



Pharmaceutical Supply chain management

Using IoT and Blockchain
technologies

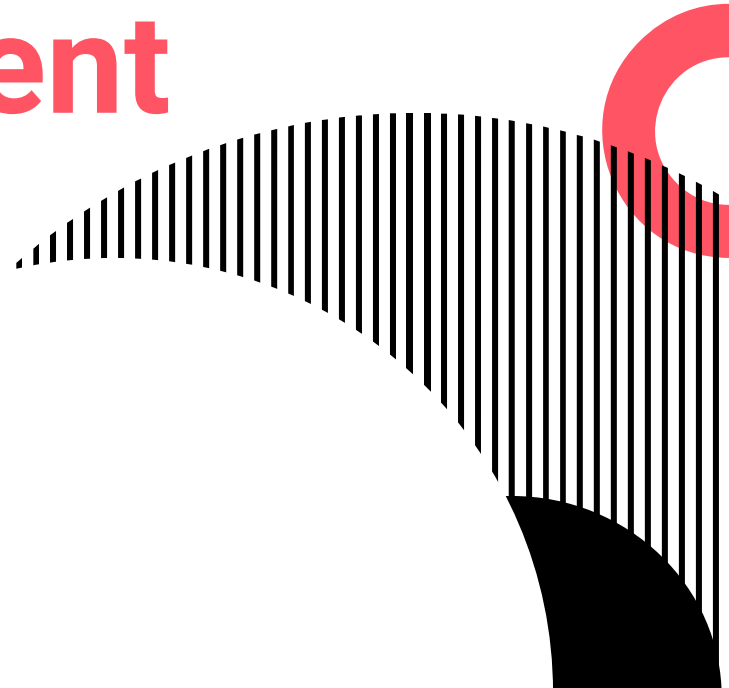




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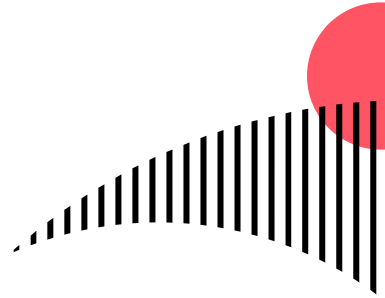
Role of lot and hardware and software
requirements



Problems faced by conventional supply chain

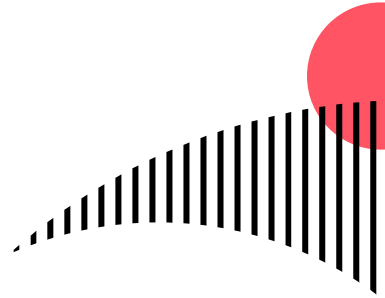
Lack of visibility

Lack of visibility from one end to other end create numerous problem such as fraud, violation in code and conduct etc.



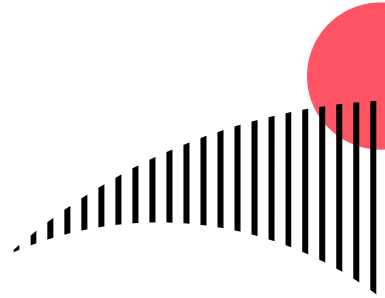
Lack of flexibility

With the effect of globalization, frequently there is change in the demand and indirectly it increases the operation cost.



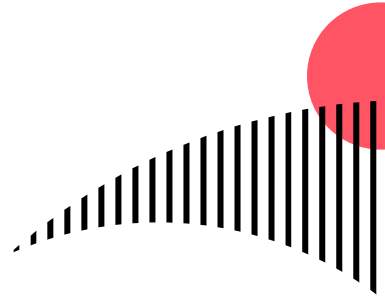
Lack of trust on security

Due to the lack of trust there is no proper information flow from one end to the other end.



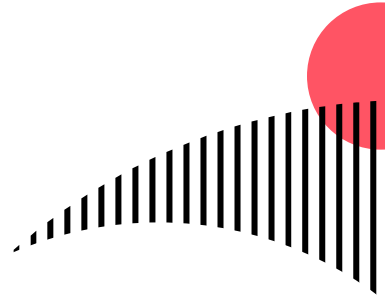
Ineffective supply chain risk management

The supply chain management system is not able to predict risk and is not able to react according to the situation.



