Maintenance in Industrial Sector based on Emerging Blockchain Technology

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Abstract: Companies on global markets today need to achieve high levels of performance and sustainability in order to remain "alive." Because of the related costs, maintenance cannot be done in a relaxed and spontaneous manner within the framework. In all manufacturing industries, maintenance strategy plays a major role. Each maintenance strategy is having its own characteristics, importance and disadvantages. A machine's performance depends on the type of maintenance strategies that it uses. Blockchain gives this dilemma a unique solution. Devices are tracked with serial numbers on the blockchain. Blockchain provide a decentralized distributed ledger network as well as protocols and processes to execute smart contracts for activities entered into the distributed ledger.

Index Terms: Maintenance, Blockchain, Distributed, Consensus, Decentralized**.**

1. Introduction

Industrialization growth affects nations ' economic development. The developed countries of the world have reversed the vicious cycle of poverty as historical documents by industrialization instead of by depending on the production of agriculture or national resources [1]. In social developments such as incomes rise, better living conditions, social stability, increased employment opportunities, more skilled labor, higher farm production, improved economic growth regulation, increased savings and investment, the industry plays a complex part [2]. Industries made a significant contribution of 30.5 percent to global GDP in 2017, compared to other sectors such as agriculture (5.9 percent) [3]. Industrial sectors can be classified into two types such as manufacturing and non-manufacturing sectors as shown in Figure 1.

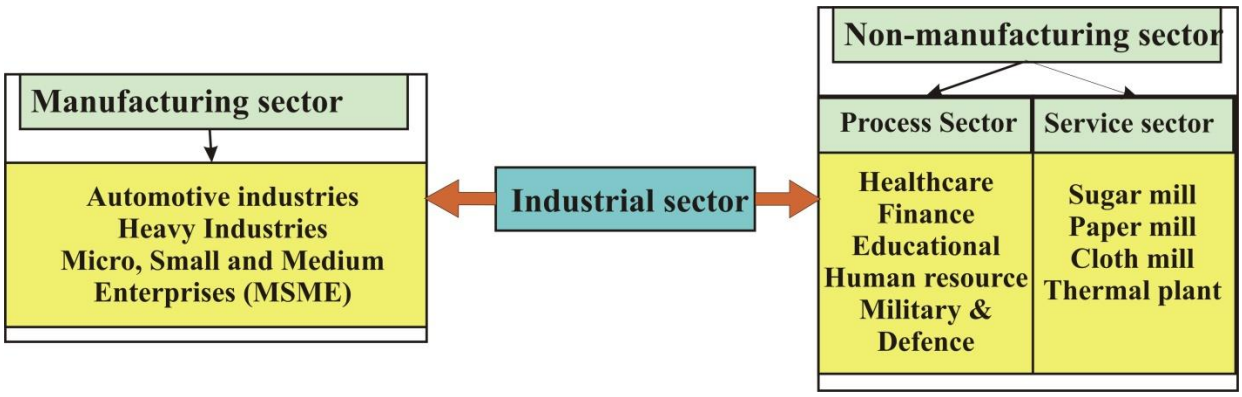

Figure 1: Classification of industrial sector

Despite such huge contributions, industries are facing various challenges that lead to the non-optimal utilization of organization resources [4]. One of the most important challenges in industrial sectors is Real-time Tracking of maintenance (RTM) works. RTM is defined as actions required to retain or restore a piece of machinery, device or program to the specified operating condition for optimum life span [5]. Maintenance can also be regarded as all activities to retain or recover an object in or in a state where it can execute its necessary task. The activities provide the mixture of all technical and corresponding administrative, managerial and supervisory behavior.

Lack in RTM of devices and equipment's cause upgrades the downtime of industries [6]. Downtime is a difficult cost to quantify in different industries, which is often attributed to maintenance problems. In addition, more than 80% of companies are unable to accurately quantify the true downtime cost (TDC) [7]. Most of the prosperity of a national highly depends on the best utilization and proper maintenance on time of available resources for the better productivity. In addition to its contributions to GDP, company adds one-third of the worldwide greenhouse gas (GHG) pollution that result in an increase in earth's temperature (Intergovernmental Panel on Climate Change, 2014). It is now a major challenge for a developing country to ensure that all the condition and quality of the building are at the top so that its serviceability can be sustained and its practical requirements can be encountered [8]

Organizations are increasingly dependent on productivity technologies. Such innovations are often represented in physical assets that need to be preserved in order to remain competitive for the enterprise. Maintaining such physical assets is usually based on proven approaches to maintenance, philosophies, theories, and strategies. It is not a trivial task to agree on an acceptable solution or plan [9]. The key focus of this paper is to design workable techniques that can significantly minimize or eradicate breakdowns of machinery and equipment in a production line and these strategies are:

- Activities performed to achieve the efficiency, output and integrity of assets at a minimal and fair cost.
- Strategies which increase the viability of plants in the long term. Business systems that ensure efficiency by offering optimum maintenance costs for the plant's availability.

