ARTIFICIAL INTELLIGENCE FOR ISLAMIC BANKING*

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ABSTRACT

This paper illustrates the Tawarruq process for both small fund amounts and big fund amounts based on the existing system, shows all of the existing problems for both clients and banks, and then describes the methodologies that will be used for the proposed approach with agent technology and reinforcement learning working together to improve the transactions, resulting in more intelligent advantages and the elimination of all disadvantages. The conclusion demonstrates the structure of the new approach and describes the work flow from one component to another.

Keywords: Agent, Islamic Bank, Tawarruq

Introduction

Islamic banking involves all banking processes that are controlled by Islamic law in what is called "Sharia" in Arabic and is guided by Islamic economics. Over the last 40 years, Islamic banking has expanded from the first modern Islamic bank in Egypt, which was created by Ahmad Ei Najjar in the late 60s. In fact, experts currently estimate that the Islamic banking industry is worth more than 1000bn RM per year and growing by 15% per annum. More than 75 countries have one or more Islamic banks or branches of their banks [1]. Many Islamic products are offered through Islamic banking, including Murabahah, Sokok, Takaful, and Tawarruq [2], the first of which is the focus of this paper. The most important tenets of Islamic banking are to avoid interest-based transactions, known as 'Riba', and to base operations on risk sharing and involvement in trading, buying, and selling with the transfer of full ownership [3].

What is Tawarruq?

In the begging, let us describe the history and the formal definition of 'Tawarruq'. It is an Arabic word based on the word 'Warruq', which means "silver". This word been used because currency used to be made of silver. So, Tawarruq means "asking for Warruq", i.e., asking for money [16].

The definition under the Sharia is "to buy on credit and sell at spot value with the objective of getting cash"[16]. In Islamic banking, under the Islamic law, it is illegal to carry or provide an interest-based loan. Islam provides a different solution for people in need of financial support from someone else.
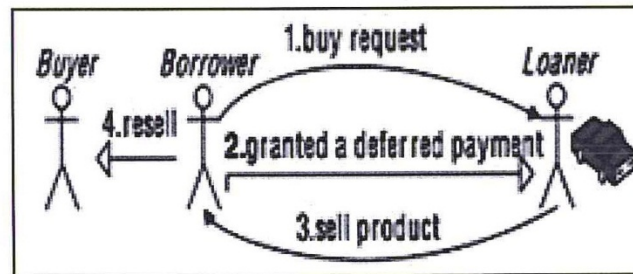

Figure 1: The Tawarruq Process

This figure depicts the Tawarruq process, which is as follows:

1. The borrower requests to buy one or more product from the seller.
2. The borrower is granted a deferred payment basis for the total amount.
3. The seller sells the product to the borrower.
4. The borrower immediately resells the product because the borrower is only interested in obtaining the cash.

Rules:

Depending on Islamic law, some rules govern the legality of the Tawarruq process:

- The borrower cannot sell the product to the same seller from whom they initially bought the product. If the borrower does, then it is called Bai' al-Ina, which is illegal under the Sharia law.
- The seller must own the product before it can be sold to the borrower.
- The seller cannot dictate the conditions for the sale of the product by the borrower.

How Tawarruq Works in Modern Islamic Banking

Islamic banks have divided Tawarruq into two different types that depend on the amount of cash that the borrower ultimately plans to obtain.

Personal Fund

This type of Tawarruq is for people who ultimately need no more than 2,000,000 RM from the process. This number is not a fixed number for all banks; each bank has its own classification. The bank analyzes last year's reports to determine how many products they sold per day to borrowers. Then, the bank searches for a company that sells approximately the same amount of products per day or more, but this company must have its primary bank account with this bank. Then, the bank signs a contract with this company to buy a certain number of products per day for sale to borrowers. The bank also obtains an agreement from the company to buy the products back again from the borrowers if they so choose

Scenario:

