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BLOCKCHAIN IN EMPLOYING RISK MITIGATION FOR INDUSTRY SUPPLY CHAIN

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ABSTRACT

PT. XYZ is a pesticide company in Indonesia. Based on previous research, risk analysis was carried out and one source of risk was obtained, namely raw materials that did not meet specifications, which was then proposed to be mitigated by evaluating supplier performance. Where this involves a lot of data so it requires efficient and effective data storage and access. Blockchain with its characteristics can be used to meet these needs. Data collection was carried out employing a literature study on the company's official website, research, and publications that had been carried out at the company to obtain historical data. In this regard, a simulation will be carried out using a website, namely a blockchain demo. The design stage starts with identifying system requirements, creating use case diagrams, compiling activity diagrams, determining subprocesses, and selecting information.

Keywords: *blockchain, simulation, supply chain, risk mitigation, pesticide*

1. INTRODUCTION

Blockchain is a technology that uses decentralized systems, distributed computing, asymmetric encryption, timestamps, and consensus algorithms [1] Therefore, the stored data cannot be changed or modified so this technology can guarantee security and trust when making transactions [2]. With the growing interest in blockchain, this technology has been widely implemented in many sectors and industries, including financial, business, industrial, voting, education and health [3]

As previously mentioned, that blockchain implementation can vary and be adapted to specific sectors. The industry is a sector that has an important aspect in the form of a supply chain, where this aspect is often associated with the use of blockchain for real applications. Although there have been many examples of success in applying blockchain in supply chain changes for the better, there are also challenges that need to be faced, such as its use in terms of technical difficulties, security, data privacy, as well as high initial investment costs [4] So, these things need to be taken into consideration before moving from a supply chain without a blockchain to a supply chain blockchain.

PT. XYZ is one of the companies that produce pesticides in Indonesia. Based on previous research on the pesticide supply chain in this company, a risk analysis has been carried out which then obtained the results of one of the risk agents, namely raw materials not meeting specifications. For these risk mitigation alternatives, it is proposed to evaluate supplier performance which of course in the process will involve a lot of data so that efficient and effective data storage and access are needed. In the supply chain of PT. XYZ still processes data independently by each actor and shares data that is considered necessary when coordinating in traditional ways so this has the potential

for data manipulation due to low transparency, data can be stolen due to weak security and requires a short time in the data exchange process.

Pesticide supply chain actors at PT. XYZ includes raw material providers/suppliers, processing/production departments, distributors, retailers and end consumers. The main raw material providers/suppliers in the form of active ingredients come from abroad, namely 80% from China and the remaining 20% from Japan, Belgium, Korea, Germany and Malaysia, while auxiliary materials and packaging materials come from domestic local suppliers [5]. Related to this problem, blockchain with its characteristics can provide benefits in the form of more transparent and secure and trustworthy data between the parties involved. With these benefits, blockchain can be used as an auxiliary means of accessing and collecting data necessary for supplier performance evaluation, such as ease of data tracking, data transparency, distributed data, and avoiding data manipulation. This also applies to other risk mitigations related to the need for data.

The stages in the design of the simulation, namely analysis of system requirements, making use of case diagrams, compiling activity diagrams, determining subprocesses, and selecting information. To see the feasibility of blockchain technology as a means of supporting risk mitigation, several aspects will be used as a reference, including security, trust, traceability, sustainability, and costs. The purpose of this study is to identify the use of blockchain for the pesticide supply chain as a means of supporting risk mitigation related to data starting from the design stage for the implementation of the simulation so that data can be obtained that will be used when the simulation is run. Then from the simulation results, analysis results can be obtained to determine the feasibility of blockchain as a means of supporting risk mitigation in the pesticide supply chain.

2. LITERATURE REVIEW

2.1. System Requirements Analysis

In designing a system, analyzing needs is something that needs to be done. Analysis of system requirements needs to be done because by analyzing it will be known the specific needs of the system, including the output to be produced, the input used so that the output can be produced, the operations / processes that occur, as well as the resources needed to support the system so that it can run properly and finally can achieve the intended output [6] The system requirements analysis diagram can be seen in Figure 1.

