Trace and Track Food Supply Chain based on Block chain and EPCIS

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Abstract - The food supply chain is the most complex and fragmented of all supply chains. The production is found all over the world both on land and in water. A lot of the producers and intermediaries are difficult to identify and track. For all the participants in the production chain this creates uncertainty and risk. Mitigating this uncertainty comes at a cost, and the outcome may still be insufficient. Examples of problems that have been difficult or impossible to solve with current technologies include establishing reliable provenance and preventing fraud and counterfeiting. These issues can have knock-one effects on public health and the environment, and reduce financial costs of unnecessary recalls of food products. To overcome the above challenges, a block chain Io-T based food traceability system (BIFTS) is proposed in this study, to achieve the following: (i) to integrate block chain and Io-T technology for effective and efficient traceability, and (ii) to support shelf life adjustment and quality decay evaluation for improving quality assurance. For the sake of better computational load, the block chain is modified as a lightweight block chain to be associated with cloud computing to support Io-T monitoring, and can be vaporized after the entire life cycle of traceability to release computational resources of the system. By using such a reliable data source, the decision support in food quality can be made by using fuzzy logic to determine adjustment of shelf life, rate, and order of quality decay, according to different situations for each batch of perishable foodstuffs at food processing sites. Therefore, the proposed traceability model is extended to the modern food supply chain environment, resulting in reliable and intelligent monitoring, food tracking, and quality assurance.

I. INTRODUCTION

Block chain has huge potential to impact global Medical Product supply chain (MPSC) by increasing productivity in terms of supply chain performance. Among many challenges the United States Center for Diseases Control (CDC) estimates that 48 million people get sick from expired medical product usage , 128,000 are seriously hospitalized, and 3,000 die each year in the U.S. alone. Apart from illness, economically and criminally motivated Medical Product adulteration is also a growing concern due to globalization and wide growing supply chain networks. Real-time monitoring of the medical product quality and visibility of that quality index would prevent outbreak of food-borne illnesses, economically motivated adulteration, contamination, food wastage due to misconception of the labeled expiry dates, and losses due to spoilage, which have broad impacts on the medical product security.

In order to improve safety and prevent wastage, modern Block chain based technologies are required to monitor the Medical product quality and increase the visibility level of the monitored data. There are a number of Block Chain based tracking and tracing infrastructures such as Electronic Article Surveillance (EAS), Radio Frequency Identification (RFID), and QR codes which are primarily targeted for automatic package level tracking. However, the role of these technologies is limited in identifying the medical product package and does not provide any information pertaining to the state of the Medical product quality. This limitation prevents quick removal of a defective product from reaching higher levels of the MPSC. For example, when a quality control lapse is identified along the MPSC, the company is forced to recall all the Medical products within a certain time frame leading to a huge economic loss, which can be mitigated with the availability of individual Medical Product package quality information resulting integrated recalls .In literature, a number of sensing techniques compatible with existing tracking and tracing infrastructure are proposed for monitoring Medical products.

These can be invasive or non-invasive in monitoring the physical or chemical properties of medical products such as pH, conductivity, and permittivity or the packaging environment such as temperature, humidity,

moisture or aroma. In general, these are aimed to prevent defective products from reaching the consumers. Furthermore, these sensors help in identifying key bottlenecks in the MPSC to improve the overall efficiency. Currently, little work has been done in integrating these to the tracking and tracing infrastructures. Moreover, the collected tracking as well as sensing data is more centralized and selectively used by specific entities of the MPSC. The consumers have to trust the quality of the product based on the printed expiry date without any additional knowledge of its current quality. To move beyond a "traceability-centric" or " income-centric" to a "value-centric" supply chain, a more decentralized approach is needed in terms of data sharing. However, a trade off exists between providing sufficient information to the consumer about an individual product and at the same time safe guarding the operational privacy of the MPSC.

