MARMARA UNIVERSITY

INSTITUTE FOR GRADUATE STUDIES

IN PURE AND APPLIED SCIENCES

CONTRIBUTIONS OF BLOCKCHAIN TO THE SUPPLY CHAIN AND LOGISTICS IN THE VEHICLE INDUSTRIES PLATFORM

FATİH KAYA

MASTER THESIS

Department of Endustrial Engineering

Thesis Supervisor

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BLOCKCHAİN TEKNOLOJİSİNİN ARAÇ SANAYİSİ PLATFORMUNUN TEDARİK ZİNCİRİ VE LOJİSTİK ALANLARINDA KATKILARI

Bitcoin 2016 yılındaki büyük yükselişinden sonra, bitcoin ve arkasındaki teknolojinin hayatımıza ve teknolojiye neler katabileceği araştırılmaya başlandı. Blockchain teknolojisi tüm endüstrilerin devrimi olabilir. Blockchain, kullanıcılara dağıtılmış bir defter (depolama birimi) sunan, verileri değiştirilemeyen, hack edilemeyen bir teknoloji sunmaktadır. Blockchainle birlikte insanlığa şeffaf, güvenli, değiştirilemeyen, anonim ve açık kaynaklı teknoloji sunulmaktadır.

Tedarik zinciri ve lojistik faaliyetleri sürekli ve etkin olarak faaliyetlerine katkı sağlayan yeni noktalar veya aracılar eklenerek genişletmektedir. Bununla birlikte genişleyen faaliyetlerle evrak, iletişim, şeffaflık, kontrol zorluğu, dolandırıcılık, üçüncü taraflara güven gibi sorunlar yaşanmaktadır. Çalışmada, tedarik zinciri ve lojistik faaliyetlerinde blockchain kullanmanın tedarik zinciri alanındaki örnekleri verilmektedir. Bu çalışmada araç endüstrisinde blockchain teknolojisinin kullanımına odaklanılmıştır. Çalışmanın asıl amacı araç endüstrisi organizayonlarını bir çatı altında toplayarak blockchain teknolojisinin endüstriye katkılarını ortaya koymaktır. Bu kapsamda yapılan çalışmalar incelenmiş, tezde yer verilmiş ve platformun bütün paydaşlarına katkıları değerlendirilmiştir. Blockchainle dağıtılmış defter teknolojisinin güncel sorunları olmakla birlikte çok kısa bir gelecekte, bu teknolojinin tereddüt etmeden tüm endüstrilerde kullanılabileceği düşünülmektedir.

Keywords: ***Blockchain, Tedarik Zinciri, Tedarik Zinciri Yönetimi, Araç Endüstrisi***

ABSTRACT

CONTRIBUTIONS OF BLOCKCHAIN TO THE SUPPLY CHAIN AND LOGISTICS IN THE VEHICLE INDUSTRIES PLATFORM

After the great rise of bitcoin in 2016, what bitcoin and the technology behind it could add to our lives and to the technology began to be examined. Blockchain technology can be the revolution of all industries. Blockchain provides users with a distributed notebook (entity of storage) and offers a non-hackable technology that can't be tampered with. With Blockchain, transparent, safe, unchangeable, anonymous and open source technology is offered to humanity. Supply chain (SC) and logistics activities are expanding by adding new points or intermediaries that contribute to their activities continuously and effectively. However, there are problems with expanding activities such as paperwork, communication, transparency, difficulty of control, fraud, and confidence in third parties. In this study, in SC and logistics activities, the examples of use of Blockchain in the area of SC are given. This study focuses on Blockchain technology in the vehicle industry. The ultimate goal of this study is to gather all vehicle industry organizations under one platform to lay out the contributions of blockchain technology. To this end, the respective literature has been studied, and its advantages for all the organization partners have been evaluated. Although Blockchain has the current problems of distributed notebook technology, it is thought that in a very short term, it can be used in all industries without hesitation.

Keywords: ***Blockchain, Supply chain, SCM, Vehicle industry***

LIST OF ABBREVIATIONS

Amb-Net : Ambrous net

AI-based : Artifical Intelligent based

DLT : Distributed ledger technology

EDCC : Executable Distributed Code Contract

EDI : Electronic Data Interchange

ERP : Enterprise resource plan

IOT : Internet of Things

IPFS : InterPlanetary File System

MOBI : Mobility Open Blockchain Initiative

OEM : Original Equipment Manufacturers

P2P : Person To Person

RFID : Radio-frequency identification

SCM : Supply Chain Management

TRI : Toyota Research Industry

Vanet : Vehicular Ad Hoc Network

XML : Extensible Markup Language

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PART I. INTRODUCTION

Today, supply chain (SC) is composed of multiple participants such as suppliers, transporters, retailers, consumers etc. Companies always need to take information of services or products correctly and just in time because they have to make payments to warehouses, employees etc. Firms operate with more than one employee in SC and logistics activities and work with many companies. They are concerned about their relations business to business and/or business to employee. Their employees could be involved in fraud or other companies can take their information.

After bitcoin whitepaper, is first crypto-currency, was published by Nakamoto [1]. Companies or individuals can make their payments peer to peer or business to business. Companies or individuals have the ability to eliminate third parties. Blockchain technology, distributed ledger technology (DLT), is an underlying technology of bitcoin and other crypto-currency. With blockchain ledger, all participants can hold their own database in the network. When new information or transaction is created by the network, blockchain holds previous one with unchangeable hash. Therefore, blockchain builds trust in business to business with immutable records, transparent and verifiable.

Nowadays; blockchain is used by many systems and industries such as the voting system, finance, logistics and SCs. IBM and MAERSK tried to use blockchain applications in international container transports. They joined their efforts in the company TRADELENS, which aimed to gather all organizations involved in shipping. Now they are comprised of more than 90 organizations including ports operators, custom authorities, freight forwarders, transportation and logistics companies. With this platform, they eliminated cost of facilities such as stamps, approvals and documentations. Paper of work costs have reached an estimated %20 of all costs of facilities. According to World Economic Forum (WEF), market size could rise %15 if this problem is not solved. Shipping industries will able to monitor shared and immutable data in real time with distributed ledger technology [2]. In this regard, the aim of this study is to provide examples of the use of blockchain in SC and logistics activities. In this study, in SC and logistics activities, the examples of use of blockchain in the area of SC are given. Although blockchain has the current problems of distributed notebook technology, it is thought that in a very short term, it can be used in all industries without hesitation. This study focuses on blockchain technology in the automotive industry. Thus, the remainder of the study

is organized as follows. Section 2 summarizes blockchain technology. Section 3 focuses on supply chain management (SCM) and the contributions of blockchain. Implementation of Blockchain on SCM and logistics is provided in Section 4. Section 5 focuses on the use of Blockchain technology in the automotive industry. The results of the study is given in Section 6, and finally Section 7 outlines the conclusions of the study.

PART II. BLOCKCHAIN TECHNOLOGY

Today, most people think that Blockchain can be as revolutionary as the Internet. In general, Blockchain is a digital platform based on tampering the history of all transactions among users on the network or adding a new information layer on the existing ones. Many users can access, control, or add data. However, all transactions created between users or counter-parties are controlled by encryption algorithms and then, grouped into blocks added to the system. No one can change or delete the information in blocks. The original information remains as permanent, leaving a public information trail or chain of processes; with all the blocks chained to each other in a sequence. This means that blockchain is an unmodified, distributed database that keeps records of digital data or events in sequential blocks.

Blockchain means that the transaction can be transmitted digitally between two parties that do not trust each other without the need for a trusted third party to mediate in the transaction. Ownership of assets is implemented by all participants with a block chain instead of a central assurance authority. Blockchain is a distributed digital notebook that contains a chain of information in blocks. The block is connected to the previous block or block series in the chain. In Blockchain technology, all blocks created can be seen. 51 percent of the data validators on the network must confirm when a new block is added. Thus, the possibility of changing blockchain becomes difficult or impossible. Since all members of the network have their own database, the database cannot be centralized and that gives the members of the network trust and confidence. Blockchain can solve the issue of trust in the digital world by its structure. Because before Blockchain, there was always a need for a third party for safety issues. The third party had the role of a guarantor that recorded its agreements and data on its own system. Blockchain has provided the ability of processing from person to person. The two persons or groups can start their transactions without the need of third parties by making their own smart contracts.

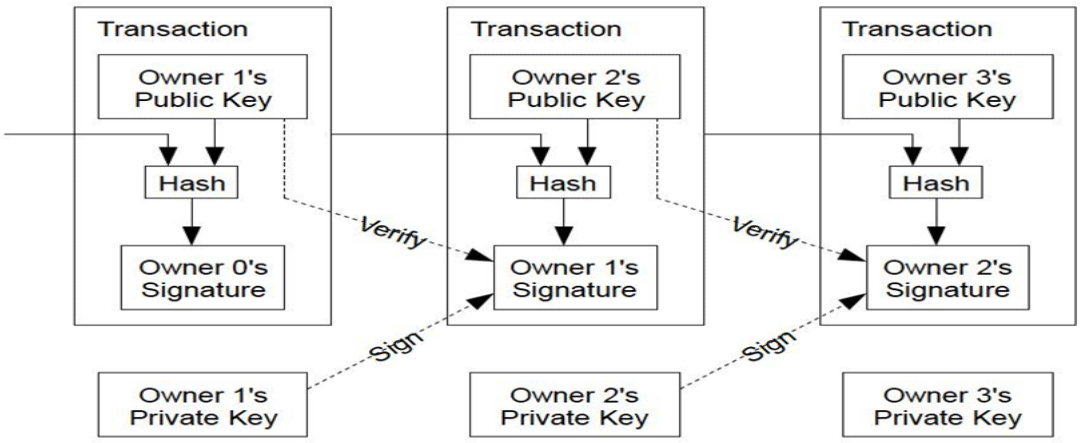

Figure 2.1: The Hash System in Blockchain (Blockchain transaction)

In the Blockchain technology, the hash code is given for the data added and this code is specific to this network only. Figure 2.1 shows when new data is added to the network, it is recorded on the block, and as a result, a hash code is generated. All members have their own private passwords (virtual signatures). Prior to adding new data, a private key must confirm the information that needs to be validated. This makes the system more secure and members can hide themselves with the private key. When added to a new data block, 51 percent of network members must be verified. Everyone on the network accepts changing data, otherwise new data cannot be added to the blocks. The system keeps the previous blocks and operations in its data storage. In case of irregularity or theft in digital environment, thieves should not leave any information or document left behind or in some cases, they have to adjust the document according to their own situation. To do so, people or institutions that are involved in any irregularity may demand to make changes or delete data. In Blockchain technology, since there is a distributed database technology, even if people or institutions demand to make changes, the whole system (51 percent) must give consent. Therefore, the hash difference and block size of these individuals or institutions will be discerned by other users of the system and irregularities will emerge. Distributed database technology stores data in chronological order. When the frauds change the data, as the block doesn't delete the old information, it will be larger than before and will have a different hash. This makes Blockchain a system that is unchangeable, non-hackable and secure. Due to the characteristics of Blockchain, it is seen that it will be the technology used in several different sectors.

