"Review of Bangladesh Electronic Government Procurement (e-GP) System for using Blockchain Technology"

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Abstract
Data level interoperability and IT Security is main concerned now day by day as e-GP System had been launched since 02 June 2011 and volume of Data is also increasing rapidly. Many implementation are available now regarding blockchain technology. But for particularly in e-GP System of Bangladesh is new study review to implement of Block chain Technology. We research cluster analysis and mainly focus of 'National Tenderer Database', 'Evaluation' and 'e-Auction' Modules for further improvement in Electronic Public Procurement of Bangladesh based on Public Procurement Acts (PPA) and Public Procurement Rules (PPR). This review will also be used to optimize processes to increase the overall efficiency, transparency, accountability and value for money in electronic public procurement of Bangladesh.

Index Terms: Blockchain , e-GP, Tender, Evaluation, NTDB, Tenderer, Data Security, e-Auction

1. INTRODUCTION

Data level interoperability and IT Security of Electronic Government Procurement System is main concern now a days. All traditional tendering process is carried out in an electronic form, using the Internet. The basic objective for e-tendering is to bring efficiency, effectiveness security, authenticity and accountability into the e-tendering and Electronic Contract Management System (e-CMS). A national e-Government Procurement (e-GP) portal (www.eprocure.gov.bd) of the Government of the People's Republic of Bangladesh is developed, owned and being operated by the Central Procurement Technical Unit (CPTU), IME Division of Ministry of Planning with support from the World Bank. Supported by World Bank. This paper demonstrate the how to implement the blockchain technology over normal public procurement process in some area like National Tenderer Database and e-Action Modules in e-GP System.

2. LITERATURE REVIEW:

Blockchain is a secure and open way to store information. In this method the data is stored in different blocks one after the other in the form of a chain. It is an irreversible digital transaction that does not only apply to economic transactions. Any operation can be recorded using this technology. It is a distributable database that records all transactions between the participating parties. Each transaction is again verified by the majority of the system. Once any information is entered into the laser, it remains permanently and can never be deleted. The blockchain consists of a verifiable record of each single transaction. This underlying technology works perfectly and can be applied to a variety of tasks.
Since blockchain technology can be used to verify

small digital information without compromising the security of digital information, it is possible to bring about a radical change in the digital world by applying it. An important application of blockchain technology is the 'smart contract'. It is basically a computer program that can automatically execute the terms of a contract. Blockchain technology databases are distributed and collective. It is not located or stored in any single place. That is, the records it contains are truly for everyone and easily verifiable. It is also free from the risk of hacking as there is no central version. Blockchain databases work depending on the majority. At the same time, every transaction is automatically verified every ten minutes. These transactions are called blocks one by one. That is, the integrity or purity of a database cannot be compromised by altering the information of a single part. This maintains transparency. The Problem: Corruption in Public Procurement is mentioned in *Figure :*

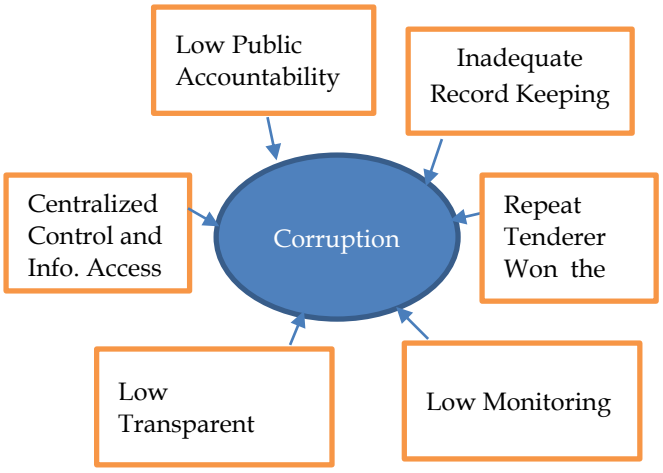

Figure 1: Possible corrupted area in public procurement to overcome by using Blockchain

Blockchain's Capacity to Mitigate the Public Procurement Problem

- Impartial: Decentralized Information Ownership and authority
- Transactional: Traceable transactions and automated functionalities
- Transparent: Real-Time Transparency and Auditability
- Immutable: Tamper Evident record
- Monitoring: Keeping record and monitor it regular basis by higher authority