1.1.Types of Maintenance:

Companies (SMEs and large groups) know how their productivity depends partly on their processes of industrial maintenance. In fact, the industry has broadly two types of maintenance: proactive/unplanned and reactive/planned [10]. These concepts are not always easy to understand or some people don't know well, so they need to be cleaned up. Each company has very precise needs and therefore a specific type of maintenance needs to be implemented [11]. To help you make the right decision and execute the perfect strategy, authors would like to explain exactly what the different types of industrial maintenance mentioned above are.

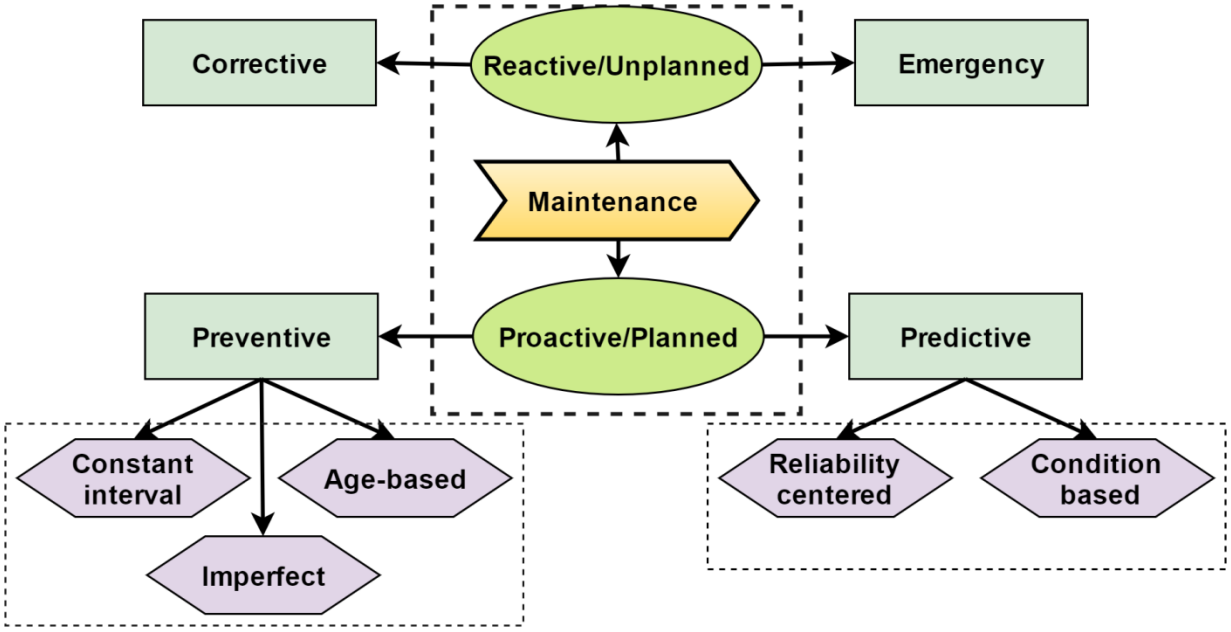

Figure 2: Classification of maintenance strategies

Corrective maintenance is carried out immediately after a defect has been found on a piece of equipment or a production line: the goal is to make the piece of equipment work again properly so that it can perform its assigned task. Corrective maintenance can be planned or unplanned depending on whether a maintenance plan was created or not [12][13]. Technicians apply unplanned remedial maintenance to respond as soon as preventive maintenance processes detect a failure could not be expected. Corrective maintenance helps technicians to carry out their activities without hesitation, even if they can choose to repair the equipment. Pre-determined maintenance, probably the less known of all the types of maintenance presented in this article, does not rely on the state of the actual equipment, but on the programs delivered by manufacturers [14][15]. All the above mentioned maintenance strategies have different objectives such as:

- To ensure the workers' health
- Preserve the plant's value by minimizing wear and tear.
- Holding the machine in the right condition to improve the product quality
- To reach optimum plant productivity by preventing failure and reducing shutdown times.
- To accomplish all the above targets with the most cost-effective mix.
- To keep the plant at maximum efficiency in production

