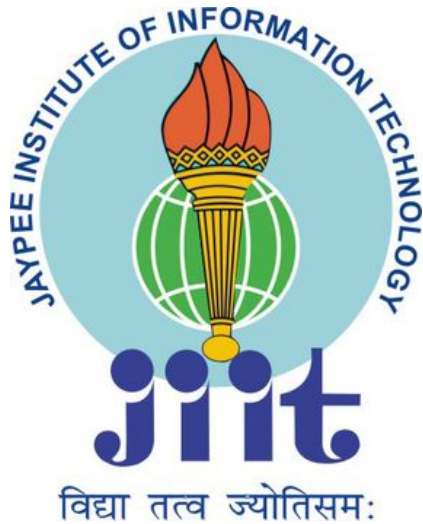


# **JAYPEE INSTITUTE OF INFORMATION TECHNOLOGY**

**DEPARTMENT OF COMPUTER SCIENCE & I.T.**

**2019-2020**



## **MINOR PROJECT**

**OpenTrack**

**Supply Chain Management for the Automotive Industry using  
Blockchain and Machine Learning**

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## **INTRODUCTION**

Automotive Industry is rapidly growing in the world. Due to globalization and competition the automotive supply chain has been undergoing tremendous changes and industry has been exploring various innovative ideas to reduce the use of fake parts used in building the product, to increase customer satisfaction, helping them in reducing their expenses and at the same time making the process of manufacturing automobile parts faster and more efficient.

The automotive supply chain for manufacturing cars and other vehicles is one of the most complex in the world. Indian car industry is small in size, compared to others in the world but has experienced a huge growth rate in the past recent years. But one of the most challenging tasks faced by Indian car industry is authenticity of motor parts used in building cars. Whether they are fake or original? If they are then how manufacturers are supposed to deal with that situation?

As we all have experienced when the system is centralized there will be corruption, because the whole power of any body is in the hands of one person or a single organization. Therefore in order to solve this problem we need something that is decentralized, that is public and available to everyone. Here blockchain ( the saviour ) comes into play.

Recently, Blockchain technology has become a revolution and has attracted the attention of many shareholders who recognize the benefits of this disruptive technology, influencing the supply chain industry, financial industry as well as other sectors. Some of the most common applications of blockchain technologies are their use in the transfer of assets and digital applications and distributed information records created using smart contracts, considered an ideal way to program logical business and operations. It has an impact on all sectors of the industry and thus it offers a vast amount of potential solutions for the Automotive Industry as well.

The integration of the Machine Learning and Blockchain technology in the automotive industry offers interesting solutions to some of the most pressing automotive problems, especially those related to the connected automotive industry. The power of this technology can drive innovation and solutions across the entire automotive ecosystem. Motivated from the facts we propose a Blockchain and Machine Learning based efficient supply chain management system for the Automotive industry.

The main objectives of the project are summarized as follows:

- We propose an Efficient Supply Chain Management System for the Automotive Industry using Blockchain and Machine Learning Technology.
- The simulation is performed on a private Ethereum blockchain platform (*ganache*) and the transactions are performed with the help of Ethereum smart contracts.
- The proposed framework is examined using real-time data statistics using Machine Learning based model, we have employed ARIMA forecasting which stands for Auto Regressive and Integrated moving Average, on the captured dataset of parts sold by the manufacturers to the vehicle manufacturing companies, we have forecasted sales data for the sold parts for the future years which gives us an insight into future demand and which also acts as important insight for inventory management.
- The experimental results show the effectiveness of the proposed model.
- We also discuss the different directions of research that we need to conduct to build a sustainable automotive ecosystem.

## **PROBLEM STATEMENT**

The increased adoption of autonomous cars in the automotive industry is seen to disrupt government regulations, manufacturing, insurance, maintenance services, etc. The integration of innovations in cars is a time-consuming process in terms of investment, development, and validation in the current business model of automotive industries. Considered one of the most advanced sectors with participants ranging from government regulatory parties, manufacturers, suppliers, and vendors to spare parts suppliers, the automotive supply chain becomes a complex and wide ranging ecosystem.

**However, one of the biggest issues in the automotive supply chain industry is counterfeiting products, which is currently estimated at several billion dollars' worth of spare parts.** Counterfeit spare parts often have poor quality, as they enter directly into the supply chain or through online channels, and have an impact on the original equipment manufacturer and spare parts suppliers. Effective planning of production capacity, tracking and tracing of individual parts across the supply chain, and accurate and real-time information has become essential in building a sustainable framework for the automotive industry.

Corporations of the world rely on supply chains when fulfilling their business and IT goals each year. Supply chain processes affect both the speed and efficient service delivery of a company. Speed and efficiency factors cost money, so it is very important to strike a balance between being highly efficient and adhering to cost reduction strategies. We are trying to achieve this balance using an effective supply chain management system.

Along with the issues as stated above there is also an issue of **Efficient Demand Forecasting** which consists of **Sales Forecasting** and **Inventory management** which go hand in hand with each other and have a direct relationship.

## **LITERATURE SURVEY**

A stronger customer-seller relationship is enhanced with Supply Chain Management. Now the first big question arises in our mind is :

- **What is Supply Chain Management?**

Supply chain management (SCM) is the broad range of activities required to plan, control and execute a product's flow, from acquiring raw materials and production through distribution to the final customer, in the most streamlined and cost-effective way possible.

In the paper titled, [“A Study of Evolution and Future of Supply Chain Management”](#),[0] the author quotes - *“Supply Chain Management is a methodology of improving the business processes, making them more resilient, more agile and as a result, more competitive. The main function of SCM is to improve the product or service competitiveness (Machowiak, W. (2012).”*

SCM encompasses the integrated planning and execution of processes required to optimize the flow of materials, information and financial capital in the areas that broadly include **tracking & tracing, demand planning, inventory management, transportation.**

Supply chain management is an expansive, complex undertaking that relies on each partner -- from suppliers to manufacturers and beyond -- to run well.

- **Importance of Supply Chain Management System**

Organizations need a SCM system to establish streamlined supply chain management processes in order to realize the very best value from their spending through supplier analysis of cost, risk and performance.

### **An effective SCM system helps accomplish the following:**

1. Managing contractual obligations to assure a continuous supply and avoid a service company's delivery disruptions.
2. Strengthening supplier relations for systematic synergy with suppliers and different lines of business.
3. Enterprise spending management to assure procurement happens through the right suppliers and reduces costs.
4. Establishing a single comprehensive supplier view and deriving insightful procurement analytics.

