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A NOVEL FRAMEWORK FOR BLOCKCHAIN ENABLED BUSINESS PROCESS

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ABSTRACT

Blockchain technology is not shielded by Bitcoin, it is spanning across diverse fields ranging from financial use cases, such as crypto currencies, banking, retailing to non-financial use cases including medicines, education, internet of things and business process management. Business process is a set of activities with defined input and output (e.g. billing process, enterprise resource planning process and supply chain process). These business processes are the building blocks of the industrial revolution or industry 4.0. With the increasing demands of industrial revolutions, the business process needs to be trusted, scalable and reliable. In order to facilitate these attributes in business processes, advantages of blockchain can be leveraged. In this paper, a complete framework by integrating business process and blockchain is proposed. Unlike other research studies, this novel framework covers three core activities of business process which are 1) modeling, 2) monitoring, and 3) execution. The proposed integration of business process with blockchain is equally beneficial for all the parties involved in the development of business process.

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1 | INTRODUCTION

Blockchain is becoming one of the promising technologies proposed by Satoshi Nakamoto in 2008 [1]. Blockchain provides the opportunity for its consumers to insert data in the distributed manner rather than using any centralized approach as shown in Figure 1, where user can leverage the consensus methodology for the storage and validation of the transactions in blocks [2].

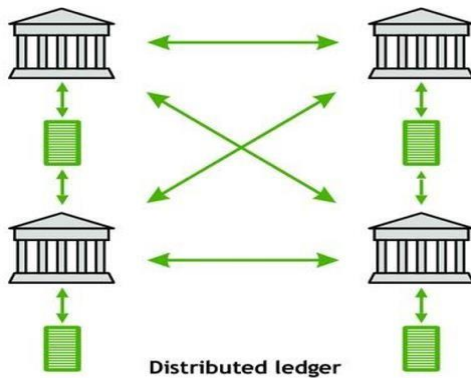


Figure 1: Distributed Ledger on Blockchain [3].

Few significant advantages of blockchain are as follows: 1) Trust and Security: Blockchain technology is able to reduce security risks, because block once recorded is impossible to alter on the network. In other words, transactions are made fully protected. 2) Efficiency: Blockchain technology eradicated the use of third party. Therefore, a smaller number of people are involved in the setup of business and industrial applications using block-chain. 3) Transparency: Blockchain is capable of handling issues like money laundering due to transparency. Transparency means user is able to monitor the recorded in-formation on blockchain [4].

Blockchain is based on decentralized approach which has presented a large number of changes in recent years with applicability in different areas, such as finance, reputation system, internet of things, and business process management.

Different applications regarding these areas are shown in Figure 2. An emerging area incorporating blockchain technology is BPM (Business Process Management). This paper is introducing the features of blockchain technology to model, monitor and execute the business processes efficiently to facilitate industry 4.0.

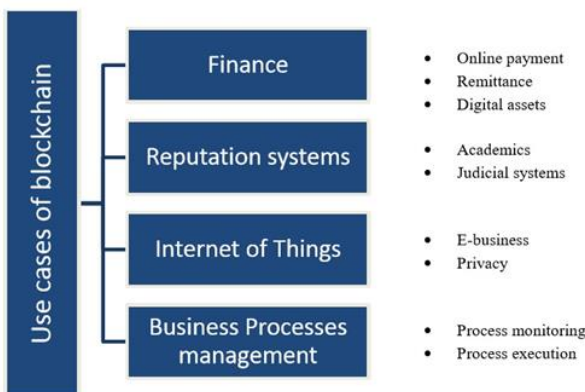


Figure 2: Uses Cases of Blockchain.

Business process comprises of set of activities having defined input and output. These business processes are essential to perform daily life operations. Three fundamental activities regarding any business process are modelling, monitoring and execution. Business

process modelling is eased with the help of various business process modelling languages, such as BPMN (Business Process Modelling Notation) and EPC (Event-driven Process Chain) [5].

Monitoring of the business process is also important step to avoid the conflicts and check cur-rent status. Execution of the business process has to deal with different checklists such as trust, scalability, quality of services and reduced cost [6].