They develop these programs based on their knowledge of failure mechanisms as well as statistics from MTTF (mean time to failure), which they observed in the past on a piece of equipment and its different components. Based on the assumption that this type of maintenance is applied only in accordance with manufacturer-developed programs, the risk of failure is higher or lower, whether the piece of equipment or part is new or old [16]. Preventive maintenance is a form of physical equipment test to prevent failure of equipment. Preventive maintenance includes activities that are initiated after a period of time or machine utilization [17][18]. The condition-based maintenance is the most complicated to implement among all types of maintenance mentioned above. This aims at avoiding errors and requires regular state tests, reliability and

other process measures [19]. All these data can be collected automatically on the field or remotely by means of a direct network connection to the equipment to ensure that it is constantly monitored. Maintenance teams will determine whether to run constant or daily interval controls: they read counters, check the wear of the pieces, and check the temperatures of the motors. These are all steps that teams should take to ensure that no piece triggers a malfunction that would harm them [20]. The industries and organization facing various challenges during maintenance process as tabulated in Table 1.

Table 1: various challenges during maintenance process

S. No.	Challenge	S. No.	Challenge
1.	Lack of participation by accounting in analyzing and reporting costs.	**8.**	Lack of consistent production goals (cost, quality, delivery and safety).
2.	Difficulties in applying quantitative analysis.	**9.**	Difficulties in measuring performance.
3.	Failure to develop written objectives and policy.	**10.**	Absence of cost reports to aid maintenance planning and control system.
4.	Standards not used.	**11.**	Inadequate budgetary control
5.	Inadequate control procedures for work order, service requests etc.	**12.**	Lack of specific responsibilities
6.	Difficulties in obtaining time and cost estimates for maintenance works	**13.**	Lack of management attention to maintenance
7.	Lack of team collaboration	**14.**	Lack of understanding on maintenance costs types

To overcome all above mentioned challenges, modern strategies for maintenance are required for the industries. The industrial internet of things (IIoT) revolution is transforming industries like steam power, assembly line production and then robots. The manufacturing floors of today are packed with software and integrated machinery and equipment that can be modified and automated to save time and work more intelligently. Your CMMS (computerized maintenance management system) is the primary beneficiary of these newly found technologies and capabilities. The key to successful manufacturers in the modern maintenance age is to leverage the information for your gain – and to keep all of your resources, staff, and processes running together require a modern maintenance solution. Blockchain is the one of the modern solution to solve the maintenance problems.

2. Objective of blockchain in maintenance Solution:

Maintenance logs continue to be regulated between suppliers, dealers, providers and machinery. When entries go wrong at any stage, they take a lot of time and are likely to make mistakes. Blockchain technology can eliminate the need for complex databases and paper binders and allow industries to manage a single record of provenance that would be immediately available to all authorized individuals. Maintenance activities could be scheduled prior to this, and this data would be available on the maintenance record, saving time, enhancing maintenance and ensuring safety.

2.1.Basic of blockchain

Blockchain is the backbone technology developed by the Satoshi Nakamoto in 2008 for Bitcoins virtual cryptocurrency [21]. The Blockchain is a shared background archive for all operations or digital events between the parties involved. Technology in Blockchain records the digital ledger transaction distributed throughout the process, rendering it incorruptible. A Blockchain interest can be registered in a transaction including a Land Estate, Vehicles and so on [22]. The database structure with the accounts and maintaining security, transparency and decentralization is descripted as Blockchain in the simplest terms. You may also see it as a chain or as documents gathered in block formats that no central authority regulates. A Blockchain is a public directory which is completely open to all on the network. As shown in Figure 3, Blockchain technology has numerous attributes. A block chain consists of data distributed over a peer-to-peer network, with transactions recorded, synchronized, and stored in a database in each node [23].

