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Implementation of Internet of Things for Condition-Based Maintenance in Elevator Systems: An Analytical Case Study

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Abstract

The aim of this paper is to show how IOT technology can allow highly distributed elevator equipment servicing by using remote-monitoring technology to ease a move from tradi- tional corrective maintenance (CM) and time-based maintenance (TBM) to more prophetic, condition-based maintenance (CBM) in evidence to accomplish different advantages.The Literature review can indicate that CBM has merit over conventional CM and TBM from a theoretical outlook, but it turns on constant monitoring enhancement via advanced IOT technology. A detailed case history was implement to bring practical proof that IOT allows elevator adamant to attain CBM.Through, a theoretical context, the CBM of elevators put together exper- tise.The venture lies in data collection, data analysis and decision making in real-world context of business. The key outcome of this research recommends that in the case of elevators the IOT can be commercialized and would improve the welfare and accuracy of equipment. It might, so, be understandable from technological, process and economic aspect. Our long term physical world case study reveal an actual way of building the CBM of elevators worldwide. Incorporating Internet of things and other modern technology will improve the safety and authenticity of elevator equipment,longer service life, minimize disruption or difficulty and business interference as a result of equipment downtime and to eliminate major repairs, thus result in low maintenance cost. A key contribution in this study stand in the empiric confirmation of the advantages and difficulties of CBM through Internet of things comparative to conventional CM and TBM in the instance of elevators. The writer had faith that this study is well timed and will be worth to company working on the same research or business strategies.These are form on condition based maintenance, IOT, Time-based maintenance and Corrective maintenance.

IndexTerms: Elevator Equipment, IOT, Condition-based maintenance, time-based maintenance, Corrective maintenance

I. INTRODUCTION

Now a days an elevator has become a common form of infrastructure that are extensively used by common peoples in daily life. After installation the continued maintenance is crucial to perform high operational reliability. Thus the pre- ventative maintenance on elevator is essential to ensure more

reliability, performance and safety of people during moving from one point to another, maintenance method is a key 'role of all-round procedure for assuring the security, accuracy and efficiency of elevators systems during the long duration due to constant use. [1]. The two most important purpose of elevator maintenance are assuring safety and reliability and at the same time the other intent involve the endure of useful life of equipment, reducing trouble because of equipment downtime. Although, diminishing major repairs and determine the occur- rence of replacement. Typically, there are two kinds of elevator maintenance strategy corrective maintenance and preventive maintenance. Where in CM type,the operation is done only when there is a failure. But in PM type, the equipment has maintenance plans to avoid complicated breakdowns [2]. The PM strategy is further categorize into two types TBM and CBM. In TBM type once a fault is reported the service technician are send periodically to elevator sites to create repairs. In major cases the TBM is performed at periodic intervals.The other type of PM strategy is been explored by elevators industry i.e. Condition based maintenance (CBM). The CBM helps to get information about the condition of system to boost the diagnosis and prognosis of failing for the purpose to reduce maintenance related costs. The basic goal of CBM is to reduce downtime and set-up costs [3]. In CBM type , a data about the condition of system can be used to improve the prediction of failing towards lower maintenance related costs. A basic purpose of CBM is to reduce delay and elevate costs. In the last few years, CBM of complex engineering has alluring a substantial attention from researches. Actually, CBM is the process of condition monitoring where signals are monitored regularly with the help of certain types of sensors or other indicators [4]. The main assumption lies behind CM is that Ninety nine percent of equipment failure occurs due to the certain indications, signs or conditions [5]. This suggest that maintenance activities are carried out only before failure encountered or when it is needed [6]. In real world context CBM is used in oil-gas refineries,in aviation, energy, the semiconductor industry and other fields where there is high investment in engineering equipment.Due to limitations of technology and the high cost required for collecting data, it is not usually possible to implement CBM in light engineering systems. As elevator service is widely used at distributed location and there is variations in sites conditions and frequency of use. There would be a challenge, to extend CBM without an effective, efficient and economic continuous monitoring mechanism. Therefore the ordinary strategy of maintaining the different components used in elevator industry still require intensive use of manpower.

During the past decades the growth of technology had brought a huge changes in maintenance functions [7]. In these days, the development of advanced sensors and IOT technology has made the remote data acquisition much more efficient and economic, which makes the business case for CBM more appealing. As in many industries there have been many projects on IOT application in real world. This domain covers both conventional industrial sector as well as consumer industries in daily life, where IOT could bring a significant improvements [8]. IOT is a wide term, used for a new technological pattern to visualize a global network of machines and devices to be capable of interacting with each other [9]. Thus, with the rapid advances in technology, to describe the basic attributes of IOT technology a common language has developed that connects virtual world object with the real world, which allows global and real time (wireless oriented) solutions for exchange and data collection problems. IOT can facilitate remote monitoring, track object and analyze data of the particular surrounding. Hence, IOT is the best solution for enabling CBM in elevators industry for maintenance needs and IOT in CBM offers rapid data analysis, that allow quick decisions about maintenance and by using cloud computing on the basis of real time information we can know the condition of equipment.Actually, we are lagging in practical research on implementing the CBM using advanced technology in industries. Therefore, the purpose of this paper is

to search for the additional benefits of CBM by IOT technology as well as analyzing how IOT can enable CBM in elevator industry.The major contribution in this paper includes a review of existing and potential outlook of maintenance in case of CBM and IOT in respective domains.The next investigation includes how IOT can be practised in real world case, in elevator servicing and how it can be implemented effectively and efficiently with the help of CBM strategies and Design maintenance services based in advanced technology. Later we review about the challenges involved, identified the issues and find out different ways to address it.