### **Relevance of Supply Chain Management Systems**

It is well known that supply chain management is an integral part of most businesses and is essential to company success and customer satisfaction.

- Boost Customer Service:

- **Quality of the product delivered** - Customer expect the quality of the product to be delivered to be as good as when it was manufactured.
- **Right Delivery Place** - Customers expect products to be available at the right location.
- **Right Delivery Time** – Customers expect products to be delivered on time.
- **Right After Sale Support** - Customer expect a good sales support after receiving the product in case of replacement and other queries.

- Reduce Operating Costs:

- **Decreases Purchasing Cost** - Retailers depend on supply chains to quickly deliver expensive products to avoid holding costly inventories in stores any longer than necessary.
- **Decreases Production Cost** - Manufacturers depend on supply chains to reliably deliver materials to assembly plants to avoid material shortages that would shutdown production.
- **Decreases Total Supply Chain Cost** - Manufacturers and retailers depend on supply chain managers to design networks that meet customer service goals at the least total cost.

- Improve Financial Position:

- **Increases Profit Leverage** - Firms value supply chain managers because they help control and reduce supply chain costs. This can result in dramatic increases in firm profits.
- **Increases Cash Flow** - Firms value supply chain managers because they speed up product flows to customers.
- **Decreases Fixed Assets** - Firms value supply chain managers because they decrease the use of large fixed assets such as plants, warehouses and transportation vehicles in the supply chain.

### **Supply Chain Management in the Automotive Industry**

Since the last few years many researches are working on innovative solutions to solve this problem of Supply Chain Management in Auto Industry. Some of the few papers which can be referred to acknowledge the work that has been done in this field so far are below :



- Analyzing this research paper, “[Blockchain’s roles in meeting key supply chain management objectives](#)”, [1] we concluded that there are many startups in the world that are providing solutions with Supply Chain Management in the field of Pharmaceutical and food. The food industry is most likely to be affected by blockchain. With the blockchain the consumers know that the food they are eating are real and authentic. Various steps are taken to increase transparency of fish and sea foods supply chain.
- The paper “[Blockchain-based Distributed Framework for Automotive Industry in a Smart City](#)”[2] proposes a blockchain-based distributed framework for the automotive industry in the smart city. The proposed framework includes a novel miner node selection algorithm for the blockchain-based distributed network architecture. We analysed from the paper that the author has concluded with the remark that **through the shared distributed record keeping structure, communication and collaboration among participants in the supply chain life cycle can be greatly enhanced; thus realizing significant time and cost savings and enabling manufacturers and suppliers to protect their brands against counterfeit products.** In this research, the authors proposed a distributed framework model for the entire life cycle phases of the automotive industry using Blockchain technology.
- The Paper “[A study of forecasting practices in supply chain management](#)” [3] demonstrates forecasting in supply chain management at various areas, the authors depict the scenario of forecasting practices based on secondary data and represent supply chain management role, demand management, collaborative coordination etc.

While analyzing these papers we concluded that the authors have approached Blockchain Technology as a distributed medium for maintaining data

about all the transactions that take place in the Automotive Industry. Adding to this, Machine Learning has been used to forecast the sales & inventory with the help of supply chain management, thus improving the efficiency of the industry with respect to sales and demand prediction.

We have analysed the results and have combined both of these technologies in a single platform which offers a Blockchain based Distributed and Transparent Supply Chain Management System as well as an Efficient Inventory Management with the help of Machine Learning for the Automotive Industry.

## **ARCHITECTURE AND IMPLEMENTATION**

### **ABOUT THE PROJECT :**

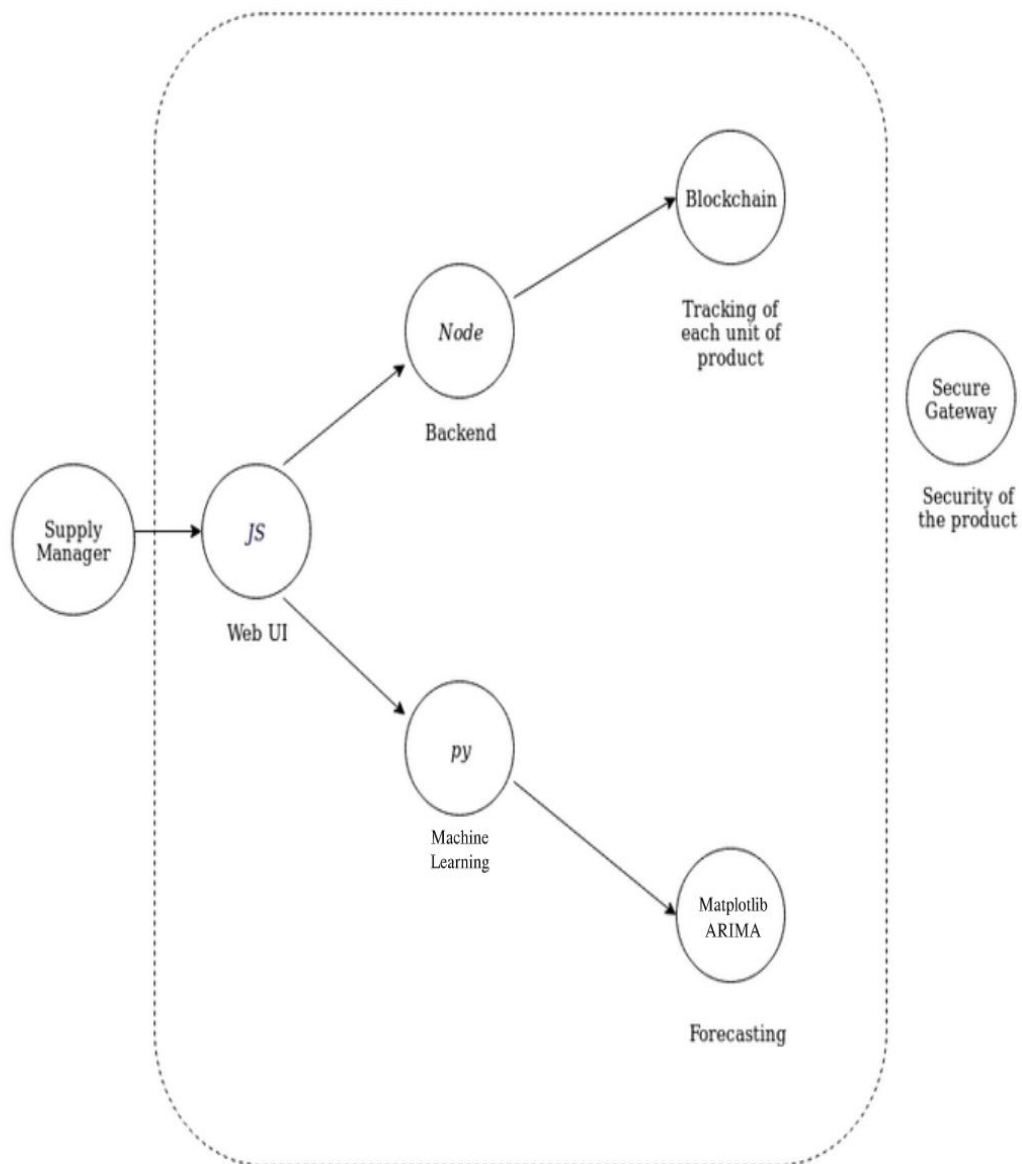
In our project “OpenTrack”, We have implemented an Efficient Supply Chain Management System for Automotive Industries with the help of Blockchain and Machine Learning. We have made a Web-App through which the various parties involved in the Supply Chain of Manufacturing (Parts Manufactures, Car Factory, Dealer etc.) of an automobile can perform the following operations :