In existing research studies, the efforts to make business processes more efficient are performed using scattered approaches. However, limited works are available to integrate business process with blockchain based approach. As the efforts to integrate both approaches are in early stage, but it is capable of providing a complete solution to business users. Therefore, in this paper, we have adopted blockchain technology to integrate with business processes. The advantages of blockchain are incorporated such as trust/security, scalability etc. Remainder paper is arranged as follows. Section 2 presents the literature review in the context of modelling, monitoring and execution of business process. Section 3 explains the proposed methodology. Section 4 provides insight on the significant aspects of the research in analysis section. Finally, section 5 closes the paper by providing conclusion and offers vision on the future directions of this area.

2 | LITERATURE REVIEW

In this section, literature review is divided into three categories targeting the core activities of the business process: 1) blockchain and business process modelling, 2) blockchain and business process monitoring, and 3) blockchain and business process execution.

2.1 | BLOCKCHAIN AND BUSINESS PROCESS MONITORING

This subsection discusses the contributions made specifically for business process monitoring using blockchain. In a research study, the integration of blockchain and business process monitoring is carried out where blockchain technology is incorporated into choreography of the processes to eliminate the need of central authority. The status of the process is stored in the distributed ledger. Standard business process modelling language i.e. BPMN is used along with translator and process implementation. Then, on-blockchain compartment is introduced to monitor the process [7]. Similarly, in another paper, the latency of blockchain is analysed using modelling and simulation tools. The proposed approach is experimented in a laboratory set up and encountered an error of less than 10% [8].

2.2 | BLOCKCHAIN AND BUSINESS PROCESS EXECUTION

Business process execution ensures the successful execution of the process by eliminating the faults/errors. In a paper by García-Bañuelos et al. [9], optimized execution of business process is performed on the commodity of blockchain. For this purpose, a process model using Business Process Modelling Notation (BPMN) is combined into smart contracts to list the pre-conditions of the execution. The limitation of this research study is the exclusion of some BPMN constructs such as timer events and only including core concepts of BPMN. In another paper published in 2017 by Rimba et al. [10], the business process is executed using two well-known technologies; blockchain (using Ethereum) and cloud service (using Amazon) to compare the cost of execution. The results indicate that cost of blockchain is higher than Amazon based cloud services.

In another paper by López-Pintado et. al [4], a business process execution engine using Ethereum blockchain is developed. This execution engine takes input as BPMN model and named as Caterpillar. It supports the instance creation. Moreover, the status of the running process can be checked using the proposed engine.

3 | IMPLEMENTATION

Following the idea of BPMN, the implementation of purchase order process is explained below. To have purchase request process completed, there are three processes which should be done. Purchase Request Process, Quotations Sub-Process, Purchase Order Sub-Process.

3.1 | PURCHASE REQUEST

This process connects the applicant with purchasing department and gives him the ability to create his own order. The applicant selects products or services from a predefined list, or he can create his own. The requested items are under processing from boss entity. The boss could have the authority level to approve the amount

or the boss level who is with higher grade. In case this purchase is approved, another sub-process is created. Quotations and Purchase Orders sub processes are the next level to complete the whole process. Once the order is approved, a notification email is sent to the applicant and purchasing department to go to sub-processes. Figure 3 depicts the purchase request model.

Even the price is needing an approval from the user's boss. Once is approved, quotations is able to be created and asked for the appropriate number of potential suppliers. One supplier can be selected from a list of potential suppliers. Quotations are selected according to the delivery date, price, and quality.

As a last step, the purchasing department selects a supplier and generates a Purchase order that is sent to the selected supplier and saved in the company's ERP.