II. CONCEPTUAL FRAMEWORK

This portion covers the alive analysis and foregoing discov- ery on internet of things,CBM and the convergence of these two so as to locate the research in context which leads the reader an outlook of associate analysis.

A. Maintenance type

A peak definition of maintenance often used which was approved by the European committee of standards SSEN. This termed as a combination of all technical,administrative and managerial intended to retain it in or restore it to, a state in which it can perform the required function. Basically, Maintenance strategies has categorize into CM and PM. Where CM is also known as on call service or reactive maintenance which is used to restore equipment to full functionality after it is failed. CM in few circumstances may delays in time. If the outcome of failure do not disturb the overall function of service. This delay in CM can rather be Planned to be executed at a time more appropriate for productivity capacity. Thus, failure or breakdown have straightforward impact on system downtime that are dangerous to safety or other specific maintenance rules, which should be maintained without delay. It is contend that this strategy leads to long period of machine downtime delay and high maintenance costs caused by sudden failure. PM is an alternative to CM, it involves carrying out maintenance activities before failure of equipment. The goal of PM is to improve the performance and safety of equipment at site. Thus Equipment downtime is decreased and the number of major repairs are reduced. The other type of PM strategy is been explored by elevators industry is Condition based maintenance (CBM)

1) Condition based maintenance: The CBM helps to get information about the condition of system to boost the di- agnosis and prognosis of failing for the purpose to reduce maintenance related costs. The basic goal of CBM is to reduce downtime and set-up costs [9].Below Fig.1shows summary of Maintenance Types. There are few critical terms used related to maintenance strategies known as failures and faults. An ISO had defined the failures and faults in machines. An engineer has advantage that it can easily identify any faults in the components or device systems because every component has its own designated level and behaviour functions. Every engineer suffers from a failure when he does not get the actual output.There are two major terms falls under maintenance are “prognostics “and “diagnostics”,where diagnostics performs three main tasks i.e. detection, identification, isolation when something went wrong in the monitoring system or device this task detects the fault and indicates the failure in system. And once the fault has been detected the identification task will figure out the nature of the fault before it fails. Lastly the isolation task will locate the faulty component. Prognostics is

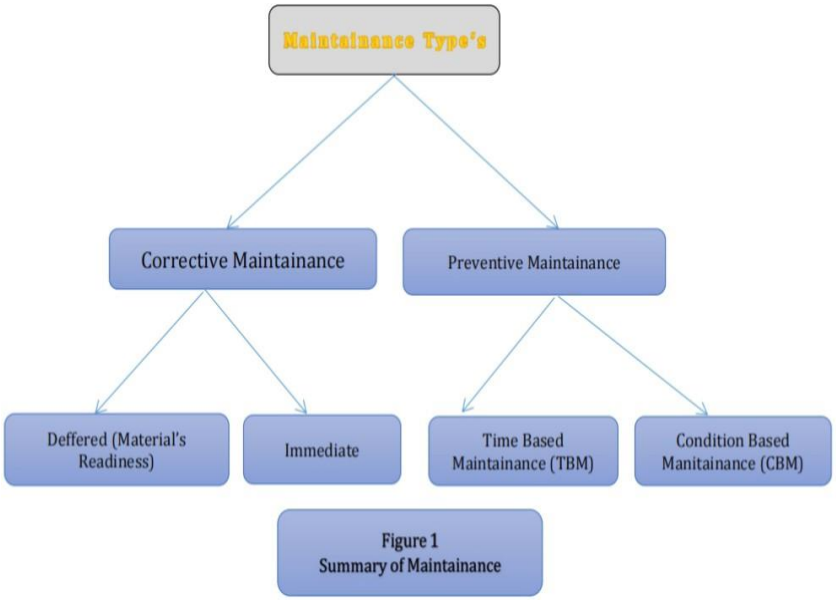

Fig. 1. Maintenance Types

the term used to predict the fault before it occur and also it estimates the times that how close the failure will do.