Lack of advance technologies

Traditional supply chain management does not have advance technology to deal with the problem that is raised due to sudden changes happened because of the globalization.



A diagram illustrating a blockchain network. A large white circle in the center contains the word "Blockchain" in red. Surrounding this circle is a network of blue nodes (dots) connected by lines, representing a decentralized structure. The background is light gray. There are three distinct colored regions: a red semi-circle at the bottom left, a black and white striped semi-circle at the top right, and a light gray semi-circle at the bottom right.

Blockchain

What is Blockchain ?

Blockchain is a immutable shared ledger that facilitates the process of recording transactions and tracking assets in a business network.

Its first use was Bitcoin the cryptocurrency.

This shared ledger can be used to record any transaction and track the movement of any asset whether tangible, intangible, or digital.



Blockchain

Each user connected to chain has copy of ledger.

Data within the blocks can not be altered by any malicious actor.

Data within the blocks are encrypted with complex algorithms.

Blockchain can be described as:

1. Collection of records.
2. Linked with each other.
3. Strongly resistant to alteration.
4. Protected using cryptography.

Blockchain Properties

- **decentralized control**
- **data transparency and auditability**
- **distribute information**
- **decentralized consensus**



Pharmaceutical Supply Chain

Pharmaceutical supply chain

Manufacturers: Manufacturers receives orders from wholesalers or distributors and ships the finally produced pharmaceutical drugs in large quantities to distributor warehouses.

Governments: Governments impose regulations and taxes on the import and export of drugs/medications.

Wholesaler: The wholesaler propagates the process and distributes pharmaceutical drugs to dispensaries and hospitals. This saves time and effort of manufacturer from the distribution of drugs.

Dispensaries: Dispensaries and hospitals purchase the pharmaceutical drugs from wholesalers. the drugs received by dispensaries and hospitals are given or sold to end-user or patients.