Blockchain provides users with 5 important capabilities:

- **Transparency**: With the help of its distributed database, Blockchain allows all partners to keep their own databases. All peer-to-peer transactions can also be seen by others.
- **Anonymity**: Everyone involved in the network has a unique address. Because the address characters are in codes, all network-wide processes are visible to everyone. However, the owner of the code cannot be detected by other users.
- **Unchangeability**: Since each transaction is recorded in the forms of blocks and certified by all the users, even if the system is attempted to be changed, the new transaction is recorded on the old blocks. For this reason, any replacement or change will be seen by everyone in the system.
- **Trust:** Blockchain, even if the users do not trust each other, ensures the trust in the system since every transaction done by partners can be followed by other partners and the new information to be added can be altered by the approval of 51 percent of the network owners.
- **Autonomy:** Blockchain allows users to keep their own database thanks to its scattered database. It also creates a completely autonomous space for the users to store their own information.

Smart Contracts: It is a contract that converts the agreements/contracts to codes and enables the activity to be paid automatically as a result of the completion of the work and the follow-up the entire system with the codes.

The Internet of Things (IoT): It can be defined as a world-wide network formed by the things and the way they communicate with each other in this network through a specific protocol. With the help of various communication protocols, it is also possible to define it as a system of devices that communicate and are connected to each other, sharing information and creating an intelligent network.

PART III. SUPPLY CHAIN MANAGEMENT AND LOGISTICS THE CONTRIBUTIONS OF BLOCKCHAIN

The supply chain is a system that covers the entire life cycle processes of the product, flowing from the raw material to reach the hands of the end customer as well as containing the flow of information in the operational units.

The majority of the world's leading companies use computerized enterprise resource planning (ERP) and supply chain management software. The companies follow the entire process from the start of production to the recycling of products through digital shipment notifications, through RFID scanning. However, there are gaps between the systems within the business and in assets in the business boundaries. When the production is digitally recorded and tracked, a PDF document is created for the shipment label, which is slightly more than one written copy for the output label when the product starts to be transported. The shipment may have its own digital number, but this number does not indicate where the box is and whom it is signed for or what actually is in the box. Companies try to maintain the continuity of information throughout the system and business boundaries, by using systems such as Electronic Data Interchange (EDI) and XML messaging to close this gap. However, point-to-point messaging systems have their own problems, as most of the time, they are not synchronized and detailed, reliable, clear information is not available [3].

Even if the supply chains have changed, it is a well-known fact that companies have not updated the basic technology for management for decades. However, with Blockchain technology, companies can re-establish their different approaches to supply chain management and integrated global view at the ecosystem level [3]. Without doubt, some problems can be encountered in all processes and Blockchain can be a solution to these problems.

Benefits of Blockchain for the supply chain [4]:

- Due to the complex network in the modern supply, companies work with multiple other companies while they continue their proceedings in several different locations at the same time. For this reason, while companies have difficulty in following up all the processes, the complications arising from process follow-up affected the follow-up of other companies, which has reduced the clarity of product and process follow-up. In

Blockchain technology, the company or customer can monitor every part of the material or product flow.

- Blockchain solves the problem in the peer-to-peer payment system. The invoice payment period is shortened in companies and enterprises waiting for payments. In Blockchain-based currencies, such as bitcoin, the transaction takes an average of an hour. Bitcoin fee costs less than the bank fee.
- Theft or irregularities can be encountered in logistics activities. Blockchain reduces the risk of fraud or counterfeit goods. When an employee being involved in an irregularity attempts to change a document, the hash code and block length will also be changed, thus the companies will be able to detect this kind of employees easily.
- It gives detailed information to the customer about planting, collecting, storing and all other processes of food supply chain.
- Individual customers need to follow their own business. When the data of the products is recorded, the lock chain technology is immutable. The ability to see personal notebooks in every part of the supply chain is acquired. In this way, as the Blockchain eliminates the intermediary, customers' personal costs are reduced and the trust in the network increases.
- It provides customers with the information they want about the product, service, supplier, shipper or product origins and the shipping route before a decision is made.

PART IV. IMPLEMENTATION OF BLOCKCHAIN ON SCM AND LOGISTICS

4.1 IBM-MAERSK

Today, the size of the global trading market is increasing every year. Likewise, the costs are rising along with the markets. The ship industry bears more than 80% of global trade markets. There are official papers or documents for all aspects of the maritime industry, such as ports, ocean customer authorities, transporters and shippers, manufacturers, terminal operators, etc. The documents and papers kept for each location reach an estimated cost of 20% of all facilities [5].

According to the World Economic Forum, if this problem is solved, market size may increase by 15%. Since June 2016, IBM and Maersk have been working together to solve the problem with Blockchain technology. Here, two basic things are targeted. The first is to establish a digital information line to provide visibility in a supply chain for all actors in the marine industry, collaborating on the Blockchain platform (see Figure 4.1). The second goal is to enable the users approve digitized documents by using a smart contract to speed up and reduce the resolution of errors [2].

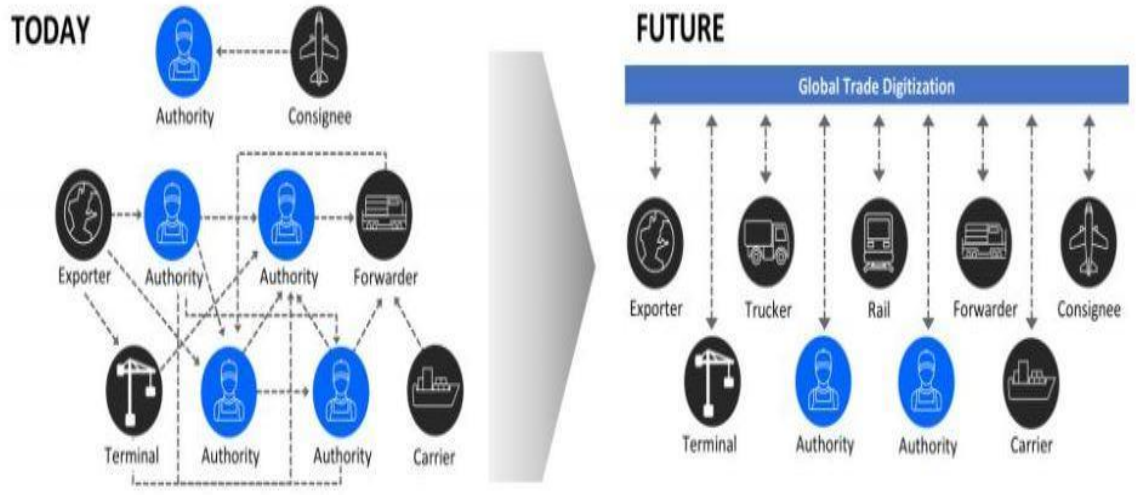

Figure 4.1: Current and future planning of the platform in sea trade

With Hyperledger technology [2]:

- IBM has ended the blind spots by removing the organizational boundary between points in the supply chain, aiming to ensure a fast, secure flow of information from a single provider of the entire network.

- Instead of complex, unwieldy and expensive documentation, it offers documents that can be verified and not be changed.
- Instead of manual, time-consuming, paper-based progress, a reliable multi-organization business process has been created.
- Instead of missing information sharing and uncertain processes, a good risk process and less unnecessary intervention have been provided.
- Administrative documentation being issued has been reduced, thus expenses have also been reduced.

Maersk's transaction of sending a container full of flowers from Kenya port to Rotterdam port via Blockchain application, has established an approximately 200 point-to-point communication networks. As a result, Blockchain has proven to provide communication efficiency, reduce costs with the elimination of paperwork and it has shown that logistics facilities are trusted.

IBM and Maersk have jointly established TRADELENS, an open source platform supported by Blockchain in the field of supply chain. The aim of the TRADELENS platform is to develop transportation-shipping solutions, promote innovation, and promote transparency in sharing accurate information. A platform has been designed with the participation of 94 companies by bringing the different parties together in the field of supply chain.

4.2 IBM-WALMART

Throughout the food monitoring process, companies operating in the supply chain have difficulty following a mix of digital and paper-based food data documentation in a complex supplier and distributor network that grows with new companies. As a result of this complex follow-up, it can take days to reach the correct information. With a digital food system, users of the network can proactively contribute to the improvement of the food system and accessing tools and data to improve food safety.

Blockchain technology stores digitized records in a decentralized and unchanging manner, promoting confidence and transparency that helps to improve the food system and provide safer food.

Walmart, IBM, JD.com, and Tsinghua University have joined forces to provide information about food for every part of the food supply chain. IBM has established the Food trust platform.

Thus, by providing transparency among suppliers, consumers, regulators and data on how food comes to consumers from the farm, consumers' ability to obtain information about the supply process has been improved. Blockchain technology can build transparency, traceability and confidence in all aspects of the food industry.

Walmart and JD.com work with food suppliers to improve standards and facilitate food safety ecosystems in China. The IBM Food Trust has created a secure, shared, and permitted transaction record. This has provided visibility at every step of the food supply chain. The IBM Food Trust has reached new levels of trust and transparency by delivering food from the farm to home in a safer and smarter way. IBM Food Trust can be helpful for everyone in the food system who work cooperatively, such as suppliers, manufacturers, distributors and retailers. If any food safety problem is reported, who is affected from this situation and who must take action can be immediately determined.

Walmart, JD.com, Tsinghua University and IBM have developed a "smart package" system along with distributed large notebook technology. With this package, the expiration date of the product, where it came from and its content have been presented to the user. With Blockchain, smart packages such as meat can be transferred from a small farm to large department stores in China, or mangoes from Latin America to the supermarkets in the US [6].

In these pilot schemes, Blockchain notebooks contain information of origin of the farm, batch numbers, transaction data, production and expiration dates and shipping. With the Blockchain smart package technology, the process of accessing information that would take days or weeks for customers and agents has been reduced to seconds. The flow of information could be more quickly obtained without contacting another person [7].

4.3 PROVENENCE

To date, customers had to contact various units when they enquired about a product. They also had to believe what was written on the label of the product without knowing whether it was true or not. The London-based Provenance company used Blockchain technology on clothing to include information of the product's origin, content etc. to meet the customers' needs. Thus, the supply chain has become more transparent and open with Blockchain technology of the London-based company.

There has been an increasing orientation call by brands, producers, governments and customers who seek more transparency than producers. In the UK, 30% of customers are concerned about the origin of the products yet have difficulty in action on the purchase decisions [8]. Provenance ensures that every product comes with a digital "passport" that proves its authenticity, and whether it is the way it claims to be. The company also creates an auditable record of the origin of the product (where the product comes from), the journey behind all products.

The company's motto is "***Look beyond the label***". For this purpose, Provenance has made each product unique by giving them individual identifications in addition to having provided the ability to monitor each product separately. Customers, by scanning the barcode of the product in Provenance application, can see what the content of the product is, where its origin is, who is the producer and who is involved in the supply process. In order to access this information, digital data can be accessed without the need for second or third parties. The company has started to cooperate with other companies on food, cereal products, clothing, shoes and many other subjects [9].