III. CBM(CONDITION BASED MAINTENANCE

Over a past few decades CBM has been a research topic as it was considered as a more economical and effective, more beneficial and realistic from other traditional CM and TBM maintenance strategies [10]. As per literature survey, mainte- nance service are facing with three major problems Includes: necessity to reduce the high cost of labor and the spare parts equipment, need for planning the maintenance work so that it can benefit for long time in a complex operational condition, and to avoid the risk of destructive failure and to eliminate random outages of systems. Therefore an alternative has been developed which address these problems.According to the British standard glossary of maintenance CBM is a method involves in carrying out maintenance activities that depends on the need,as indicated by the condition of equipment and it is used reduce the uncertainty of maintenance activities.In case of CBM it is assumed that the 99% of system failures happens due to certain signs, indications or conditions.Thus CBM is commonly applied in the maintenance service as it provides the information about the condition of the equipment by continuous monitoring the system. CBM comprises of 3 main steps

1. Data Acquisition
2. Data processing
3. Maintenance Decision making

Based on the data acquisition technique Hashemian and Bean classified CBM into three sections:

- Existing sensor based techniques
- Test sensorbased techniques
- Test signal based maintenance technique

Data processing corresponds with arithmetic and data mod- elling analysis along with this recently it also includes big data analysis, cloud computing and Deep learning. In decision mak- ing research includes decision support system, integrated work on machine learning, organizational and human behaviour science.(sabnavis et al, 2004; Lai et al.,2016). The main reason why CBM cannot be locate widely because it leads to high investment required for enabling the data collection via continuous performance

monitoring system. Due to the development of advanced sensors and IOT technology that makes the CBM more efficient and economical for business case. Hence the condition based monitoring process are more widely installed in many industries, alongwith the development in advanced technology.

IV. How IOT is enabling CBM in service business?

Today every service companies are looking to develop the best maintenance strategies and planning with a perspective to improve production and lower cost maintenance. From the pre- vious section we saw that CBM is considered as more effective and productive with an lower cost maintenance strategy from the theoretical concepts, and the underpinned assumptions of CBM includes understand of each components its useful life and prediction of failure on real condition basis and hence can reduce setup cost and downtime.In real world context CBM is used in oil-gas refineries,in aviation,energy, the semiconductor industry and other fields where there is high investment in engineering equipment.Due to limitations of technology and the high cost required for collecting data, it is not usually possible to implement CBM in light engineering systems.As elevator service is widely used at distributed location and there is variations in sites conditions and frequency of use. There would be a challenge, to extend CBM without an effective, efficient and economic continuous monitoring mechanism. Therefore the ordinary strategy of maintaining the different components used in elevator industry still require intensive use of manpower.As correspondence with the rapid development of the advanced technology, IOT is a real time solution across global.It serves a wireless medium to collect and exchange data, it has the capability to monitor particular locations and track objects from remote locations; and along with all this functions it can also provide broad analysis of data about the surrounding conditions. on the basis of previous research, we come to an end that IOT can raise firms' value from different aspects, improving the speed and efficiency of decision making and tracking behaviour, enhancing situational awareness with the improving navigation control and automation, optimizing resources planning and enabling information sharing and col- laboration(Chiu et al.,2010; Lai etal.,2016). Thus, the IOT technology allows the remote acquisition of condition data more economical and efficient nowadays, IOT is proved to be best way to implement in CBM strategies. The major benefit of adopting IOT for CBM is not restricted for more economical real time, remote monitoring, thus it involves the rapid data analysis and quickly find out the condition of the equipment on the basis of real time information served by adv cloud computing. Moreover IOT technology may grant more firms to promote integrated product service operations. For monitoring and condition system different types of sensors have been used on the real time based information and this systems comprises of distributed autonomous sensors devices that monitors the real time status of the product which includes temperature, its location or component utilization for better maintenance. (Atzori et al, 2010).The enterprises will recognize the key value of IOT when the connected devices will able to integrate with in house business intelligence applications.(Bradley et al,2013). The continuous development in IOT technology leads the CBM to be practiced in safety management. This results that the IOT based equipment for safety management are feasible and CM scientific and furthermore it can ease the management of equipment maintenance for the extend safe service life of equipment.(Rymaszewska et al.2017). An survey of fruitful implementation of IOT in power generator manufacturing proved that the CBM can also be used in larger projects so as to improve the reliability of main value proposition helps the end customer to get in the form of lower ownership costs. This research paper deals with how IOT can use to enable CBM in elevator service. However, from the past decades there have been many projects to apply CBM to elevator industry. To ensure the elevators must met high safety standards in high buildings

the manufacturers implemented continuous monitoring of braking system with the acceleration and deceleration of elevator. The main idea is to use product degradation information that may be extracted using online sensing techniques to reduce the risk of failure by estimating the system down time. Finally, the CBM has been set out to the rapid growing of CBM equipment, data collection cost has been decreased rapidly at the same time the complex data modelling and signal processing and data analysis have become much faster grateful to cloud computing.