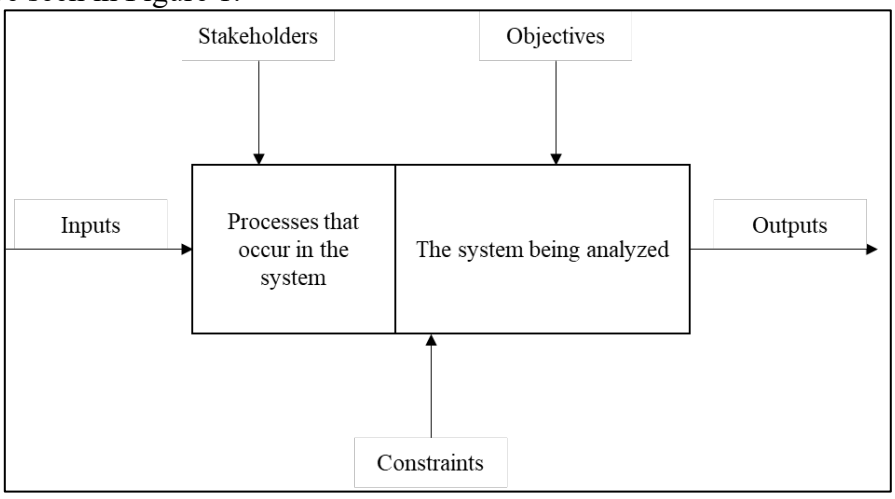

Figure 1 System Requirements Analysis Diagram
(Source: D. Ardifah, 2019)

2.2. Use Case Diagram

Use case diagrams are modelling to identify the behavior of a system to be created. Through the use case diagram, it can be seen how the interactions that occur in the system as a whole starting from system users, treatment of the system, and how user treatment can affect the system. In this diagram, there will be two parts or characteristics to distinguish between actors who interact directly and indirectly, namely actors outside the system and actors within the system. Where the two positions of these actors will be opposite each other to make it easier to provide a complete picture [7] The use case diagram can be seen in Figure 2.

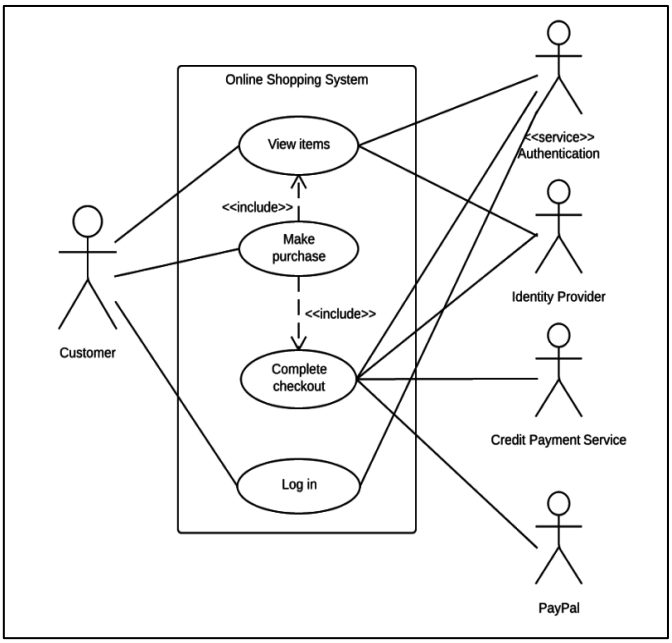

Figure 2. Use Case Diagram
(Source: https://www.lucidchart.com/pages/uml-use-case-diagram)

2.3. Activity Diagram

The definition of an activity diagram is a diagram that gives an overview of a series of processes as a whole. a series of processes will be described specifically from one activity to another so that the process flow from start to finish can be seen clearly and is easy to understand. when compared between activity diagrams and use case diagrams, the most important difference is their function. The activity diagram provides a detailed description of the operating process from start to finish, while the use case diagram provides an overview of the interaction between the user and the running system. in the activity diagram there are certain signs and symbols that describe specific behaviors when carried out so that they are easier to understand. This diagram has the advantage of a complete and detailed yet simple depiction of the process [8]. The activity diagram can be seen in Figure 3.