4.4 WALTONCHAIN

The purpose behind Waltonchain's establishment is to create a true, reliable and traceable business ecosystem with complete data sharing and absolute information transparency. It was created with the combination of Blockchain technology and RFID (Radio Frequency Identification) which aims to integrate Blockchain and the Internet of Things. Waltonchain has named it as Value Internet of Things (VIoT) [10].

While the attempt to use and influence smart contracts outside the block chain was nothing new, it was known that previously related technologies failed to establish an effective and potentially automatic connection between a virtual network and the real world. It is clear that Blockchain technology will be the direction changer for traditional Internet of Things. While Internet of Things (IoT) eliminates the missing links in information distribution from person to person (P2P) with blockchain, it also performs operations without third-party approval and offers scalability, single point failure, timestamps, records, privacy, reliability. In addition, Waltonchain, which uses Blockchain and IoT on smart systems, can connect real-world product and identification tags with RFID technology, which can successfully link everything to each other and create a real smart economy era. Waltonchain can play an integral part in the industry by solving problems related to the development of the system compliance plan based on special

RFID and blockchain technology, storage, logistics, stores and after-sales goods purchase, distribution, storage. At the same time, with the Waltonchain RFID and blockchain technology, ompanies will be able to keep their own analytical data [11].

The primary task of Waltonchain is to bind the data. In the Waltonchain ecosystem, multi-chain architecture, by establishing a link like in the form of a parent-child chain, tends to develop a block-chain technology among industries. Business logic is integrated in-depth to create an open industry expansion mechanism with strong vitality. The Waltonchain is striving to build an intersectoral blockchain ecosystem by collecting the worldwide exclusive sub-chain project. Waltonchain continues to work on smart city network, smart agricultural network, smart medication network, smart food monitoring, smart vehicle industries [11].

4.5 AMBROSUS

The main mission of Ambrosus is to establish a decentralized protocol that monitors, stores and transmits sensor data and the assembly line related to food, pharmaceuticals and chemicals. Ambrosus is working on centralizing the supply chain management by creating a system of sensors that can monitor the logistics measurements along with RFID chips and QR codes to transfer the data. For this purpose, the company has set up its own blockchain network, the **Amb-Net**. Amb-Net is an IoT network that works with blockchain for food and pharmaceutical companies and provides a safe and non-friction dialogue between sensors, distributed notebooks and databases to optimize supply chain visibility and quality assurance.

The trade agreements between suppliers and other actors in the supply chains are coded as smart contracts on Blockchain that works with Amb-Net. Encrypted tamper-proof protection mechanisms label customer products in accordance with a unique and unchangeable digital identity to reduce the risks of supply chain counterfeiting [12].

The quality, safety and logistic data generated by the sensors and transmitted by the Amb-net masternodes automate the self-execution of the contract and the resolution of events in counter-party disputes.

4.6 TECHROCK (TAEL)

The establishment of Techrock, formely known as Walimai is based on the Chinese milk scandal in 2008, resulting in the death of 6 infants and hospitalization of more than 50,000 babies. The aim of the team is to prevent consumers from death or serious difficulties due to these counterfeit products. Techrock operates mainly in China where counterfeit products such as baby food, cosmetics and alcohol are of great importance [13]. The team has created labels with RFID chips and scannable QR codes. It allows consumers to scan an item's label before purchasing to ensure that the product is authentic. If the geographical location data of a particular product does not conform to its intended route, the customer is warned to avoid the product and the manufacturer is also given a warning about it [14].

Wabi (TAEL) is the encryption currency to be used as a payment and reward method in the Techrock ecosystem.

Techrock ecosystem consists of 4 main elements [15]:

4.6.1. Consumers: People who are in need of products share their identities on the Tehcrock platform. They get information about the authenticity of the products. When the customers buy a standard product from a store, they scan the barcodes of the products on the Techrock network to check the authenticity. If it is not an authentic product, the network notifies the supplier as well as the brand. When RFID chips are opened on the package, they are registered in the system. In the same way, the average consumption time is observed as the customer buys the product again. The campaign message may be sent to the customer before the product is finished. As a result of the personal data being shared, the customer receives new products advice according to the products used by that person before and at the same time the person is rewarded with Tael for allowing the data to be shared.

4.6.2 Brands and Sellers**:** Suppliers and brands with Techrock network should obtain a certain amount of TAEL to learn about a customer’s average consumption time of the product and to provide the right product to the customer. The company, having the access to the correct information, can start a campaign to lead the customer to re-buy the product by sending messages prior to the average consumption time.

4.6.3. The Stock Markets**:** Their main function is to provide liquidity for other actors in the ecosystem.

4.6.4. Techrock: The company that protects and sells high quality consumer products with proprietary NFC and Hyperledger-based technology.

PART V. BLOCKCHAIN TECHNOLOGY IN VEHICLE INDUSTRY

5.1 THE EXISTING SYSTEM

Today, vehicle companies set up a network of parts and services after the vehicle is put on sale and generally all transactions remain to the users. If there is a malfunction in the general initial state of the vehicle, this will be published in the online system and when the vehicle is in maintenance, the authorized centre service fixes the problem or if the problem is not in a solvable state, then all the vehicles are collected by informing the public in the first place. The applicability of this situation and the process of accessing to the customers are difficult. The companies often condone this situation or conduct regional operations. With Blockchain technology, when the companies encounter this kind of a problem, they can update their vehicles with 'Vehicular Ad Hoc Network (VANet)' or if the problem is beyond being solved, the vehicle could be taken back. Accordingly, as the information of the holder of the vehicle will be acquired easily and fast, the customer satisfaction will be increased.

Figure 5.1: Current model of automotive industries

A central bartering unit (notary) maintains its own data record and verifies all financial transactions, a single one of which can take several days to process. Instead, by using Blockchain, when we consider the data records that are automatically and instantly transmitted to each financial institution, the swap point can be eliminated, or it is systemised with

confidence-based transaction databases between the buyer and the seller by using the distributed database to the swap point. As a result, there will be transactions that are confirmed within seconds or minutes with increased productivity, greater security, and reduced costs [17]. Figure 5.1 presents the flow of information in the current system in the automotive industry [16].

5.2 THE NECESSITY OF THE NEW SYSTEM

Blockchain is a network that can have a huge impact on the supply chain of the automotive world. While vehicles with thousands of parts can be produced in the automotive world, the traceability of production and supply activities with complex systems can be increased. Today, even if *Original Equipment Manufacturers (OEM)* can establish a secure connection with their suppliers, the rest of the process is based on assumptions. It is assumed that the shipping process will function properly during the delivery of materials from one place to another. Obviously, regardless of some situations that may occur, for example, if any physical tampering is not noticed or if the vehicle delivering the parts has not been stolen or the train has not been delayed, if seals are intact, OEMs and the like assume that the supply chain can be trusted [17].

In fact, the fake parts are not openly debated today, but this will be the subject of the greatest nightmare with the presence of autonomous cars on the horizon. The automotive supply chain is a convenient place to start researching the block chain. With block chain, original vehicle parts manufacturers and companies in other rings of the supply chain can share information on a reliable network. They can make the accurate time planning for processes such as delivery and follow-up of the products, as they work in a clear and transparent way by going beyond simple assumptions. Today, if companies are in contact with each other, they act assuming that the incoming products are original pieces. Follow-up consists of assumptions based on mutual trust. If no clear problems are identified, original equipment manufacturers act on the assumption that the supply chain will be relied upon. Thus, the companies either simply defer it or act as if there are no hazards at all. In cases where counterfeit parts cannot perform as original parts, it is obvious that autonomous cars will cause malfunctions or accidents.

Vehicle companies, vehicle owners, vehicle maintenance services, expertise, insurance companies, government agencies keep different and unverifiable information that is not confirmed by with each other for the same vehicle in their database. Only its own users can access this information stored in the database. The central institution does not share information

with other institutions. In order to share existing information, the requester must pay an extra fee. Blockchain can collect all the information about the vehicle in a single database and help all existing units gain access to the database. In addition, any irregularity to be done in the dispersed database; incidents such as deletion of kilometres can be detected by other central institutions [18]. Thus, information related to the vehicle can be restored to the old reality, and the necessary legal processes related to the irregularity unit can be initiated.

By switching to the autonomous vehicles instead of manually driving, that is to say, when moving out of ordinary, data sharing between vehicles will begin and roads will be filled with more autonomous cars, thus there will be more data collection in vehicles and in life. The use of Blockchain can enable drivers to have vehicle-related data, buyers can rely on a vehicle's data, and manufacturers can quickly recall and replace faulty equipment [19]. Dimitri De Jonghe, the implementation manager for blockchain in Bigchain DB explains how the defects of the faulty parts can be reported to the manufacturer (IoT) and how the faulty parts can be recalled or how these can be replaced with new parts immediately with an EDCC or a smart contract. This quick response will probably save countless lives.

What is important in the supply chain is to reach a system that can handle real-time supply and demand in the entire ecosystem. For the transition to the method being suggested, each piece taking its own unique identity, as part of the supply chain can solve the problem [2].

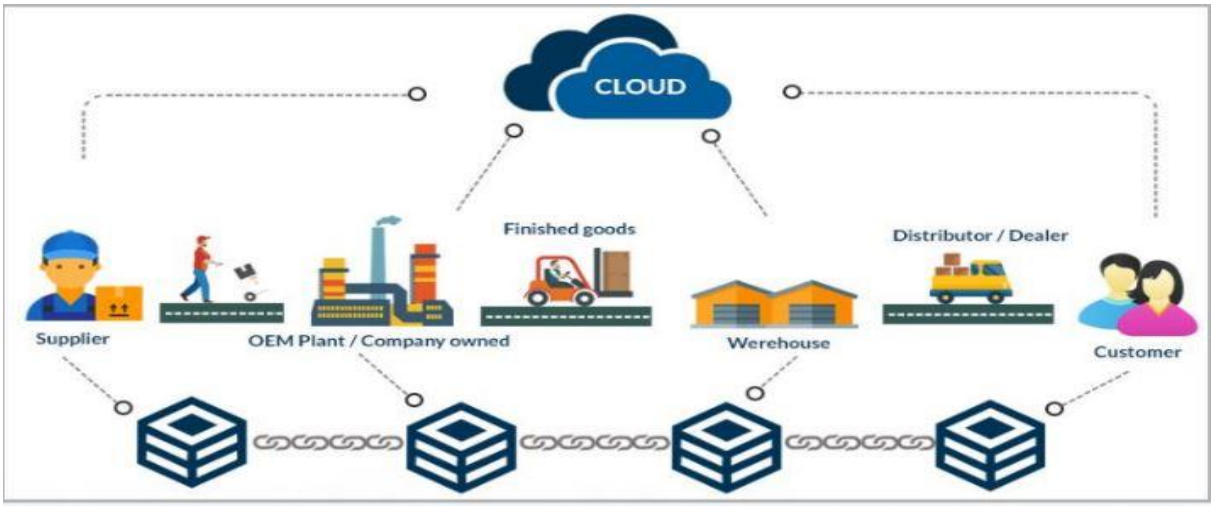

Figure 5.2: Flow of information on SCM with blockchain technology

Blockchain technology can establish a trust protocol in the automobile industry with its transparent, distributed and unchangeable structure. While forming the basis of the supply chain by creating individual identities for each product, Blockchain can preserve its authenticity in a

way that everyone can trust. A unique code or identity can be created for each department or action transmitted to a secure distributed database that is open to OEMs and supply chain partners. The distributed database also provides access to other important information in the supply chain, such as what parts are created, how much is created by whom. This establishes a control and balance system that verifies and records everything with cloud servers for the entire supply chain community (see Figure 5.2) [20]. The digital transaction book provides transparency and trust with an open foundation that partners can use [22].