Blockchain stores the confidential data only in encrypted format in the blockchain, where you have to ensure that exactly those people that should have access to the data have the relevant private key. Alternatively, for some application scenarios store the confidential data outside the blockchain, with adequate access restrictions, and only include the link to as well as a hash of the data in the blockchain itself. Then still ensure that the data cannot be altered without this being noticed in the blockchain, at least by those users that have access to the data [g]

National Tenderers Database (NTDB) of Bangladesh in e-GP System

A national tenderers database has been developed into e-GP System by using traditional method. It has been made for tracking for following key modules

- Tenderers Work Experiences
- Annual Contraction Turn Over
- Liquid Asset
- Employees History
- Awarded
- Debarment Information

It is expected to streamline the procurement process in the country. Tender Evaluation Committee can easily identify more expertise Tenderers by using

this module into e-GP System. NTDB Module using Cryptography and Blockchain can be more useful and to ensure Trust in Electronic Public Procurement System.

Tender Evaluation Process

Tender Evaluation process is very crutial part in public procurement. Currently it's manual process in e-GP System which is convered the following features:

- Eligibility Checking / Tender Evaluation Report 1 (TER1)
- Technical Responsiveness/ Tender Evaluation Report 2 (TER2)
- Financial Evaluation and Price Comparison / Tender Evaluation Report 3 (TER3)
- Final Evaluation with Post Qualification/ Tender Evaluation Report 4 (TER4)

e-Auction:

An 'electronic auction' is a repetitive process involving an electronic device for the presentation of new prices, revised downwards, and/or new values concerning certain elements of tenders, which occurs after an initial full evaluation of the tenders, enabling them to be ranked using automatic evaluation methods [d]. e-Action Module using Cryptography and Blockchain can be more useful and to ensure Trust in e-GP System.

Why Blockchain

Blockchain is built on the principles of distribution, transparency, and security. It's central point is a decentralized network of users, or peers, and their collaborative effort in creating a shared ledger. Every new transaction is to undergo a verification process by each peer to be recorded into this ledger. New blocks are added in a linear, chronological order, and contain append-only information, making up a detailed and immutable history of transactions performed within a single blockchain. So, if any of the network users decides to make a change in one record, it will automatically trigger changes in all the following records thus making them invalid. This workflow is designed to eradicate the possibility of replacing or forging any record in the network.

How does it work in Public Procurement?

Data volume with transparency

In public procurement, it is crucial to keep full transparency in as many transactions as possible. The course of a public procurement procedure is a complex process involving a number of activities like tender registration with all the subsequent documents (e.g. procurement item description, requirements to suppliers, etc.), the supplier registration and prequalification, Q&A period, the auction flow, the auction results, the winner qualification, the appellation and complaint submission stage, if necessary, and, of course, the contract signing and payment procedure. As can be seen, a good deal of transactions take place within a single tender, with a public procurement system holding, on average, around 100, 000 tenders daily. This all means a huge amount of data continuously generated. Due to blockchain, there is no doubt that the needed information will be always at hand to track any deals, especially the questionable ones.

Immutable history and data security

Applying the blockchain technology, the aforementioned data can be properly ordered and sorted, as well as verified by each authenticated network user and, most importantly, become impossible to be tampered with. With blockchain's key advantage - the interconnection of all the blocks - and the public procurement system's transaction

amount and frequency, it can be practically unreal to hack the system. As a result, any information about any tender is made by no means alterable but still open to everyone. And even if any intrusions do happen, it will be easy as pie to find out who did what and when.

Pricey… but worth it

Blockchain is considered to be pretty costly in implementation, as the technology is well advanced and elaborate. Consequently, there is a need for a steep learning curve for the software engineers to excel at projects with blockchain. This all results in high demand for blockchain professionals with relatively low supply of the latter, thus making blockchain solution development a rather expensive service. So far many may believe this is a significant disadvantage of the technology, but is it really, taking into account the need for security and transparency at the same time? After all, application of the state-of-art technologies for your software development is the mark of a true leader in the digital world [f].

Once blockchain technology will be used in public procurement for 'National Tenderer database', 'Tender Evaluation' and 'e-Auction' for increasing the efficiency of procurement.

3. METHODOLOGY

Though the implementation of e-GP systems has contributed to enhanced efficiency and transparency in government procurement, there is potential for further advancement of the existing e-GP systems:

Features of Existing Module of NTDB

The module requires interaction from three different types of users. Thus, it is best described from all three users' perspective as follows:

- Contractor's Perspective
- Procurement Entity (PE)'s Perspective
- Tender Evaluation Committee (TEC) Member's Perspective

Contractor's dashboard: Upon logging into the system, the Contractor view and add their profile information except debarment information. Because debarment information are automatically generated by the system. The Contractor is not be able to add their work experiences directly like others, to do this, an approval is needed by Procuring Entity. After approving Procuring Entity, it is be added in Contractor's profile and applicable in tender evaluation process. The Contractor is be able to modify all information except debarment information.

