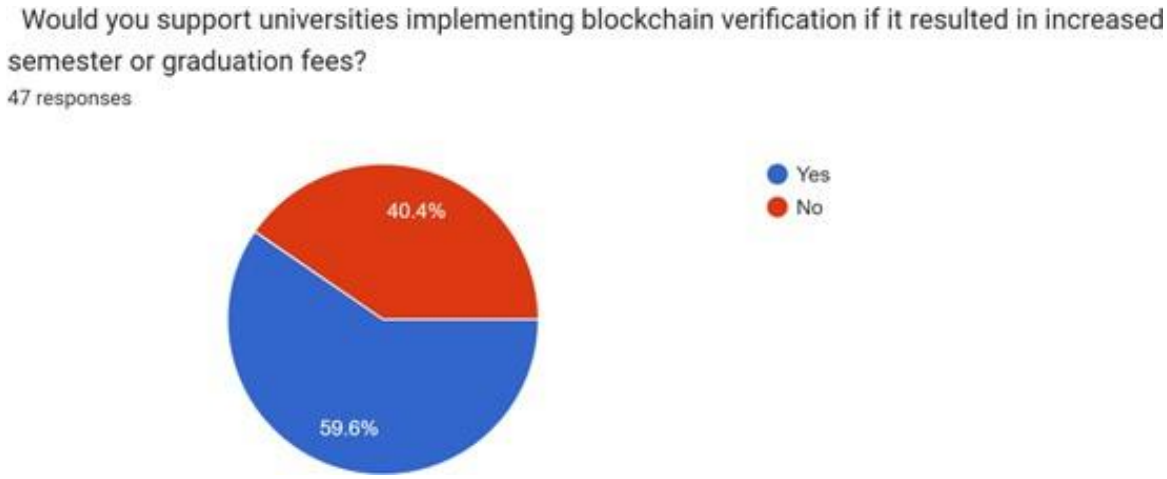

Figure 6: Participant support for Universities

4.7 Respondents Perception on Blockchain

91.5 percent of the respondents believed that the use of blockchain-based systems could help minimize indirect cost, such as those involved with traveling to get a certificate attested. Surprisingly, most of the respondents (91.5%) agreed with this potential benefit to blockchain implementation, but only 8.5% of the respondents disagreed.

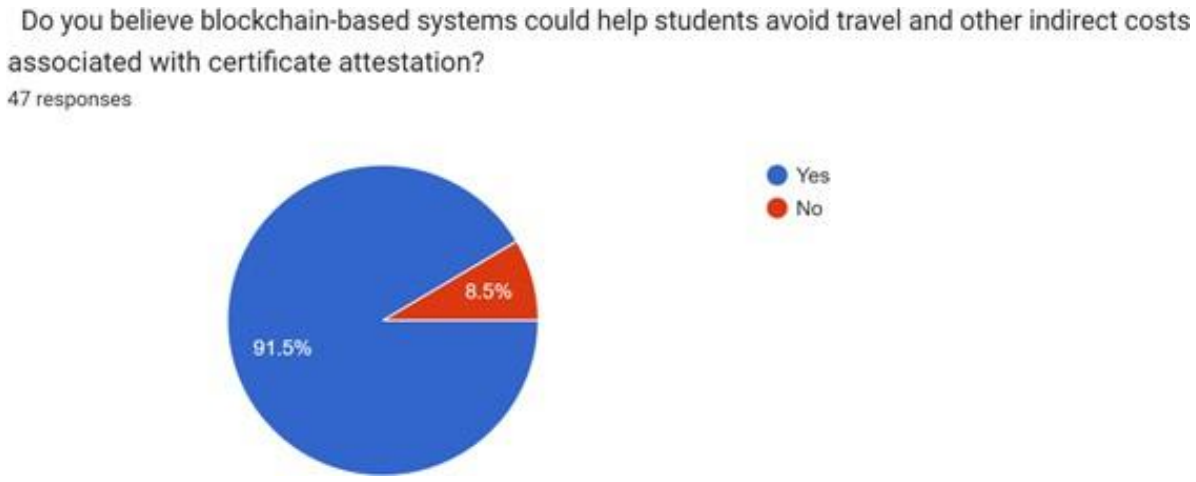

Figure 7: Participants belief in Blockchain

5 Assessment against the Global Benchmarks for deployment of blockchain

Worldwide, the implementation of the distributed method has become a popular solution of problems associated with the existing model of manage certificate issuing and authentication techniques. Global adoption of blockchain-based system has been practiced in first world countries including United States, UAE and Bahrain where the Massachusetts Institute of Technology or MIT and University of Bahrain respectively have embraced the use of block chain. Such systems assure you of a tamper proof record, instant verification, and therefore are trustworthy. Since it has no middlemen, Blockchain is cheaper, efficient and can barely have cases of impersonation. For instance, Dubai's Blockchain Strategy as enshrined under cutting edge compiling it includes academic credentials among its objectives delivering a smooth digital verification mechanism.