- **Step 1 : Building & Registering Parts :** The Spare-Parts Manufacture builds Parts (Eg: Wheels, Transmission, Engine) through the ProductManagement Smart Contract and then registers them to his Company through his Public Address by using the SetOwnership routine of the ChangeOwnership Smart Contract. All of these transactions are recorded on the Blockchain network.
- **Step 2 : Changing Ownership of Parts :** Spare Parts Manufacturer when done building sufficient parts transfers the ownership of the parts from his address to the next party (Car Factory) through its Public Address by using the ChangeOwnership Smart Contract. Having done this, the transaction is loaded onto the Blockchain network as well.

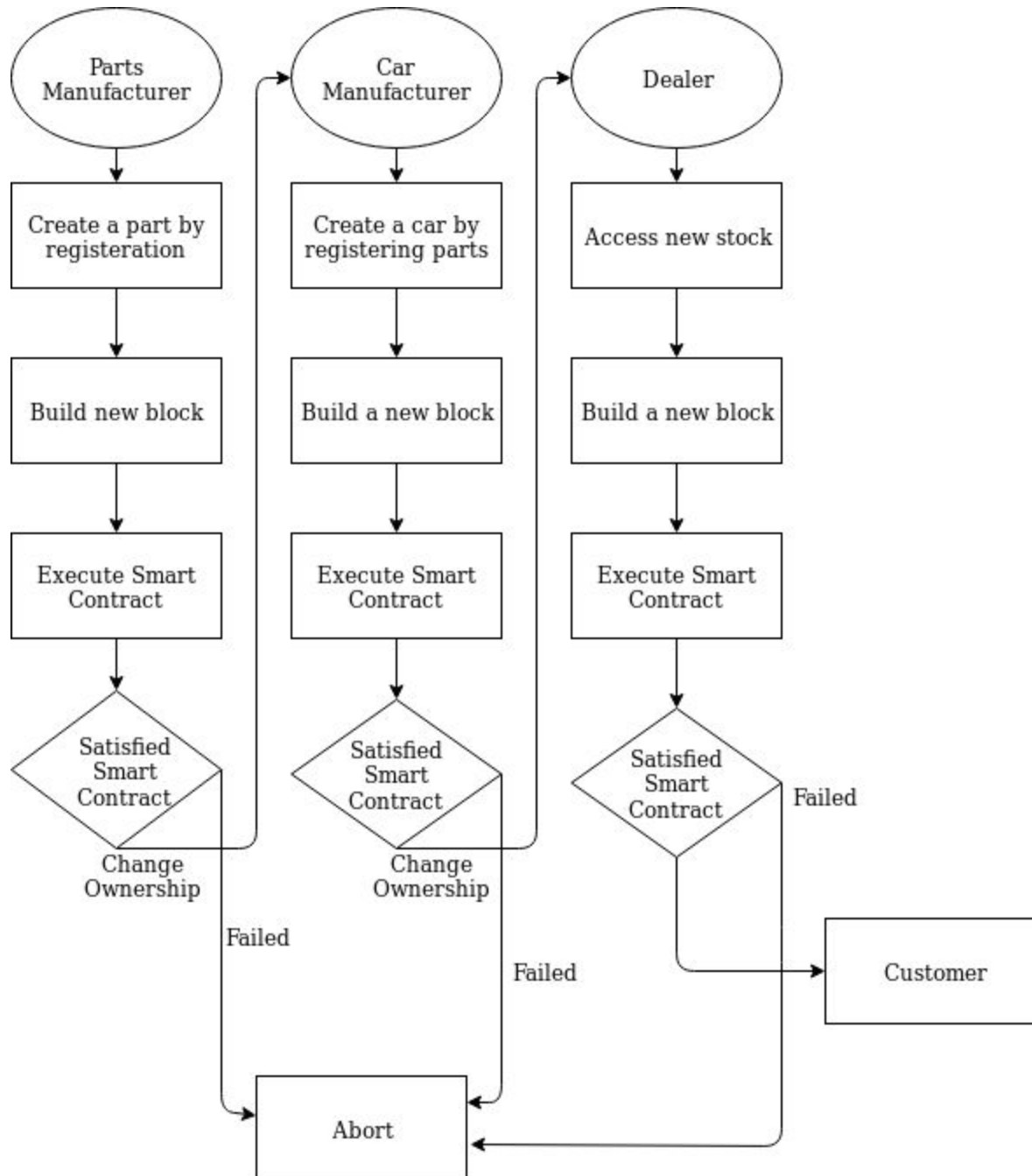
- **Step 3 : Building the Car from the Parts :** The Car Factory having assembled sufficient parts for building a Car (mostly 6) selects the Parts, Builds a car using the BuildProduct subroutine of the ProductManagement Smart Contract and then registers it to his Factory through its Public Address by using the SetOwnership routine of the ChangeOwnership Smart Contract.
- **Step 4 : Changing Ownership of Car to Dealer :** The Car Factory when done building sufficient parts transfers the ownership of the parts from his address to the next party (Dealer) through its Public Address by using the ChangeOwnership Smart Contract. Having done this, the transaction is loaded onto the Blockchain network as well.
- **Step 5 : Verifying the Authenticity of Car & its Spare Parts :** Now, the Car has been delivered to the Dealer. So, now the Dealer can take a look at all the parts of the Car and where they had been manufactured and at what timestamp. This will help him as well as the customer who buys the car from him verify the quality and authenticity of the spare-parts being used in the Car with the help of the transparent Blockchain network.
- **Step 6 : Sales & Inventory Forecasting through Machine Learning :** Now we examine our proposed framework using our simulated real-time data statistics using Machine Learning based model that is Auto Regressive and Integrated Moving Average [ARIMA] model on the captured dataset of parts sold by the manufacturers to the vehicle manufacturing companies in different Indian states, after applying ARIMA model we have forecasted sales data for the sold parts for the future years which gives us an insight into future demand and which also acts as important insight for inventory management since sales forecasting and inventory management goes hand in hand.