- Bank A sells 100,000 products per day to borrowers.
- Bank A finds company B, which sells 500,000 products per day to local warehouses and has a bank account with Bank A.
- Bank A buys 100,000 of product Y from company B at 10,000 RM for each Y product.
- Borrower requests to buy 10 products Y from Bank A and is granted deferred payments.
- Bank A sells products Y to the borrower at 12,000 RM for each Y product.
- Customer resells product Y or authorizes Bank A to resell product Y on their behalf.
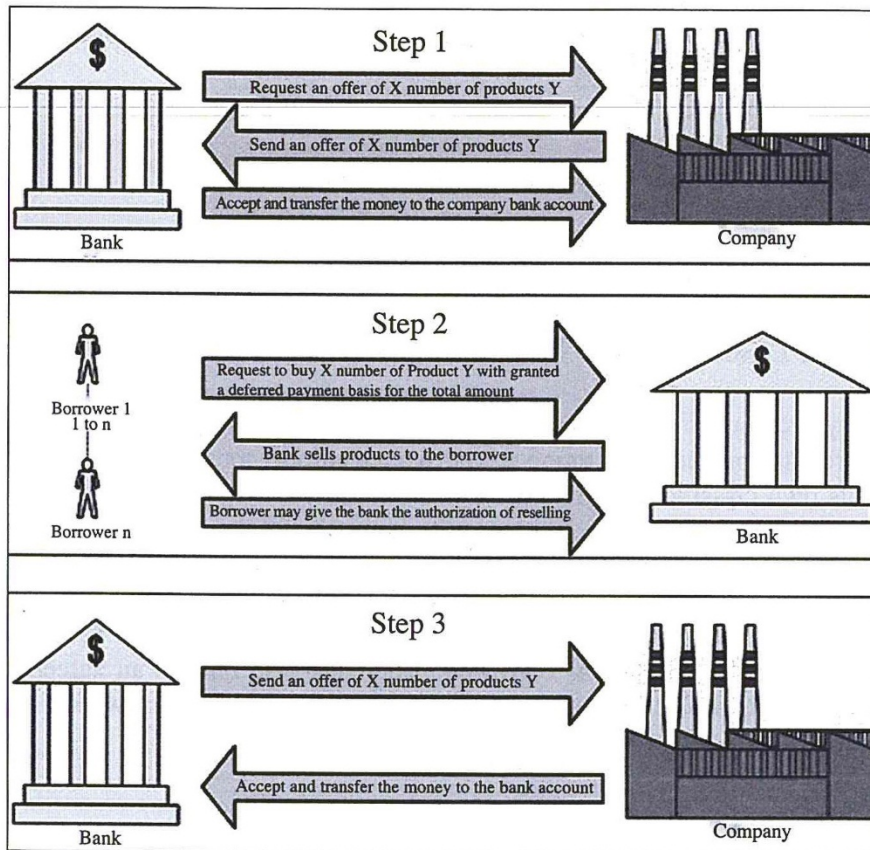- Bank A resells the product on behalf of the borrower to company B at 10,000 RM for each Y product.

Step 1

Request an offer of X number of products Y

Send an offer of X number of products Y

Accept and transfer the money to the company bank account

Bank · Company

Step 2

Borrower 1
1 to n

Borrower n

Request to buy X number of Product Y with granted a deferred payment basis for the total amount

Bank sells products to the borrower

Borrower may give the bank the authorization of reselling

Bank

Step 3

Send an offer of X number of products Y

Accept and transfer the money to the bank account

Bank · Company

Figure 2: Tawarruq Process Personal Fund

Figure 2 illustrates this daily process.

The benefit of this type of process is that no products are wasted or on hold for more than one day because the process takes only one day. The risk involved in reselling in this way is very low.

On the other hand, some Islamic organizations think that this is a prepared Tawarruq, and since it is against Islamic law to use fax or e-mail in this process, the process can become slow. In this process, borrowers only work with the bank, which makes generating a profit from the resale of products difficult. Each day, the bank works with large numbers of products in the markets, which will give the bank the power to make a profit in the resale procedure.