Block chain has emerged as a decentralized public consensus system that maintains and records transactions of events that are immutable and cannot be falsified. Block chain technology has attracted attention beyond crypto currency due to its ability to provide transparent, secure, and trustworthy data in both private and public domains. The technology is based on a distributed ledger, which is not owned or controlled by a single entity. Data in the public ledger is visible publicly and any authorized entities can submit a transaction, which is added to the Block chain upon validation. The advantage of Block chain technology can be applied in MPSC to improve the digital data integrity which is obtained as the product passes through different entities of the MPSC. The complete Medical product visibility across different entities of the supply chain can become a reality with the integration of sensor based Block chain technology data management systems. The key benefits of applying Block chain technology in MPSC are: real time tracking and sensing of Medical products throughout the MPSC, and allowing identification of key bottlenecks; Discouraging adulteration of Medical products, and identifying weak links on occurance; determining the shelf life of Medical products leading to reduced waste; providing end to end information to the consumer; and allowing specific and targeted recalls. A test prototype of the Unique ID is integrated are demonstrated experimentally in this work. The Unique ID integrated can be attached to a food package to extract information regarding the package along MPSC.

II. PROPOSED ALGORITHM

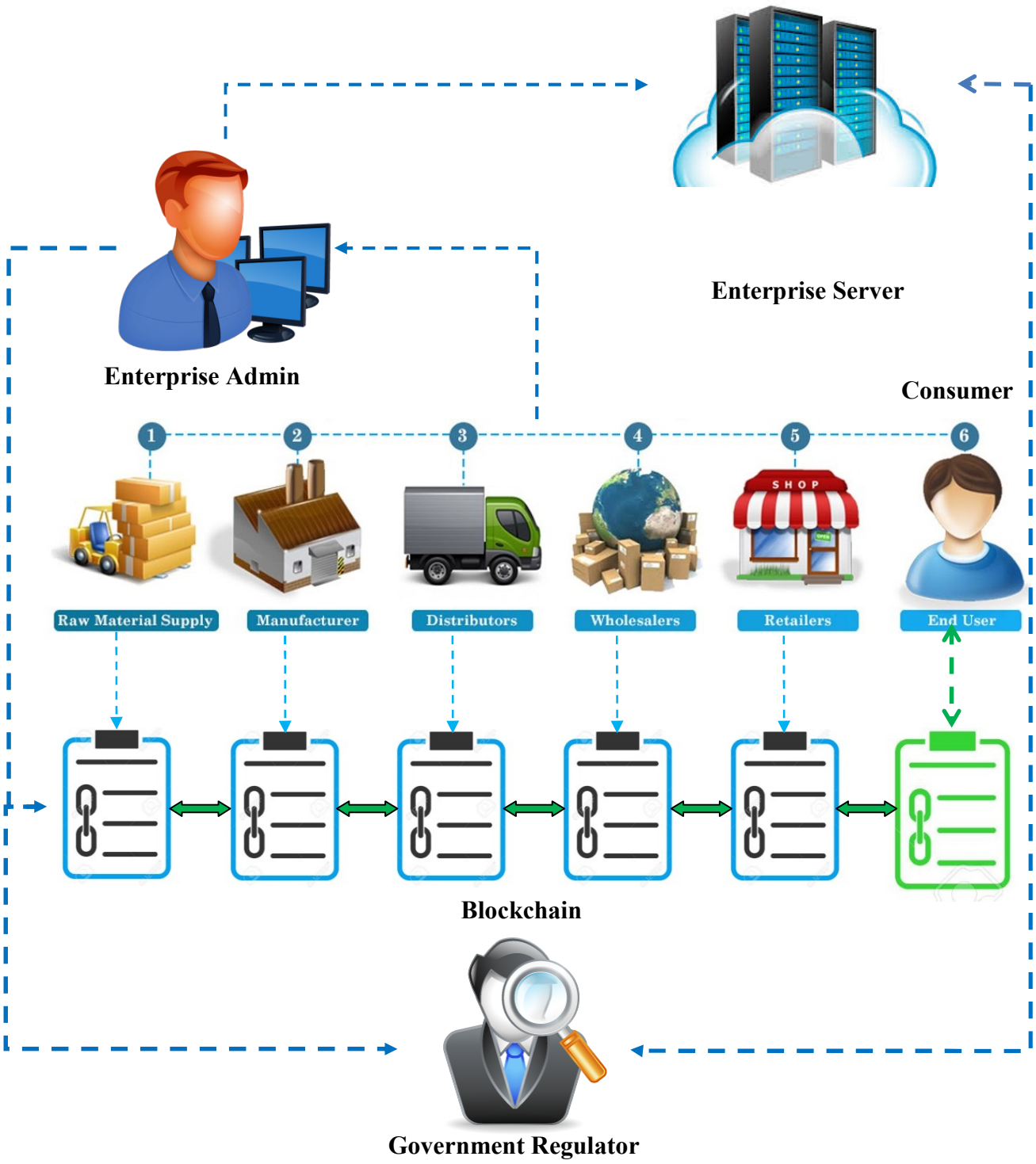
- The block chain is a new set of tools for digitization. The reason block chain technology is interesting is that there are certain functions that are very valuable for the digital world that hasn't been invented before the block chain.