V. METHODOLOGY

This section covers a single in depth case study of an elevator industry a company operating in china.The main motive behind this investigation is this company is adopting the new technology which are carried out in real-life context. This company has adopted the most advanced technology and dealing with complex data modelling and along with that it has the ability to work with the machine learning and artificial intelligence to build into business mode. Actually this study is an interesting to figure out the importance of new emerging integrated technology and CBM in elevator service including the existing challenges in CBM and IOT. Further we report about how the IOT ease the implementation of CBM in elevator service. Based on the two years of real world data collection here we also foreground the main benefits of CBM relative to conventional TBM and CM.For this research we have collected the data from the number of sources. The information was collected from the publicly available information to the company, from its website also went through the documentation available in the links provided and external research from the articles and numerous sources.

VI. CASE DESCRIPTION

This section covers the detailed study on the topic, based on documentation review,various market assessment and direct observation, and outcome of interviews. This various source of data helps us to understand the strategy and planning of managerial presumption to IOT and CBM beneficence, also their inculcated method of generating value internally for the both customers and shareholder. subsectionCase Background The background case we studied from a leading company situated in Europe that gives solution for the various prob- lems in installation, their maintenance and modernization of escalator and elevators. Which was innovated and has a strong presence in china. Along with the manufacturing equipment in china, the company is actively expanding its business service by giving grant for the major repairs, retrofits in CM . TBM and complete replacement service at the end of an installations useful life as shown in Fig2 The company provides a platform by offering, its service to attract the customers and installs a lots of its equipment through the worldwide. Thus the company encourage and gets opportunities vigorously on order to expand its service offerings for the external to generate higher revenue and internally increasing the service produc- tivity by lowering the cost. Therefore,such company gives the best maintenance service and maintain its standard, covering basic maintenance addition to that repairs spare part and labor. Overall this leads a company to great future.

VII. ELEVATOR MAINTENANCE SERVICE

In this part, we spotlight about the maintenance service, As per public safety is concerned maintenance is the major and most important part of an elevator system.It plays a vital role in ensuring that the elevator operate safely, it must be reliable and should efficient throughout the long period and continuous usage of the system.For the owners or builders in- stalling elevators, operational safety and reliability are the two

major parameters.(park and yang,2010). From the customers perspective the key objectives of the elevator to be considered are:

- Need to improve safety and reliability
- Extend useful life
- Need to reduce the major repair cost
- Find out the probability of occurrence of failure and troubleshoot the problems
- To minimize the business interruption or inconvenience due to system downtime

Generally, the elevator maintenance operations are carried out by the personnel maintenance dispatched regularly to each sites. A maintenance carried out at least once a month is termed as scheduled maintenance. These are classified into two types namely Basic maintenance and Preventive maintenance. Basic maintenance (these are routine tasks that vary from one equipment to other), includes cleaning, lubrication and re-tightening which involves common work for all elevators. Whereas in preventive maintenance the task vary broadly depending on the parts to be (repaired or replace) maintained. Due to the conventional major problems in conventional CM and TBM strategies it is now suggested to use CBM strategy in elevator servicing.

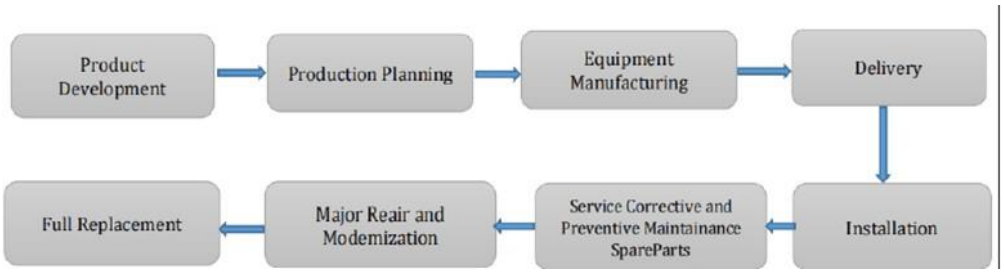

Fig. 2. Product:Life Cycle

VIII. IOT ELEVATOR SERVICE OFFERINGS

IOT is trending with its diverse features attracting the attention of various firms and actors in the technology and still researchers and engineers are working to get its full potential. The company working in china in the elevator industry, along with the manufacturing it has been extend globally and locally to introduce the IOT offerings the last few years. The key points they has focused on the connected services that can allow remote monitoring and has been put for the existing improving TBM strategy.As each company uses connected devices according to their specific requirement in one or the other way.out of which some provide connected services to fulfil the basic public safety requirements, and other adv company uses the IOT platform to seek attention from the small or medium elevator industries that lack the capital investment.(Lai et al., 2018a). The summary of benefits offered by IOT is sown in Fig3 The concept behind this offering, the partner and the client to check before or after the repair and replacement done.Based on the evidence of concept design, the company gathered all the co-creation designs from the shareholders. The reason is to confirm the project would return a value to the shareholders. For a while a local authority was expecting that the IOT - CBM connected service has ability to transfer the information quickly, and enables a fast rescue to the stuck customer, and reducing the frequency with ensuring the other safety incidents.Thus CBM lifts are considered as more reliable and more safer to public safety.The CEA (china elevators association) conclude that (IOT - CBM
) might increase transparency and upgrades complete assets management, which will further leads to policy improvements, how this service could improve reliability, prolong useful life and fulfil the end user satisfaction in direct or indirect manner.Fig5 shows the complex network of activities with the IOT ecosystem which require correct coordination within the shareholders including vendors, service providers, authorities and customer).