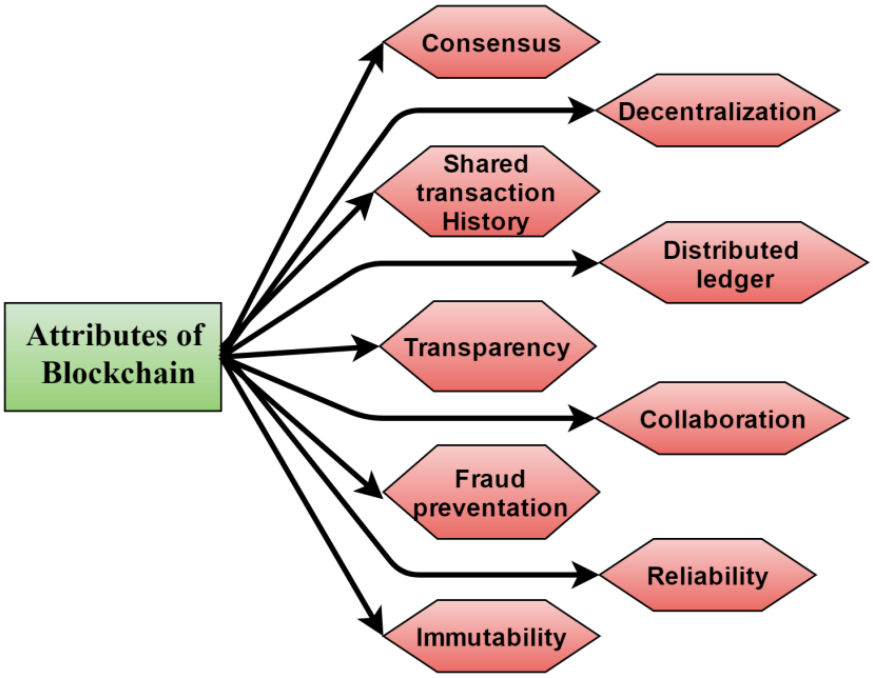

Figure 3: Attributes of blockchain technology

Firstly, the problem would be defined in such a way that blockchain technology can be applied. After defining the problem, construct the design and methodology for blockchain implementation. After that, implement the blockchain technology to solve the problems and incorporate it with existing scenario.

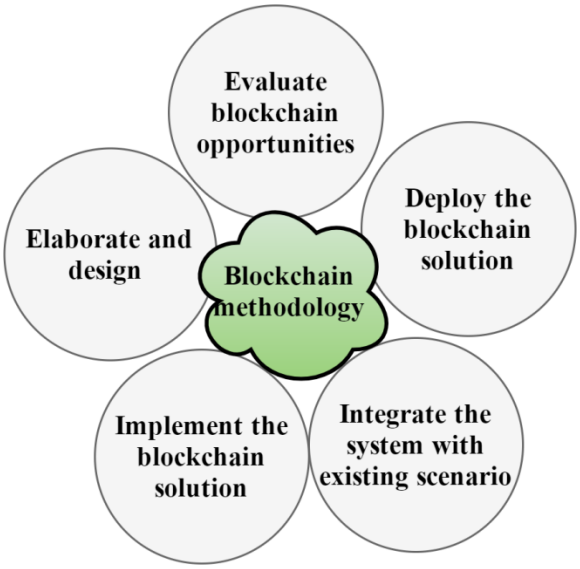

Figure 4: Blockchain implementation procedure

2.2. Advantage of blockchain technology in maintenance

Blockchain will support new maintenance methods and shorter maintenance times (such as automated service agreements). These innovations are needed to manage the advanced production machinery's greater complexity and technological sophistication. Users add service agreements and installation documentation related to each device to the blockchain record to facilitate outsourced maintenance, creating a digital device twin. Blockchain technology can then allow scheduled maintenance to be automatically performed and paid. To enable outsourced maintenance, users add to the blockchain record service agreements and installation records relevant to each computer, producing a virtual twin of the device. Blockchain technology can then allow the scheduled maintenance to be automatically performed and paid for. A maintenance-intensive machine can trigger a service request and generate a smart work contract or replacement part. Payment processing takes place automatically upon completion of the order. Similarly, the blockchain record is attached to the immutable documentation of the maintenance history. Such applications, which are still in the early phase of development, improve equipment reliability, facilitate health and attrition monitoring of equipment, and create auditable machinery health assessments.

Furthermore, in the context of maintenance performed by in-house teams, the blockchain record can be used as proof to equipment providers that the maintenance team has performed. In the future, shorter product life cycles and rapid changes in design will motivate manufacturers to more frequently upgrade their machinery. Also facilitating the sale of used equipment is the immutable documentation of maintenance history. A manufacturer can direct prospective buyers to the blockchain record when selling used equipment for evidence that the equipment has been properly maintained.