Proposed Work

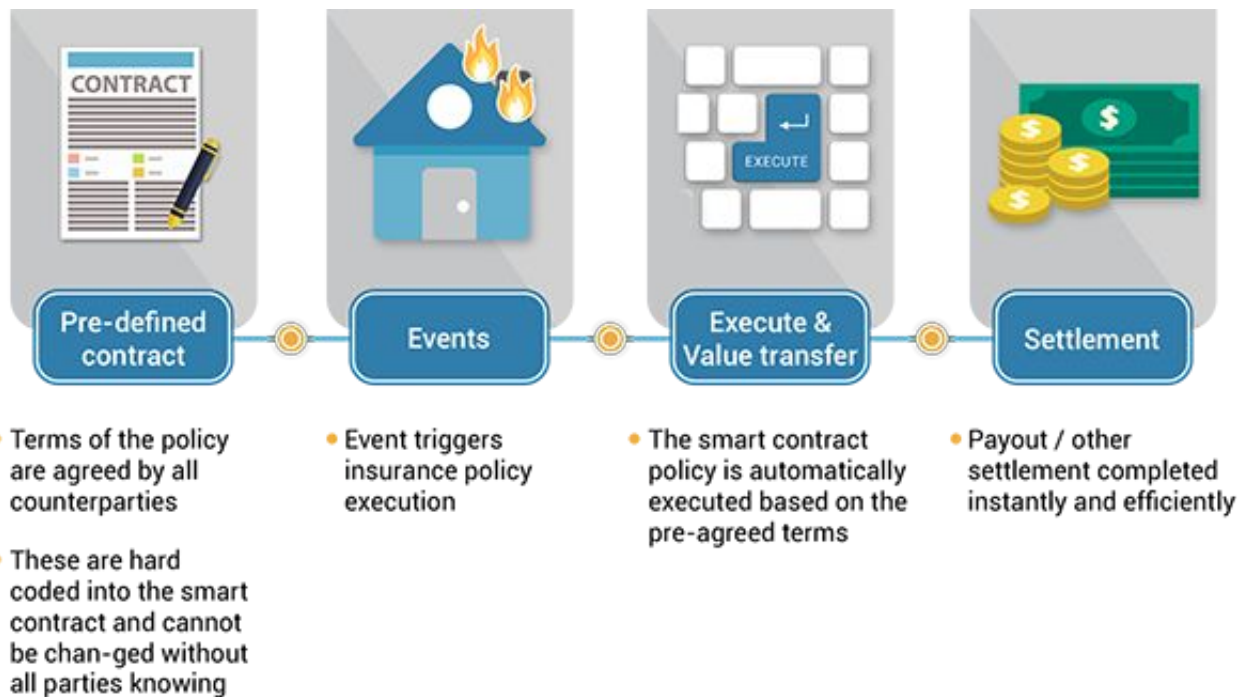
Blockchain and IoT based Supply chain

A blockchain-based supply chain management system is built on a shared distributed ledger which provides an immutable record of all the data related to shipment status, truck status, storage environment conditions and more.

Product source

1. Both the company, as well as the consumer, can track the entire product life cycle throughout the supply chain using blockchain and IoT technologies.
2. Blockchain is an accurate data record where all the communications among IoT devices are saved in the history. It provides instant access to all the information related to the products, the date when a medicine was manufactured, transferred and shipped – a complete record of its journey company to stores.

Smart Contract



Blockchain and IoT based Supply chain

Smart contracts

Blockchain and IoT together ensure safe cargo shipping, even in cross-border trades. The smart contract is an agreed set of terms and conditions for a product which the complete supply chain must follow. The smart contract is unique and cannot be deleted from the system.

Our system

We build a Blockchain framework with following components :

- RFID scanner
- Sensor
- Order creation(Asset creation)
- Order transfer(Asset transfer)
- Smart Contract

Our solution

- We proposed a system where all the stakeholders agree on a set of terms and conditions for the package through a smart contract(business contract).
- In this paper we considered a temperature of -6°C and below which is necessary for medicines to be viable.

Business Contract

If the temperature of package exceeds -6°C , the package must be inspected. The party responsible for the package at the time of the temperature increase is held accountable for all losses.