## PRODUCT DESIGN

### Architecture Design



- **FLOW CHART**



## **TOOLS/TECHNOLOGIES USED:**

- **Frontend Stack:**

- **Bootstrap** - A CSS library for building user interfaces.
- HTML5, CSS3, Script.Javascript

- **Backend Stack:**

- **Node.js** - A javascript runtime build for running javascript outside browser.

- **Blockchain :**

- **web3.js** - web3.js is a collection of libraries which allow you to interact with a local or remote ethereum node, using HTTP or IPC connection.
- **Ganache-cli** - ganache-cli is a part of Truffle suite for Ethereum Development and a command line version of **ganache** . Also, it is Fast Ethereum RPC for development. Ganache helps us to quickly fire up a personal Ethereum blockchain which you can help us to run tests, execute commands, and inspect state while controlling how the chain operates.
- **Truffle** - Truffle is an environment for deploying, testing and compiling smart contract, linking, deployment and binary management.
- **MetaMask** - It's an extension used to run Ethereum Apps on your browser with running full Ethereum node.
- **Solidity** :*Solidity* is an object-oriented, high-level language for implementing smart contracts

- **Machine Learning :**

- **Statsmodels:** It is a Python module that provides classes and functions for the estimation of many different statistical models, as well as for conducting statistical tests, and statistical data exploration, we used statsmodel to implement ARIMA forecasting.
- **Matplotlib:** Matplotlib is a Python 2D plotting library which produces publication quality figures in a variety of hardcopy formats and interactive environments across platforms. Matplotlib can be used in Python scripts, the Python and [IPython](#) shells, the [Jupyter](#) notebook and web application servers.
- **PyLab:** PyLab is a module that belongs to the Python mathematics library Matplotlib. PyLab combines the numerical module numpy with the graphical plotting module pyplot.

## SCREENSHOTS

```

→ OpenTrack git:(sidntrivedi012) ✖ ganache-cli -m "sell grid mask they april art amount cook easily fire loyal naive"
Ganache CLI v6.7.0 (ganache-core: 2.8.0)

Available Accounts
=====
(0) 0x6C358338b9641D525B709306730747C046f920E9 (100 ETH)
(1) 0xcA1b34A829cADc6F6b2A2c19036fbab420888c6b (100 ETH)
(2) 0x8B92cd1b2289f2308650ea0F5488C579B0592081 (100 ETH)
(3) 0x8636789db4627d80f5585e4fe3cEAB2309d7040A (100 ETH)
(4) 0xf774cc1dfE3aD883C0B14E768bf091a25EbAA1c0 (100 ETH)
(5) 0xf2C16F170CF75635eb485FF33d9a03C9f1379678 (100 ETH)
(6) 0xb040D81933e22e5A621cFd6bD9f774ef75964024 (100 ETH)
(7) 0xB3b277c3c2cE95Ef98495636cb144156a4fC0F9F (100 ETH)
(8) 0x89611b1ff220222295A18BD0DE3EcBa7545b6ee3 (100 ETH)
(9) 0xFE2F8d3D034C6ef580728F915423a144db4F775 (100 ETH)

```

**Fig 1: Accounts generated by ganache-cli**

```
-> OpenTrack git:(sidntrivedi012) ✖ truffle migrate

Compiling your contracts...
=====
> Everything is up to date, there is nothing to compile.

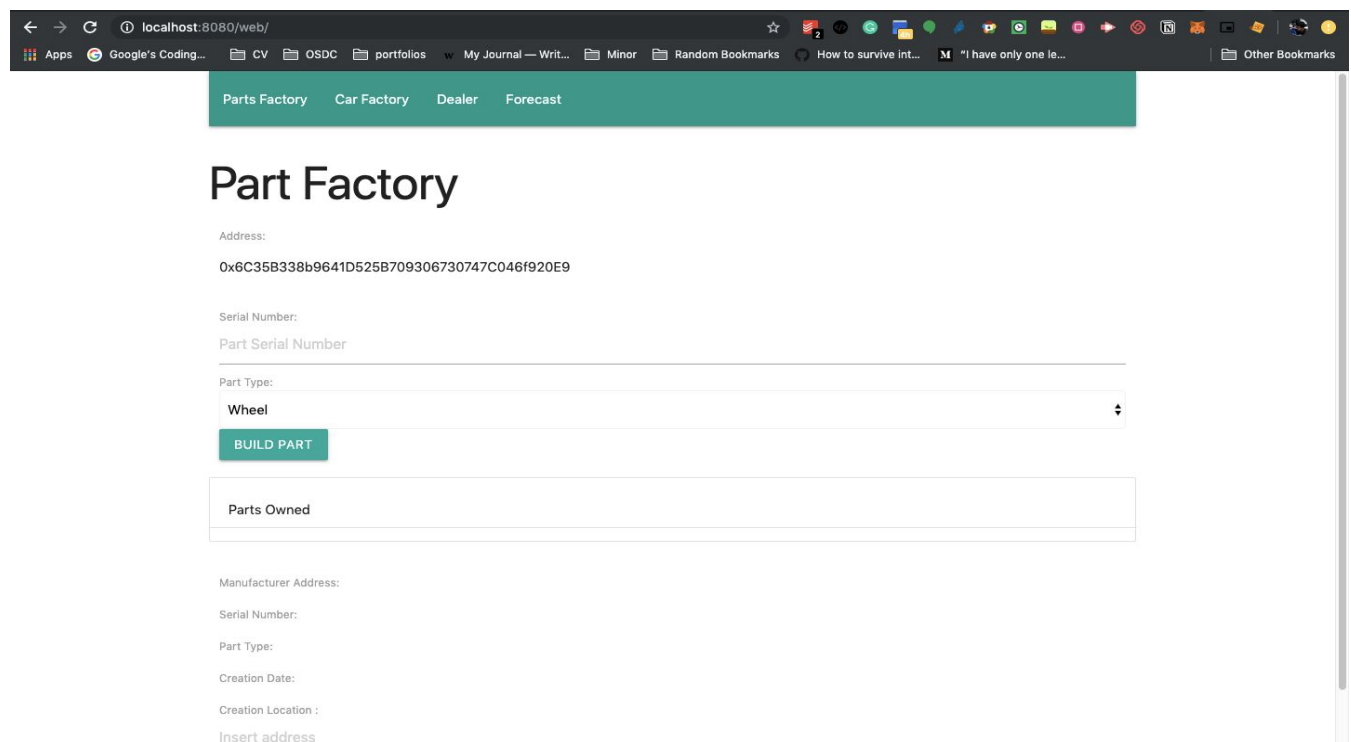
Starting migrations...
=====
> Network name:    'development'
> Network id:      1574717370818
> Block gas limit: 0x6691b7

1_initial_migration.js
=====

Deploying 'Migrations'
-----
> transaction hash: 0x336860225305c4c377e38c6b4ed477eebbd6a4f392a088cac07a497671bd92ec
> Blocks: 0        Seconds: 0
> contract address: 0x0c3Ff40c345218b9b839B5C48DD5575BB30EEecF
> block number:     1
> block timestamp:   1574717418
> account:          0x6C35B338b9641D525B709306730747C046f920E9
> balance:          99.99477214
> gas used:         261393
> gas price:        20 gwei
> value sent:       0 ETH
> total cost:       0.00522786 ETH

Deploying 'ProductManagement'
-----
> transaction hash: 0x5627827dddbcb19c2da0660d447a93a6870dc63134dfe862ce45330119ddf434
> Blocks: 0        Seconds: 0
> contract address: 0x38f1b2f36F6144bA888AEAc327f551EFc0d8cC58
> block number:     2
> block timestamp:   1574717418
```

