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Integration of RFID, NYC and Blockchain Technologies

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ABSTRACT: The current functioning of different management are complicated as the technology used are laidback causing lot of repeated human efforts which are prone to risks. The resources stored at warehouses and their proper management are factors that decide profit and success of any unit or organization. The paper focuses on taking a good blend of the prevalent technologies to fulfil the management needs of warehouses linking them to supermarkets. The supermarkets are taken as an example to put forth the idea of management of products in warehouses in and out. This could be used in any application to make complete use of technology in an effort to increase efficiency. Learning of current technologies along with their benefits and limitations has been done in the paper to clear the idea of possible implementations in warehouses. There have been lot of challenges encountered in the deployment of supply chain management at warehouses due to difficulties in item level tracking and identification of goods. The paper proposes a product management system by integrating technologies like RFID, IOT and Blockchain that could coexist to present better with growing demands.

KEYWORDS: RFID tags, NYC trolleys, Blockchain Ledger, product identification, Distributed Data Environment.

I. INTRODUCTION

Supply Chain Management (SCM) is the “management and control of all materials and information in the logistics process from acquisition of raw materials to delivery to the end user” [5]. Nine out of ten companies rate SCM and stock control as the key to their company’s future success and survival [3]. Leading corporations show reluctance to invest large amounts of capital in new technology that is yet to prove itself in SCM. The paper is informing the pros and cons of adopting technologies for SCM as well as a model that could makes use of these technologies. The logistics ecosystem involves many players and moving parts. Products are required to be handled and transferred between the manufacturer, suppliers, the distribution center, retailer, and customer. The number of nodes in supply chain network is decided based on the need for informed network with regards to product whereabouts and their specifications. Knowledge into supply and demand would benefit all stakeholders as their demands can be better met with this level of intelligence.

II. RELATED STUDY

Need of technology integration in this field are due to reasons like:-

- Labour Reduction
- Asset Tracking and Returnable Items
- Enhanced Visibility

Technology linking with SCM must also ensure the following:-

- Quality Control and Regulation
- Reliability
- Security
- Ability to Withstand Harsh Environments



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Low Cost

Easy Deployment

They can be understood as:-

A. *Improved Inventory Management:*

Without real-time visibility, inventory management relies on guessing. Real-time visibility means one cannot possibly know time the drivers spend active with load, if they take the most effective route, and whether improvements could be made to this throughout the warehouse. Moreover the internet of things improves inventory counting. Manual data collection spells inventory disorder. Warehouse operators tend to spend a huge amount of time chasing lost or misplaced pallets caused by data entry errors. These issues can be eliminated by tracking down each minute detail. Sensors have contributed to some extent to take out the human element, potentially leading to 100 percent inventory accuracy.

B. *Real-Time SCM:*

SCM (Supply Chain Management) always suffers from the problem of storing data or information about the products. Furthermore the problem is the limited data that can be stored which has to be solved efficiently. Today technology has put forward ways to record all kinds of information production date, expiry date, warranty period, after sales details allowing real time and more efficient supply chain management. The second problem is to whom the information can be passed and the ease with which it can be done [2]. Thus SCM needs to focus on bringing more collaboration amongst suppliers and customers in the supply chain in terms of management and information distribution to benefit all thereby to increase productivity.

C. *Increased Logistics Transparency:*

Transparency ensures better cost of returns, the removal of defective goods and lowers transports due to lower reshipping rate. The kind of transparency is improvised using smart objects that monitor goods and their condition during transportation to and from warehouses. Required alerts can be raised if such kind of transparency is achieved which reduce loss of products and hence leading the company to profits. One can use smart objects either to all the load in the carrier or the carrier itself can be made smart. Choosing one of them is based on the type of load, its sensitivity and its stability in transport.