Companies Lending

In this type of Tawarruq, borrowers need financial support in the amount of more than 2,000,000 RM, and the borrowers mostly consist of companies or factories. The problem in this type of Tawarruq is that the bank will not find a local company that sells enough products daily to cover this amount of money. In this case, banks contact international brokers to buy products from international markets The bank then adds a profit on the total and then resells it to the borrower; most of the time, the borrowers authorize the bank to resell the products on their behalf, in which case the bank contacts the broker again to resell the products for the borrowers.
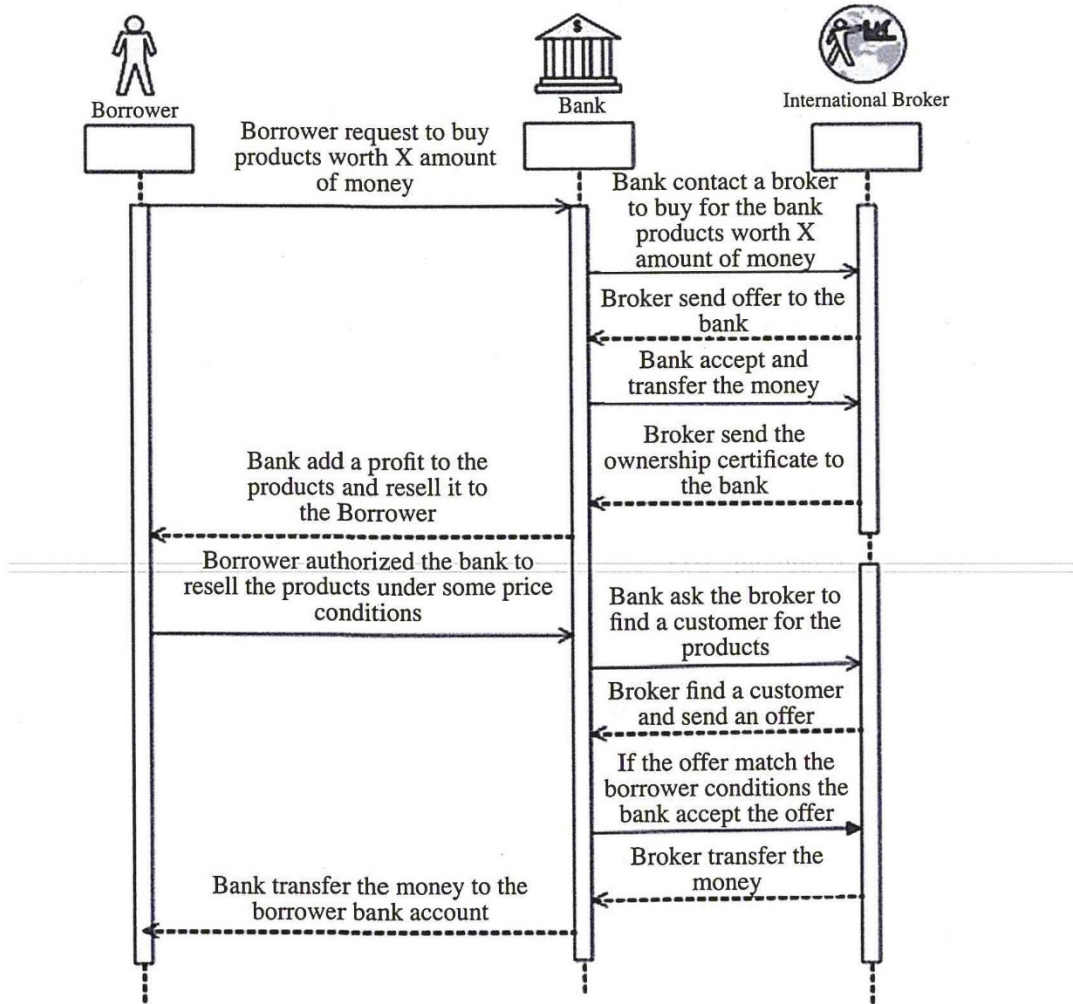
Figure 3: Tawarruq Process Companies Lending

Figure 3 clearly shows that too many messages are passed between the parties involved, which increase the total time for the operation. Fax and e-mail are the chosen methods of communication, which only affects the borrowers because international markets change very quickly. As the operation time increases, the risk in reselling increases as well. According to some existing bank statistics, 95% of all borrowers lose money in the resale of the products. In this type of Tawarruq, when borrowers lose money, they lose millions. Some borrowers can post profits with the resale of the products, however, because they choose the right market at the right time.

Proposed Methodologies and Techniques

The current system uses well-known, simple methods of communication, such as fax and e-mail. All of the members in the process have a limited view of the market. This process is much clearer in the event that a small amount of money is needed and the bank buys and resells to the same company. For a large amount of money, however, the bank only works with a very limited number of brokers and has no idea about the true state of the market. Therefore, the proposed solution suggests the utilization of some new technologies, a description of which follows.