**Fig 2:** Compiling Ethereum Smart Contract with truffle



**Fig 3:** Registration of parts(wheel,engine and transmission)



CA-15456

Part Type:

Wheel

BUILD PART

Parts Owned

0xd03dad6611a97edc6ae674ee1ef91686071161c90973d544be19d22be33c2df6

0xdac7e1d51ffa29d31b723d188403dcd5ded99b63f744b3a4333c29116b88b42e

Manufacturer Address:

0x6C35B338b9641D525B709306730747C046f920E9

Serial Number:

CA-15456

Part Type:

Wheel

Creation Date:

03:06:29 26/11/19

Creation Location : [Uttar Pradesh](#)

0xcA1b34A829cADc6F6b2A2c19036fbab420B88c6b

CHANGE OWNERSHIP

**Fig 4 : Changing Ownership to Car manufacturer**

Parts Factory Car Factory Dealer Forecast

Car Factory

Address:

0xcA1b34A829cADc6F6b2A2c19036fbab420B88c6b

Parts Owned

0xdac7e1d51ffa29d31b723d188403dcd5ded99b63f744b3a4333

BUILD CAR

Cars Owned

Serial Number:

Car Serial Number

Manufacturer Address:

Serial Number:

Parts:

Creation Date:

Creation Location:

Insert address

CHANGE OWNERSHIP

**Fig 5:Part Transferred to Car Manufacturer**

Parts Factory

Car Factory

Dealer

Forecast

# Car Factory

Address:

0xcA1b34A829cADc6F6b2A2c19036fbab420B88c6b

Parts Owned

Cars Owned

0x2a5c3b3e3178453108391e33182c12b81752675170ba38a606

Serial Number:

CA-15462

BUILD CAR

Manufacturer Address:

Serial Number:

Parts:

Creation Date:

Creation Location:

Insert address

CHANGE OWNERSHIP

Fig 6 : Registering Car from parts

Car Factory

Address:

0xcA1b34A829cADc6F6b2A2c19036fbab420B88c6b

Parts Owned

Cars Owned

0x2a5c3b3e3178453108391e33182c12b81752675170ba38a606

Serial Number:

CA-15462

BUILD CAR

Manufacturer Address:

0x6C358338b9641D525B709306730747C046f920E9

Serial Number:

CA-15462

Parts:

0xdac7e1d51ffa29d31b723d188403dcd5ded99b63f744b3a4333c29116b88b42e  
0x4219485bbe3fd8bde0000712803b3ecaa36fb6462c0e4fa5a7f7af11e3d02d7c  
0x42949f817a5d39253aa65ce36d84afee34359d2d5daf3077a1febda8a64f872a  
0x72c37d6395e0b1aaa7a5793d220e52bffcd171eb3e8fa4e04f75be3ed56fa079  
0xa9ea86396f28b97a42826b6650be134661d7e9832d2a43c15d93e29694539c8a  
0x45103d7e8f1789520e77be27f185fef15843b671886f81f5787cacb89342494a

Creation Date:

03:08:32 26/11/19

Creation Location:

Uttar Pradesh

Insert address

Fig 7: Addresses of parts used in building Car

Address: 0x8B92cd1b2289f2308650ea0F5488C579B0592081	
Cars History	Parts History
0x2a5c3b3e3178453108391e33182c12b81752675170ba38a606	0xb523e70c992fa52e1a9b1718b3b85340f6cbaeee651e331d97c
0xbb6a89939775bcd7352634a20c3ddef2efb1bed9939b85aa0	0xce10ea8eb6e4bdb1f91de630bdf77159d104e6f77881b575530
Owner History: 0x6C35B338b9641D525B709306730747C046f920E9 0x8B92cd1b2289f2308650ea0F5488C579B0592081	0x7f288b43285a4dc4a64405dce3b814b1e80a3e0e3ff8fdb956
	0x7d69050d1cbd276b9264bd98399d392327bd7549aa8113769
	0xd03dad6611a97edc6ae674ee1ef91686071161c90973d544be1
	0xdac7e1d51ffa29d31b723d188403dcd5ded99b63f744b3a4330
	0x4219485bbe3fd8bde000712803b3ecaa36fb6462c0e4fa5a7
	0x42949f817a5d39253aa65ce36d84afee34359d2d5daf3077a1
	0x72c37d6395e0b1aaa7a5793d220e52bffcd171eb3e8fa4e04f76
	0xa9ea86396f28b97a42826b6650be134661d7e9832d2a43c15
	0x45103d7e8f1789520e77be27f185fef15843b671886f81f5787c
	Owner History: 0x6C35B338b9641D525B709306730747C046f920E9 0xcA1b34A829cADc6F6b2A2c19036fbab420B88c6b 0x8B92cd1b2289f2308650ea0F5488C579B0592081