Creating a corporate blockchain architecture that can expand when new suppliers are added to the chain, and implemented by Original Equipment Manufacturers and suppliers, would be the most comprehensive approach. Each section with a strong digital identity can be seen in this monitoring system. OEM and each supplier's book contain an encrypted record which allows immediate identification of a faulty or counterfeit part. It is thought that no other approach will come together to create, without any intervention, such an open system that constitutes trust, identity and transparency [21].

The benefits of creating a business ecosystem for Original Equipment Manufacturers and suppliers are clear. Identity and database, which are identical in the blockchain, will be able to solve the vast majority of security problems. This structure can perform a number of basic functions, such as cryptographic services, gateway services, data services, general management, and operations.

5.3 COMPANY OPERATIONS

5.3.1. MOBI

The Blockchain structure consists of three main components; a computer network, a network protocol, and a consensus mechanism. Founded in 2017, MOBI - Mobility Open Blockchain Initiative - is a smart car consortium that comes together to increase efficiency, safety, transparency of vehicle industry and to make it more affordable and greener by developing standards. It is an organization with partners, governments, non-profit organizations and corporations to ensure the rapid adaptation of Blockchain distributed notebook technology and related technologies in the automotive industry. Blockchain reduces costs because it coordinates the activities of business networks. To accelerate adoption of this technology and

achieve many potential benefits, MOBI wants to establish a worldwide network of cities, infrastructure providers, consumers and mobility services manufacturers. [21].

Companies ranging from IBM and Context Lab to Ford, Honda, GM, Renault, BMW have announced their cooperation in Futures Blockchain Summit and have come together to form the Mobility Open Blockchain Initiative (MOBI). The association will explore the more possible use of blockchain and examine how this technology can make the global transportation industry cheaper, safer and more widely available to citizens worldwide [22].

Blockchain technology has distributed the information to a stand-alone computer network to ensure that the transactions are secure, and data privacy, property rights and integrity are protected. Working in a consortium enables MOBI and its partners to reduce mobility friction and transaction costs, such as reducing fees or additional fees imposed by third parties and the risks of fraud in addition to create transparency and trust among users [21].

With an open-source approach to block chain software tools and standards, the MOBI consortium seeks to encourage faster and scalable adoption of technology by other companies developing autonomous vehicles and mobility services. Beside global mobility providers and Blockchain innovators, the group also aims to cooperate with non-governmental organizations and institutions to develop blockchain-enabled vehicle data and mobility services applications [21]. MOBI also wants to develop the ecosystem in an open and inclusive manner, which includes all the stakeholders throughout the mobility value chain to create a “minimal viable network”. Stakeholders include technology companies, automobile manufacturers, distributed accounting firms, public transportation and toll road providers, transportation types in other world, beginners, academic institutions and regulatory bodies [23].

MOBI aims to work on projects related to the following issues with its partners:

-Mobility pricing and payments of infrastructure, vehicle, pollution, insurance, traffic congestion, energy etc. based on usage of the vehicle

-Supply chain monitoring, transparency and efficiency,

-Travelling information and vehicle sharing

-Vehicle data tracking, history and identity

-Secure mobility ecosystem trade

-Autonomous machinery and vehicle payments

-Data markets for autonomous and human driving

5.3.2. TOYOTA

Among the partners of TRI (Toyota Research Industry), Berlin-based Bigchain DB and Toronto & Dallas-based Oaken Innovations, which exchanges data to share driving and autonomous vehicle test data, develop an application for payments done with the newly created mobility icon, vehicle access and P2P vehicle sharing. Commuterz, an initiative from Israel, is working with TRI for a P2P vehicle solution, and Gem from Los Angeles works with Toyota's joint venture telematics car insurance company 'Toyota Insurance Management Solutions' (TIMS) and in the usage-based insurance platform, works with Aioi Nissay Dowa Insurance Services, [24].

TRI assesses that Blockchain can create transparency and trust among users, reduce the risk of fraud, and reduce or eliminate transaction costs, such as fees or additional charges imposed by third-party companies. With an open-source approach to software tools, TRI aims to encourage the faster adoption of Blockchain by other companies that develop autonomous tools and provide mobility services, by creating a user consortium [25].

Hundreds of billion kilometres of unmanned driving data are needed to develop safe and reliable autonomous vehicles. With the contract done with Blockchain and approval of the companies, the period of time to collect data from vehicle owners, fleet managers and manufacturers can be shortened and the advantages of autonomous driving such as convenience, safety and efficiency can be revealed.

TRI works in cooperation with many industry partners to develop applications and conceptual evidence for the new areas of the mobility ecosystem:

- Driving / Testing data sharing,
- Vehicle / travel share transactions,
- Usage-based insurance.

Driving / Testing Data Sharing: DLT can allow individuals and companies to securely share their driving data and earn money from it and gain access to others' data in a safe market. Advanced vehicles are becoming increasingly aware of their environment with built-in sensors, all of which are more connected to the cloud that generate large amounts of valuable data, road

infrastructure, and other tools. DLT technology can create the opportunity to share the driving / autonomous testing data, data of the creator in an environment that protects ownership [25].

Vehicle / Travel Share Transactions: The vehicles based on Blockchain technology have the potential to give car owners the power to drive their vehicles, make money with the use of a cargo area or even with the vehicle itself. The Blockchain can store information about vehicle usage, vehicle owners, passengers and drivers. This profile information can help verify a "smart contract" between the parties; it can also manage the services for payment between them without the need for a financial instrument, thus saving on additional transaction fees. The new system can provide connection to vehicle functions for remote unlocking / locking and engine start / shutdown [25].

Usage-Based Insurance: DLT can be used to save on insurance costs for vehicle owners. Vehicle owners can qualify to lower insurance costs further by allowing car sensors to collect and store vehicle data in a DLT, increasing transparency to reduce fraud in insurance companies and giving access to driving information and data to measure safe driving habits [25].

5.3.3. HYUNDAI

Hyundai Commercial, a subsidiary of Hyundai Financial Services, has partnered with IBM, the American technology giant, to transform their business model with Blockchain. Network participants, including automobile dealers, distributors and manufacturers, have access to a real-time, shared view of all transactions of this chain, ensuring that this data is securely managed and efficiently distributed. Technology can thus gain efficiency by automating manual operations [26].

Hyundai has been reported to use Blockchain technology to increase users ' security settings and prevent security issues when sharing custom settings on the server. Drivers will be able to adjust the engine's seven performance features such as maximum torque output of the engine, acceleration and deceleration capabilities, regenerative braking capacity, maximum speed limit, sensitivity and energy use in climate control [26].

Hyundai has been reported to have developed smartphone-home-based performance tuning technology that allows users to customize primary functions with a smartphone application [27].

For the first time in the Korean financial industry, Hyundai Card introduced an AI-based chatbot for customer service. It is called ‘Hyundai Card Buddy’. It sets a connection with customers to quickly answer frequently asked questions; frees Hyundai professionals to meet more complex customer service needs. The system continuously learns about its interactions with users and based on the natural language processing and machine learning technology from IBM Watson, Hyundai Card Buddy can understand the hidden meaning, interpret customer questions, and provide answers and information to improve customer experience and facilitate customer service [28].

5.3.4. RENAULT

Renault has announced that it will carry out ***car passport*** studies which will allow all the data required for a vehicle to be contained in the vehicle’s brain. Renault has also established a partnership with Blockchain, Microsoft and VISEO to ensure that the data on the car passport is stored securely and transparently on the Blockchain [29].

The current method of storing information about customers and their vehicles has been extended to the main system of different information systems held by car manufacturers, insurers, repair shops and more. Renault wants to gather the entire network together with its partners in one environment. Renault wants to consolidate this information with the power of Blockchain technology. With its transparent and open structure, all information about an automobile can be collected at a point for customers to access [30].

Renault's aim is to ensure that customers record all vehicle information on a regular, tamper-proof and secure digital car passport. The problem today is that the information about customers and their vehicles has been spread to many systems including automobile manufacturers, insurers, repairers, etc. It is possible to collect all the information in a customer-accessible location by using Blockchain technology. If the vehicle owner wishes to sell a vehicle to another person, the information on the vehicle's history will be more transparent by authorizing the potential buyer to access all important information in the digital vehicle maintenance book in the Blockchain. In this way, more trust will be established between the buyer and the seller [31].

The special thing for all cars in the Renault project is the car passports. In vehicle sales, the owner of the vehicle can provide more accessible information than potential sellers can rely on by accessing the vehicle's old information passport, which is now in a passive state [30].

Groupe Renault Digital and Connected Vehicles Director Elie Elbaz explains:

“This digital car maintenance book will enable us to offer our customers new services in the ecosystem with insurance companies and dealers. Blockchain technology can establish a reliable trust protocol. Beyond this project, it will be a big step forward for this technology-related tools and the related micro-processes and security requirements.”

5.3.5. TESLA-OAKEN

Oaken Innovations has developed a Blockchain-based hardware and software platform to strengthen toll road and vehicle services. With the secure blockchain, the vehicle sharing and renting platform provides a ubiquitous data repository for mobility capacity (cars available for rental) among all manufacturers without the need for intermediaries [31].

Technology and payments infrastructure to operate toll road systems at present is costly and insecure. Oaken eliminates the need for payment processors and expensive cloud infrastructure by using Blockchain-enabled IoT (Internet of Things) applications to automate toll road payments from vehicles [32].

With Oaken Protocol, an e-connection between Tesla and the tollbooth has been established. Facilitated interaction with RFID, Ethereum blockchain and IPFS allows for seamless toll charges. Evidence of this automated toll booth concept system suggests replacing the existing toll road infrastructure with an inexpensive smart contract protocol. Existing toll roads have large server infrastructure requirements for accounting, identity and payments. Typical user transaction fees are 3 percent or more. Oaken expects wages to fall below one per thousand as a result of a solution [33]. The system will provide a significant reduction in immediate transfer and credit card processing fees. As a result, the toll charges will automatically be transferred to a road maintenance charge after the designated fees have been paid.