Procuring Entity dashboard: When Contractor is forward a work experience information to Procuring Entity for approval, Procuring Entity downloads the Contractor's uploaded documents, justify all information and process it as approve or return or reject. Procuring Entity also can add Contractor's Work Experience. In case the contract is not completed through e-GP system, the Procuring Entity is also be able to add or modify debarment information of that contract.

Tender Evaluation Committee (TEC) Dashboard for NTDB: Tender Evaluation Committee is able to view Contractor's profile where Contractor's Litigation History, Annual Construction Turnover, Liquid Assets, Employees, Equipment's, Debarment Information, Awards/ Certificates/ Professional Affiliation and Work Experience is displayed by the system. TEC Chairperson can be able to verify the experience of Offline Tender. After justify all these information Tender Evaluation

Committee finalizes the evaluation of that Contractor.

Process Diagram of National Contractor Database is shown in ***Figure 2***:

Figure-2: Working cycle of National Tenderer Database in e-GP System

Area to use of Block chain Technology in NTDB

De-duplicated Work Experience Certificates: Many countries have had good success in developing a national database of suppliers. However, till date, there is not a reliable mechanism to de-duplicate and distinctly identify suppliers across all the e-GP systems world-wide.

Online repository of Payment certificates: e-GP system has to be developed to enable Tenderer to submit their Payment Certificates in an authenticated electronic format from any e-GP system across the Bangladesh.

Real-Time View of Tender Capacity: Block chain Technology will ensure to show real time Tender capacity based on payment certificate in e-GP systems. It would also show the financial year wise tender capacity with multiple currencies.

Award or Certification: Block chain Technology will ensure to capture Award or Certification in e-GP systems for NTDB and it would also ensure the unique certification or award.

Debarment History: Block chain Technology will ensure to show debarment history in e-GP systems for NTDB if Procuring Entities will debar any tenderer then it will be automatically impacted in his dashboard.

Tender Evaluation Process

Tender Evaluation Committee (TEC) members get access to e-GP tenders only at the time when PE forwards it to them. The role of committee members can be chairperson, member secretary or member. The committee members are able to perform their activities based on these roles.

Evaluation Configuration

At first, TEC chairperson configures the evaluation process as Individual or Team. For team evaluation, TEC chairperson also creates a team among the members and nominates a member to perform the activities in e-GP System. In an evaluation process, system as well as Evaluation Committee generates four reports as

- Eligibility Report / Tender Evaluation Report 1 (TER1)
- Technical Responsiveness Report / Tender Evaluation Report 2 (TER2)
- Financial Evaluation and Price Comparison Report / Tender Evaluation Report 3 (TER3)
- Final Evaluation Report / Tender Evaluation Report 4 (TER4)

Evaluation Committee perform the evaluation process as follows:

- Individual Evaluation: All TEC members separately complete the technical evaluation, configure TER1

and TER2, and separately send their individual technical evaluation reports to TEC chairperson for finalizing the responsiveness (Technical).

- Team Evaluation: In this process, TEC members complete the technical evaluation as a Team, configure TER1 and TER2, and send team evaluation reports to TEC chairperson for finalizing the responsiveness (Technical).

Technical Evaluation

Evaluation Committee evaluates the technical part of a tender/bid. It includes declarations, justifying the response of technical forms, seeking clarifications, TER1 and TER2 configurations, finalizing the responsiveness and signing TER1 and TER2 which are described below:

- Declaration (Under evaluation tab): To initiate the evaluation process at first TEC members give declarations in e-GP System. Without giving the declaration, system will not allow to initiate the evaluation.

Evaluate Technical Forms: TEC members can see Tenderer's details those are evaluated, justify Tenderer's response against each technical forms and Evaluation Committee also can be able to seek clarification to Tenderer's if required, which is described below. After justifying the Tenderer's response in each technical forms, evaluation committee members must express their opinion in the system along with the decision taken to accept or reject the Tenderer's response as well as the technical form.