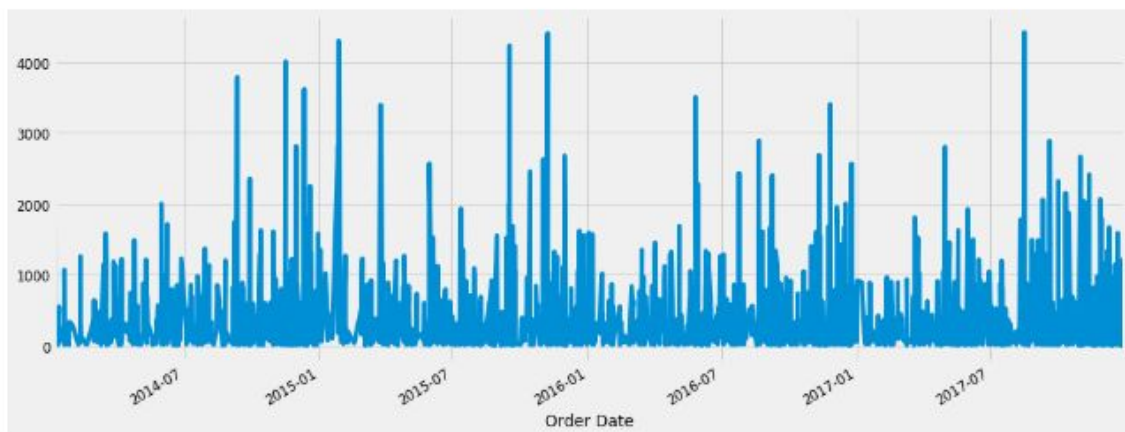
**Fig 8 :** Details of the ownership of cars & its parts

# OpenTrack Forecasts

Time Series Analysis & Sales Forecasting of Motor Parts

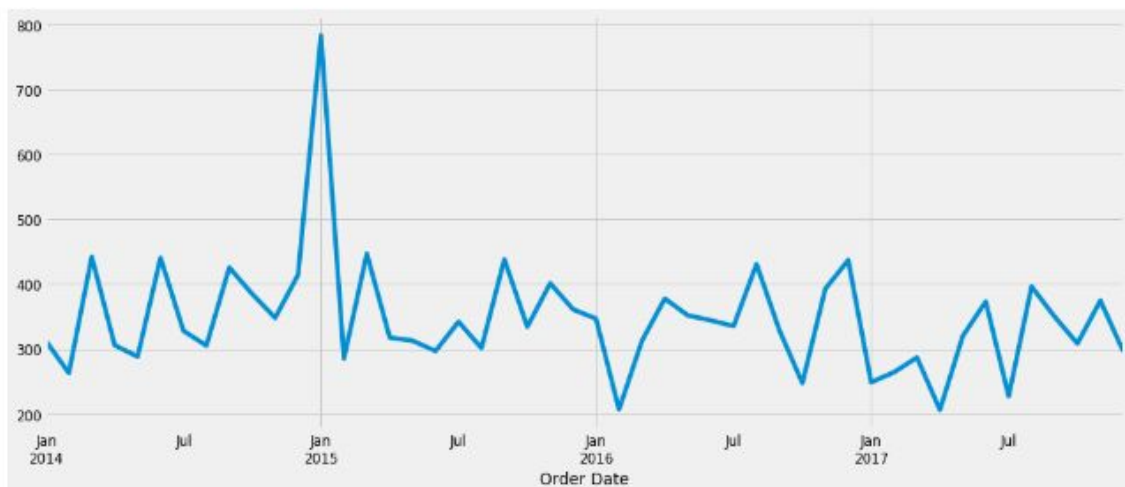
## Plot 1

Plotting Sales Without Resampling to months **or** any other offset.



## Plot 2

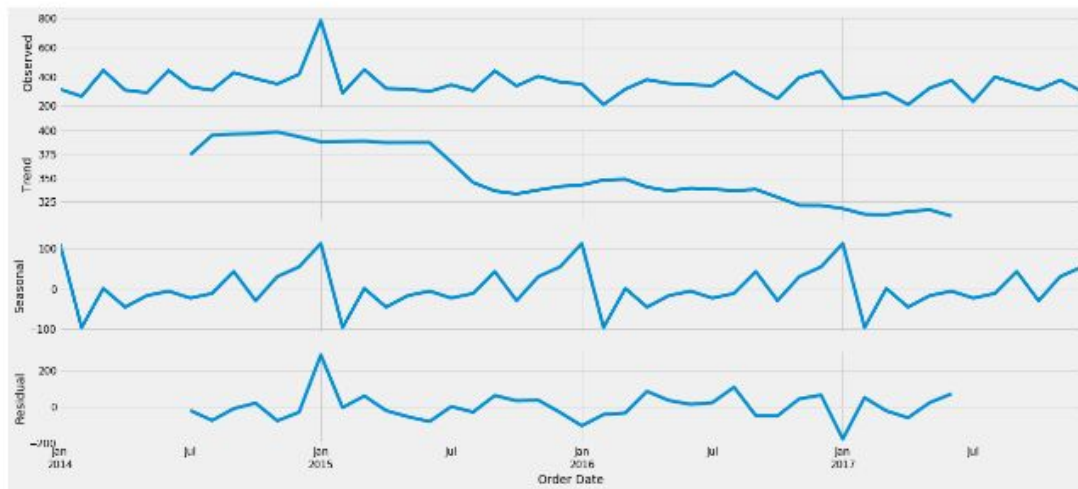
Plotting Sales data by Resampling to month start frequency.