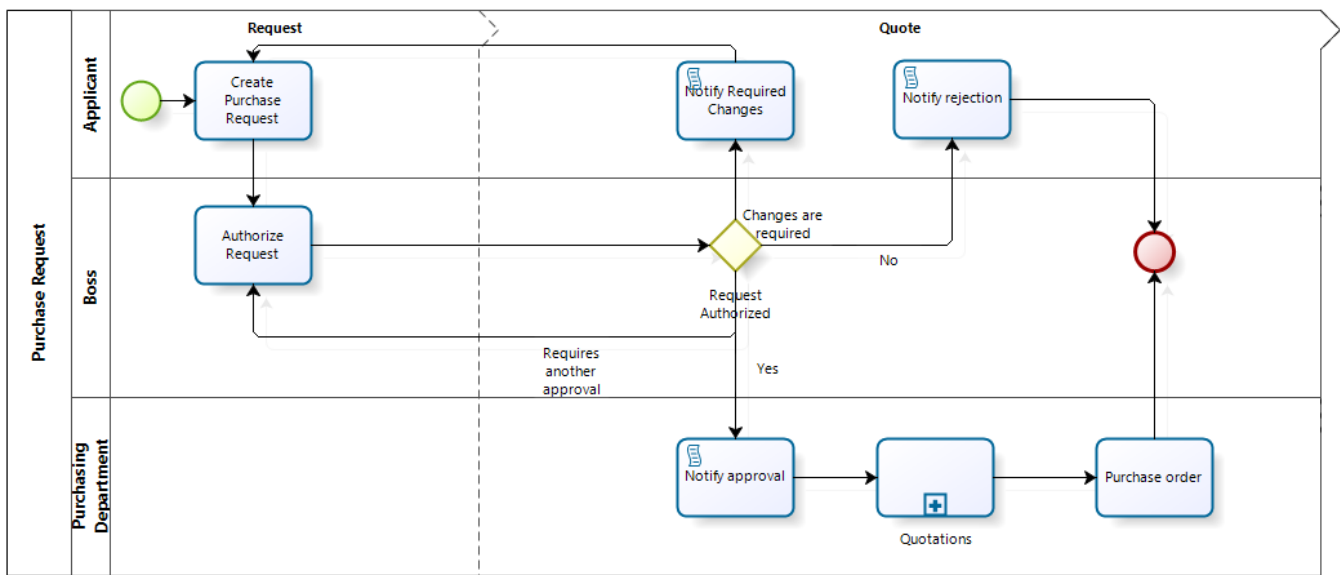


Figure 3: Purchase Request Model [11].

3.2 | QUOTATIONS

Quotation will be created for the approved purchase request. The purchase department re-quests and receives quotations. Then, one of them will be selected in order to choose a supplier with whom the purchase request will be carried out.

Request Quotations activity let the department to request all quotations. For each received quotation a set of information is needed. According to the total price of the purchase, the minimum number of quotations required is handled through a Business Rule.

As a last step of this sub-process, the selection of the one supplier. Each supplier will introduce his offer by showing the delivery date and price in addition to his ranking. Quotations model is shown in Figure 4.

3.3 | PURCHASE ORDER

In this step, an administrative manager approval on Purchase order is needed. Once it has been approved, a notification would be sent accordingly. The purchase order model is depicted in Figure 5.

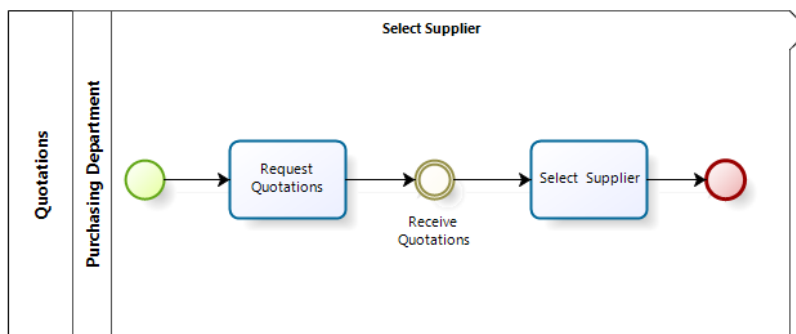


Figure 4: Quotations Model [11].