Multi-Agent technology

According to Huhns and Singh, an agent is "an active, persistent (software) component that perceives, reasons, acts, and communicates" [4]. An agent perceives the current state of the environment through sensors or data collection.
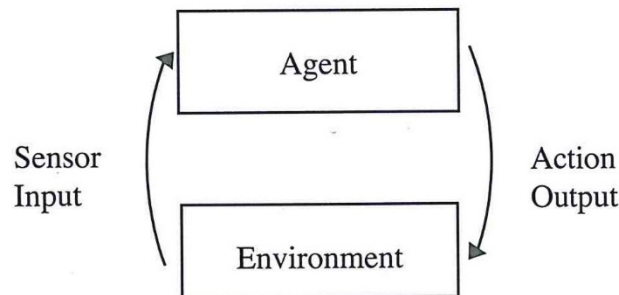

Figure 4: Agent Interaction

The first agent that was created to do some tasks on the user's behalf was developed in 1970 by Nicholas Negroponte [5]. Then, the meeting-schedule agent was developed in 1993 by Kozierok [6]. In late 1999 and the beginning of 2000, SwiftFile was developed by Segal and Kephart to help users organize their e-mail into folders [7]. At the same time, Haubl and Trifts were developing an online recommendation agent [8]. Most agent researchers agree that agents must have the following are properties:

Autonomy: Agents should act independently of users' lead and should control their own behavior and internal state. Agents should choose the right action at the right time for the right situation in a fully automated way [9].

Proactive: Agents should react to change in their environment if the current state does not lead to goal-directed behavior; in other words, agents should generate and attempt to recognize chances to achieve goals [9].

Reactivity: Agents' environments will not remain static. As the environment changes, agents should continue interacting with and responding to the environments in a timely manner so that the responses are useful [9].

Social Ability: The real world is a multi-agent environment. Some goals cannot be reached by a single agent. Cooperation with others may be needed to achieve a goal, so agents need the capability to interact with other agents and humans, not simply communicate with them [9] [10].

To make intelligent agents more powerful, extra properties may be included, such as beliefs, desires, intentions, and knowledge.

Reinforcement Learning

Reinforcement Learning is one of the successful areas in machine learning and was introduced in the early 1970s. This type of learning is inspired by human and animal learning, where the system interacts with the environment through a series of actions. These actions make some changes to the environment. The system receives rewards if the actions lead towards the goal or punishments if the actions miss the goal or lead to delays. The main purpose of the system is to learn how to maximize future rewards through correct action [11] [12].

Q-learning Algorithm. Reinforcement learning algorithms learn from trying actions and then collecting rewards. In Q-learning, two matrixes are possible: one has the rewards in the real world, R; and one has the memory of what the agent has learned from previous experiences, Q. Each matrix represents agent states and actions. Based on trying new actions, the agent updates the Q matrix using the following formula [13]:

$$\mathbf{Q}\ (state, action) = \mathbf{R}\ (state, action) + y\ Max\ [\mathbf{Q}\ (next\ state,\ all\ actions)]$$

Where y is a discount factor with the following range:

$$0 \le y < 1$$

0 immediate reward   **1 future reward**
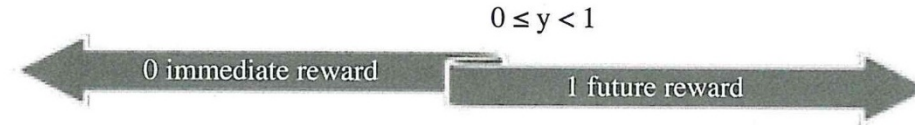
Supply Chain Management

Supply Chain Management involves coordination and planning between the supplier, the manufacturer, the wholesaler, the retailer, and the consumer. Supply chains manage the data flow between the supply chain network participants [14] (See Figure 5).
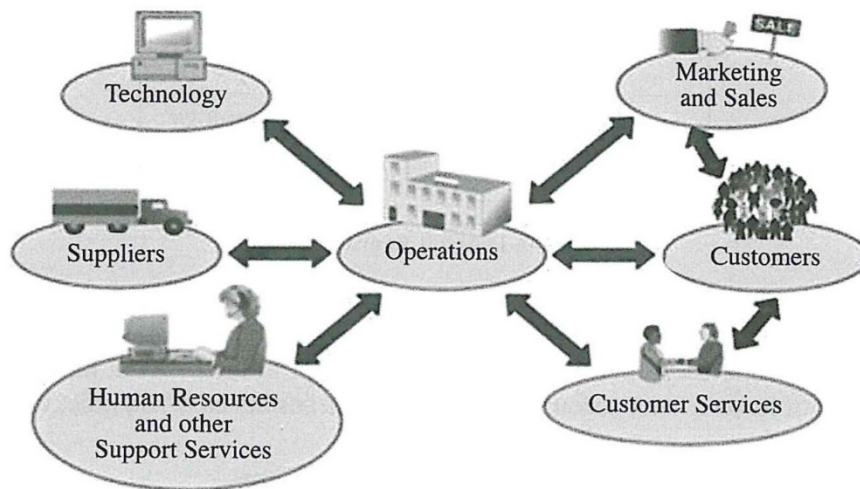