Architecture/Model

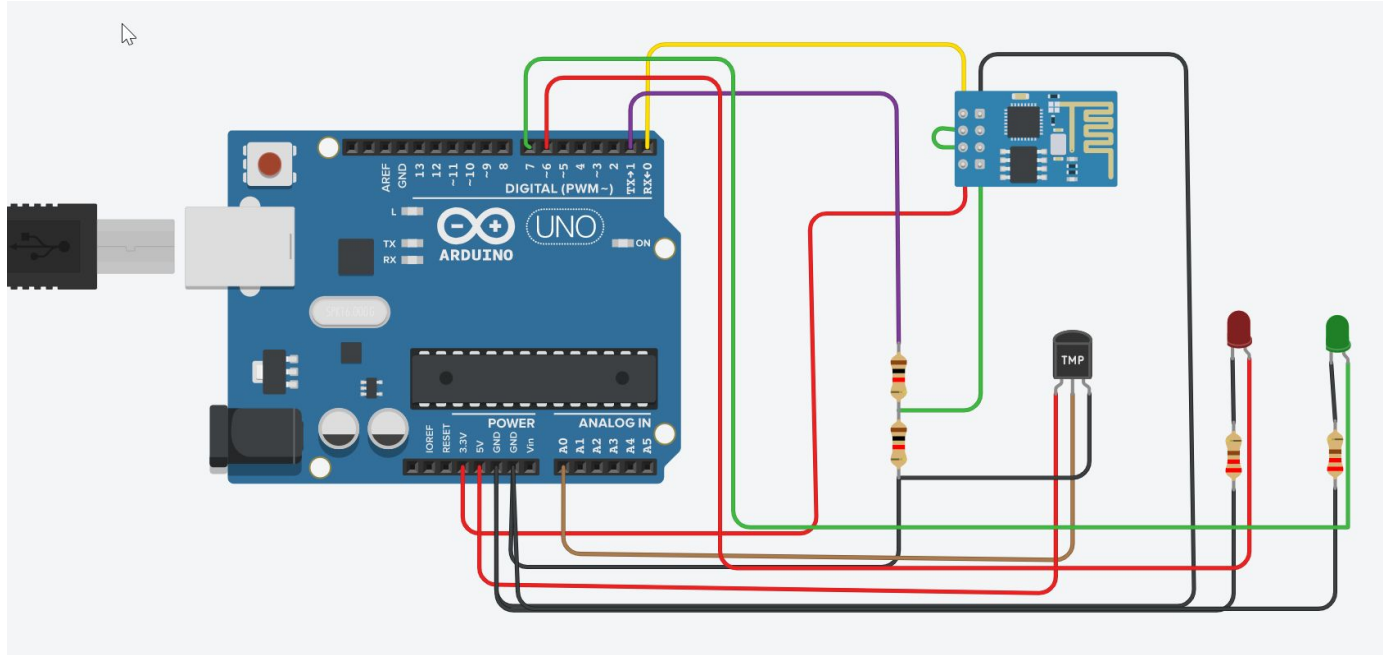


Fig 1.1

Architecture/Model

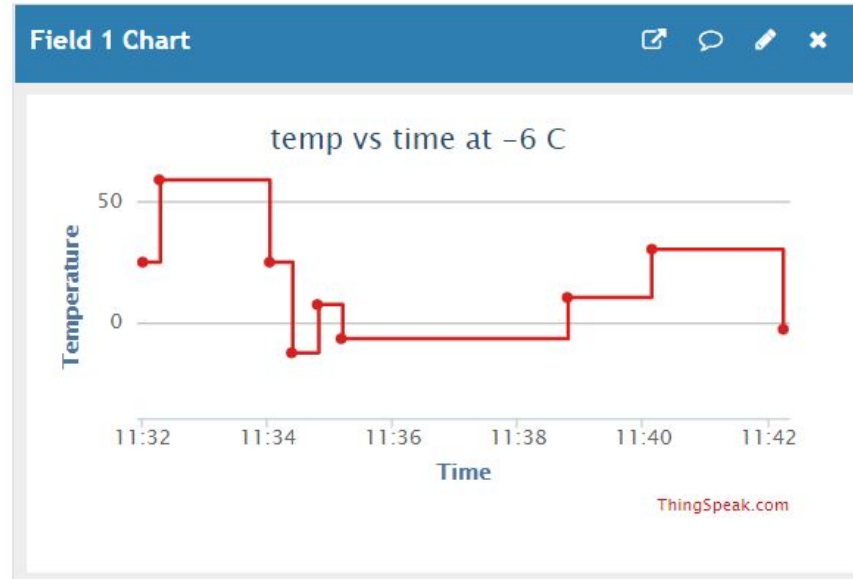
The architecture/circuit for the temperature sensor is given in Fig 1.1 Here we made the circuit on tinkercad and we also plotted the graph by sending to Thingspeak.

Components of Architecture:

- Arduino Microcontroller
- WiFi Module(ESP8266) to send data to Thingspeak
- Red and Green LED
- Temperature sensor(TMP36)