- Integrated Io-T and Block chain

- The data collecting and processing node, that scans a secret code is termed as a 'terminal'. The common network shared by all the terminals is termed as 'shared network'. The scan of a secret ID by a terminal and enlisting the data is termed as a 'transaction'. Once a transaction is validated based on the consensus of participating terminals, the transaction is converted into a 'block' and included in the Block chain. Apart from terminals, there exists another type of node, a 'manager', that is responsible for policy making and processing requests based on consensus with other nodes. Finally, there exists a third type of node, called 'agent', that requests information about a secret ID from the block chain by providing a proper cyber address. 'Address collision' is referred to the existence of a minimum of two identical cyber or physical addresses. A typical Food product based supply chain is each packaged food product with an embedded secret ID travels through multiple stages of transactions at different terminals starting from packaging through transportation, storage and finally to a consumer for purchase. A data block is created containing the information about the package at each valid transaction. Once the transaction is verified, the transaction of the secret ID is converted into a block of information and appended to its pre-existing data blocks thus forming a chain of information blocks and thus a Block chain.

III. EXPERIMENT AND RESULT

Architecture Diagram



Data Flow Diagram

A data-flow diagram is a way of representing a flow of a data of a process or a system. The DFD also provides information about the outputs and inputs of each entity and the process itself. A data-flow diagram has no control flow, there are no decision rules and no loops.

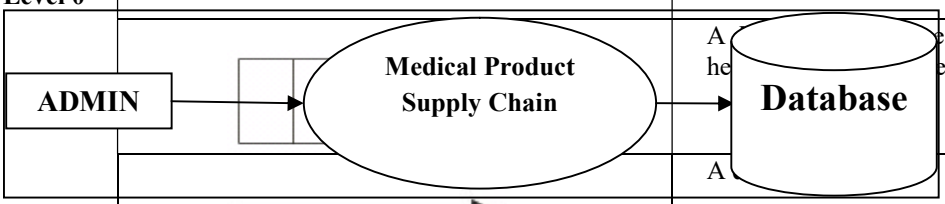
The visual representation makes it a good communication tool between User and System designer. Structure of DFD allows starting from a broad overview and expand it to a hierarchy of

detailed diagrams. DFD has often been used due to the following reasons: ... Determination of physical system construction requirements.

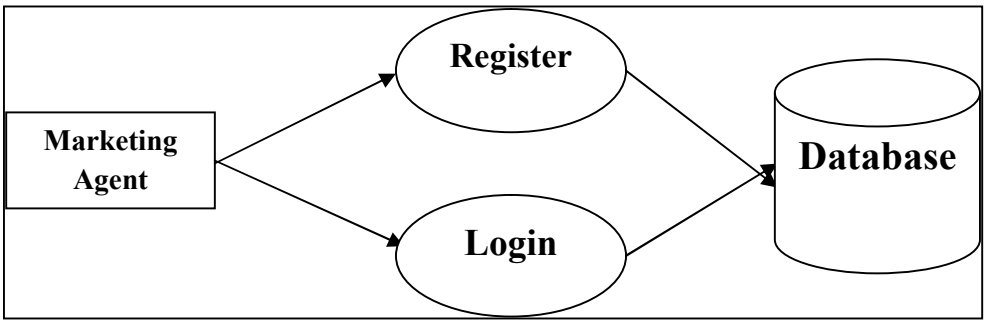
Data flow Symbols

Symbol	Description
	An **entity**. A source of data or a destination for data.
	A **process** or task that is performed by the system.
	A ... where data is he... es.
	A ...