Figure 5: Supply Chain Network

The following three types of data are passed between the network participants [15]:

- *Product data flow* (e.g., when product was shipped from suppliers to customers and when customer returns a product);
- *Information data flow* (e.g., customer's information and the updated order); and
- *Finances data flow* (e.g., payment amount, credit details, and ownership arrangements).

Proposed Design

A different design is proposed for each type of Tawarruq because each one has unique criteria.

Personal Fund Design

The proposed design creates a supply chain network that includes borrowers, banks, suppliers, and warehouses. An agent represents each of the members. Borrowers' agents, suppliers' agents and warehouses' agents must be registered and authorized by bank agents.

Agent Type	Supplier
Agent ID	IZ23423VK456K
Protocol	FIPA
Ontology	Tawarruq Ontology
Language	FIPA SL
Provided by	HSBC

Table 1: Agent Registeration

All of the agents should be registered in a similar format. We assume that all of the agents communicate using the same agent communication language and can understand each other's ontologies. Each agent in the network must have control of its own bank account to make money transfers easy and quickly.
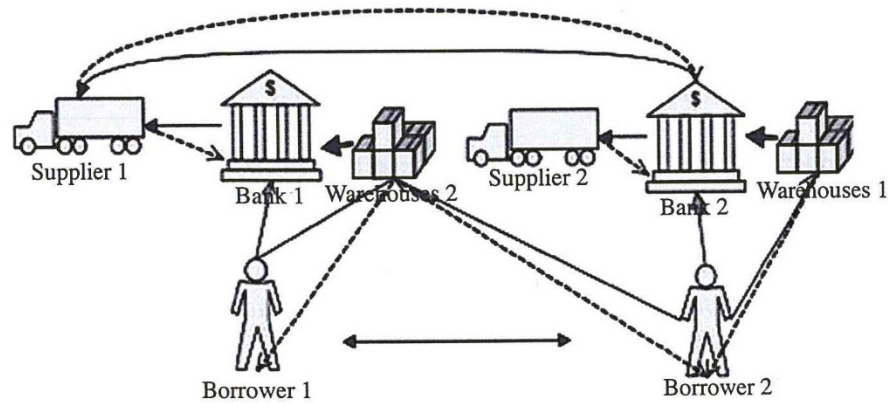

Figure 6: Design for Personal Fund Tawarruq

Figure 6 shows an example of the process that occurs when a new borrower creates a new borrower agent, registers it with the relative bank agent, and then requests a Tawarruq operation from the bank agent. Additionally, the borrower agent chooses the product type, and, after completing each operation, receives a reward or punishment, depending on whether the borrower made a profit from the resale or not. This reward or punishment is sent to the bank agent as well as in the form of feedback. The bank agent sends messages to all of the suppliers who provide what the borrower agent requests. Suppliers send offers to the bank agent from whom they received a request. The bank agent chooses the cheapest offer. Ultimately, the bank agent closes the deal with the chosen supplier by signing an electronic contract.

Contract ID	SDFS342340CKVKF0
Seller ID	SUP_EEFEF32423
Buyer ID	BAN_3453FFKGD
Product ID	VFVGDK4005FSL
Quantity	300
Price per Unit	100
Total Price	30000
Date	1/4/2008
Signatures	

Table 2 Buy and Sell Contract

Then, the bank agent transfers the money to the supplier agent's bank account. The bank agent adds a profit and then resells it to the borrower agent with another contract.