D. *Enhancing In-Transit Visibility:*

Allowing devices to “talk to each other” in the right way SCM becomes more and more successful. Connected devices enable organizations to work smarter, plan better, and foster more intelligent decision making processes. Intelligence of this level is helpful in automating the manufacturing process to achieve improved visibility within the warehouse. Context-aware intelligence brings out visibility and reliability in SCM through IoT. Many RFID technologies have also been introduced to take care of minute details from the manufacturer to the retailer and monitor them that have an impact on the quality of a product in-transit. All these technologies allow the stakeholders to act proactively that help in making better efficient decisions which was not easy task without the use of technologies. This kind of visibility keeps the stakeholders socially aware that drive overall productivity. This is not limited to some stakeholders but covers all of them in the ecosystem.

III. METHODOLOGIES USED

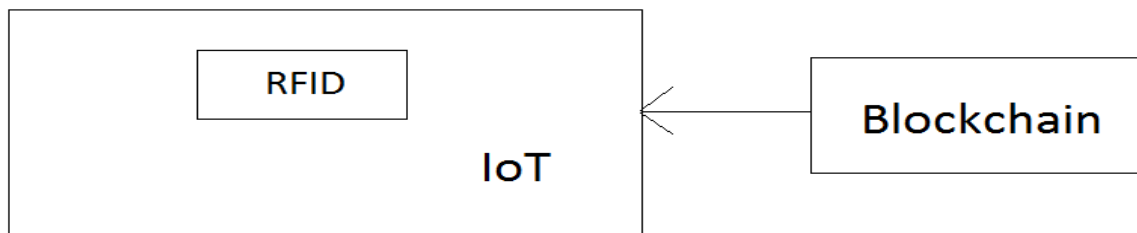


Fig. 1. Technologies used in the study.



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A. Internet of Things(IoT)

The internet of things (IoT) is a network of objects integrated with radio frequency identification chips. Many more similar technologies are included so that the objects could communicate and interact with each other. IoT can also be referred as "Internet of Objects". RFID is still implemented as it is the subset of IoT. IoT is build using Sensing Nodes, Embedded Processing Nodes, Wired and Wireless Communication Capability/Nodes. Sensing nodes vary based on the applications using them. They can be cameras, radars or RFID readers. Phil Van Vormer has explained role of the Internet of Things (IoT) in bringing real-time visibility of the products in a chain.

The ability to track and monitor almost any resource helps to bring companies and people together to save time and yet earn better results.

Need to get information at right place in right time and in the processed form to be useful in warehouses is an advantage of IoT. Availability of information is essential for SCMs. Monitoring or tracking is much needed in management chains which are taken care of in IoT. IoT is a bit costly affair to implement but the amount of time that is saved pays for the money spent on devices as well as ensures great profit. IoT implementation cannot be kept common everywhere at every unit which is due to compatibility issues. The need and provisions at different warehouses decide the ways to use the IoT technology. Thus, IoT is differently implemented based on its demand. It also needs proper study before implementation due to the complexity involved. IoT does not ensure any kind of security with the information stored hence security issues may arise. This issue can be resolved if different technologies are combined for e.g.: - the data collected through IoT can be stored in clouds or through blockchain technology. IoT devices ensure reduced costs which also improve business efficiency, and remove single points of failure in business networks.

B. RFID

Radio Frequency Identification (RFID) system is a form of recognition system. The information is in the form of radio waves. Tag or transponder is used to retrieve it. RFID is the technology which best suits for automatic identification. There are many applications of RFID in everyday lives some of which are book stores, libraries, asset tracking, traffic management, supply chain etc. RFID is used to collect information about the items scanned. This information obtained is used for tracking stock. Barcode is machine readable object .Barcode reader is used to scan the information about the item scanned. Barcodes are used to automate the checkout system. Most of the supermarkets still operate using barcode system. But it has certain drawbacks. To overcome those, we are implementing RFID.

RFID is small electronic device. It comprises of antenna and a small chip. It helps in unique identification of objects. The RFID device must be scanned in order to retrieve identifying information.

A typical RFID system is composed of a reader, tag and a computer.

Tags-They are embedded in the product and they are inexpensive.

Reader-The reader is comparatively more complex and is more capable. It is connected with host computer for storing and processing of collected data.