5.1 Today's Problem in Pakistan's Verification System

Due to various hurdles, more particularly the HEC in Pakistan has some problems related to the verification of the academic certificate which includes delay in the efficiency of the process of verification of the certificates and the problem of scamming. Nevertheless, with expansion characterized by the production of an estimated 500, 000 graduates per year, the system is manual and complicated. Most of which has resulted to student

dissatisfactions and operational backlogs. It emerges that people are complaining of unreliable processes, and fraudulent services, all of which call for change.

5.2 Prospects of Blockchain Implementation in Pakistan

Therefore, implementation of blockchain in Pakistan can update the certificate verification process that is in line with the international standards. Blockchain would enable the creation of safe, alter-immune and accessible records, thus obviating intermediaries and sparing costs in the ultimate run. This man could also mean faster processing for the increased number of graduates who require attestation for employment or further studies especially outside their country.

5.3 Economic Consequences and Cost Differences

Globally, blockchain based verification systems have been observed to be cheaper in the long run even though it requires a huge amount to be installed. Currently in Pakistan such a change may entail a huge capital investment but once done it would reduce operational costs and enhance efficiency. Suggested fair fee charges such as, PKR 3500 for each verification should be adequately justified as they bring much more additional value and process each application much faster than the existing fee of PKR 1000. Such a structure would ensure that the system becomes self-sustainable provided that administrative chores take their toll.

5.4 Learning from Trends

Pakistan can learn from various global pioneers by scaling and adapting the blockchain based solutions. Such an example as shown by the UAE's use of blockchain technology in its education sector shows that partnerships with technology firms can quickly turn the idea into practice. Firstly, organizations could involve both global and domestic partners with governmental endorsement to transition to blockchain verification.

The probability of upgrading a struggling system in Pakistan into a world class system is evident if blockchain technology is adopted for the verification of the academic certificates. Thus, overcoming current shortcomings and following the tendencies of the nearest countries' experience, Pakistan will be able to offer other students and freshly graduated individuals considerably faster, secure, and reliable certification processes, which will increase confidence in the educational systems of the country and strengthen competitiveness in the world.

6 Implementation Roadmap

This roadmap identifies the measures, actors, and approaches needed to transform the current paper-based framework to an optimal, clear, and safe blockchain framework.

6.1 Assessments of Current Requirements

The first step involves raising awareness of the gaps within the existing system, as well as defining what is needed to incorporate the chain system.

• **Challenges:** Attestation of results, fraud, high cost of operation, lack of credibility and inefficiency.

• **Requirements:** Blockchain technology infrastructure to handle a large number of secure transactions; legal requirements regarding blockchain; availability to fit the HEC structure.

• **Stakeholders:** Higher Education Commission (HEC), Ministry of Information Technology, University and College Administration and Faculty, Students, and Employers.

6.2 System Design & Technology Selection

The architecture for the blockchain system should be designed considering re- quirements of the academic certificates verification system in Pakistan.

The first step involves raising awareness of the gaps within the existing system, as well as defining what is needed to incorporate the chain system.

• **Blockchain Type:** Permissioned for restricted access so that data cannot be accessed by the unauthorized person and also more secure.

• **Technology Partners:** Partnerships should be made with other blockchain solution providers such as IBM Blockchain, Hyperledger or probably local ones.

• **Data Privacy:** Compliance with all related Pakistani laws along with the preservation and interpretation of data with local and global standards.

6.3 Nationwide Deployment of the System

The expansion of the system should be done in accordance with the findings of the pilot project.

• **Phased Implementation:** The system should be phased-in over the course of time for all universities, colleges and any other institutions that provide degrees.

• **Integration with HEC:** The system's integration with existing processes of HEC should be ensured.

7 Economic Analysis of the Blockchain-Based Certificate Verification System

7.1 Present Worth

The Present Worth (PW) is the current value of all costs and benefits associated with the blockchain-based certificate verification system. With a present worth of PKR 46,991,993, it reflects the discounted value of future cash flows at an interest rate of 12% over a 10-year period. This value incorporates the initial cost of implementation, annual operating costs, revenue generation, and the salvage value. The negative present worth indicates

that, at the current cost and revenue structure, the system has not yet achieve a positive return on investment (ROI).

7.2 Annual Worth

The Annual Worth (AW) is that cash figure which must be recovered every year in order to keep the project financially viable. The annual worth PKR 15,166,686 is calculated from the continual cost and revenue and the interest rate for whole life of the system. This figure needs to be ensured that the project is financially feasible on an annual base and is important for determining whether the project can generate enough cash to cover its operating expenses as well as creating profit.