5.3.6. VOLKSWAGEN

Volkswagen plans to update its new connected car with IOTA Tangle over the air. Unlike Blockchain, IOTA doesn't contain blocks and mining. The Tangle app provides reliable data access to networked vehicles. Together with IOTA, Volkswagen aims to integrate travel planning, reservation, payment services into the Intelligent Vehicle ecosystem [34].

5.3.7. MERCEDES

Mercedes-Benz has announced that they have developed and programmed a prototype with Icertis, based on blockchain technology, which enables the storage of documentation and contracts in complex supply chains. The aim is to ensure that standards and contractual obligations relating to working conditions, human rights, environmental protection, safety, work ethics and compliance in the supply chain are met and controlled in partnership with suppliers directly. The Blockchain prototype provides a transparent mapping and can monitor this transmission throughout the entire supply chain. In case one of the subcontractors deviates from the contractual obligations; this appears in Blockchain, similar to a secure accounting system [34].

With its Blockchain prototype in increasingly complex supply chains, the company aims to directly increase transparency beyond the suppliers. For this purpose, Mercedes-Benz will work in partnership with car suppliers. Another application is the traceability of components and raw materials. Complex supply chains can be explained, their roots can be traced between relevant partners [34].

5.3.8. PORSCHE

Porsche is currently in cooperation with the Berlin-based start-up XAIN and is testing blockchain applications directly in vehicles. The company is the first automobile manufacturer to implement and successfully test Blockchain in an automobile. The applications having been tested include locking and unlocking the vehicle through an application, temporary access authorizations, and new business models based on encrypted data logging. The services developed on the basis of Blockchain are fast and very safe. The car becomes part of the blockchain and enables a direct offline connection. The process of opening and closing a car that takes 1.6 seconds through the application, without deviating from the server, is six times

faster than before. In addition, efficient encryption becomes available. This ensures that all activities are documented and viewed using an application to prevent them from being changed in the blockchain. With the help of the auditable data record, the data to be processed is encrypted in a locally distributed blockchain. All activities are documented in the Blockchain and make the erasures transparent. Local data can be used to achieve regional learning impacts that can be safely shared with other vehicles. At the same time, the customer can use the protected cluster data. Blockchain technology makes it possible to grant temporary access privileges to the vehicle. Access authorizations can be deployed digitally and securely and the vehicle can be monitored by the owner at any time. Access also works remotely. In the future, users can provide remote access to a vehicle for third parties, such as couriers, temporarily or for just the luggage area [35].

A protected connection to the vehicle data and functions can be provided by using Blockchain. It also preserves all communication between participants. Third-party providers can be integrated without the need for additional hardware, using only “smart contracts [35].

Blockchain technology can facilitate the secure payments: for example, it provides the convenience of invoicing the energy cost after an electric car is charged, or paying a post-parking ticket [36].

For service providers operating through the Porsche platform, the lock of the virtual vehicle can be unlocked by the user. This makes it possible for parking charges to be billed directly. Once the door is opened, it can have direct access to the customer who wants to use the provider services. The Porsche customer goes to a parking lot and presents an RFID card for identification at the entry gateway. The gateway uses electromagnetic waves (radio frequency identification) to transfer required identification data to the parking terminal. When the customer leaves the parking lot, the identity is transferred again and the parking fee is billed via a virtual customer blockchain wallet in which a block of data is generated to document the transaction. Customer data is known only by Porsche. Blockchain allows customers to use services from other providers and then pay their fees through Porsche. Another important advantage of Blockchain is that transaction fees are not paid for such “micro payments, because documented data blocks mean that intermediary service providers are not required [36].

5.3.9. JAGUAR

Jaguar has announced that they started to work with IOTA. Using Smart Wallet technology, Jaguar car owners earn credits by allowing their vehicles to automatically report useful road condition data, such as traffic jams or pits, to navigation providers or local authorities. Drivers can then use them for coffee-like prizes, or they can automatically use them for toll payments, parking fees and smart recharged electric vehicles. Jaguar Land Rover aims to achieve zero emissions, zero accidents and zero congestion. A part of achieving this goal includes developing a common economy in which the vehicle plays an integral role as a data collector in the smart city of the future [37].

PART VI. CONTRIBUTION OF BLOCKCHAIN TECHNOLOGY TO THE VEHICLE INDUSTRIES PLATFORM

Today's vehicles have become semi-autonomous driving devices equipped with radar, laser sensors, lidars, GPS devices, cameras and many more sensors. Companies have started to introduce fully autonomous driving vehicles. For vehicles to be fully autonomous without drivers, they need to contact the vehicle to vehicle, vehicle to human, vehicle to infrastructure.

However, with the establishment of a smart city infrastructure, the vehicles will be able to exchange data among themselves, detect lights and signs, and have to comply with speed limits. Thus, safer road driving and autonomous vehicles that comply with the rules will be on our roads [38].

Automotive supply chain is an incredibly complex structure that includes a large number of components, hardware, software and firmware suppliers, distributors, dealers, regulatory agencies, insurance companies, and more. A blockchain-based system will ensure more accurate information flow and transparency of transactions between different parties; it will contribute to improving timely logistics, reducing incorrect orders, and keeping the right amount of inventory ad inventory ranking. With the help of distributed-based system, spare parts manufacturers can see their customer companies' existing stock to the extent permitted by the them.

Thus, they can plan production capacities, stock level, raw materials and spare parts and working tempo according to the stock level of its customers. Various block chain technologies can also be applied throughout other phases of the supply chain. Security, identity and granting affect measures against counterfeiting in the supply chain; smart contracts, oracles, and custom code, can support the compliance of security and suitability; it can also support the transfer of payments and contracts to facilitate reconciliation of the agreement and the transfer of money and goods from one side to another [18].

Together with a platform such as the IBM-WALMART blockchain platform, it is possible to bring transparency to the whole flow of the supply chain by bringing together all components of the vehicle supply chain, from the regulators, parts manufacturer, factories buyers, sellers to scrapping process. Producers can adjust the production planning according to the stock held by the consumer [39]. Producers can make each part they produce as unique products by giving their own IDs to them. Thus, the place of counterfeit products in the supply chain is reduced.

Companies and carriers can truly follow the process of moving products during the supply chain phase. They can follow the delay and early arrival processes on the platform and make more accurate planning accordingly. Following the delivery of the products, they can make payments quickly with smart contract and IoT systems as in the case of WABI and without any additional transaction. Government or central institutions obtain more accurate information in product follow-up processes. Tax evasion can successfully be avoided because volume tonnage and other information on the system is correct.

The **Carpass** project is designed to facilitate the tracking of the vehicle through the "digital wallet" that monitors the vehicle's "life cycle". It collects all information about vehicles on one platform. It primarily includes telematics data that monitors where and how a vehicle is used when the engine is running too hard. Using automobile history, artificial intelligence algorithms can accurately estimate the car's sales value at any time. Being able to follow a vehicle also means better implementation of environmental laws and inspection of producers. Vehicle tracking also gives manufacturers the chance to sell value-added services to customers [39].

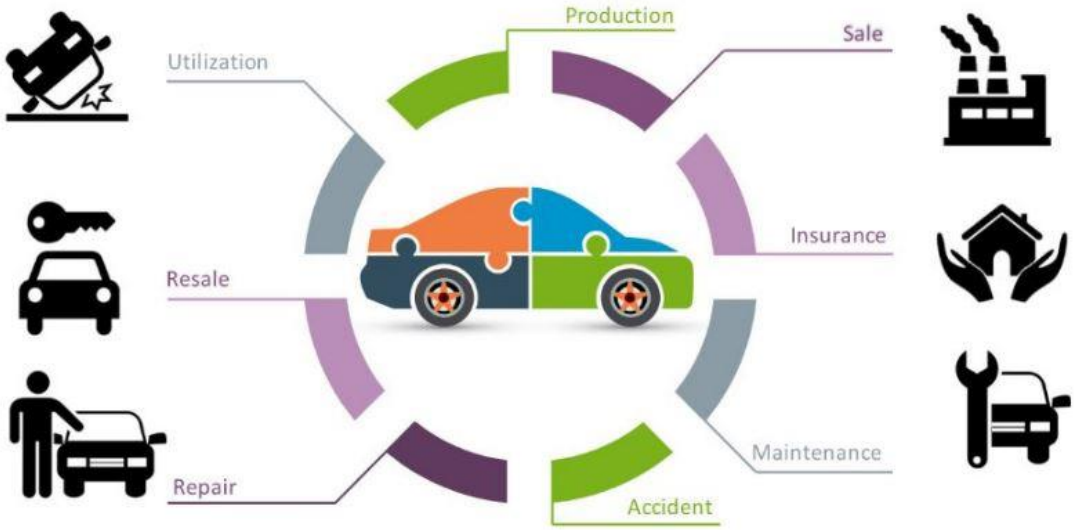

Figure 6.1: Using blockchain with in car life cycle

Car passport: When the vehicles come out of production, each piece on the vehicle will be assigned to its own Blockchain system by giving unique numbers which are different from other vehicle parts, so that both the vehicle and its parts will be unique. The blockchain system, which is integrated into the vehicle, will be able to record all data from sensors, cameras and other IoT

parts by working as a black box system. In the blockchain system of the vehicle, all parts on the vehicle will be labeled with RFID and given the individual numbers. Any damage or alteration in the vehicle will be recorded in the system. Parts replacement or damage, accident incidents will be distributed to the entire network with *Vehicle to Everything* technology. Thus, the data will be available in the state, service, insurance companies; vehicle owners will be prevented from providing incomplete or incorrect information when selling the vehicles; and a sense of trust in the system will be processed [40]. (See Figure 6.1)

6.1. CONTRIBUTION OF NEW SYSTEM TO INSTITUTIONS AND USERS

Blockchain can gather all units such as fabrics, OEMs, insurances, repairer, sellers and other organizations. Blockchain technology will be used in 12 possible areas in automotive industries (see Figure 6.2)

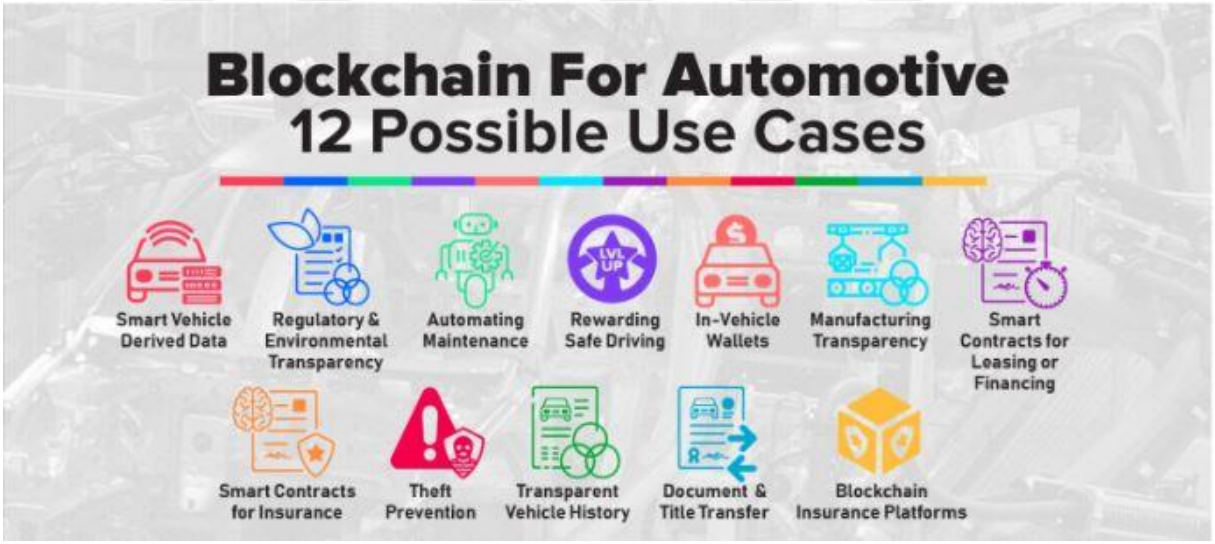

Figure 6.2: Possible use case Blockchain technology in Vehicle industries

6.1.1. VEHICLE AND SPARE PARTS MANUFACTURING COMPANIES

An automobile manufacturer must wait several weeks or months before receiving payment for vehicle transport from an importer / distributor / dealer. There is a heavy flow of paperwork with multiple parties controlling different steps in the chain. A Blockchain-based system will enable more accurate information transparency between different parties, faster processing of

export / import and banking documents, and consequently reduce the reconciliation process [18].

