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Industrial Case: Blockchain on Aircraft's Parts Supply Chain Management

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Full Paper

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Abstract

With the growth of aviation domain across the world, there has been steep demand in aircrafts. In this domain, avionic machines and hardware are shipped to single assembly hubs, located globally. All parts come with certain life expectancy, specific requirements and inevitable need for maintenance. In this paper, we will take an industrial scenario of aviation's industries' supply chain management, and demonstrate the necessitation of having decentralized system like Blockchain, not only assisting to maintain inventory of the aircraft's individual segments but also to monitor the performance, usage, etc. This will help to achieve a transparent network of aircraft's part's supply and will reduce the risk of availability of aircraft segments in black market and will help the analysts to analyze the supply, demands, source of availability of aviation parts and method to procure them from the right sources.

Keywords

Supply Chain Management, Blockchain, Aircraft, Segments.

Aim and Objective

Aim to establish Blockchain technology in business process of aviation industry, which has specific set or types of components that would enhance the overall goal to improve timing and assure the quality of products and services during the whole supply chain service. Objective is to reach the goal through introduction of newly developed business models and digital services as it is exemplified with the block chain paradigm.

Introduction

Supply chain management is the backbone of any industrial sector, different industrial organizations, globally, specialize in manufacturing of one particular type of product and are operated as production house for any particular segment, which would be required by another manufacturer to produce another product or part of final product, may be located at another part of the world. By the end product, individual parts go through series of chain of supplies called multi-tier supply chain. Aviation industries stand no different in this process. Individual parts or segments are imported, a proper inventory is

maintained and assemble domestically. Aircrafts may overhaul to another region depending on type of service required.

These supply chains are well regulated and properly monitored by individual companies at their individual levels. There is a possible risk of parts or segments replacement, bad quality replication, and decommissioned or preceding products being sold in black markets. There is no single supply chain of product manufacturing but a web on interdependent manufacturers, heavily depended on each other for segment production. There are certain pre requisites that should satisfy specific requirements before moving forward in this chain that would make product worth and efficient for future use. In most cases, when specific requirements are not met, they are either returned or remanufactured, further increasing the delay in obtaining the final products.

In this paper we take industrial scenario for aviation's supply chain management, on which, we implement the concept of Blockchain technology where each transactions is monitored by individual tiers of this supply chain, later smart contracts platform between individual tiers can monitor quality and proper flow of products in this chain. Individual databases at individual level will record and update all transactions that would be flowing along different tiers. This concept and technology into supply chain management can really bring significant added value to business process through more easy flow, higher reliability and better quality in aircrafts parts or segments.

We will talk about supply chain, its features and how problems in future can be overcome. Different levels of OEMs (Original Equipment Manufacturers), MRO (Maintenance, Repair and Overhaul) consist of their own individual supply chain and idea of Blockchain on integration of tier will model a transparent and reliable chain.

Features of Supply Chain in Aviation

By 2035, there will be a significant growth of passengers' traffic and consequential demand in aircrafts, as a result, significant increase in aircraft production is expected (Madhwal, 2017). This growth will seek huge demand for more flight carriers, therefore the supply chain should proceed in perfect sequence, without any error. Soaring demands also lead to pressure on the supply chain causing delay and failure. Example, the problem to unhandled this situation could be at any level where the supplier is not able to process demands due to unavailability of products at preceding level (PricewaterhouseCoopers). Behind every final product, there is a long chain or levels of assemblies, but some researches have combined these individual levels, which produce for OEMs into 3 main tiers supplies (Supply Chain Features of the Aerospace Industry Particular Case Airbus And Boeing):

- Tier 1: This level directly works for OEMs, for example, dealing with engines, brakes, etc. they are first suppliers to the assemblers.
- Tier 2: They are the suppliers to tier 1, they supply products, which are manufacture from their own productions. Example, assembling individual parts of Engine.
- Tier 3: These are individual small-scale component production companies, which usually provide small components like electrical components, raw material etc.