Temperature simulation

Exercise 1





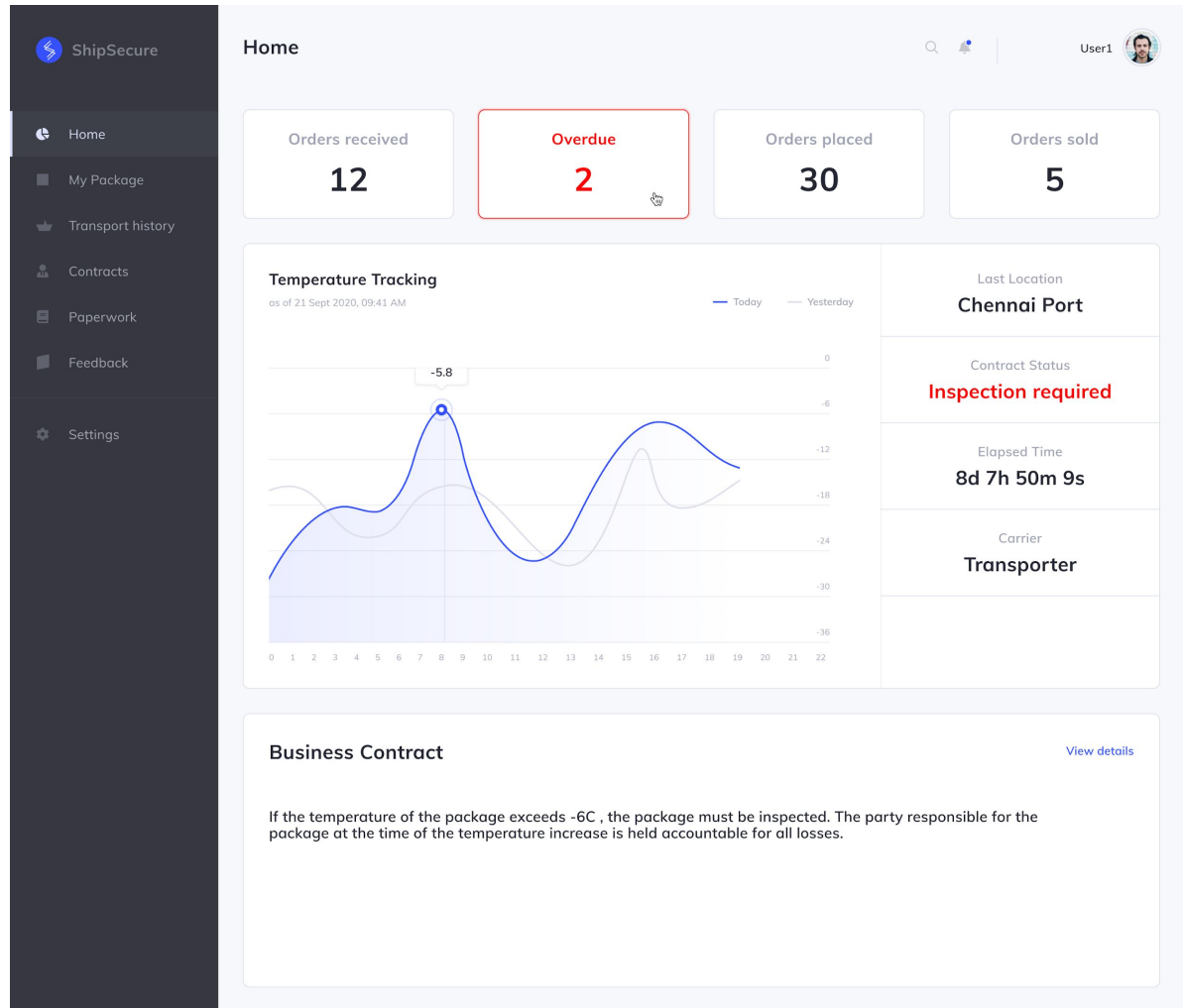
Proposed Platform Mockups



ShipSecure


Dashboard 2.1

Retailer's view



Dashboard 2.2

My package

 ShipSecure

Home

My Package

Transport history



Contracts


Paperwork

Feedback

Settings

PKG100980



User1

My package

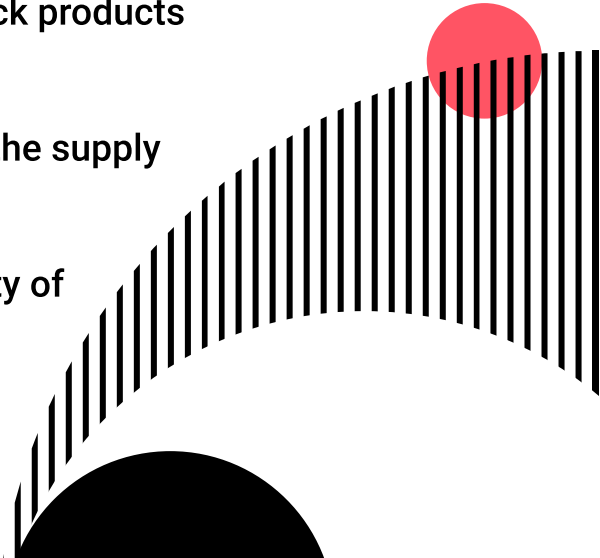
SortFilter

Block	Carrier	Date	Compliance
Block #2452	Transporter	Sept 21, 2020 3:30 AM	INSPECTION REQ
Block #2451	Transporter	Sept 20, 2020 8:00 AM	SATISFIED
Block #2450	Ocean Carrier 2	Sept 19, 2020 7:30 PM	SATISFIED
Block #2449	Drayage Operator	Sept 18, 2020 5:00 PM	SATISFIED
Block #2448	Drayage Operator	Sept 18, 2020 4:00 PM	SATISFIED
Block #2447	Ocean Carrier 1	Sept 17, 2020 2:00 PM	SATISFIED
Block #2446	Ocean Carrier 1	Sept 17, 2020 11:30 AM	SATISFIED
Block #2445	Drayage Operator	Sept 16, 2020 1:00 PM	SATISFIED

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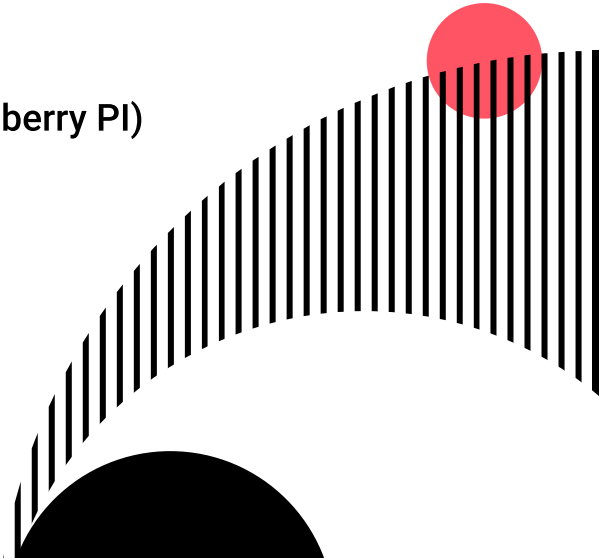
IoT Significance in the proposed work

- Using IoT integrated blockchain system, the product movement data can be shared and accessed.
- IoT enables remote monitoring, control, and management of the healthcare products.