## Plot 3

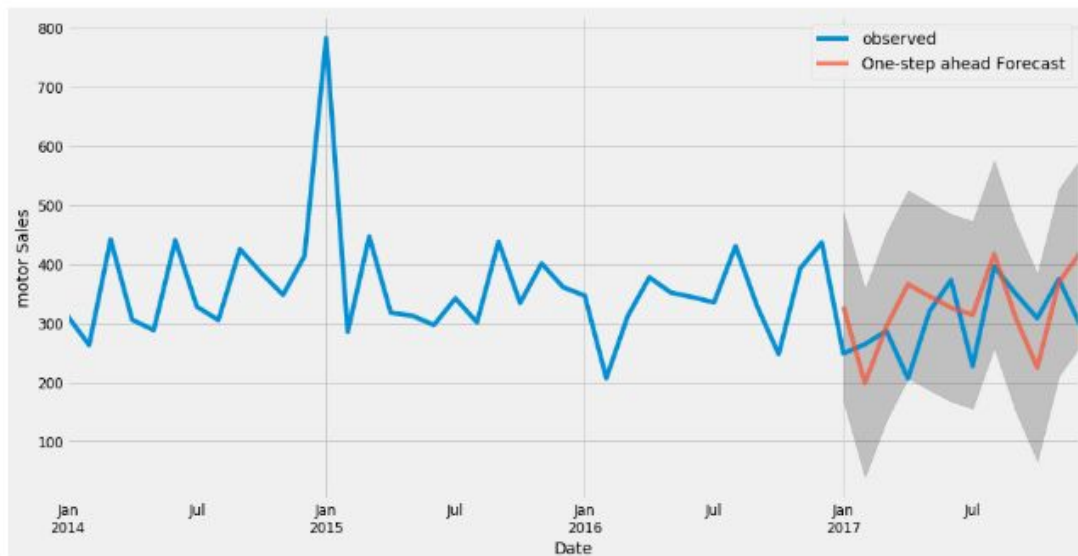
Decomposing Time Series Data into Distinct Components.