- Seeking Clarification (if required): TEC members can query through the system to any Tenderers whose tenderers are evaluated with mentioning last response date and time for replying the queries. These queries would be form specific and can ask the query against each technical forms. Tenderer can reply against the query through e-GP System within the stipulated time. TEC member can sent all queries and replies to the chairperson at once in an evaluation process for finalization. TEC chairperson justifies and finalizes the queries and replies. However, TEC chairperson can also be able to ask their members for any clarifications regarding the queries. Then, TEC chairperson justifies the member's answer and proceeds the evaluation.

Configure TER1 and TER2: TEC member configures Tender Evaluation Report 1 (TER1) and Tender Evaluation Report 2 (TER2) in approved tabular format where TER1 and TER2 represent the following evaluation criteria:

- After configuring TER1 and TER2 by TEC members, it is sent to the chairperson for finalizing the responsiveness. TEC chairperson sees evaluation, finalizes the responsiveness and configures TER1 and TER2 based on the above listed criteria.
- Sign TER1 and TER2: All committee members must sign TER1 and TER2 to complete the technical evaluation. Without signing by all committee members, system will not allow to proceed the evaluation process further.

Working Process of Technical Evaluation are mentioned below *Figure 3:*

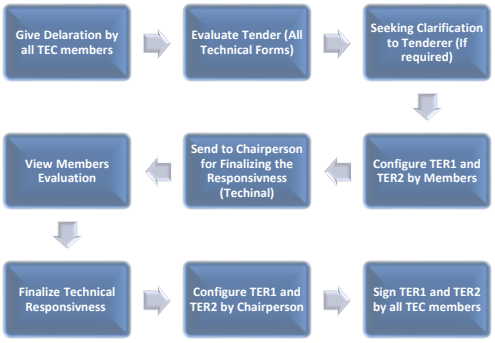

Figure-3: Working Process of Technical Evaluation

- Financial Evaluation
- After completing the technical evaluation, TEC chairperson initiates financial evaluation on that tender. It includes to identify winning tenderer/bidder, complete post qualification, generate TER3 and TER4, and sign TER3 and TER4 which are described below:
- Price Comparison: TEC chairperson generates Price Comparison Report (PCR) wherein system automatically generates the ranks as L1 (lowest1), L2 (lowest2) and so on based on the Tenderer's quoted price. System also identifies the winning tenderer/bidder based on the winner selection criteria according to PPR, 2008 and PPA, 2006 with the subsequent amendments. TEC chairperson completes the post qualification of wining Tenderer. If the winning tenderer/bidder is disqualified from post qualification or declined Notification of Award (NOA) or failed to accept/decline NOA within stipulated time, or failed to submit the Performance Security through e-GP registered bank, system automatically gives the option to generate Price Comparison Report (PCR) again.
- Post Qualification: After identifying the winning tenderer/bidder, TEC chairperson initiates post qualification process in the system mentioning the date and time to visit the site of winning tenderer/bidder if required where winning tenderer/bidder is notified through the system about their site visit date and time. After visiting the site, TEC chairperson enters post qualification data and uploads documents in the system and completes the post qualification. In case of disqualifying the wining tenderer/bidder in post qualification, TEC chairperson generates price comparison report and initiates the post qualification again for the next lowest evaluated tender.
- Generate TER3 and TER4: After successful completion of post qualification, system generates Tender Evaluation Report 3 (TER3) and Tender Evaluation Report 4 (TER4) where TER3 represents Tenderer's rank, official estimated cost, quoted amount, deviation amount, % of deviation, post qualification information, etc. and TER4 represents post qualification report of winning Tenderer, recommendation for re-tenders, retention money (if applicable) etc.
- Sign TER3 and TER4: All committee members must sign TER3 and TER4 to complete the financial evaluation. Without signing by all committee members, system

will not allow to complete the evaluation process.

The Financial evaluation process is shown in the following *Figure 4:*

Figure-4: Working Process of Financial Evaluation

Following Area may use Block chain Technology in Tender Evaluation Process for efficiency and data security

- **Eligibility Report / Tender Evaluation Report 1 (TER1)**

  TER1 will be generated based on fourteen (14) criteria by using Blockchain technology so that different users will sign may different time with different opinion. Sequence of Block will be maintained accordingly by this technology. Data level interoperability and security will be enriched.

- **Technical Responsiveness Report / Tender Evaluation Report 2 (TER2)**

  TER2 will be generated based on six (6) criteria by using Blockchain technology so that qualification and Tenderer Experience may be identified by using sequential block.