7.3 Future Worth

The earning capacity of the system has been assessed at PKR 613733.3 per annum for the 10-year period. The Future Worth (FW) is estimated to be PKR 1,630,570,309. They are, for instance, the ability to capture accumulated interest and the salvage value of the system as a way of proving the terminal value of the value system in its capacity to generate value. Another aspect of the future worth calculation reveals the ability of the system to have a high return in the long run, thus making it worthy to be implemented in the next years.

7.4 Capital Recovery Factor

The Capital Recovery Factor (CRF) is established at PKR 92,916,686, which is the factor that converts the first outlay and operating expenses into their annual value up to or during the useful life of the project. This is important in computing the annual payment necessary to pay back the initial investment in the system plus cost of operations. In turn, it assists in marshalling the necessary annual revenue, which the system must produce to recover its costs over its lifetime with consideration of the specific interest rate.

7.5 Internal Rate of Return

The IRR of 3% reveals the rate at which the sum of money to be invested in the project will have a value equivalent to the sum of the present value of future cash flows from the project which represents the expected return from the system of blockchain verification of accounts. This relatively low IRR means that the project may not be financially feasible under the existing circumstances simply because it does not provide a better return usually expected and considered acceptable (usually above ten per cent) for most government projects.

7.6 Benefit to Cost Ratio

The BCR of 1.6411 means that to every rupee invested, the system shall be capable of producing 1.64 rupees in benefits the value of BCR has to be more than 1 for a system to be implemented and the calculated BCR is 1.6411. The BCR is greater than 1; this means that the project has more benefits that costs even at the lower IRR level, which is good signal towards the long-term investment evaluations. But it is always important to

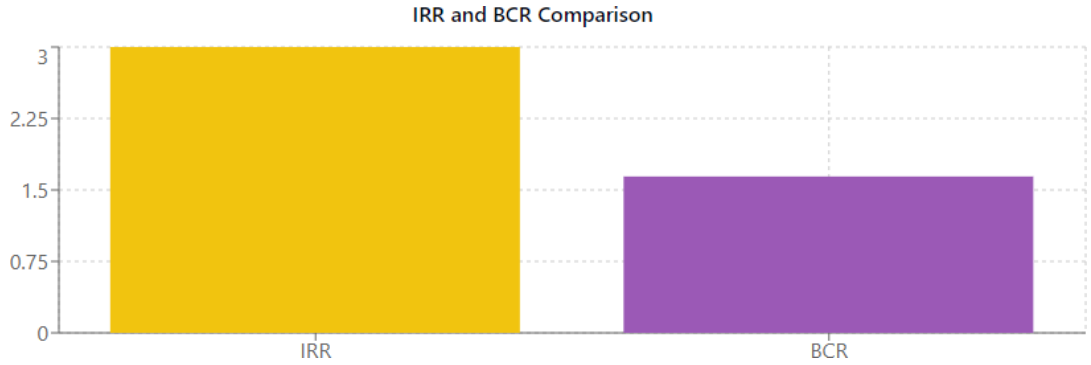

Figure 8: IROR & BCR Comparison

determine whether the various benefits gained outweigh the initial investments and costs of operations.

7.7 Summary

This report thus finds out that though the blockchain based certificate verification system in Pakistan has a potential to offer positive impact in the future its sustainability is questionable. Thus, the low IRR and negative present worth mean that cost structure has to be adjusted or the annual revenues raised to make the project economically feasible. The Benefit to Cost Ratio posed by the study indicates that there exists the possibility of getting high return on the set investment over the life span of the project.

8 Future Directions

The technique of creating Blockchain-based verification for certificates especially the academic certificates in Pakistan has possibilities for future improvements and developments. Future improvements may be aimed at the connection with foreign blockchain networks to provide data verification for students who want to continue their education or find a job overseas. In the same way, it could be possible to improve the verification processes relying on features like smart-contract to eliminate the interference of human factors as much as possible.

It is recommended to involve employers, universities, and regulatory bodies in further development of the system to satisfy new necessities. Studies on the ways through which the cost of access to those unreached areas can be minimized will guarantee equal service access. Exploring into other systems to validate other forms of identification like professional certifications and licenses makes the whole program a complete solution to all sorts of identity verification. Phased progress developments in blockchain technology, can put this initiative on the map of Pakistan as a secure and transparent source of academic verification.

9 Conclusion

The issue of using blockchain-based verification of academic certificates in Pakistan is the current service solution to those problems hindering the attestation in the Pakistan

Higher Education Commission. With the help of blockchain, the system can facilitate security, transparency and productivity with lesser time and no fake transactions. To the best of my understanding this innovation is in harmony with the global tendencies of digital verifications and coincides with the issues that Pakistani students and fresh graduates would encounter. These have their costs in terms of capital outlay especially in the tendering and establishment stage, but the accruable gains such as efficiency, technical synergies, customer satisfaction, and consequent trust overwhelm any problem with the system.