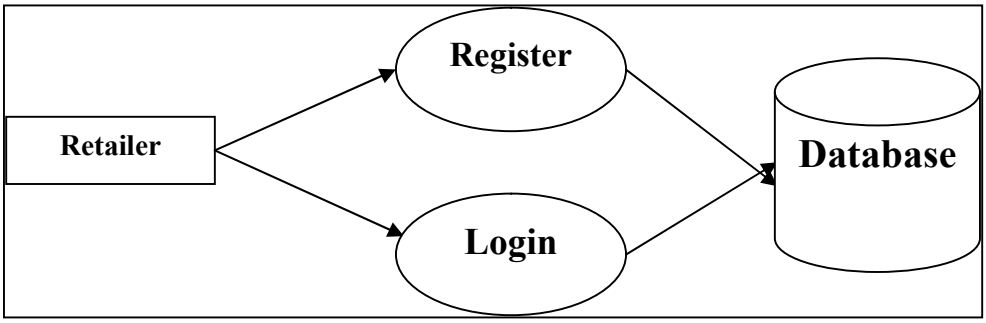
Level 0



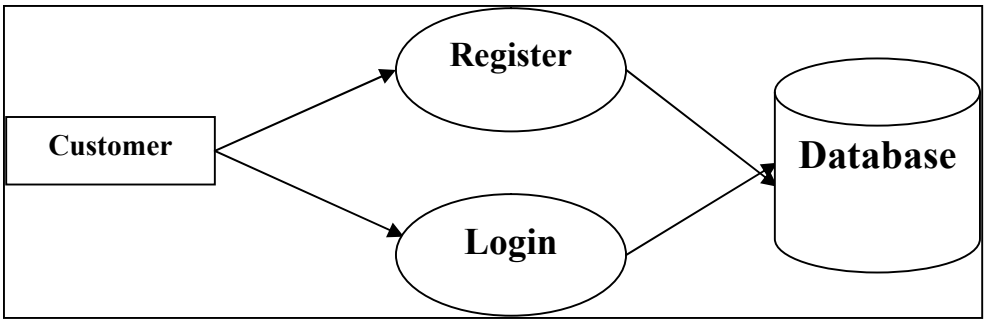
Level 1



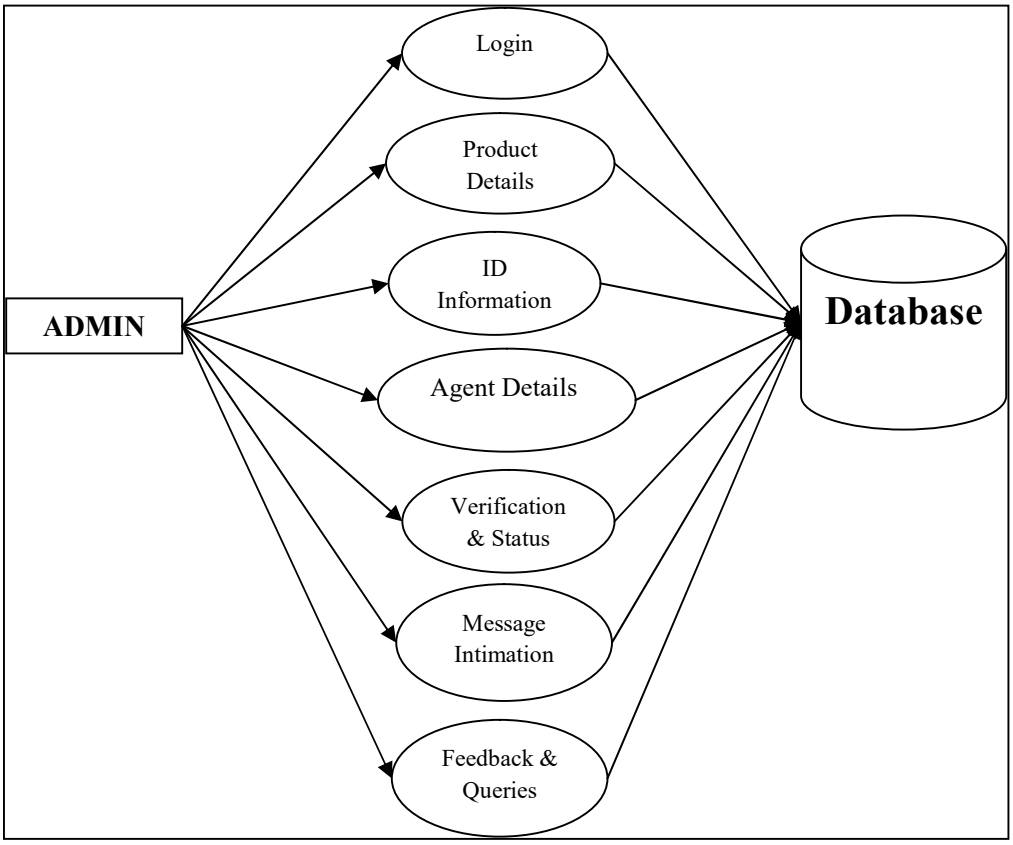
Level 2



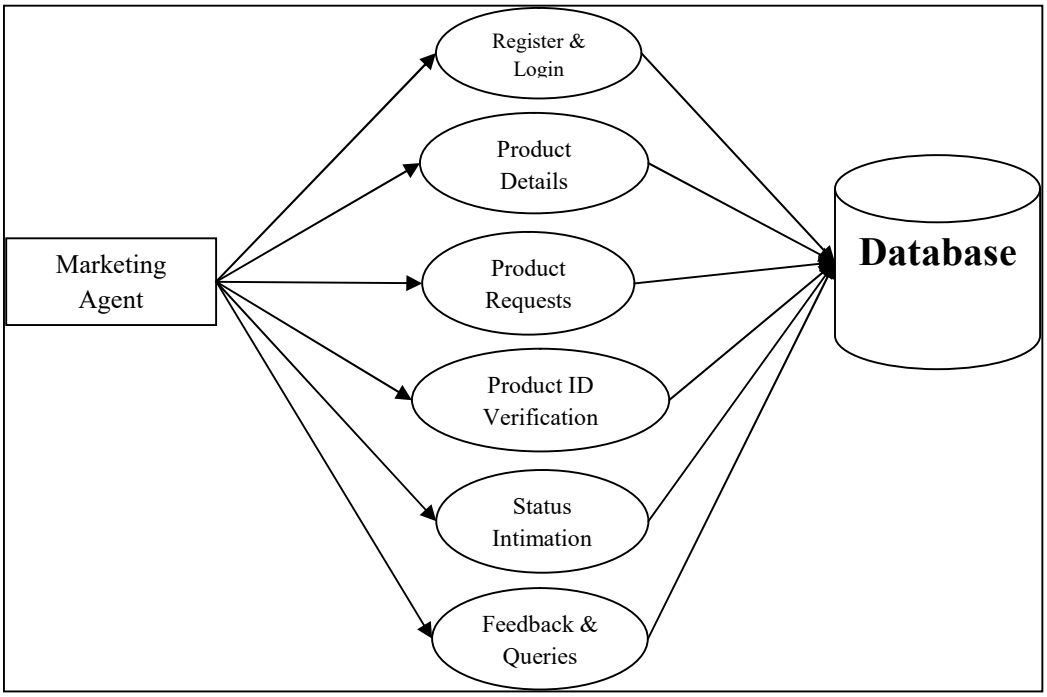
Level 3


Register
Customer
Database
Login