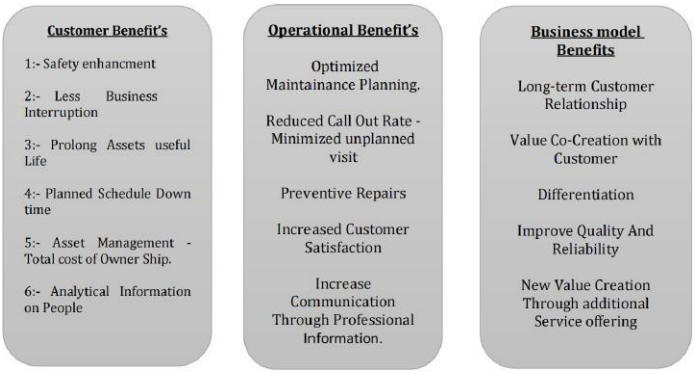

Fig. 3. Benefits offered by IOT

without any interruption machines(escalator and elevators) can communicate with each other. In consequence data analysis and cloud computing can be used to generate alerts before the failure and identify the machines condition before failure and likely it generates and alert issue to a remote monitoring center.Fig4 shows basic elevator IOT offering activities From the above Fig4overall working actions can be encountered, following from the dispatching technician teams to the site with equipment parts to be audited and repair the the tips in advanced before the failure occurs. Last a user portal enables

CASE ANALYSIS

In the earlier sections, we have discussed about the mainte- nance strategy types , the general process, principles involved in system, system operation and commercial considerations. Also given the description

about the background to the case study and set out the new offerings from the company which relates to the subject of this study.Here we are discussing about the three main elements of maintenance strategy(Jardine et al.,2006) namely,Data collection, Data analysis and the decision making actions.Further we will analyze the difference between CBM and traditional CM and TDM.

A. Data collection

It is one of the most important and challenging task in any maintenance operation.There are various parameter like operational, informational or predictive parameters in which data can be collected with respect to this parameters. But there is always a timing or duration effect concerning data set, according to which data one is measuring a failure data, operational data or other. This signifies that the depending on parameter always include timing in seconds, minutes, hours or days.This case study disclose that by using CBM only limited data can be collected because large amount of information can only be collected after the failure of the

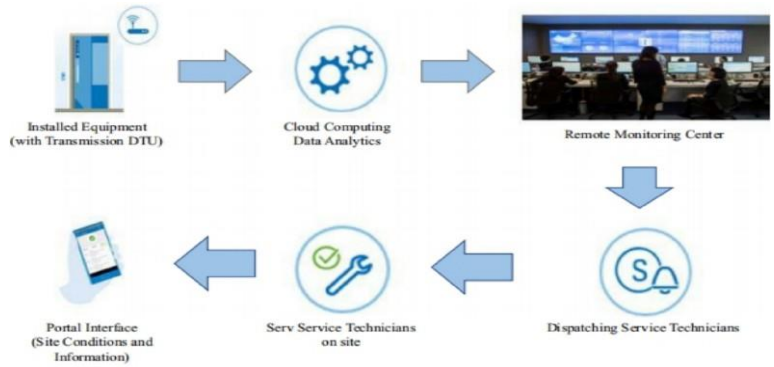

Fig. 4. Basic elevator IOT offering activities

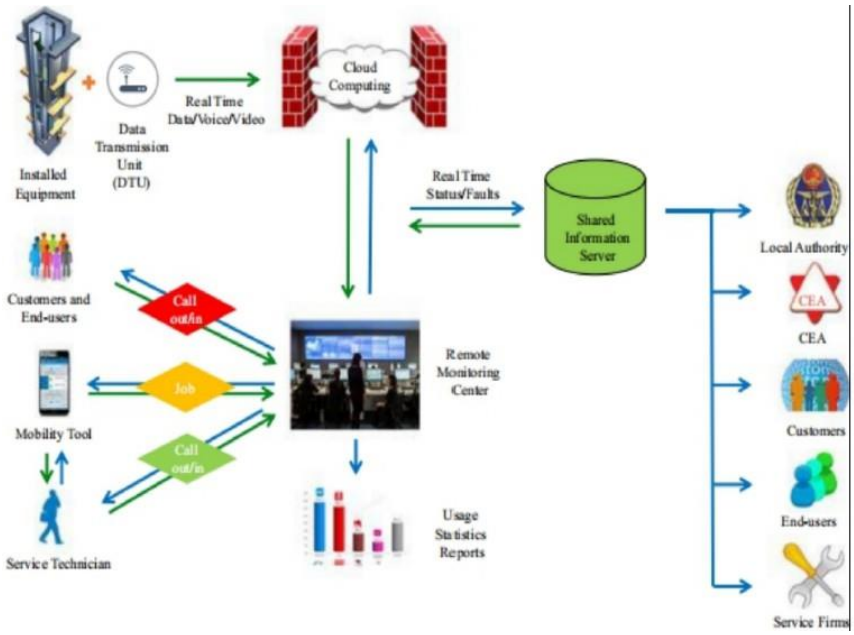

Fig. 5. IOT ecosystem

equipment. But still there ispossibility of limited collecting data by downloading it from the control system which is attached at equipment. In case of conventional, preventive TBM, Maintenance is required at regular intervals so it makes the data availability in every site, but the drawback is that the data may not be correct or incorrect also it is not available all the time. For predictive analysis of data a considerable amount of time Is required to collect the sufficient information.Every single elevator has its own different