Figure 1 below is a sample tier representation of Aviation Turbine Company, though this company would be serving at some tier for another "Originating Buyers" i.e. each component of any supply chain at any tier would have its own tier of supplies.

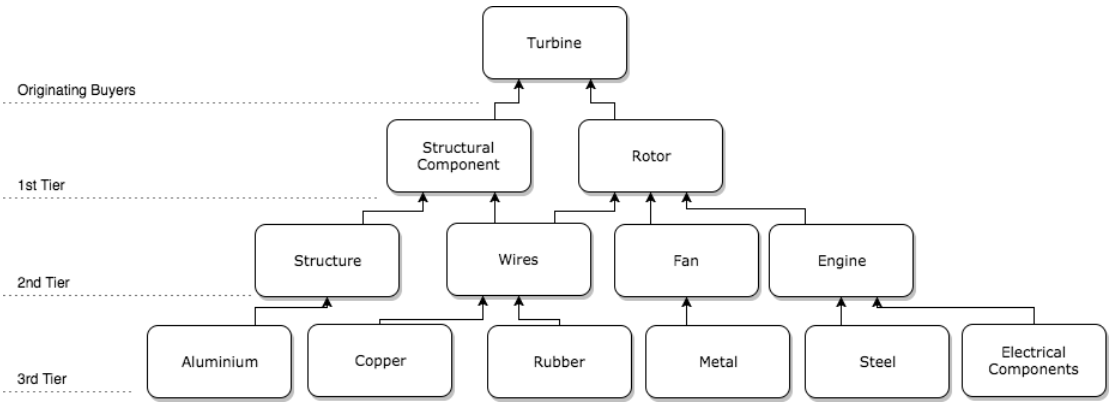

Figure 1. The aircraft's Turbine's Supply Chain

Even after the proper path of supply chain, the risk and challenges like careful coordination among different bodies, challenges of managing the risk across global network and complex supply network, risks like guarantee, functioning, quality control, usage control, etc. still exist in OMEs. Necessity by the organizations to understand not just the direct suppliers they buy from, but also those who indirectly contribute component or service across the extended supply chain (Raza).

MRO Supply Chain Methodology

The purpose in any supply chain is to ensure that right product is produced at the right time and is at proper flow in the chain. It is highly dependent on the external factors like mode of transportation and internal factors like availability of inventories to produce and meet the required demands. These chains consist of exorbitant amount of flow information, product and money. Components of supply chain management [5] are complex but based on:

- Planning of Inventory i.e. from which part of manufacturing hub, it will be easy to procure the required product, etc.
- Development in making relation with supplier of raw material.
- Make i.e. manufacturing and measuring the quality of product.
- Delivering final product to required party
- Run i.e. finally testing or running the product as required.

There are instances when an aircraft is required service, part replacement, or sometime overhauling where it as a whole may be used for performance testing. Aircrafts move from one place to another for getting serviced as that specific service could be present at some particular place hub. This ensures the quality and performance marking and if there is any error of fault, then it is either repaired or replaced.

Blockchain in Supply Chain Management

Blockchain technology (Blockchain) plays a vital role in today's era of IT. It was initially introduced by Bitcoin, which focused to decentralize the common database used to record transaction between different users by enabling individual ledgers among the users that will update all the transactions anonymously and would be difficult for a single party to manipulate to interfere with. Blockchain calls for traceability, with open ledger we can know which product is transacted to which member of the chain, though two parties stands anonymous.

In aviation supply chain network, User will have the access of involving parties in the transaction. If there is some error or fault in the final product, then we can easily trace it back to the path of supply. We can monitor the progress and with it plan the future manufacturing. In supportive of design principles in Industry 4.0 (4.0), we propose the following:

- Interoperability: Each individual segment to be enabled with sensor or special id, helping different tiers bodies to connect and communicate among each other.
- Information Transparency: Ability to show the individual processes at each level, for example, if any changes made at any level in this chain all the users will be updated with the change with new details.
- Technical Assistance: This would enable to assist systems to support individual in chain by aggregating and visualizing information comprehensibly for making informed decisions, future planning and resolve problems quickly.
- Decentralized Decisions: Enabling individual companies with make their own decision and to perform their task.