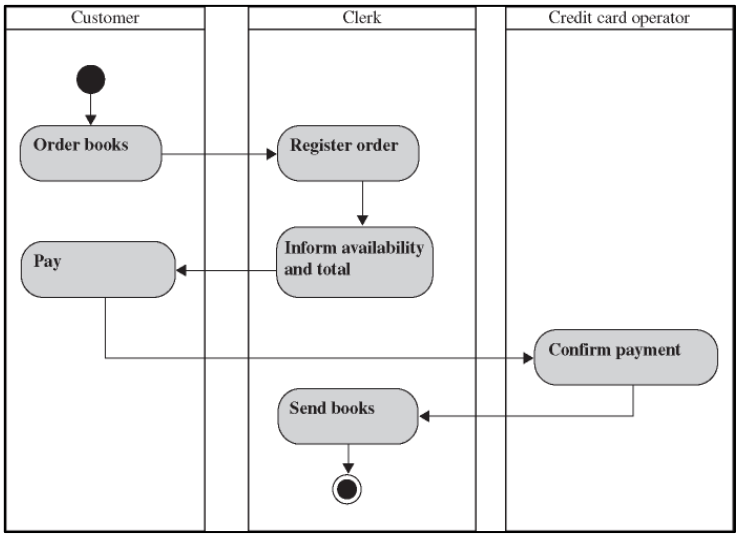

Figure 3. Activity Diagram
(Source: https://ebrary.net/73277/computer_science/business_activity_diagram)

2.4. Subprocess determination

From the known processes, then it is selected which subprocess will be supported by blockchain technology. The selection is based on activity types that are full of cross-individual data transactions. The selection can also be based on the activities that have the highest risk. Such the highest risks need to be mitigated with a blockchain system. One form of risk is data misappropriation and manipulation [8]. In determining the sub-processes in the pesticide supply chain, it will be determined based on the processes that have been arranged in the activity diagram. Determination is based on a sub-process where there is a lot of general data exchange between pesticide supply chain actors. In addition, sub-processes related to risk mitigation that have been proposed in accordance with the pesticide supply chain will also be considered.

2.5. Information selection

Information selection is choosing which information from the activity will be supported by the blockchain function. This information needs to be carefully selected to prevent the system from managing a lot of data. Data needs to be made efficient without having to reduce the effectiveness of data transactions. The information chosen can be based on the main purpose of the system to be applied to the blockchain [8]. The main objective of the pesticide supply chain system is to maintain or improve the performance of the supply chain itself. In maintaining supply chain performance, one of the things that can be done is risk mitigation. Thus, the information that will be used as data in the pesticide supply chain simulation is information related to the proposed risk mitigation alternative. For example, risk mitigation is in the form of supplier performance evaluation, so the information that will be used as data is data related to the supplier performance evaluation process.

2.6. Simulation Website

In carrying out blockchain simulations, third-party tools will be used in the form of websites, namely Blockchain Demo (https://demoblockchain.org/). This website can simulate blockchains that can perform key blockchain-related functions, such as hash, block, blockchain, distributed, tokens, and coinbase. This website is maintained by the Blockchain Institute of Technology, where the institute educates and certifies developers and executives know how to develop and apply blockchain technology. The appearance of the blockchain simulation website can be seen in Figure 4.