environmental factors, the quality of maintenance and installations depends on the site conditions and further all this parameter affects the operation of service system and follow up maintenance.Therefore, CBM is adopted to ease a more efficient and effective way of handling this variability than conventional TBM or CM. IOT and cloud computing has made remote monitoring much more economical and it justifies in the case of highly distributed equipment as elevator for supporting CBM strategy.In our case study the IOT system used are capable of monitoring more than 200 escalator parameters in real time. The various parameters are numbers of starts,operating directions, braking distance, deceleration time, door operations, stopping accu- racy, tension(escalator),step chain speed vibrations (noise and engineering statistics. Below Fig6 shows the critical parame- ters of elevators DTU (Data Transmission unit) is attached to the control system in elevator, it is used to collect real time information and transmit it to the cloud. The installation site is linked through an APN(access point name) using a 3G/4G network signal and further Fig6 Critical parameters measured for both elevators and escalators.The data could be transmit through

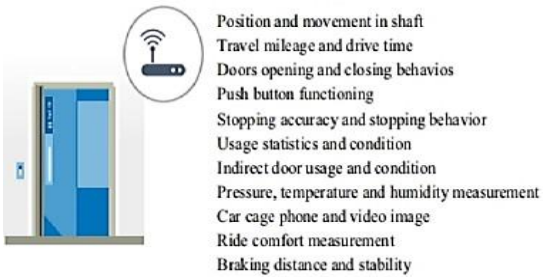

Fig. 6. Critical parameters of elevators

the mobile network to the cloud, if there is no network or the signal is to weak at that instance a sub district network is used. LAN and DTU provides an access to the internet through a wireless relays and wireless transmitters.For the high density of escalators In a group of building, sub way stations,schools, shopping malls etc, a sub district local network which consists of group of elevators are connected directly to the internet via DTU with the single data flow for each group of elevators.The below Fig7, illustrate methods of data uploading to the cloud. Data security in any system is very important although, in

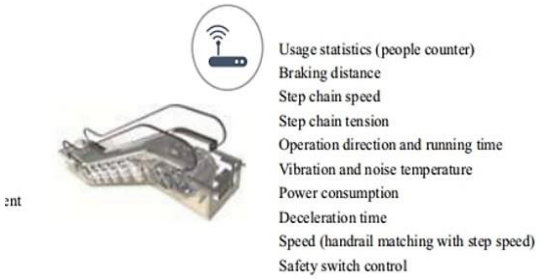

Fig. 7. Methods of data uploading to the cloud

elevators the connections between the cloud and sensors are encrypted and it requires authentication. Thus, the company working with cloud partners always adopts secure methods of software development.

IX. DATA MODELLING/ANALYSIS

In data analysis process,a data is collected about the various condition and equipment used in the system and all this data are further calculated and modeling to get the information, so as to formulate it for the

future plans and decisions. Fig8 shows the bathtub curve assumptions. The above Fig9 is based on the assumption based on the reliability concept with respect to weibull distibution and bathtub curve.(Hameed et al,2010). According to this curve during the burn in period the rate of the failure of equipment decreases,and then it will remain constant in the useful life, and then rises at the wear out period that is at the end of the life cycle before failure actually occurs.

X. Decision making

In this process the information is used that are obtained from the analytical modeling to take decision about the maintenance. The major aim is to reduce or cut down the unplanned maintenance and to avoid the machine failure which causes interruption to safety incident. As the public safety is the most critical objective in this service.Thus the maintenance decision are ruled by two main principles. Firstly, every elevator service must have compulsory maintenance regulations.Lift maintenance regulator has made mandatory bi monthly maintenance much be checked.The second rule was that need to examine OEM recommendation based on statistical simulations and historical failure data along with the knowledge of experienced skilled engineers.Every company has their own standards with different understanding of man- ufacturing modules, control modules, landing door modules, equipment designs, maintenance procedures and installation quality, which vary from company to company.Thus all these decision factors based on the requirement and their modules directly affect the cost of maintenance. In case of CBM maintenance, as prognostics is the major concern, with the help of deterioration modeling it can be accomplished by using both current condition evaluation(CCEB) and future condition prediction based(FCPB) methods. A real case of installed elevator is shown in below Fig10.