- **Financial Evaluation and Price Comparison Report / Tender Evaluation Report 3 (TER3)**

  Responsive Tenderer's Rank, Official Cost Estimated , Quotated amount and % of Deviation will be generated based on this technology so Data level interoperability and security

- **Final Evaluation Report / Tender Evaluation Report 4 (TER4)**

  Post qualification decision will be enriched by using this technology and also Cryptography and Blockchain will ensure in this Platform

e-Auction:

In house development of e-Auctioning Platform using Cryptography and Blockchain will ensure Trust in Platform in e-GP System.

The detailed process of these activities is described below:

Auction Types and Rules:

The e-GP System will feature different types of Auctions, from which the Auction Administrator or Departmental Administrator will select the method based on legislation. These types include:

- English
- Dutch
- Dynamic Sealed
- Sealed
- Lot wise / Item wise

All these types will be selectable for both Reverse and Forward Auctions. Along with the type of the Auctions, the Auction Administrator or Departmental Administrator will also be able to customize the Auction rules and winning criteria, such as:

- Lowest/highest bid wins

- Highest/lowest quantity wins
- Multi-variable bidding
- Assigning weights to different variables
- Use of formulae etc.

It is worth mentioning that the system will also support Parcel Auctions, where Bidders will be able to place one bid for a lot or individual bids for each component that constitutes a lot.

The usage of Forward and Reverse Auction is listed below:

Forward Auction will be used for disposal of public assets or selling licenses of different services:

- License for mobile network operation
- License for operating VOIP services
- License for driving training institute operation
- License for exploring mines
- License for establishing hydropower
- Broadcasting spectrum license etc.

Reverse Auction will be used in:

- Competitive bidding for buying standard goods and service, which will have predefined standard specifications
- Negotiation in the procurement methods where it's permitted.
- Second stage of the Framework Agreements in case of multiple supplier-based agreement.

Functionalities from Users' Perspective:

The Auction process will have different types of Users who will perform different tasks.

- Super Originator
- Departmental Originator
- Auction Administrator
- Auction Buyer and Auction Seller

The system will facilitate customization of the following auction parameters:

- Item name and quantity
- Auction start price
- Auction reserve price
- Auction period or closure time
- Minimum bid increment/decrement amount

Automatic extension of Auctioning period – where Auction time will be extended automatically if last submitted bid falls within predefined time window

Key Feature of e-Auction for Buyer and Seller:

The Auction Buyer will have a multitude of functionalities:

- The Auction buyer may delegate proxies to undertake the Auctioning.
- The system will have tabular view for showing multiple simultaneous Auctions. This will help Buyer/Seller manage multiple simultaneous Auctions.

- The system will let Bidders see prices during Auction in real time. The moment a new bid is places, the latest going price will be communicated along with ranks, number of participating Bidders etc. on basis of rules defined in the bidding documents.
- The system should allow the Users to view history of items and their associated prices during and after the auction with date and time stamp.
- The system will not show the identity of bidders during Auction. It will show unique randomly generated identities for all Buyers/Sellers, which will be generated upon joining an Auction. This identity will not persist for later

Auctions; the same Auction Buyer/Seller will have different identities for different Auctions.

- The system will send notifications and pop-up messages to participating Bidders during the auction.
- The system will show in real-time the time remaining, up to the last second, till the closure of an Auction to both Administrators and Bidders.
- The Auction times will vary depending on thresholds. Very short auctions will have an auction time as short as 15 minutes. Typical auction times may be 1-3 hours, consisting of a main part and an extension part.
- The auction time will be extended whenever a new Bid arrives shortly before the Auction's end time. This will allow all other bidders to respond. The provided response time will vary, e.g. starting from 3 minutes as an initial extension down to a few seconds at the very end.
- A login mechanism is imperative. Passwords are distributed through safe channels, among them PGP encrypted emails or SMS.
- A Report on the auction result will be provided to all participants.
- High security standards will be maintained. Any kind of data disclosure or manipulation will be prevented. This is why SSL will be used, as it is also supported by common browsers.
- The server will not reveal any information to any auction participant that the participant is not allowed to see.
- Consistency of the auction data will be ensured. This makes it necessary to use a robust industrial standard database (MS SQL) and define a suitable number of plausibility checks.
- The system should support export capabilities for extraction of data from the auction system into a flat file or Excel spreadsheet.
- The system will generate the data and records in the format of Open Contracting Data Standard (OCDS) and also publish the relevant documents.