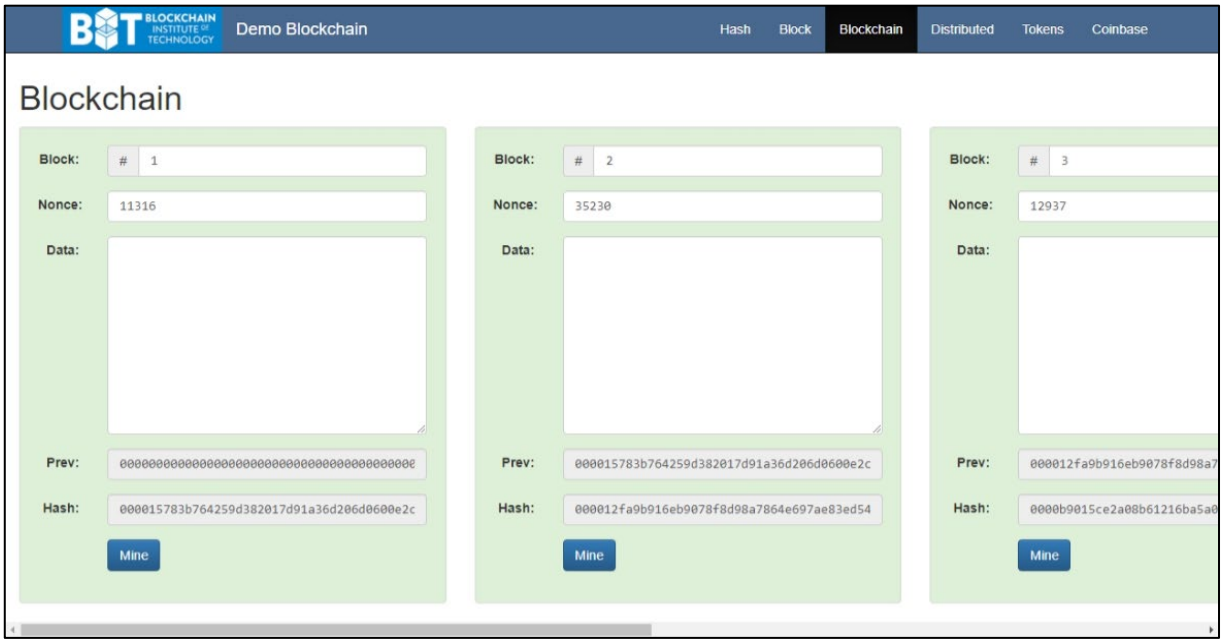

Figure 4. The appearance of the Blockchain Simulation Website
(Source: https://demoblockchain.org/blockchain)

2.7. Blockchain Definition

Blockchain is a ledger of cash transactions that are digital and scattered, recorded and reflected in real-time on a computer or node network. In validating transactions, a third party or a party with higher access is not required, which is why blockchain is referred to as a peer-to-peer trustless mechanism. In essence, blockchain technology provides a more secure way for cash ledgers to store records and databases without the need for centralized manual intervention. So, the cost of verifying the archiving of transactions in a blockchain-based system is much cheaper than in a centralized verification system by humans. The result is an operating model for transactions in the system based on system-based trust, not counterparty-based trust.

Blockchain technology can track every activity in the blockchain, where each activity record is a validated activity. Blocks contained in the blockchain have contents in the form of data from all transactions that have been carried out within a certain period of time and are able to carry out digital signatures with the function of verifying the integrity and authenticity of information connected to the next block and the previous block. Transactions that have been made will be stored in blocks. If the transaction has been verified by a consensus of all or a majority of members in the network, then the transaction that has been stored in the block cannot be changed or deleted [9]

2.8. Blockchain Mechanism

In blockchain technology, generally in a block there will be 3 parts, namely the data you want to store, the hash generated by the block, and the hash of the previously generated block. Therefore, in order to remain connected to the transaction chain that has been stored, each block must have its own hash as well as the previous hash. the form of a hash is a series of numbers consisting of a mixture of unique numbers and alphabets with a fixed length, obtained by calculating from the data contained in the block, timestamp, and previous hash.

The data stored on the blockchain is a data structure that has been grouped. Each block will store different information and the information contained may vary. When a block has successfully stored data, then the block will be directly connected to the block behind it and also the block in front of it. This collection of blocks is known as a blockchain. Blocks that have been joined to the chain will function as a permanent data record, stored with a timestamp, and connected to an unlimited network [10]. To better understand how the blockchain works, you can see the blockchain structure in Figure 5.