Introduction of Smart Contracts, can help to achieve the desires, required and up to the mark product. This process will have all the details like, serial number, validity of products, i.e. all the information that would guarantee its authentication and uniqueness. Initially the supply chain was reordered on papers and where never digitalized where bundles of record books were piling and lot of time was wasted when details were requires. Now many multinational companies provide with user the status updates with the location or time of arrival. This helps to attain secure transparency across global chain supply, which will help to reduce frauds, reduce delays, paper works, other wastes, etc.

Industrial Case Study

Now we will imply Blockchain to aviation industries' supply chain and monitor how, if details that are share across the platforms of individual users in this network, can actually benefits the aviation sectors in terms profit and safety. We will take the help of figure 2 below describing small scenario.

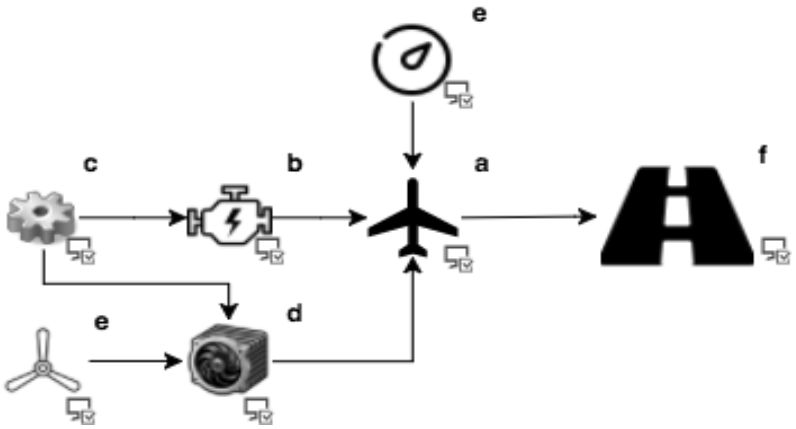

Figure 2. Small Supply Chain

Let us begin at an assembly hub 'a', this assembly hubs procure different parts from different places and are assembled into one individual standing aircraft. This hub is one of the individual bodies of the supply chain that procured parts like engine and turbine from different companied 'b' and 'd' respectively. When procuring and assembling one part for e.g. turbine into an aircraft at hub 'a', a transaction and assembly ledger will be updated across all the members of the network indicating that turbine of unique id along with other segments were assembled together, producing aircraft which itself will act like a new product of unique id. Assembly ledger will keep the record of all the new products generated at each level, which would be integrated with transaction ledger that will show the transacting details among the individual members. This whole network could also works as inventory registry for individual companies along with details of the products, which will show the production details.

Now at individual assembly hubs, will maintain their own supply chain path. At some tire level in this chain, if a products is replaced or tampered and the database of the hub, that will receive this product, is manipulated, due to the decentralized ledger, this process would not be validated as there would be mismatch, for example, may be in serial number and hence this can avoid and kind of future malfunctioning that could have happened.

Once the part is assembled into a plane and is serving for a purpose (commercial, private, etc.), during the overhaul at any maintenance hub, the engineers would have a proper and easy access to check for all the required maintenance, remaining life expectancy of products, hence, reducing the time and increasing the efficiency of work. If any part is close to expiration, it will indicate before hand and the performance can also be monitored during the working and with parallel monitoring.

Conclusion

Using Blockchain technology in the supply chain management can improve the overall scenarios in aviation sector, not only to aircraft producers, but also its supporting units like logistics, suppliers, etc. This is will be most efficient and transparent transactions, hence enhancing the outcome and performance. The prospective of information transparency of parts movement, will enable the individual company companies to monitor its production and regulate process of production with the constant information supplies from supporting companies (tier 1). With all information in hand, anticipation for the reduction in counterfeit products would be achievable. Introduction of smart contract (Contract) would minimize the possibility of corruption practices as it can eliminate the involvement of 3rd party (Lexology) and with the data information spread across, the buyers from different sectors like defence, private players will be self-capable to purchase.

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