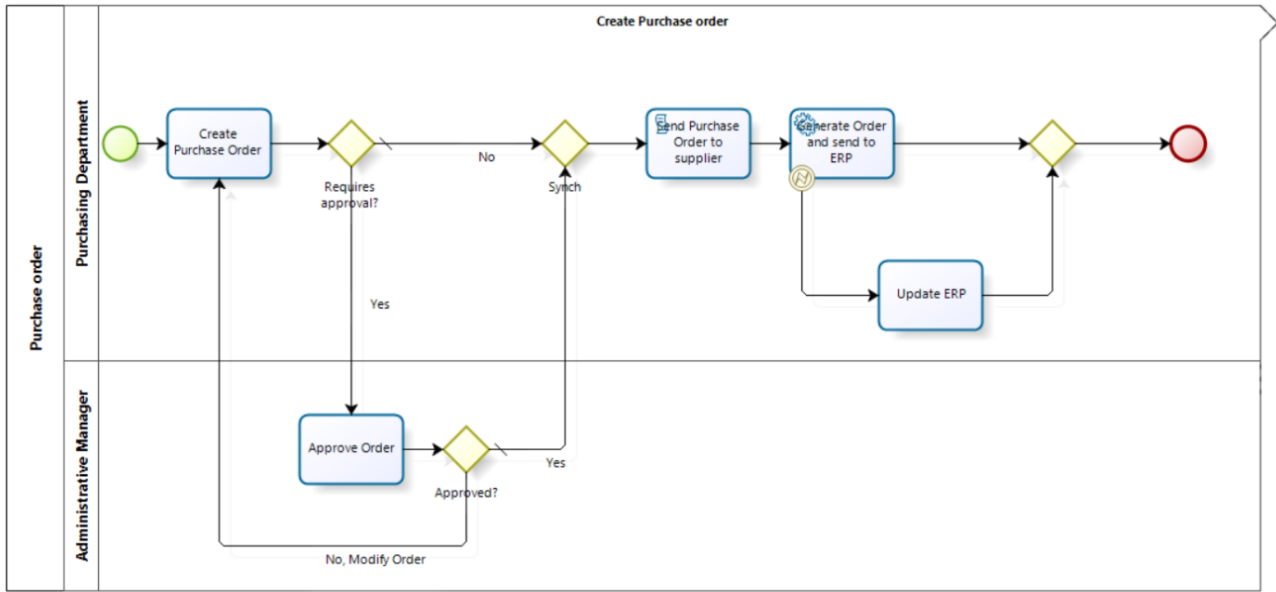


Figure 5: Purchase Order Model [11].

3.4 | RE-ENGINEERING

The concept of Business Process Re-engineering is the way of re-developing any business process in another thinking a flow in a goal of improving the productivity, quality, reducing execution time, or reducing costs. It is not an easy task; it focuses on changing the current processes fundamentally. It has two probabilities, either to succeed or failed. This can be extremely time-consuming, expensive, and risky. Unless you have the ability to flow each step successfully.

For the process that is mentioned in this paper, cost and time efficiency are the major metrics that will be presented. Before exploring the BPR (Business Process Reengineering), a list of time duration of each activity in each process and sub process is displayed in Table 1.

As noticed, the purchase request process needs 3 days and 16 hours for completion which is time-consuming for any applicant. In the purchase order sub-process, there is a long activity which takes around 4 hours to wait for administration manager approval. The manager is supposed to check the details of the purchase order types, quantities, and agreed prices for the requested products. This activity could be done implicitly through the purchase department where the order details has been decided before. Also, the

supplier is selected before in the Quotations sub-process where the selected one know the details of the order before. Then the reengineered module will be as the below:

Once the order is generated by the purchase department team, it will be moved to the selected supplier by email. Figure 6 depicts the Re-Engineering model .

Table 1: Activities Execution Duration

Activity	Duration
Create Purchase Request	1 hour
Authorize Request	3 hours
Request Quotations	2 days
Select Supplier	4 hours
Create Purchase Order	1 day
Approve Order	4 hours
Update ERP	4 hours
Total	3 days and 16 hours