The RFID Inventory system uses RFID reader for detecting signals. When item moves from the scanning zone, RFID reader captures signal transmitted from RFID tags

Working of RFID system:-

The signals transmitted by reader contain power data and clock information. It collects energy generated by interrogation signals as soon as when tags enter the detection zone of reader. Using that energy it supports operations related to internal circuits. The tag response is passed through reader module which identifies unique code associated with tag.

The RFID tags collect the information about which item is purchased and send it to RFID Reader. The reader then collects the data and sends it to the computer. The data is then processed. The tag number is then matched with number of items or product they represent. This will help the owner to track various information. The software can be used detect the number of items sold out and the ones remaining on the shelves. There are various other advantages. The data is processed using data processor called microcontroller. The data is processed using assembly language. The microcontroller uses LCD screen. It is used to display information related to items from tags. The tag has unique ID encrypted within it. This ID is identified by RFID reader. The detection zone detects the tags and their activation signal and the data within the tag is decoded and the data is transferred to host computer for processing.



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How Tags Are Beneficial?

Nowadays tags are water proof, easy to hide and suitable for products which are kept in freezer. Tags are improving the quality and prices of tags are falling day by day. Passive tags are most affordable option. We will consider tagging to be done at production level.

There are various types of tags depending upon power suppliers:-

- 1) Passive Tag: As they have no internal power supply and no radio transmitter, the electromagnetic energy is sent by RFID reader. The wave consists of rectified energy which drives the internal circuits. The passive tags can use two types of reader's i.e. handheld readers or fixed readers depending upon the need. It is less costly. It lasts longer than active RFID tag. The accuracy of moving stock is more.
- 2) Active Tag: It has internal power supply. This power supply proactively transmits signal. Active tags are fixed tags and are more accurate for real time security.
- 3) Semi Passive Tag: It has local battery. The energy required for battery is driven from readers.

EPC (Electronic Product Code):- EPC is stored within the internal memory of RFID tags. The Chip is pre-programmed with tag identifier (TID) which is a unique Number assigned by chip manufacturer. The chip consists of memory bank. It is used to store unique tracking identifier i.e. EPC. The tag antenna is used to collect energy and provide it to chip. EPC is based on RFID technology. The reader reads RFID tags which has EPC code and sends EPC to savant for processing. Savant is the local data repository for EPC and linked information. After that the local Information Server (IS) finds the data from EPC .The data is found according to the savant requirements and sends it to the savant. If information is not found, IS sends request to ONS (Object Name Service) which is same as DNS and used to access internet address. The ONS returns IP address of remote IS. The IS stores the product specific information which savant takes those data and store it in local IS for further inquiry.

NFC is also developed from RFID technology. RFID applications combine with NFC smart payment can be used for automated checkout system. The NFC mobile phones stores information about payment certificates.

From EPC point of view, the shopping trolley is equivalent to edge savant. The RFID reader and NFC reader are combined to form new reader interface via reader adapter. The information is transformed in unified format by the reader and then transmits it to the reader. The event filter is customizable according to the needs. The filter than calculates the total amount of trolley.

RFID advantages over barcodes are:-

- 1) The RFID tags can be read from the distances and even from box or enclosed bags
- 2) If the tag is removed, it raises security alarm
- 3) The tag reader or scanners are not orientation sensitive
- 4) RFID system do not require human intervention
- 5) Each tag can store lot of information
- 6) Each and every item can be labelled individually
- 7) More than one tag can be read simultaneously
- 8) Barcodes are slower and can be affected by dust

C. Blockchain

The data from RFID chip is stored as blockchain. Blockchain technology is in highlights due to its exclusive feature of decentralization and security. Blockchain is managed as blocks where each block contains the checksum of previous block, thus forming a chain, hence called as "blockchain". These chains are distributed then in the network which ensures the biggest benefit of no centralization to control data. The chains follow proper order and the hash after encryption of previous block is stored with the current block. This continues for all the blocks in chain. The security provided is such that data is tamperproof and fail-proof due to its encryption technique. A blockchain maintains a digital ledger that records transactions across many computers. Thus, the registered transactions cannot be altered.