Level 4


Login
Product Details
ID Information
ADMIN
Database
Agent Details
Verification & Status
Message Intimation
Feedback & Queries

Level 5



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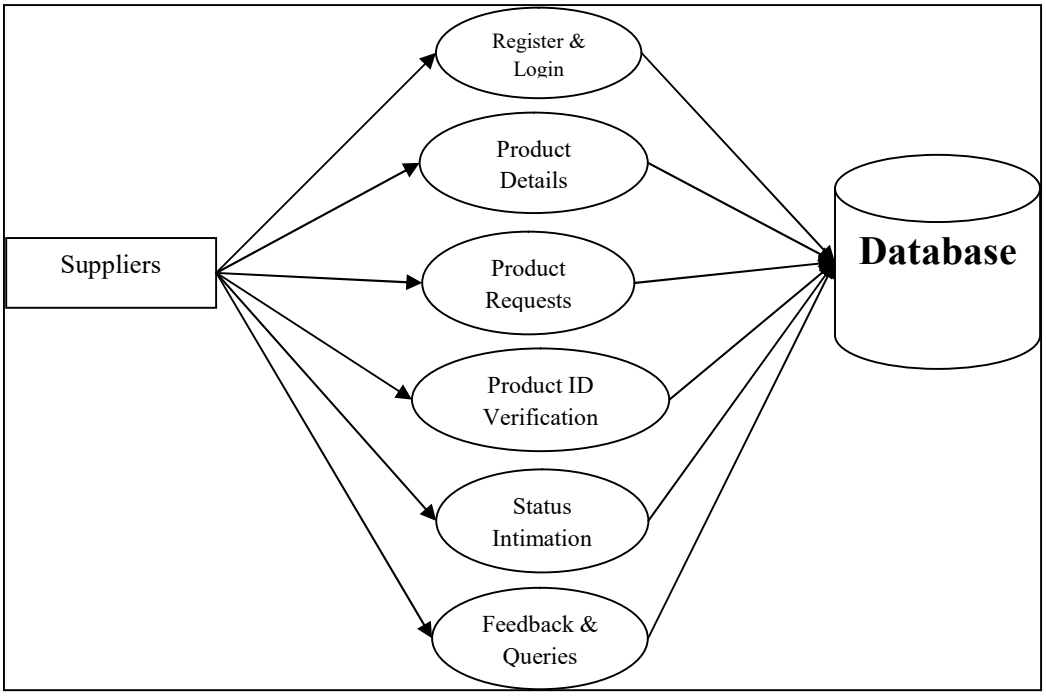