Contract ID	SDFS342340CKVKF0
Seller ID	BAN_EEFEF32423
Buyer ID	BOR_3453FFKGD
Product ID	VFVGDK4005FSL
Quantity	300
Price per Unit	105
Total Price	31500
Monthly Payment	875
Monthly Due Date	25
Date	1/4/2008
Signature	

Table 3: Monthly Deferred Payment Contract

The borrower agent starts to advertise the product by sending messages to all of the warehouses' agents in the supply chain. Inventory agents send offers to the borrower agent, who chooses the highest offer and then ends the deal with the same contract that is used between the bank and the supplier. In the end, the inventory agent transfers the money to the borrower agent's bank account.

Borrowers agents can communicate, cooperate, and coordinate in order to maximize the profit that they generate, and supplier agents can communicate to satisfy a bank agent request.

Advantages:
- Shortens the process lifetime to a matter of seconds;
- Avoids involvement in a prepared Tawarruq by opening the market for more suppliers and warehouses;
- Helps learn the market and find the safest products to buy and to resell;
- Communication, cooperating, negotiation, and coordination between agents give the supply chain the power of intelligent ability; and
- Remains in accordance with Islamic law.

Companies Lending Design

In this type of design, speedy transmission of messages between the borrower, bank and broker is very important. Similar to the design for the personal fund type, each member is represented by an agent in the operation, but the broker is replaced by an intelligent agent that informs the bank and the borrower of the best product to buy and shows them, in a short period of time, all possible selling opportunities. The broker agent can communicate with a large amount of information resources or other agents who share their knowledge. Reinforcement learning can help the bank agent to learn from each Tawarruq operation.
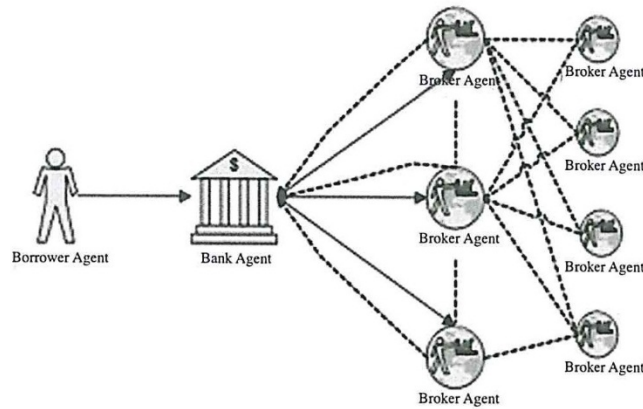
Figure 7: Design for Company lending Tawarruq

The borrower agent starts the process by requesting a Tawarruq operation from the bank. Once the bank agent discovers that this request does not meet the criteria of the first type, it will be unable to find local suppliers to cover the borrower's request. Then, the bank agent starts communicating with an international broker agent that searches the global market for markets that cover the borrower's request and sends the results back to the bank agent. The bank agent then contacts the borrower agent to obtain confirmation. The bank agent closes the deal using the buy/sell contract and then resells to the borrower with a profit, using a monthly-deferred payment contract.

The borrower agent sends messages to the international agent broker to resell the product. The broker agent then sends the best offers for the borrower to choose one or negotiate with more than one.

Advantages:
- Minimizes the time to reach the lowest risk in reselling;
- Finds many markets with the best prices;
- Two or more broker agents may cooperate together in the operation;
- Bank agent learns from each operation to give best prices to the borrowers; and
- Remains in accordance with Islamic law.

Conclusion

Every year, the number of Islamic banking customers increases, but a limited amount of research has investigated how Islamic banking can obtain the benefits of new technologies. This paper describes a method to free personal Islamic finance. This method involves gathering all participants in the Tawarruq operation into the same supply chain network in order to increase the value of the supply chain and give each participant more options in making decisions. Using agent technology will increase the speed of the process, which will minimize the risk involved in reselling. This will mostly affect the requests for big amounts of money because they are dealing with international markets. Agent properties help the operation through its social ability, which allows multiple borrower agents to communicate with one another to reach a common goal.

Future Work

This design will be developed and implemented with some Islamic banks. Islamic law experts will be contacted to review the process flow and cover all of the points of Islamic banking law to ensure that the future design is in accordance with Islamic law. For the technical part, after making all of the changes to the design, it will be developed using an agent toolkit to create the platform. Security, trust, and some other issues must be studied and resulting changes then implemented into the design to give the supply chain members the confidence necessary to use the proposed design.

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