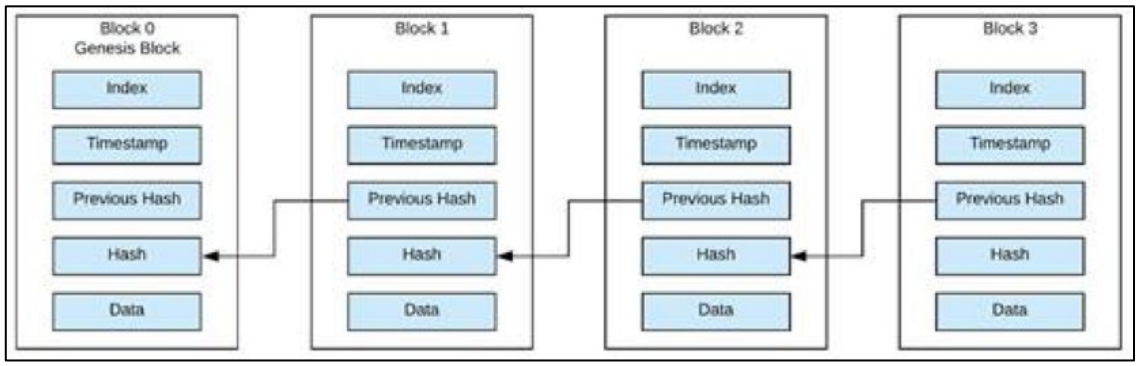

Figure 5. Blockchain Structure
(Source: https://www.spheregen.com/blockchain-technology-basics/)

In a block there will be data from that block, a hash generated from the information stored, and the previous hash obtained from the block behind it as a link. If the hash changes, the block will be considered invalid in the blockchain. A hash is a string that is returned from a mathematical function, which is called a hash function. The hash function takes various inputs and converts them into fixed-length strings. Even if the change to the input string is very small, the hash function will generate a new hash that may differ greatly from the actual result. Usually, the hash function used in the blockchain is SHA-256. The longer the blockchain chain, the more complex the hash value to look up [11] The hash function can be seen in Figure 6.

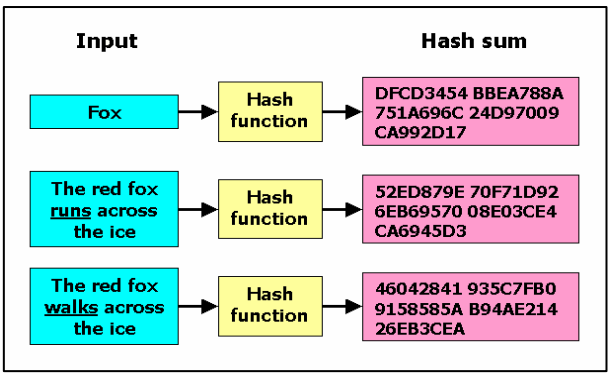

Figure 6. Hash Function
(Source: https://blocksec.ca/what-on-a-hash/)

2.9. Blockchain Characteristics

Blockchain is a unique technology, having various characteristics simultaneously in one technology that other technologies don't have. These characteristics are considered the strengths of blockchain technology that make it special. The following are the characteristics found in blockchain technology [10]

1. Decentralization
   In blockchain technology, there is no longer a need for a third party to become a link and be the center of every transaction in validating, for example a bank. This will result in

additional costs, burdens and problems on the central server. Since this does not exist on the blockchain, what is used is a consensus algorithm to maintain data consistency on a distributed network.