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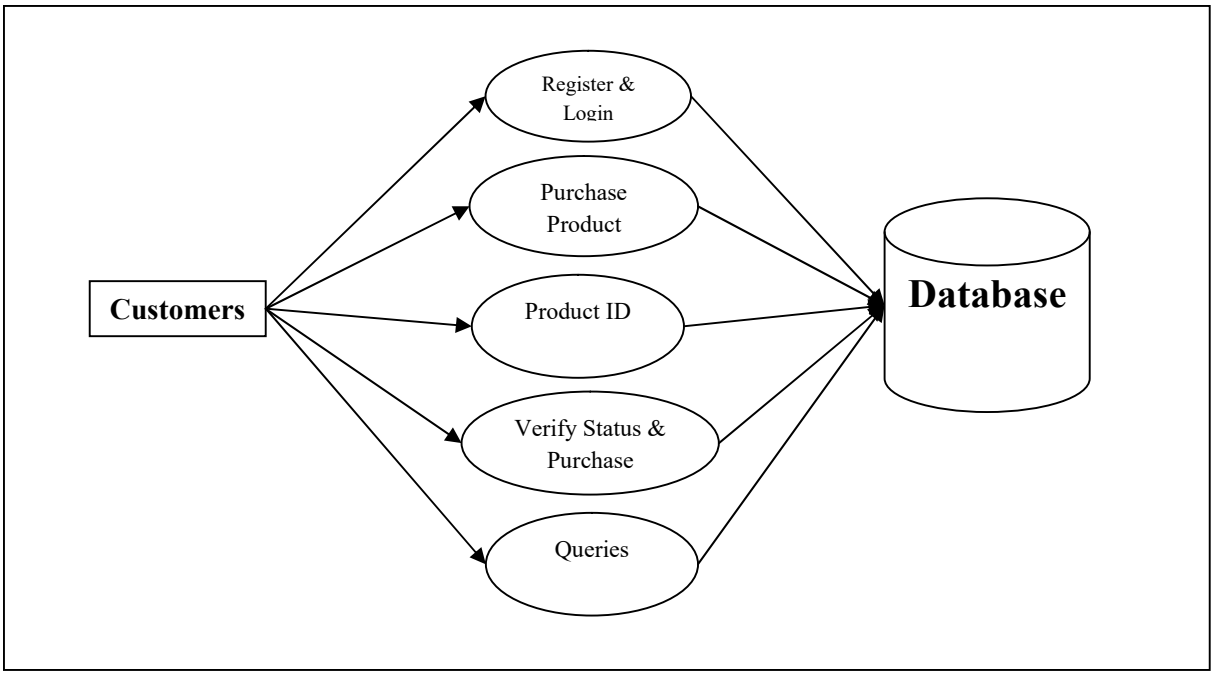

IV. CONCLUSION

A Block chain based FSC monitoring architecture has been proposed in this work. Sensing modality was integrated with identification with a small footprint for tracking and quality monitoring of the Food product packages. When the Food Product packages are scanned at different retailers, logistics or storage stage within the supply chain, the real time sensor data is updated in a block chain providing a tamper-proof digital history. Any consumer or retailer can check the public ledger to obtain information regarding the specific Food product packages. The information helps in updating the shelf life, identifying key bottlenecks in the FSC, implementing targeted recalls and moreover increasing visibility. A single secret ID integration was demonstrated in this work. The proposed architecture takes consensus from participating terminals in the network before updating the block chain data. The broader participation of all the nodes helps to keep the network decentralized. The security analysis showed that the validation of a fake block drops with a higher number of node participation in the network and multiple consensus stages.

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