In CCEB the unusual opening and closing of doors are detected by condition based monitoring system. Before main- tenance action is taken the system continuously tracks the unexpected failure and evaluates when to activate the mainte- nance action and system has to look at the condition either it is reparable or not.

Fig10 illustrates the unusual opening and closing of the doors frequency is calculating by the system. It also predicts the breakdown or failure of probability in the upcoming days.Thus, to avoid the safety incident the system triggers im- mediately for the planned maintenance to be designed and ac- tivated. This is the approach of FCPB maintenance.Therefore the challenges lies is to get rid of noisy data or say noise in the data when the external forces interrupts the system.

XI. Comparison between corrective, TBM and Condition based maintenance

Here in this portion we are differentiating CBM based on an IOT based remote monitoring service to the conventional TBM and CM. An IOT based remote -monitoring system, with a CBM allows detection of the faults and failure as indicated in Fig13. In theory, a remote monitoring system is much more effective and efficient than conventional condition maintenance.Fig11 shows a case of elevator failure at instal- lation unit. Once a failure occurs a customer will call to the hotline service and further the call center service will send the technician to the site. Moreover the follow up situation can be understand by the below Fig12.Fig13depicts the lead of CBM over TBM. A CBM provides better service than TBM, the remote monitoring system triggers fault, based on real time information.It helps us to understand better. By comparing both we can conclude that IOT based CBM is much more effective and efficient.