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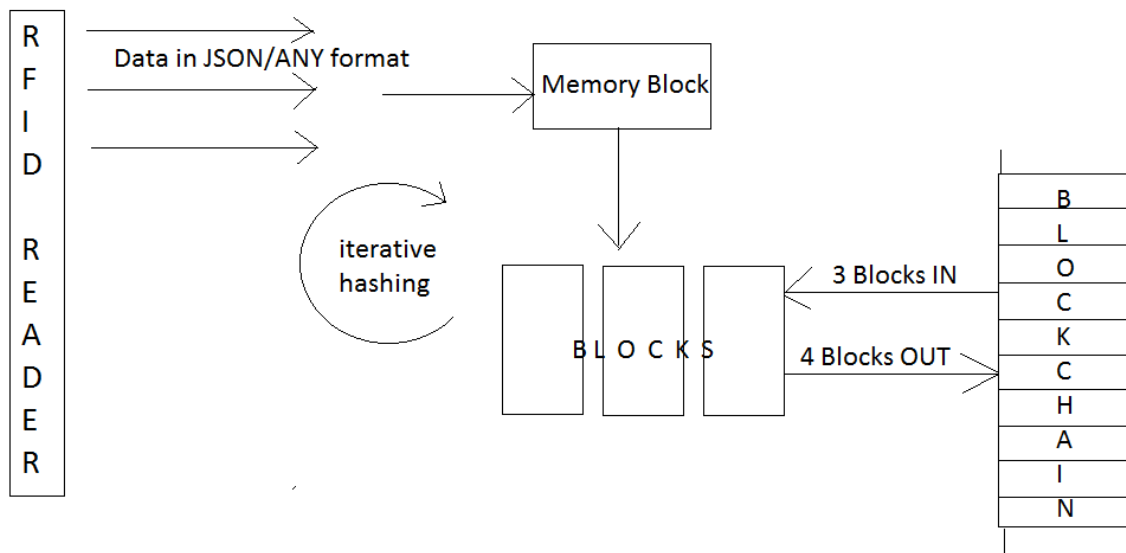


Fig. 2. Working of Blockchain

The public availability of the ledger would make it impossible for any one party to hold ownership of the ledger and manipulate the data to their own advantage. It can be used to track status of every product from the very origin of the raw material used to the stakeholder with whom it is available. The ledger lets any authorized member to input information about required materials/supplies. The cryptography-based and immutable nature of the transactions would make it nearly impossible to compromise the ledger. Data from SCM can be linked to Blockchain which keeps the data available to all stakeholders yet in a way that it cannot be tampered by unwanted unauthorized access. Thus blockchain supports the process as a whole by eliminating human intervention [6]. Other advantages of blockchain include scalability, safety, and proof of correctness, high performance, self organized. Blockchain has been gaining importance in the field of supply chain management (SCM) as circulation of counterfeit products can be controlled with its upbringing of transparency in number of different industries. This fight against product counterfeiting is done using BlockVerify by which the product details are stored in each of the blocks hence tampering or creating redundancy is not possible. In blockchain each product in the chain will have its own unique identity to reduce market frauds to considerable extents. Blockchain is playing a major part in the Internet of Things by enhancing security and in managing devices more easily. The RFID Tag due to its varied benefits can be used to meet service needs in warehouses. The blockchain can track the shipment of goods. The applicability of blockchain can be tested at a smaller unit of supermarket and warehouses to explore its applicability into supply chain management. Since RFID is intended to be used in these cases, this becomes an IoT application. RFID tags and barcode scanners can be plugged into a blockchain. Data from RFID Readers are sent using wifi sets attached to the devices to other devices in the network as part of communication. The Blockchain data is stored as JSON or files that later undergo hashing and stored as a block. In case of Blockchain data resides everywhere meaning there is no single access point to result in breaching of entire system creating a distributed environment hence it is better than cloud storage