However, special attention to the ethical factor, social aspect, and infrastructure will keep the availability of the service equal and widely accepted. Following the documented step wise approach and embedded implementation plan along with the improvements in the basic economic status indicators such as cost- benefit analysis and the IRR evaluation, this project could go a long way in transforming the academic verification system in Pakistan to make the higher education system more reliable and credible.

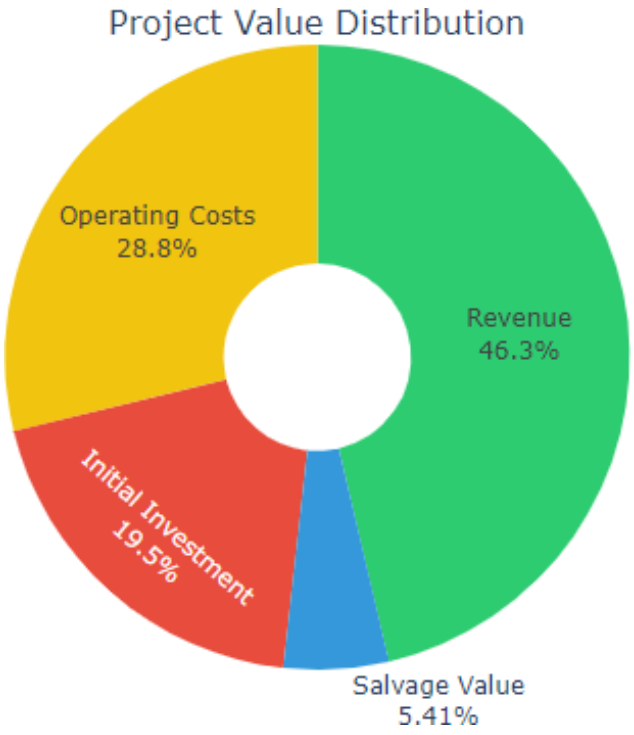

Figure 9: Value Distribution of Project

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11 Appendices

11.1 Appendix A

11.1.1 Survey Questions

1. What kind of user are you? (e.g., Student, University Administrator, Employer, Other)

2. Have you or has your organization ever contacted the Higher Education Commission (HEC) or any similar organizations for verifying your certificates?

3. Have you experienced any problems while engaged in the attestation process? (Select all that apply)

4. Would you agree to be charged a higher fee if your certificate is to be verified through the blockchain in a faster and secure way?
5. Which would you like more, a full-Access fee that allows an individual to access the blockchain-based verification service for his or her lifetime or an on-demand fee that the user pays per use of the service?
6. If universities decided to adopt blockchain verification, would you pay additional semester or graduation fees for the same?
7. In your opinion, do possibility of implementing blockchain based systems free students from travelling and other in-direct expenses for attesting their certificates?
8. To what extent are you willing to spend for the utilization of blockchain based certificate verification?

11.2 Appendix B

11.2.1 Interview Questions

1. What do the costs generally look like in terms of developing and implementing a blockchain based verification system?
2. Which aspects impact the cost of using blockchain-based verification in an academic environment?
3. What costs are associated with modifying the system in such a way to suit the needs of specific academic institutions in Pakistan?
4. How do you manage the incorporation of traditional academic data into the blockchain system?
5. On which average time does a transaction of verifying the academic credentials occur on the blockchain and how do you keep the transaction time uncompromised?

11.3 Appendix C

11.3.1 Analysis

Analysis of Blockchain Based Verification for Academic Certificates

		Year	Cash Flow
Initial Cost	525,000,000	0	-525,000,000
Salvage Value	145,950,000	1	47,250,000
Interest Rate (%)	12%	2	47,250,000
Number of Years	10	3	47,250,000
Annual Operating Costs (Annuity)	77,750,000	4	47,250,000
Annual Revenue(Annuity)	125,000,000	5	47,250,000
Present Worth (PW)	46991993.88	6	47,250,000
Future Worth (FW)	1630570309	7	47,250,000
Annual Worth(AW)	15166686.18	8	47,250,000
Capital Recovery Factor(CRF)	92916686.18	9	47,250,000
Time Value of Money(TVM)	1630570309	10	193,200,000
Internal Rate of Return(IROR)	3%		
Net Present Value(NPV)	336,575,921.40431		
Benefit Cost Ratio(BCR)	1.6411		

Verification Fee = 1000 (Old System)

Verification Fee = 3500 (New System)

Number of Graduates Every year = 500,000

Figure 10: Financial Analysis