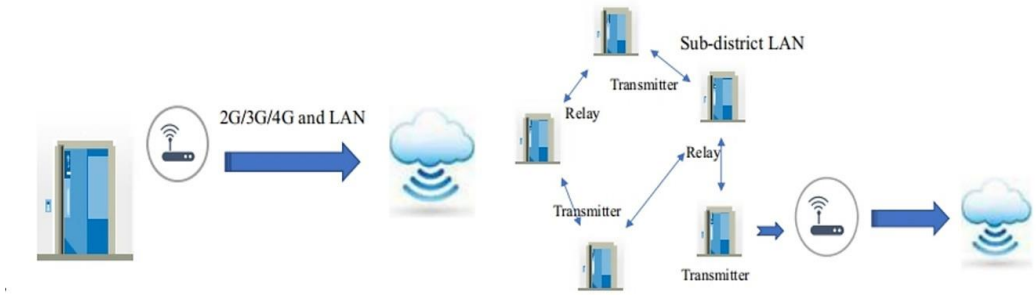

Fig. 8. Bathtub curve assumptions

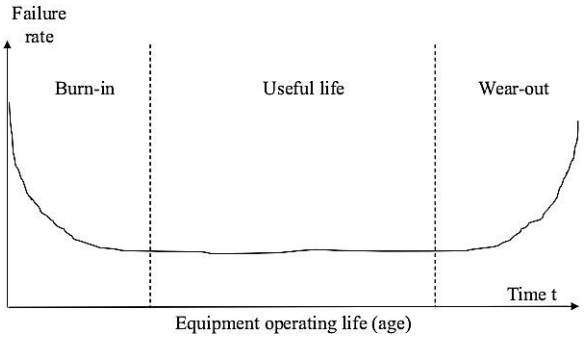

Fig. 9. PM Braking Noise adjustment

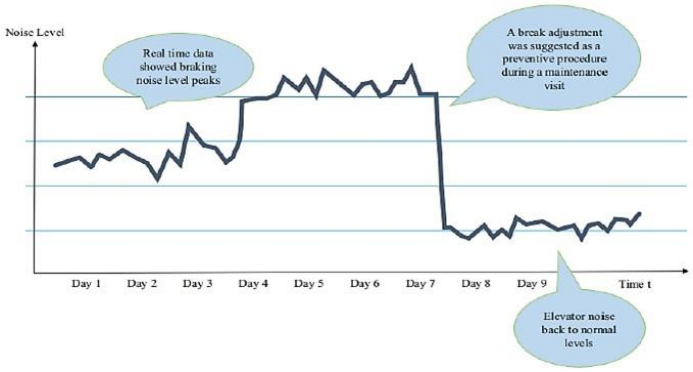

Fig. 10. PM Braking Noise adjustment

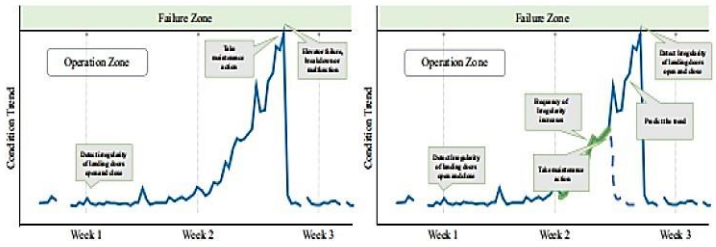

Fig. 11. IOT CBM CM

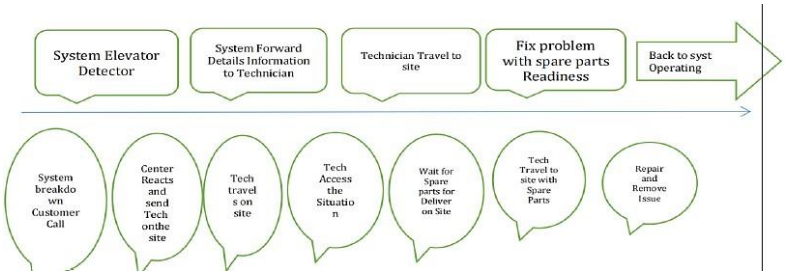

Fig. 12. IOT CBM vs TBM

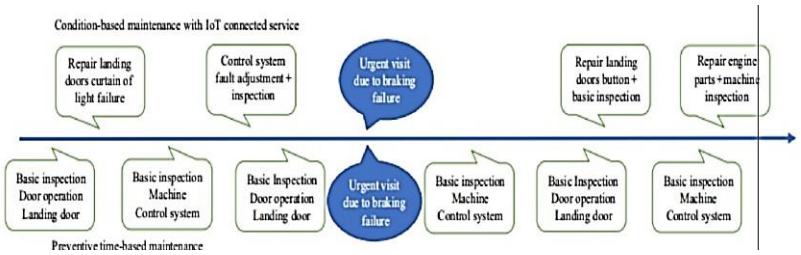

Fig. 13. Condition Based IOT system

CHALLENGES AND CASE MANAGERIAL IMPLICATIONS

In this part we are going to look out the main challenges of IOT - CBM applications and their solution to overcome it.In case of maintenance optimization a real time data show an raise in noise level, thus it is not adequate to trigger instantaneous maintenance action. Implication is that CBM should be studied thoroughly, and along with this maintenance strategy, managers use other strategy to optimize complete resource use. Data acquisition- A data set could be in the voice or video form or in text format. So it is necessary to look after the cost effective justification for ongoing days real time monitoring of all data set format.In case if any passenger gets stuck in the elevator the system should trigger quickly because public safety is the utmost priority taken into consideration. So it depends on the customers need according to location and network availability.Thus, the implication is that the advanced technology provides faster mobile networks at lower carrier cost.Moreover, data availability, Data integrity, data modeling and many more, all this are the major challenges in some or how manner. To overcome and to make maintenance service much better in future IOT technology along with Artificial intelligence, Machine learning and cloud computing technol- ogy with their advanced features and access availability. Using all this technologies along with CBM in maintenance service will resolve all the problems associated to elevator service.

—sectionConclusion IOT is converting our global world.It ought to have a huge effect at the bodily global,enhancing operations and decreasing costs, developing new merchandise and enterprise fashions and riding engagement and consumer experience. Recent advances in IOT era have supplied financial and powerful approaches for enterprise to pass closer to non-stop overall performance tracking solutions. Performance tracking, especially on a real-time basis, is the important thing detail within side the shift from traditional TMB to CBM. The principal element restricting the implementation of CBM is that the desired tracking machine is simply too state-of-the-art to be applied or too costly. Hence, CBM has had very restrained software so far, specifically, it's been utilized in aviation, oil-fuel refineries, the strength sector, the semiconductor enterprise and different sectors in which there may be excessive investment in heavy engineering device. In those sectors, it's miles really well worth making an investment in costly overall performance tracking structures due to the fact CBM allows to keep device in good situation and

prolongs its beneficial life.Elevator device is hooked up in hundreds of thousands of dispersed places and is utilized by many humans in normal life. Maintenance is vital to make sure the device operates smoothly and safely. From a theoretical perceptive, adopting CBM is greater practical and useful than TBM or CM in elevator servicing. However, within side the enterprise surroundings it's miles each difficult and costly to enforce CBM for elevator servicing because of the demanding situations of collecting JQME Downloaded with the aid of using Drexel University At 01:fifty nine 22 March 2019 (PT)non-stop records for predictive modeling cost-effectively. Nonetheless, the unfold of IOT has the capability to make non-stop tracking a great deal greater possible and low priced than it was many years ago. In this paper, we illustrate the capability blessings and benefits of CBM underpinned with the aid of using IOT era for a notably disbursed elevator provider over TBM and CM through empirical industrial demonstrations. We finish that CBM is now not constrained to the geographical regions of concept and educational studies; way to technological advances, it is able to now be applied in a industrial surroundings.The elevator provider enterprise used to awareness on area provider offerings,however is now transferring to analytic and new forms of experience, with a win–win scenario for all associated stakeholders. It is locat- ing higher approaches to deliver,operate, talk and tailor its offerings to customers, with the purpose of making sure more safety and comfort. We have mentioned numerous demanding situations and obstacles referring to records collection, records integrity, records evaluation and modeling.There is scope for similarly studies in those regions and into the improvement of CBM enterprise fashions and ecosystems from each scholarly and sensible perspectives. Our primary aim is that IOT based CBM will have massive affect at the implementation of eleva- tor device protection reliability assessment, prediction, hazard mitigation and could in the long run result in the introduction of new enterprise possibilities and enterprise fashions.

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