2. Distributed Database
   Data storage on the blockchain uses a distributed network known as a public ledger. This means that every user in the system will have an exact copy of all transactions that have taken place on the blockchain network.
3. Immutable
   Once a block has been successfully connected to the blockchain, it will be very difficult or even impossible to modify or delete the data or block. This happens because the blocks have become one in the blockchain and interlock between the blocks behind it and in front of it. If changes to a block are made, even if they are small, it can cause all hashes in each block in the chain to become invalid.
4. Transparency
   Every transaction that occurs can be seen by everyone in the system, and all participants can know who took what action at that time.
5. Security
   The blockchain network system does not have a central control or a special place to store data, meaning that all data will be present on every computer connected to the network, in other words, data is dispersed. To be able to take over power on the network, it is necessary to carry out an attack on every computer in the network simultaneously and this is impossible to do and if done it will be very expensive and not necessarily successful.

2.10. Blockchain Application in Supply Chain

Blockchain technology has become a concern for stakeholders working in various industries, one of which is the supply chain. By using the blockchain, many benefits can be obtained, including that each asset can be effectively recorded in every process that occurs in the supply chain, guarantees payment when making transactions, then tracking orders that are accurate while being able to track digital assets including guarantees in a safe and transparent way. This shows that blockchain can have good compatibility with supply chains. In addition, it can also be seen that there are aspects of the blockchain that affect supply chain performance, including the overall decision-making mechanism, scalability, privacy of each user, network performance, proof of payment and location tracking. There are two general designs for blockchains, namely public and private. In a private design, users on the network will know other users and there is no disguise of data, such as in a supply chain network where there are entities that are known to work to produce and distribute products and other entities with their respective roles. Then the impact that is given when blockchain is applied to the supply chain is to make the network in the supply chain more streamlined, trust between supply chain actors can increase, and the supply chain is more resilient in the long term (Litke et al., 2019).

To apply blockchain technology to the supply chain in a business in Indonesia, it is needed to know the regulations. In Indonesia, related to blockchain technology development activities, some regulations regulate this. This regulation can be seen in the Government Regulation of the Republic of Indonesia (PP) number 5 of 2021 concerning the implementation of risk-based business licensing in Article 149 paragraph 5. There is also the standard classification of Indonesian business fields (KBLI) 62014 of 2020 with a description; This group includes blockchain technology development activities, such as smart contract implementation activities, designing public blockchain infrastructure and private blockchains. This group does not include trading in crypto asset commodity futures.

3. RESEARCH METHOD

The research method was carried out by using secondary data in the form of historical data obtained employing literature studies originating from the company's official website, research, and publications that have been carried out at the company. The data collected includes general company data, supply chain mechanisms, supply chain business processes, and supply chain management. The following is the process of the method used:

a) Literature study of scientific journals and proceedings related to the subject matter of interest to researchers. With this study, it can enrich researchers in knowing developments, problems, and research gaps that can be studied.
b) The formulation of the background is carried out in accordance with the findings obtained by researchers from various sources that have been obtained, then compiled so that potential problems that need to be addressed can be found.
c) From the background that has been prepared, ideas are obtained regarding potential problems to be used as research topics that will be studied further.
d) Based on the background, problems can be found so that potential problems are further identified so that clear and specific problem identification is obtained.
e) Then the formulation of the problem and research objectives are determined so that the research conducted becomes more directed and focused.
f) Next, a secondary data search and collection is carried out in accordance with data relevant to the research conducted by researchers, namely general company data, pesticide supply chain mechanisms, pesticide supply chain business processes, pesticide supply chain management, and the results of chain risk identification and analysis supply of pesticides.
g) If the required data is sufficient, then data processing can be carried out, including analyzing the needs of the system under study, making use of case diagrams, compiling activity diagrams on the system, determining the subprocesses that will be simulated, and selecting information that will become simulation data.
h) Carry out a blockchain simulation according to the data that has been processed using a third-party tool in the form of a blockchain simulation website, namely Blockchain Demo (https://demoblockchain.org/).
i) Evaluate the results of the blockchain simulation of the pesticide supply chain. Evaluation is carried out on the benefits that can be obtained when blockchain is applied to the pesticide supply chain.
j) After the evaluation is carried out, the feasibility of the blockchain in the pesticide supply chain will be analyzed to serve as a supporting tool in risk mitigation.
k) When all the questions in the formulation of the problem have been successfully answered through this research, the last stage, namely conclusions, will be made to conclude the results of the research carried out and provide suggestions.