The fact that the vehicle or a spare part happens to be defective and the companies take a notice of that defect after the distribution process and they initiate a recall process will cause a big loss both material-wise and in terms of respectability. When a user encounters a problem with a defective part, it affects the company in a negative way. In addition, companies must reach out to distributors and all dealers to recall the faulty products. This process might last for days and the procedure of the tracing and reaching out to all the parts is very difficult. In addition, some installations and updates can be made via remote blockchain connection.

Blockchain can be the solution for removing counterfeit parts from the supply chain. By creating labels with different identification codes for each piece produced and adding time and spatial information to this information, each part is obtained as a unique piece. The movements of the actual part can be monitored by giving part-specific numbers. When a spare part is to be mounted on the vehicle, the information of change can be processed on the identity of the vehicle, thereby ensuring the authenticity of the parts. With Blockchain, manufacturers can track the parts of vehicles with the provenance system. The tags are connected to the blockchain and the level of authenticity protection is increased by a provenance tracking system. [9] The owner of the vehicle who wants to know about the authenticity of the part can get approval from the company by having the part checked with its tag, as in the WABI protocol. In addition, the customer can confirm the changes made on the vehicle via the system, so that incomplete or excessive changes are prevented. With the approval and controls made by the customers, the companies confirm the authenticity of the products and ensure the removal of counterfeit products from the market. [11] The recall of the faulty part to the manufacturer companies becomes easier. The manufacturer can be signalled when the service reaches a product usage limit and stocks are running out, allowing the process to be automated and tracked by smart contracts. Thus, the contribution of the companies to lean manufacturing will be increased as a result of the pull effect with the decrease of the stocks of the customers without the need for additional accounts, additional documentation and telecommunication requirements among the companies.

For each product, setting up separate, unique codes would be an additional cost for the companies. However, in addition to this additional cost, the company will increase the likelihood of equalizing the faulty or counterfeit product from the market. Because no matter

how fraudulent the material is, for the product users, when the product malfunctions early, the value of the company that owns the brand will decrease in the eyes of the customers. Companies must use blockchain in the supply chain due to their early impact on the market, the follow-up process and contribution to lean manufacturing.

6.1.2. INSURANCE COMPANIES

Insurance companies carry out insurance and insurance transactions according to the data of the vehicle and the information of the persons available on the system. However, users hesitate to notify insurance companies about most issues and solve problems themselves. Besides, they cannot detect frauds such as mileage change and has to settle for the report given by its own maintenance services, but insurance companies can control everything with blockchain.[19] Together with the smart city and smart cars, a comprehensive knowledge of both the vehicle and the user can be obtained. With applications such as car passport, insurance companies can determine insurance risk premiums in the insurance and insurance fees according to the usage information of the person [25].

As a financial provider, insurance companies often have no idea about the actual driving behaviour of vehicle drivers or the service history of their vehicles. A blockchain-based system will ensure that driving schemes and service events are sent to a common book accessible to all parties. The transparency of information about the actual wear and tear of a vehicle will help the auto finance provider to measure the new value of the vehicle more accurately. [31] A typical automated financing involves a series of verification steps to which the blockchain can be applied for efficiency gains [18].

In cases such as accidents, maintenance services can present the costs higher than the actual costs to spare the car as a scrap vehicle, or lower to indicate that the actual damage is reported to be less by the government agencies. If the vehicle is spared as scrap vehicle, the insurance companies will face unnecessarily high costs and suffer losses. If insurance companies know the material value of each part through their systems, this can be a deterrent factor for malicious maintenance services.

6.1.3. CENTRAL INSTITUTIONS

As a result of the applications made by the users to the central institutions, these institutions can have information about the vehicles. If no application is made, they can only have the information written on the license. When the police or security control units conduct an identity check, they obtain information about the actual owner of the vehicle through the license. However, if there is nothing remarkable after the license and identity check, the vehicle is released. It is very likely that a stolen vehicle will pass from such a check. Because it takes days for stolen vehicle notifications to be entered into the system and reach all sub-units. Instead, with the vehicle-ID number given to vehicles with Blockchain technology, central authorities can learn the actual owner of the vehicle without a license or ask to whom the vehicle owner is gave the right for short-term use. In addition, in case of vehicle theft, this information is reached to all units by means of a distributed database when the first unit enters the information to the system. The same thing happens when the police go to the scene. Users may have the right to access the police or government agencies for a reasonable period of time, such as on the Porsche platform [35]. In this way, police can stop or slow down stolen or escaped vehicles remotely by means of smart cities and vehicle-IDs to catch the thief.

6.1.4. AUTHORIZED SERVICE / REPAIRERS

Fake automobile parts, which are genuine in appearance, often enter the supply chain and land at dealer service centres. These parts usually malfunction immediately after installation, and this damage the brands of the car manufacturer and the parts supplier. To combat these frauds, automobile manufacturers use a number of anti-fraud technology and operational layers, but in some way fake parts can always leak into the supply chain [18].

Maintenance services always leave some questions in the customer's mind when servicing vehicles. Because customers have trouble obtaining accurate information. They may demand extra money from customers by stating that there are other malfunctions besides the main breakdown of the vehicle and that they have fixed it. Even in this case it is doubtful that they use original parts. Because there is no clear information about the fate of spare parts on the journey from the beginning of the supply chain. If the original parts arrive on time, the buyer should treat them as original. There is also the possibility that companies use fake products to

make more profits. Even if the new replacement part fails again, the customer cannot apply make a demand and may have to pay the same cost again.

With a blockchain technology that can be applied in vehicles and a memory such as black box / car passport, customers can see all the information through their own vehicle what processes the service maintenance personnel apply or don't apply even if it's necessary on the vehicle. They can learn the authenticity of the parts with the unique part identification numbers given for each part. An upper version of this application can check the authenticity of parts by checking it from the phone, as in the case of WABI.

6.1.5. USERS

When buying and selling second-hand vehicles, users pay extra fees to many institutions to learn the accurate information about the vehicle. Notary price, expertise mechanic price, notarized sales price, state tax etc. taxes are extra charges to buyers [17]. Even if the buyer looks at the insurance or government record to obtain the correct information about the vehicle when buying the vehicle, the vehicle owners will have difficulty in accessing the actual information unless the actual owners report the malfunction. In maintenance services or expertise, they can access data on the history of the vehicles, but they find it difficult to detect irregularities such as mileage change if the vehicle has not been serviced for a long time. For this, they also have to pay money to the expertise. In that case, the users assume that what reports and dealers state is true. Also, in that situation, there is no one to consult in case of a breakdown. Instead, with the help of the black box / car passport that will come with the Blockchain, users can see all the accidents of the vehicle, all the part changes and make a quick evaluation on their own and buy the vehicle.

Customers can trade on a network where the entire supply chain is combined with an application such as IBM-Watson Supply Chain. Thanks to Smart Contracts, users do not have to go to central institutions such as notary. Thus, while the cost is reduced, the whole network registers the new owner of the vehicle. Vehicle owners can act without a vehicle license [17].

With the widespread implementation of Blockchain application on which Porsche is working, the main vehicle owner can grant other users the right to log in for a certain period of time. The system can answer questions about how many miles the authorized user has driven, where he's headed, or many other questions one can think of. With the application, when the user is away

from the vehicle, only the tailgate of the car could be opened. This means that owners who are not at home or who are obliged to buy cargo have limited openness to other persons [35].

Uber/taxi-kind of applications are offered for service to people who do not have a vehicle or who do not use their own vehicle at a time. However, the vehicles of the people who goes to work by company bus or tone of the vehicles of those who have two cars stay at home unused. With the idea offered by Oaken to the project, vehicle usage can be shared. Users can provide other users with vehicles that are idle/unused while contributing to their budgets. In addition, due to the fact that it is determined who has damaged the vehicle in the vehicles given the right to sit, the material costs can be demanded as a result of the damage [32].

With the expansion of Blockchain and its evolution in the vehicle industry, vehicle buyers can access the information of the vehicle through a platform to be established between the dealers. When a new customer buys your vehicle, he can examine all the history of the vehicle from the vehicle's black box; the parts that have been changed, the accidents, in sum the whole history of the vehicle [25]. Instead of believing the vendor's discourse, he can see everything through the system. For a quick check, he can take the system to the service or get information from the service and find out the accuracy of the vehicle's data. Thus, the necessity to go to expertise for the purchase and sale of vehicles may be eliminated. This leads to a significant reduction in users' costs. In addition, a vehicle that shows its entire past provides transparency while providing confidence among users.

In CarVertical Application, the company collects all the information about the vehicles and presents them to the users. Thus, users who intend to purchase vehicles will have access to extensive, accurate, non-modifiable information about vehicles. Users will be able to access information that will be developed and open to all users connected to the network [41].

6.1.6. GALERY AND VEHICLE FLEET OWNERS

Vehicle provider companies offer packages to users when renting the vehicles to people. The user who accepts the costs that vary according to the insurance costs does not accept the situation when there is a different problem with the vehicle and informs the company that it is their fault. The company can only explain the situation with damage records on paper. In the same way, malicious car rentals can also claim extra money from users at any time by not writing the exact breakdowns of the vehicle. In this case, users may have to pay for irreparable

damages as they go unnoticed. With Blockchain technology, this problem or non-transparent situations will be completely eliminated since the whole vehicle history, fault and damage records will be written on the system with the vehicle identification [25].

Company owners may grant vehicle tenants the right to log in / use for a certain period of time with the blockchain system. Thus, firms save on most of the paperwork [32]. Users also have to avoid the need to carry an extra document with them. Companies rent a car by its brand. Carpass application can determine the material cost of the vehicle as well as the hourly rental price according to the vehicle condition. The vehicle users may be charged on an hourly-based usage, not day-based. Users connected to the network can be charged after leaving the car.