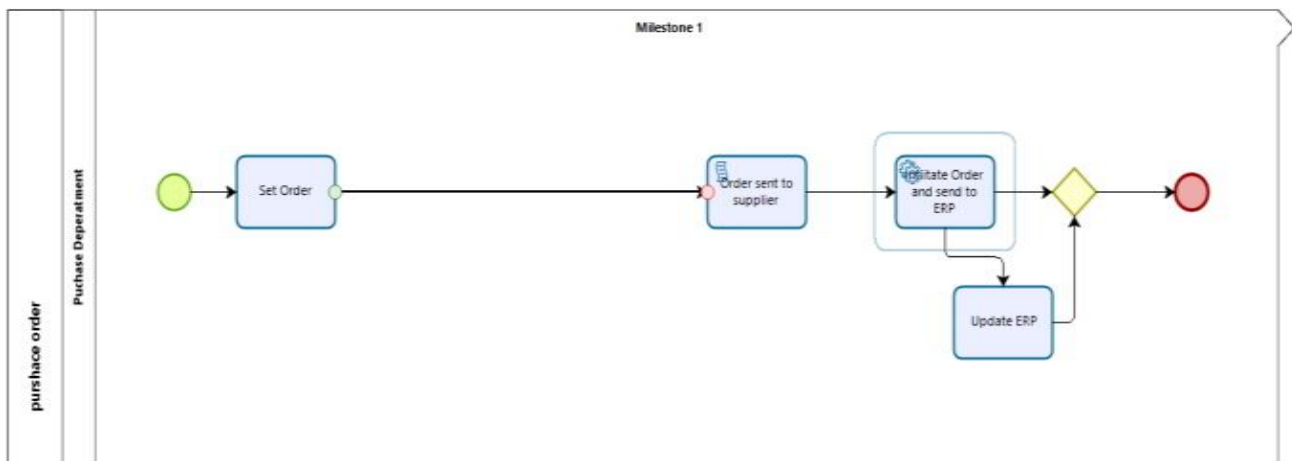


Figure 6: Re-Engineering Model

4 | CONCLUSION

In this paper, a complete framework by integrating business process and blockchain is pro-posed. This novel framework covers three core activities of business process which are 1) modelling 2) monitoring and 3) execution. The pro-posed integration of business process with blockchain is equally beneficial for all the parties involved in the development of business process.

REFERENCES

- [1] G. Chen, B. Xu, M. Lu, and N.-S. Chen, "Exploring blockchain technology and its potential applications for education," *Smart Learning Environments*, vol. 5, no. 1, p. 1, 2018.
- [2] M. Nofer, P. Gomber, O. Hinz, and D. Schiereck, "Blockchain," *Business & Information Systems Engineering*, vol. 59, no. 3, pp. 183-187, 2017.
- [3] J. Schmidhuber, "Emerging Opportunities for the Application of Blockchain in the Agri-food Industry," 08/29 2018.
- [4] O. López-Pintado, L. García-Bañuelos, M. Dumas, I. Weber, and A. Ponomarev, "Caterpillar: a business process execution engine on the Ethereum blockchain," *Software: Practice and Experience*, vol. 49, no. 7, pp. 1162-1193, 2019.
- [5] A. Amjad, F. Azam, M. W. Anwar, W. H. Butt, M. Rashid, and A. Naeem, "UMLPACE for Modeling and Verification of Complex Business Requirements in Event-Driven Process Chain (EPC)," *IEEE Access*, vol. 6, pp. 76198-76216, 2018.
- [6] W. Viriyasitavat, L. Da Xu, Z. Bi, and A. Sapsomboon, "Blockchain-based business process management (BPM) framework for service composition in industry 4.0," *Journal of Intelligent Manufacturing*, pp. 1-12, 2018.
- [7] I. Weber, X. Xu, R. Riveret, G. Governatori, A. Ponomarev, and J. Mendling, "Untrusted business process monitoring and execution using blockchain," in *International Conference on Business Process Management*, 2016: Springer, pp. 329-347.
- [8] R. Yasaweerasinghelage, M. Staples, and I. Weber, "Predicting latency of blockchain-based systems using architectural modelling and simulation," in *2017 IEEE International Conference on Software Architecture (ICSA)*, 2017: IEEE, pp. 253-256.
- [9] L. García-Bañuelos, A. Ponomarev, M. Dumas, and I. Weber, "Optimized execution of business processes on blockchain," in *International Conference on Business Process Management*, 2017: Springer, pp. 130-146.
- [10] P. Rimba, A. B. Tran, I. Weber, M. Staples, A. Ponomarev, and X. Xu, "Comparing blockchain and cloud services for business process execution," in *2017 IEEE International Conference on Software Architecture (ICSA)*, 2017: IEEE, pp. 257-260.
- [11] Bizagi. "Business process essentials." <https://www.bizagi.com/> (accessed 18 June, 2020).