To see the process flow of the methods used to conduct this research, it is made in the form of a flowchart. The method flowchart can be seen in Figure 7.

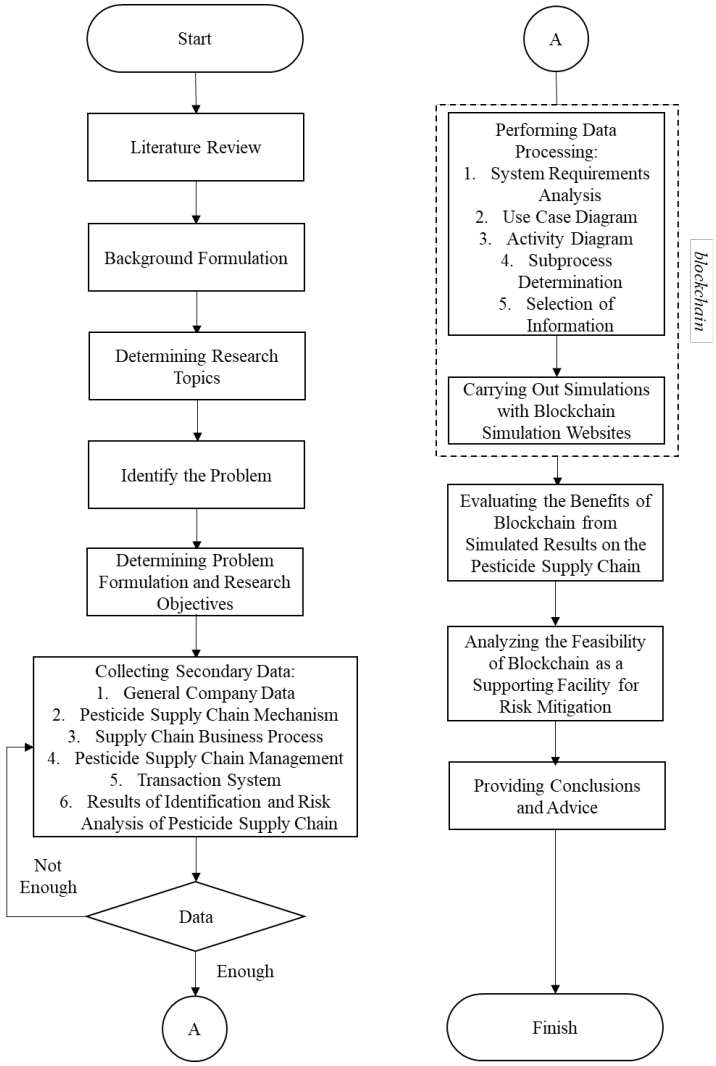

Figure 7. Method Chart

4. CONCLUSION

Based on the introduction, literature review, and research method above, it can be concluded a hypothesis that blockchain has a positive effect on risk mitigation in the supply chain industry, especially data recording and storage. This study should be continued with the research about the simulation results that could show that data can be stored and organized properly and connected, as evidenced by the hash successfully generated by each block and the hash then becomes the previous hash contained in the next block. Also, the feasibility of blockchain technology to be used as a means of supporting risk mitigation related to data in the pesticide supply chain is declared feasible according to the results of a comparative analysis between supply chains without blockchain and with blockchain which is carried out based on five aspects, namely security, trust, traceability, sustainability, and cost. Even though the cost aspect is a challenge that needs to be faced.

5. FUTURE RESEARCH

Future research should define the results of calculations related to the comparison ratio between the benefits obtained and the costs incurred to see the number of benefits that can potentially be obtained. In addition, calculations can also be made regarding the increase in the level of efficiency and effectiveness of the pesticide supply chain when blockchain is applied as a means of supporting risk mitigation related to the use of data.

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