A common, unethical car dealer practice is to sell a gallery vehicle and then not notify the bank that lent money of the sale of the vehicle. This allows a dealer to have business capital to defraud payroll and suppliers. If the bank notices that, it will take immediate action against the seller. However, since the vehicle is legally sold, the bank cannot make any claims regarding the vehicle. At the same time, financing to the seller has been spent and must be closed. Transparent access to data eliminates the asymmetry in the information that allows this to happen. Blockchain provides immediate transparency and gains value as more stakeholders participate, [18].

PART VII. RESULTS

The use of blockchains in the vehicle industry can contribute in two different ways. The initial is gathering the projects of IBM-Maersk platform, Mercedes work condition plan, Provenance label system and WABI platform under one umbrella. The first of these is to establish a network like IBM-Maersk, where all supply chain institutions and users in the processes starting from the follow-up of the raw material of the product to the final process of the vehicle in scrap form. Members of this supply chain can agree on Mercedes project about work condition. The aim is to ensure that standards and contractual obligations relating to working conditions, human rights, environmental protection, safety, work ethics and compliance in the supply chain are met and controlled in partnership with suppliers directly. Provenance company model can integrate unique ID for every product. With WABI model, partners can control and monitor flow of products at points to points with RFID, GPS, Iots.

The contributions of this network are:

- Members of this supply chain can ensure that standards and contractual obligations relating to working conditions, human rights, environmental protection, safety, work ethics and compliance in the supply chain are met and controlled in partnership with suppliers directly.
- With the established blockchain network, network partners within their authority can obtain information in a precise, instant and reliable manner without the need for additional communication for information abstention [9].
- With the established IBM-Maersk blockchain network, network partners within their authority can obtain information in a precise, instant and reliable manner without the need for additional communication for information abstention [9].
- Since the producer companies can see the stock level of their customers with IBM-Walmart model, they can make their production planning in the light of this information. Thus, the pull effect in the market contributes to lean production. The producer company can make its own preparations before the customer company form a new demand of a product. The number of products in the stock level may be reduced.

- Tax evasion will be reduced as central agencies receive the correct information from the Blockchain network in port and other border enterprises [2].
- Instead of trust based on assumptions and mutual communication and lack of delay in the product supply chain flow, companies rely on the system within the instantaneous information they receive via RFID, sensor, location devices, IoT, and they can easily monitor this on the network [2].
- OEMs eliminate counterfeit parts on the market that cannot be completely removed from the system, with RFID and QR code-like applications given specifically to each part, as in the case of WABI. Thus, vehicle owners can be saved from counterfeit parts, reducing the possibility of accidents and malfunctions. Companies avoid having financial costs due to counterfeit parts in the future. In addition, since every piece of counterfeit product that malfunctions or is damaged will be considered as OEM defective in the user's system, this negative situation will be eliminated, and customer satisfaction will be increased in the future [11].

The second contribution is gathering the projects of Porsche, Jaguar, Renault, Provenance, IBM-Maersk, Oaken and Car Pass. Blockchain can be used in the vehicle industry in a way to form a platform like IBM-Maersk, where the vehicle manufacturer, service provider, non-profit organizations, central institutions, insurance companies, buyers and sellers will be available. Combining Provenance and WABI Protocol, every part of vehicle can be given unique ID to eliminate counterfeit part. Porsche and Oaken Project makes it possible to grant temporary access privileges to the vehicle. With the help of Renault car passport, all information about vehicle history can be gathered on the vehicle.

The contributions of this network are:

- The buyer can check the information stored on the system when the vehicle is to be purchased. Since there is a correct flow of information between the buyer and seller, the real financial value of the vehicle is determined through applications such as Car pass, [25].
- Data dispersed on systems is collected in a network and the information that varies from the institution to the institution and that can not be verified is collected in the network in an accurate and irreversible manner with car passport [30].

- Insurance companies can obtain more accurate value by adding information such as depreciation share and usage data to the current state of the vehicle when determining the cost of the vehicle [25]. In light of this data, user insurance costs can be reduced with the usage-based insurance system. Irregularities such as mileage reduction are prevented [18].
- Users can earn additional income with Oaken and Porsche project by providing short term rights of usage by other people to their vehicles and renting the vehicle for periods other than their own use. The information on how the vehicle has been used becomes accessible for the real owner on the system. Accordingly, the extent of the use of the vehicle may be restricted remotely. Institutions such as couriers can only open local areas such as luggage [36].
- When users go to the maintenance service with their vehicles, they see in car passport which part of the vehicle has been changed and which operations have been performed. This increases confidence in service providers and repairers. Since all the processes are registered in the system, the new buyer can see every process that has been done in the future [30].
- Drivers can earn rewards with Jaguar project by sharing data such as road status and traffic information, while helping other users to travel more safely and reduce accident rates [37].

	Countibution to Vehicle Partners	Current Technology	Blockchain
VEHICLE AND SPARE PARTS MANUFACTURING COMPANIES	Counterfeit part	+	-
	Payment fee	$$	$
	Idle time	+	-
	Transparent	+	++
	Traceablity	+	++
	Trust of partners	+	++
	Paper work	+	-
INSURANCE COMPANIES	Traceablity	-	+
	Paper work	+	-
	Cost of insurance	$$	$
CENTRAL INSTITUTIONS	Paper work	++	-
	Traceablity	+	++
	Time savings	-	++
AUTHORIZED SERVICE / REPAIRERS	Trust of partners	+	++
	Traceablity	+	++
	Counterfeit part	-	+
USERS	Payment to central institutions	$$	$
	Paper work	+	-
	Trust of sellers	+	++
	Traceablity	+	++
	Remote Access	+	++
GALERY AND VEHİCLE FLEET OWNERS	Paper work	+	-
	Remote Access	+	++
	Traceablity	+	++
	Trust of sellers	+	++

Table 7.1: Comparison of Current Technology with Blockchain Technology

- "-" means absence in the respective field.
- "+" means that the systems are under control, "++" denotes high level of contribution to the system.
- "$" and “$$” represents the cost in USD with the same logic above.

PART VIII. CONCLUSION

Today's supply chain is becoming increasingly complex. With each newly added network, the traceability of growing organizations becomes more difficult. Expanding companies have difficulty even in tracking the systems within themselves. Because, although all transactions are tracked on electronic data systems, data entry to these systems is still done by people. It is clear that the entries cannot be made at the right time in the current situation. To connect points, nominally neutral, non-profit or government agencies are given the task of creating a centralized data storage to provide reliable information flow.

The complexity of the system makes it vulnerable and open to irregularities. Looking at the entire supply chain, governments and control units have difficulty in monitoring product's arrival at the right time and its quantity. At the same time, there are differences in planning stages and implementation stages in transportation and handling operations for companies. Delays, paperwork or additional communications, in short, every operation returns to companies as an additional cost and time loss.

For these reasons, distributed database technology offered by Blockchain can be a solution in many industries. Everyone in the network can keep their own database. Distributed networking can give businesses a sense of trust because the databases are not changed, and everything goes through a common approval process. With the help of the platforms, third parties, that is, intermediaries are eliminated, partnerships with smart contracts can also be carried out with unreliable partners. In supply chain processes, while all actors in the supply chain reach the accurate information at the same time with integrated RFID, location, QR code, smart contracts have proven to be a solution to the disruptions that will occur through the system. In addition, time delays can be added to the time schedule, as the time loss will appear on the system. The government and other authorities monitor systems in a transparent environment. Transitions and tax payments can become easier.

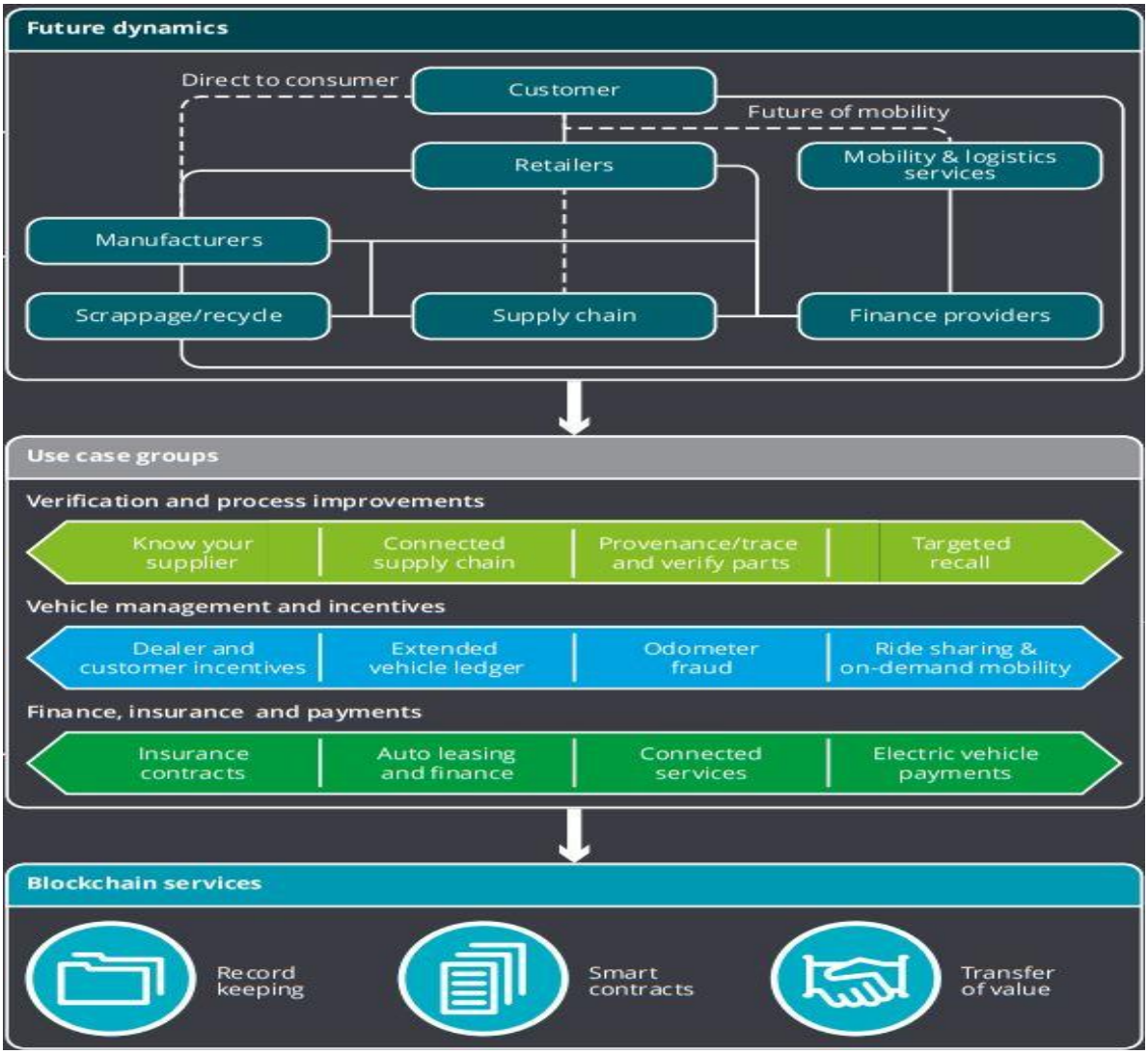

Figure 8.1: Future planning of Blockchain technology in the automotive industry

Supply chain and logistics organizations can reduce the cost of paperwork and maximize the efficiency of communication with Blockchain. Suppliers, transporters and customer representatives can follow their products in confidence, on an open and transparent platform. Customers gain the ability to learn more about food information such as products, farm, materials, transportation. In conclusion, it is seen that Blockchain will be a resource for many sectors, including supply chain and logistics, within a few years.