- Observed
- Trend
- Seasonal
- Residual



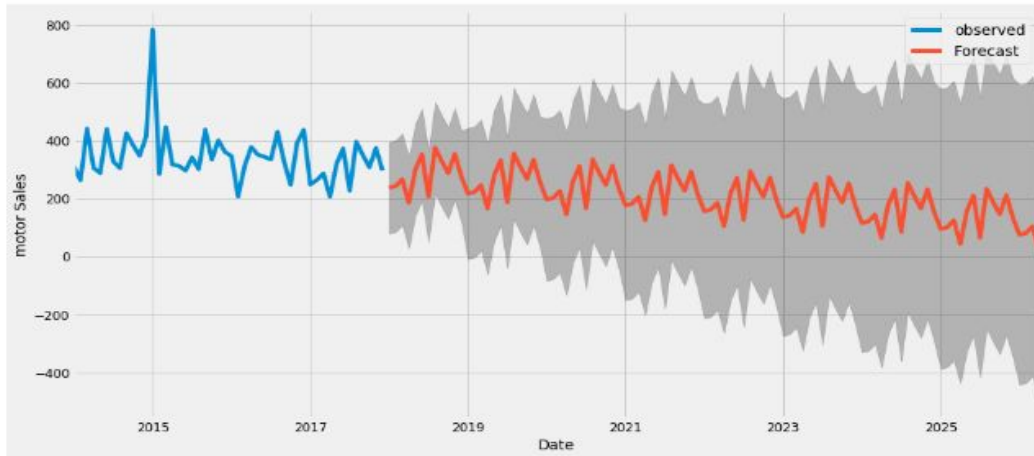
## Plot 4

Validating Forecasts



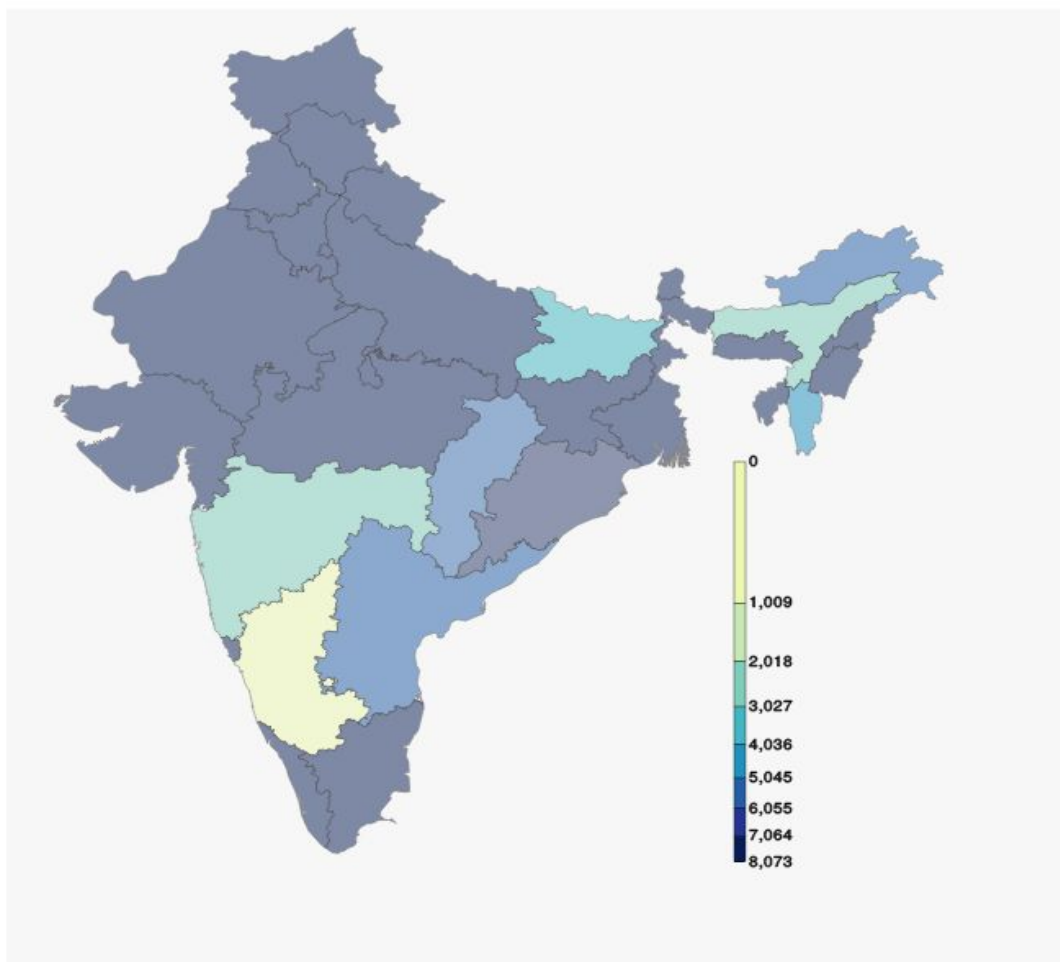
## Plot 5

Finally Producing & Visualizing forecasts



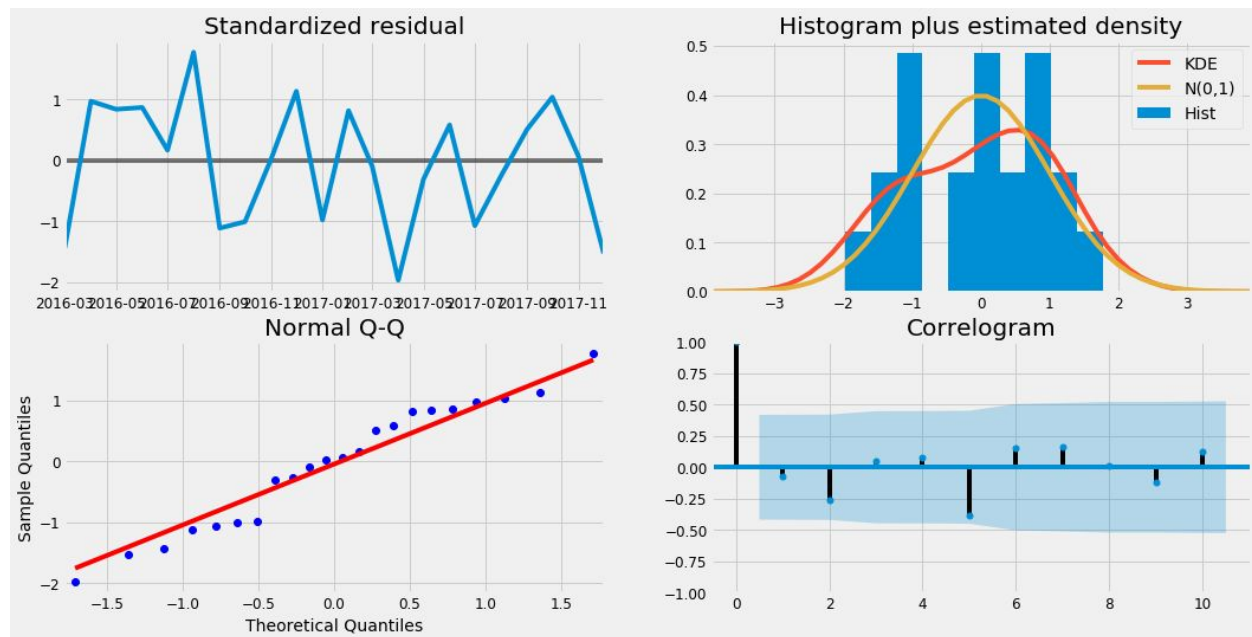
## Plot 6

State wise sales of various Motor Parts.



## **PERFORMANCE**

The performance achieved in ARIMA forecasting can be interpreted via this graph.



The Root Mean Squared Error of our forecasts is **76.88**

The Mean Squared Error of our forecasts is **5911.26**

## **EFFECTIVENESS OF PROPOSED SOLUTION**

In the supply chain, manual paper-based processes and humans carrying documents such as sales records are eliminated. As mentioned in the research paper - [“Blockchain’s roles in meeting key supply chain management objectives”](#)[4], Maersk’s case indicates that all the documents for shipping containers can be fully digitized and the containers can be tracked. The case of Everledger suggests that blockchain can make it easier to automate supply-chain certification processes. Modum’s example makes it clear that blockchain makes it possible to allocate just the right amount of resources to perform shipping and other activities.

Our proposed solution which incorporates both Blockchain and Machine Learning if used wisely and properly will help to improve the efficiency of the

Demand-Supply Model of the industries. Also, it can be applied to various other sectors and can help reduce corruption and middlemen-bribery practices in various industrial transactions. Many organizations like Walmart are already working on improving the efficiency of their Supply Chain Management Systems. With this solution, many huge automotive industries which have a large Supply Chain can easily manage their inventories and can also prevent the inclusion of fake parts and tools in their automobiles.

### **FUTURE ASPECTS :**

Blockchain is a technology that is ready to be explored by the automotive industry. As an emerging technology, the blockchain will continue to evolve due to its ability to disrupt industries and areas of research in various sectors. The blockchain works as a distributed value of the system, it depends heavily on collaboration with stakeholders, suppliers and competitors, etc. For the realization of a sustainable IoT network of smart cities, blockchain technology can wield positive impacts.

- Co-integration with IoT platform : Co-integration of platform with IOT to scan the QR/Serial No. of parts with the help of a scanner.
- Standardization : Currently, due to the lack of common standards, different organizations are developing their own blockchain and standards. In the public domain, blockchain-based applications are supposed to work within the regulatory framework.
- Structurally adaptable: The structural design of smart contracts directly affects the adaptability of the entire framework as an attribute of quality needed by many industries.



## **COMPREHENSION & AWARENESS**

- **Top Startups working on Supply Chain Management**

- [Blockverify](#) – A startup focusing on improving anti-counterfeit measures. Currently, the company verifies products, goods, merchandise, and transactions.
- [Everledger](#) – A blockchain startup that helps track the provenance of luxury items (like diamonds). Additionally, the startup assists in fraud and risk reduction.
- [Origintrail](#) – A blockchain-powered data exchange protocol for interconnected supply chains.
- [Provenance](#) – An emerging blockchain company making information open and accessible all along the supply chain and at the point of sale.
- [Shipchain](#) – Blockchain-powered logistics and freight platform pursuing smart contract applications in the logistics industry.
- [Skuchain](#) – Applies the cryptographic principles developed in the Bitcoin network to security and visibility for the global supply chain.
- [SyncFab](#): Available capacity, transparent order tracking, and purchase order management secured by blockchain.

## **CONCLUSION**

In the automotive industry, inheriting the features of blockchain and machine learning has helped the organization to reduce their cost by employing sales and inventory forecasts. It not only helps organizations to keep track of their products via inventory management but also helps them to identify the fake products. In this project we proposed a framework for automobile (car) industry which is a Supply Chain Management solution designed with the help of BlockChain and Machine Learning. In the future work we will extend our framework and integrate it with

Internet of things by using IOT devices and automating so many tedious tasks such as scanning QR codes of the shipped products and henceforth maintaining data in real time and also using our blockchain based framework in the backend.

Blockchain has helped and can also help achieve robust cybersecurity measures. Trust and security can thus be improved with blockchain. At the same time, more resources need to be devoted to addressing concerns such as participation of diverse supply chain members and enrichment of the existing blockchain ecosystem in order to realize the full potential of blockchain.

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