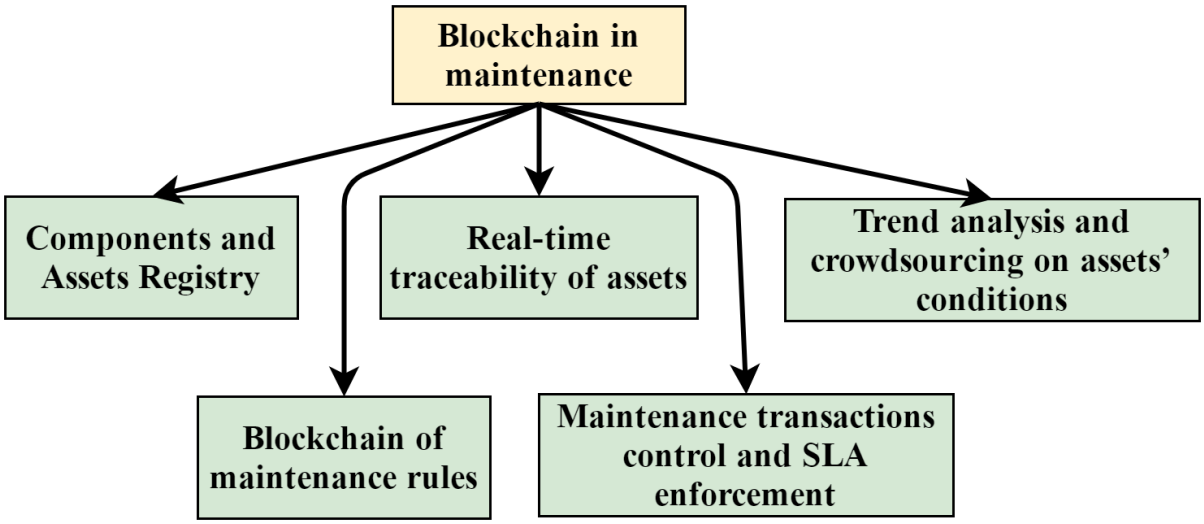

Figure 5: Benefits of Blockchain technology in maintenance process

Blockchain-based maintenance frameworks template maintenance data and transactions as smart contracts checked and implemented accordingly. Advantages of blockchain implementation in maintenance process are as follows:

- **Components and Assets Registry**

The shared ledger can be used within an enterprise as a decentralized database of equipment and property. The blockchain, in particular, provides a clear advantage for the implementation of a decentralized database of resources as it offers a centralized, scalable, unified network. Full information on each piece of equipment can be given in this blockchain-enabled database, including all relevant data along with full information on the use of the component during its operation.

- **Real-time traceability of assets**

As an element or resource visits throughout specific supplier, stakeholders, the various stakeholder blockchain networks can track data and position alterations. Similarly, the property can be entirely traceable, including a complete track of the related maintenance activities. In addition, asset status can be tracked in real time, along with immediate access to work conditions to all plant resources. This can be of great assistance to maintenance workers and engineers as it gives them real-time visibility of their asset status

- **Trend analysis and crowdsourcing on assets' conditions**

Vendors can be given a decentralized network based on blockchain technology equipment that store data about their goods and how they work in the various plants. It contains material about their employed situations, but also in various processes, in diverse plants and ecological circumstances. The blockchain provides plant resource and equipment managers / customers with a scalable, distributed and unified mining data system instead of collecting and storing information on a centralized cloud infrastructure.

- **Maintenance transactions control and SLA enforcement**

A blockchain can records and manage maintenance-related transaction material, including smart machine connections, IT systems, and commercial material schemes. As a protuberant illustration, smart machineries

will depend on blockchain technology to record and verify orders for spare parts and schedule activities with maintenance experts to find the best point in time for their maintenance. Applicable relations can be carried out in a flexible and protected manner that respects existing SLAs (i.e. "smart contracts") between systems (i.e. asset management, ERP) of the service chain investors, such as appliance dealers, plant workers, and apparatus care operators.

- **Blockchain of maintenance rules**

To record the rules is useful that govern asset management, in line with their use in industrial processes, instead of storing and mining the asset status. Such rules may also be focused on smart contracts and may represent contracts between various investors in maintenance. When blockchain technology develops and executions become available, the probability of blockchain to become an enabler for new presentations based on distributed control and full knowledge about the resources being managed is available. In addition, a mixture of the associated features of financial transactions (e.g., use of bitcoins to purchase or print a spare part) may occur.

3. Conclusion

The preset study offers a wider perspective of maintenance activities and research carried out around the world, but as maintenance is now a widely recognized financial advantage philosophy, there is a need for more research work in the industry. Working strategies and previous approaches to maintenance strategies are less and less suited for modern world turbulence. Therefore, a unique solution of blockchain technology with maintenance strategies is suggested by the authors in this work.

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