IV. A SURVEY ON POSSIBLE WORKING MODEL

The model proposes use of the RFID technology which is subset of IoT along with NFC and block chain in a supermarket and warehouse management. Taking into consideration, the existence of a back store where the goods would be stored that are brought from the warehouse. The back store will have backroom door that will track the product movement in/out. In the supermarket we are considering RFID readers at the floor door through which the goods will be brought in from the back store and at the front door where customer will carry their goods out of supermarket [7]. We are also implementing the concept of smart shelves and smart trolleys with the NFC implementation which will help in automated payment. The RFID reader is also placed at some specific points on each

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Vol. 5, Issue 5, May 2017

floor premise to trace the location of items. The monitor centre maintained at the back store checks if products in the supermarket have reached the threshold limit then fills the supermarket shelves by movement from back store. In traditional warehouses, employees used to search and scan different floors of warehouses to reach desired products spending hours in gathering. This is solved by the RFID readers which along with the product information also stores each product's shelf details which can be restored at each restocking in an easy manner. The monitor centre updates the blockchain network when the threshold limit has reached which in turn leads to transportation of goods from the warehouse to the back store. It maintains an account of goods that come in and move out to ensure fraud less management. The data from all RFID Readers placed in warehouses, supermarkets and their back store maintains data in blockchains thus data becomes available from any point to create a distributed environment. The top management does not have to worry about the data availability from each point as it is available to all authorized points from anywhere and everywhere. The data storage can be made possible using different techniques like cloud storage but blockchain ensures security and transparency which cannot be tampered by any means. The model brings out that the communication of all devices should be made possible only through blockchain to ensure the same data throughout the network.

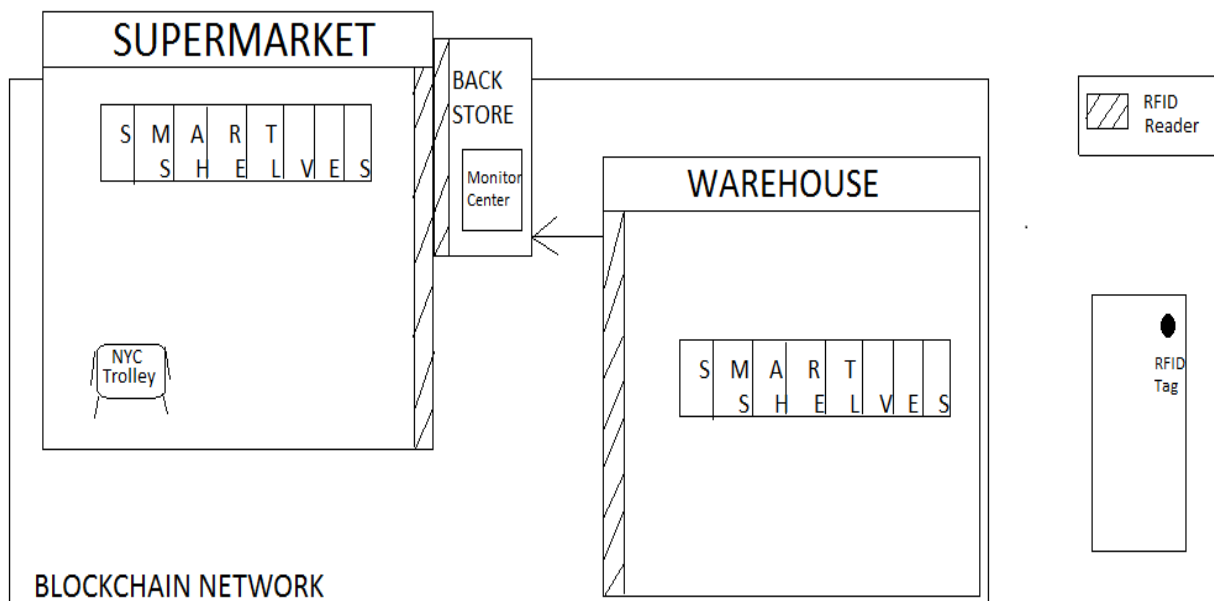


Fig. 3. Flow of Model

The working / flow of tracking the products are as follows:-

- 1) The RFID tags are fixed on each item before they are brought to the back store from the warehouse itself. This is done at production level and the tag will be used to store all the information which will help to trace the item for further processing.
- 2) The Items as per requirement are brought from back store to the supermarket. The backdoor of back store if fitted with RFID readers can easily track the item going out from the store room. This data collected would notify the out movement of item from back store and accordingly number of stocks of that item remaining can be understood. Thus supermarkets can tackle out-of-town situation.
- 3) The items as soon as brought from back store to the supermarket floors are scanned using RFID readers implemented at the doors of market floor. This RFID reader scans the items and after processing the data would notify about the respective shelf numbers for the respective items. The expiry date read using RFID