As a result, with the use of Blockchain technology in the vehicle industry, gathering each transaction in an open, transparent and unchangeable network gives all network partners a sense of trust. In near future, with blockchain technology, flow of information will be in every direction. Suppliers, manufacturers, leasing companies, users and others will use this technology without hesitation (See figure 7.1). Although the integration of the blockchain in

the vehicle industry may seem initially costly, this can be ignored due to its contributions. Companies using Blockchain technology can become more preferable to customers in this industry where the sense of competition is high and spare parts and vehicles are precious. With smart cities and vehicles to vehicles, vehicles to humans, and vehicle to everything, in short, with the spread of the Internet of Objects, secure and encrypted sharing will become a necessity. When moving from semi-autonomous to full autonomous driving, concepts such as accurate information flow, secure communication, road information and road priority will become even more important. It is clear that storing this data in a secure, non-modifiable network environment will require blockchain technology in the vehicle industry in the future for instant data transmission to all network stakeholders.

PART IX. REFERENCES

[1] Nakamoto, S., "Bitcoin: a peer-to-peer electronic cash system", , https://bitcoin.org/bitcoin.pdf, (2008).

[2]White, M., "Digitizing global trade with Maersk and IBM", Retrieved from URL: https://www.ibm.com/blogs/blockchain/2018/01/digitizing-global-trade-maersk-ibm/, (2018).

[3] Brody, P., "How blockchain is revolutionizing supply chain management", Digitalist Magazine, August 23: 1-4, (2017).

[4] Sadouskaya, K., "Adoption of blockchain technology in supply chain and logistics", Bachelor's Thesis, South-Eastern Finland University of Applied Sciences, Finland, 20-25 (2017).

[5] Allison, I., "Maersk and IBM want 10 million shipping containers on the global supply blockchain by year-end", Retrieved from URL: https://www.ibtimes.co.uk/maersk-ibm-aim-get-10-million-shipping-containers-onto-global-supply-blockchain-by-year-end-1609778, (2017).

[6] Hackett, R., "Walmart and IBM are partnering to put Chinese pork on a blockchain", Retrieved from URL: http://fortune.com/2016/10/19/walmart-ibm-blockchain-china-pork/, 2016.

[7] Hackius, N. and Petersen M., "Blockchain in logistics and supply chain: trick or treat?", In Proceedings of the Hamburg International Conference of Logistics (HICL) Digitalization in Supply Chain Management and Logistics-23, 3-18, (2017).

[8] Young W., Hwang K., McDonald S., Oates C.J. "Sustainable consumption: green consumer behaviour when purchasing products" , Sustainable Development Volume 18-Issue 1, 8-15, (Feb 2010),

[9]Provenance, "Blockchain: the solution for transparency in product supply chains , Retrieved" from URL:https://www.provenance.org/whitepaper, (2015)

[10] Brauer, E., "Waltonchain: An Interconnection Between the Physical and Virtual Ecosystems", Retrieved from URL: https://www.investinblockchain.com/waltonchain/, (2017).

[11] Waltonchain, “Waltonchain: Leading humanity to a reliable digital life”, Retrieved from URL: https://www.waltonchain.org/, (2018).

[12] Ambrosus, “Decentralised IoT Networks for Next-Generation Supply Chains”, Retrieved from URL: https://ambrosus.com/#blockchain_protocols8, (2018).

[13] Belton, P., “The battle against deadly fake goods goes hi-tech”, Retrieved from URL: https://www.bbc.com/news/business-42152892, (2017).

[14] TAEL, “Tael – token for safe consumer products”, Retrieved from URL: https://taelpay.com/, (2019).

[15] TAEL, “Our Ecosystem Detailed: Actors in the Ecosystem”, Retrieved from URL: https://medium.com/@Taelpay/our-ecosystem-detailed-actors-in-the-ecosystem-ac149f1f23d3, (2019).

[16] Lawson T, “Accelerating technology disruption in aoutomotive market/Blockchain in the aoutomotive industires” Retrieved from URL: https://www2.deloitte.com/content/dam/Deloitte/cn/Documents/consumer-business/deloitte-cn-consumer-blockchain-in-the-automotive-industry-en-180809.pdf , (2018)

[17] Alam M.,” Why the auto industry should embrace Blockchain”, Retrieved from URL:https://www.connectedcar-news.com/news/2016/dec/09/why-auto-industry-should-embrace-blockchain/ ,(2016)

[18] Yadav G, “Blockchain Writing a New Chapter for Automotive Industry” , Retrieved from https://hackernoon.com/blockchain-writing-a-new-chapter-for-automotive-industry-48a8151eec99 ,(2018)

[19] Roni R., “How Can Blockchain Benefit The Automotive Industry?” Retrieved from URL: https://www.ethnews.com/how-can-blockchain-benefit-the-automotive-industry ,(2018)

[20]Alam M., “Blockchain Technology Could Reinvent The Auto Industry”, Retrieved from URL: http://mahbubulalam.com/blockchain-technology-could-reinvent-the-auto-industry/ ,(2016)

[21] Mobi, “Mobility Open Blockchain Initiative”, Retrieved from URL:https://dlt.mobi/ ,(2018)

[22] Suberg W, “New Blockchain Research Group Launched By 30 Members Including Car Giants BMW, GM”, Retrieved from URL:https://cointelegraph.com/news/car-giants-bmw-gm-among-30-members-of-new-mobi-blockchain-group , (2018)

[23] Faraz T., “Top automakers, startups, tech firms, others form blockchain consortium MOBI”, Retrieved from URL:https://coinreport.net/top-firms-form-mobi/ ,(2018)

[24]Shieber J., “Toyota pushes into blockchain tech to enable the next generation of cars”, https://techcrunch.com/2017/05/22/toyota-pushes-into-blockchain-tech-to-enable-the-next-generation-of-cars/ ,(2018)

[25] Toyota, “Toyota Research Institute Explores Blockchain Technology for Development of New Mobility Ecosystem”, Retrieved from URL: https://media.toyota.ca/releases/toyota-research-institute-explores-blockchain-technology-for-development-of-new-mobility-ecosystem, (2017)

[26]Huillet M., “Hyundai Commercial Partners With IBM to Accelerate Blockchain Development”, Retrieved from URL: https://cointelegraph.com/news/hyundai-commercial-partners-with-ibm-to-accelerate- blockchain-development,(2019)

[27]Partz H., “South Korea’s Largest Car Supplier Hyundai to Use DLT in Smartphone-EV Pairing Tool”, Retrieved from URL: https://cointelegraph.com/news/south-koreas-largest-car-supplier-hyundai-to-use-dlt-in-smartphone-ev-pairing-tool,(2019)

[28]Bloomberg, “Hyundai, IBM ile blockchain ortaklığına gidiyor”, Retrieved from URL: https://www.bloomberght.com/finansal-teknoloji/haber/2197699-hyundai-ibm-ile-blockchain-ortakligina-gidiyor,(2019)

[29]Pollock D, “Renault Uses Blockchain to Store Car Passport Details”, Retrieved from URL: https://cointelegraph.com/news/renault-uses-blockchain-to-store-car-passport-details,(2017)

[30] Groupe Renault, Microsoft and VISEO join forces to create the first digital maintenance notebook prototype, Retrieved from URL: https://media.group.renault.com/global/fr-fr/groupe-renault/media/pressreleases/94238/groupe-renault-microsoft-et-viseo-sassocient-pour-creer-le-premier-prototype-de-carnet-dentretien-nu1 ,(2017)

[31] Klancir L., “How Blockchain will Change the Automotive Industry”, Retrieved from URL: https://www.asynclabs.co/blog/how-blockchain-will-change-the-automotive-industry/?utm_source=facebook&utm_medium=social&utm_campaign=news. (2018)

[32] Scott M., “Project Oaken and the Future of Ethereum-based Smart Transportation”, Retrieved from URL: https://btcmanager.com/project-oaken-and-the-future-of-ethereum-based-smart-transportation/?q=/project-oaken-and-the-future-of-ethereum-based-smart-transportation/& ,(2018)

[33] Oaken Innovations, “UAE GovHack - Tesla & Tollbooth on Blockchain”, Retrieved from URL:https://www.youtube.com/watch?v=XyRQLRfzvcM&feature=youtu.be , (2017)

[34] Volkswagen, Volkswagen Over The Air Update PoC With IOTA At Cebit 2018, Retrieved from URL:https://iota-news.com/volkswagen-over-the-air-update-with-iota-at-cebit-2018/ (2018)

[34]Mercedes, “Mercedes-Benz Cars develops Blockchain-prototype for sustainable supply chains for the first time”, Retrieved from URL:https://www.prnewswire.com/news-releases/mercedes-benz-cars-develops-blockchain-prototype-for-sustainable-supply-chains-for-the-first-time-300800787.html, (2019)

[35] Porsche, “Blockchain: the key technology of tomorrow”,Retrieved from URL: https://newsroom.porsche.com/en/company/porsche-blockchain-technology-opportunities-digitization-16800.html ,(2019)

[36] Porsche, “Porsche introduces blockchain to cars”,Retrieved from URL: https://newsroom.porsche.com/en/porsche-digital/porsche-blockchain-panamera-xain-technology-app-bitcoin-ethereum-data-smart-contracts-porsche-innovation-contest-14906.html ,(2019)

[37] Harbor C., “On The Money: Earn As You Drıve Wıth Jaguar Land Rover”, Retrieved from URL: https://blog.iota.org/jaguar-land-rover-fc7f6b029053 Accessed:11.04.2019

[38] Chorus, “Blockchain Solutions for Transportation”, Retrieved from URL: https://www.chorus.mobi/.(2017)

[39]IBM, “IBM Blockchain Car Lease Demo”, Retrieved from URL: https://www.youtube.com/watch?v=IgNfoQQ5Reg ,(2016)

[40]Smith B.,“The Effects of Blockchain on the Automotive Industry”, Retrieved from URL: https://www.azom.com/article.aspx?ArticleID=15671 ,(2018)

[41] “What are the Top 5 Blockchain-based solutions in the Automobile Industry?”, Retrieved from URL: https://www.kryptographe.com/top-5-blockchain-based-solutions-automobile-industry/, (2019)

RESUME

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