- Automates the identification process of products, trace and track products globally, achieves transparency, reduces time and cost.
- RFID technology is used to track the products at each stage of the supply chain.
- GIS and GPS enable tracking the vehicle location and thus safety of onboard product.



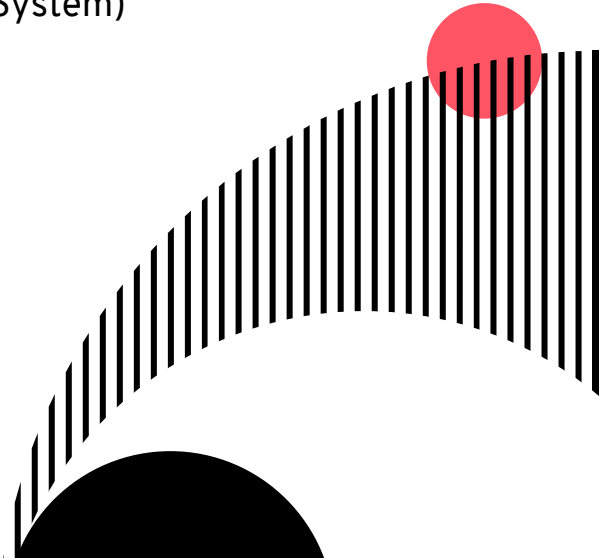
IoT Significance in the proposed work

- WSNs for tracking and controlling the status of various devices or sensors.
- IoT Cloud platforms are used to link IoT devices and their applications.
- Constrained Application Protocol (CoAP) and cloud services can be integrated with the IoT embedded software.
- The embedded software of IoT hardware boards (Arduino, Raspberry PI) are modified to support blockchain and cloud functionalities.



Software and Hardware Requirements

- Ethereum
- JavaScript Interface
- CoAP Server
- GIS (Geographic Information System), GPS (Global Positioning System)
- RFID
- Sensors (Temperature, Humidity, Flow level, etc)
- Wireless Sensor Networks (WSNs)
- IoT Cloud Platform



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