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Vol. 5, Issue 5, May 2017

readers can allow the employee to follow FIFO principle while placing items on the shelves such that the items with nearer expiry can be sold out first.

- 4) The RFID reader placed on each floor would help in tracing the lost or misplaced items on each floor.
- 5) The RFID system if used on shelves turning them to smart shelves can check if correct items are placed on correct shelves to improve supermarket management, ensuring more compactness.
- 6) The smart trolleys can be implemented with NFC for automated payments [8].
- 7) As soon as a customer selects any product from goods shelves, the smart shelves pass the product information like product EPC (Electronic Paper Code) to the shopping trolley.
- 8) The trolley then calculates the total price. The NFC reader is placed on the trolley which identifies the NFC smart phones of the customer. The shopping trolley generates the order and while NFC reader generates and transmits the order.
- 9) The customer checks the price. The NFC mobile transmits the digital certificate to the third party payment for authentication. The third party returns digital certificate on which customer authenticates and enters the pin.
- 10) NFC mobile transmits the payment request to the third party payment system which authenticates customer accounts.
- 11) Third party system then generates payment order which is passed to the customer who verifies it and then confirmation payment.
- 12) Third party then sends payment accomplished information to the retail super market.
- 13) The retail super market sends payment completed signal to the trolley.
- 14) The trolley can pass the RFID gate only after successful payment through NFC, thus RFID reader at exit door will help in replacement, restocking and also for analysis of popular product.
- 15) If NFC payment is difficult to achieve then usual payment methods can be followed until the practicability of NFC payments are ensured.

Benefits of implementing Item-level RFID in retail super market:

- 1) To prevent theft
Biggest loss is due to shoplifting and internal theft. The RFID can help by tagging all the products with item-level passive RFID tags and equipping all exit doors with RFID readers, all items attempted to be removed without successful payment receipt of it out of premises will be detected and notified. If RFID is programmed accordingly it will alert even if someone tries to destroy or remove the tag. It will also help in pinpointing where, when and how the theft happened.
- 2) To ensure items are fresh and on the radar
When goods are arrived they are scanned to check whether goods are correct. It also helps in verifying whether products are brought in FIFO order according to expiry date.
- 3) Automated Checkout
The RFID readers will scan and carry out payment with the help of NFC hence fully automating the payment and checkout process.
- 4) Automatic misplaced product alerts
The smart shelves will notify when wrong products are placed on shelves.
- 5) To tackle out-of-stock condition
If the product goes out-of-stock it will notify the back store to refill the products thus helping in availability of products to customer. The notification about the availability of products can also be provided to customer online.

Limitations of RFID

- A. There should be up gradation of software and equipment.
- B. To implement RFID tags there should be proper cooperation between supplier and retailer.



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Vol. 5, Issue 5, May 2017

- C. The RFID tags are costly hence incorporating it requires large funding but to be solved in future.
- D. Lack of proper standards
- E. Privacy is the main concern because if tags are placed on all the items, it will continue to be traced even after consumer has purchased it
- F. It uses radio spectrum to transmit its signal hence susceptible to interference and hinder the ability to transmit clear and reliable information to RFID reader.

V. CONCLUSION AND FUTURE WORK

The paper has been done in an attempt to study and put forth the benefits of integrating the technologies. The ways in which the technologies can be combined is brought in the proposed model. The implementation is understood and explained through supermarkets and warehouse communication with the help of devices. The future work on any of the technologies must ensure which devices and in what manner can bring efficiency, intended results in less cost and more profit. The future work must be made based on the requirement of management to ensure best results.

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