The Auction module will work as separate Web Service. Bi-directional communication between e-GP System and Auction will be done using REST (Representational State Transfer) API Endpoints by using Blockchain Technology. This will allow utilization of Blockchain Technologies in Auction module without changing the architecture of e-GP System. Also, any change in e-GP System's architecture will not impact the Auction module as long as the API Endpoints are not revamped while using Blockchain technology.

Uses of tools for e-Auction Module for Blockchain Technology are listed below:

- Virtual DOM
- JSX: JSX (JavaScript XML)
- React Hooks
- Spring Framework, MS SQL Server, Hibernet
- WebSocket:

How all these technologies will interact among each other and with e-GP System is illustrated in *Figure5*:

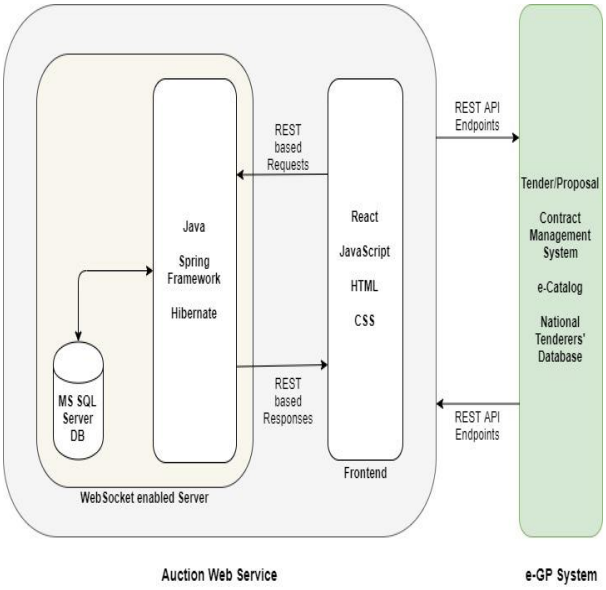

Figure-5: e-Auction Architecture for e-GP System

Following Area may use Block chain Technology in e-Auction Module for effective more efficient Auction

- Procuring Entity(PE) Dashboard
- Tenderer Dashboard
- Organization Admin Dashboard

In general, this technology will ensure confidential data only in encrypted format, where those people that should have access to the data have the relevant private key and also store the confidential data outside the blockchain, with adequate access restrictions, and only include the link to as well as a hash of the data in the blockchain itself and data cannot be altered without this being noticed in the blockchain for e-Auction Module.

4. Results and Finding:

Following Public Procurement area have been improved by using block chain technology in Bangladesh Electronic Procurement

- Enhancement of Data level interoperability and IT Security
- Detection of fraudulent and collusive practice
- Improvement of transparency in public procurement
- Improvement of best value for money
- Improvement of Monitoring compliance of procurement law
- Blockchain's promise warrants cautious enthusiasm and thoughtful experimentation in this context.

5. Conclusion and Further Recommendation

Governments devote an estimated $9.5 trillion each year to public procurement – an average of approximately 15% of national GDP. This money goes to public goods and services such as the construction of roads and the delivery of healthcare services, but also tends to line the pockets of corrupt government officials, corporate

Both the UN and the Organization for Economic Co-operation and Development (OECD) estimate that 10-30% of a public contract's overall value is commonly lost to corruption. These numbers have led the World Bank to conclude that "curtailing procurement corruption may represent one of the most effective economic development programmes that a country can adopt." [e].

Bangladesh is well advanced in south Asian countries in implementing e-GP. It provides fully internet-based interface to ensure better resource utilization by providing fair competition and equal opportunity for all stakeholders. It brings

transparency in the procurement process and drastically reduces corruption in public procurement. To enrich e-GP System as international standard and significantly increase national productivity by eliminating manipulation in public procurement blockchain chain technology should be implemented in proper ways.

It is recommended for following modules for further enhancement of e-GP System using Blockchain Technology:

- Development of Framework Agreement (FA).
- Development of Electronic Catalogue
- Development of Contractor Performance Appraisal/Rating System.
- Development of e-GP System Interfaces with Other Government Services Developments for Incorporation of OCDS with e-GP System.
- Development of Red Flag Monitoring and Reporting Tool.
- Develop and Enhance the Audit Module of the e-GP system.
- Development of Dashboard for Procurement Post Reviews and for Audit Purpose

Successful execution of 'National Tenderer Database', 'Evaluation' and 'e-Auction' Modules modules and above recommended functionalities will definitely make e-GP System more effective, useful and time oriented after using blockchain technology.

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