IoT based Construction Equipment Monitoring System

Kalpesh Kantilal Patel[1]
PG Student,
Department of Civil Engineering,
NDMVP'S K.B.T. College of Engineering, Nashik, Maharashtra, India

Pritesh D Aher[2]
Assistant Professor,
Department of Civil Engineering,
NDMVP'S K.B.T. College of Engineering, Nashik, Maharashtra, India

---

ABSTRACT: Internet of Things is a concept with the advanced level applications of it in our regular life. It focuses on how IOT devices work and how they are developed. It describes how it helps to the human life and also how it is changing human life. The report overviews the advantages as well as challenges. It discusses the concept of origin of big data and big data analytics. The topic in detail explains how Internet of Things are linked in several areas like robotics, automobile industry, smart home systems, smart cities etc. with the opportunities they provide followed by scope of Internet of Things. It gives an overview about IOT, analyzes security challenges and requirements in IOT, introduce IOT mechanism to secure communications in each protocol, as well as limitations and some improvements and open issues for further research.

Keywords: IOT, Big Data Analysis, IOT mechanism, Communication Protocol.

1 INTRODUCTION:

The word internet of things refers to network and things. The IOT is nothing but a set of devices connected in a network which can communicate and pass collected data with each other devices. In today's world internet application development demand is very high. Basically IOT is a network which helps all physical objects to be connected to the internet which can be done by network devices or routers and exchange data. IOT effectively helps objects to be use and control remotely across any network in infrastructure. Technology is changing how we design and adopt new construction machinery techniques in process of constructing civil engineering projects. Internet of things is the new Era in the field of construction industries throughout the world. It is working friendly and cost effective. It also has many social benefits such as checking status of basic elements of construction equipment's such as fuel status, location of machine, machine running time etc. through mobile application.

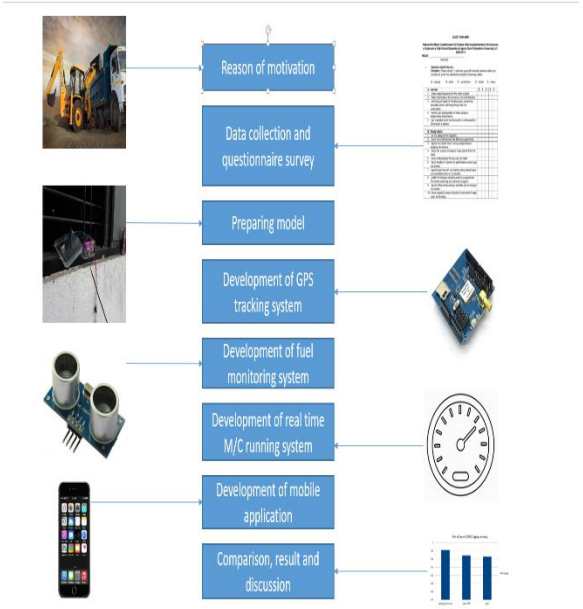
2. OBJECTIVES:

1. To study IOT technique.
2. To identify and analyze factors affecting construction equipment's.

3. To prepare the model.

4. To compare existing and IOT technique.

3.1. METHODOLOGY:

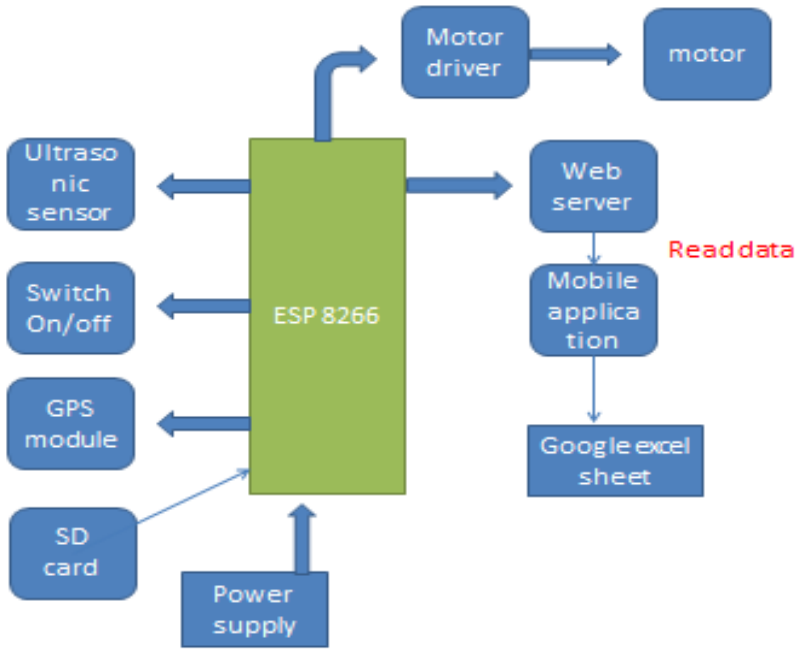


This is about to assessing the study of IOT technology which will be very beneficial for construction industry. The purpose of this study is to understand the IOT system and to identify the factors affecting construction equipment's which helps in maintaining a hassle free process. A model is to be prepared by understanding the problems occurred on site and to make a comparison of existing and based model with its efficiency and cost benefit.

3.2. PROPOSE SYSTEM:

ESP 8266 (Atmega) is a new self-operated Wi-Fi working solution, which can host application and offloads Wi-Fi working function from other application processor. It has integrated cache to improve the performance of the system in such application. Alternately, the Wi-Fi adaptor, wireless internet access can be commanded to micro controller based design with simple connectivity (SPI/SDIO or 12C/UART interface). ESP 8266 (Atmega) is a Wi-Fi chip, it is integrated with antenna switches, RF balun, power amplifier, low noise receive amplifier, filters, power management modules. It requires external circuit and the entire solution including front end module is designed for minimal PCB area. ESP 8266 also integrate an enhanced version of Tensilicas L106 Diamond series 32-bit processor, with on-chip SRAM, besides the Wi-Fi functionalities. ESP 8266 (Atmega) is integrated with external sensors and different application specific devices by its GPIOs, sample codes for such applications are provided in software development kit (SDK).

3.3. DEVICE FLOWCHART:



3.4. HARDWARE DETAILS:

❖ **Features-**

- 802.11 b/g/n.
- Integrated low power 32-bit MCU.
- Integrated 10-bit ADC.
- Integrated TCP/IP protocol stack
- Integrated with (TR) switch, balun, LNA, amplifier and network.
- Integrated PLL, regulators and power management units.
- Supports antenna diversity.
- Wi-Fi 2.4 GHz, support WPA/WPA2.
- Supports STA/AP/STA+AP operation mode.
- Supports smart link function for Android and IOS devices.
- SDIO 2.0, (H) SPI, UART, 12C, 12S, IR Remote control, PWM, GPIO.
- STBC, 1*1 MIMO.
- A-MPDU and A-MSDU aggregated and 0.4s system guard interval.
- Deep sleep power <10uA, power down leakage current <5uA.
- Wake up and transmit packets in <2MS.
- Standby power <1.0mW (DTIM3).

- +20 dBm output power in 802.11b mode.
- Operating temperature range 40c – 125c.
- FCC, CE, TELEC, Wi-Fi Alliance and SRRC certified.

The current consumption is based on 3.3V supply, and ambient, using internal regulators. Measurements are done at antenna port without using SAW filter. All the transmitter measurements are based on 90% duty cycle, continuous transmit mode. ESP 8266 is embedded with memory controller, including SRAM and ROM. MCU can visit the memory units through iBus, and AHB interfaces. The memory units can be utilized by request, with a memory arbiter which will decide the running status or sequence according to the requests are received by the processor.

1. RAM size should not be less than36kb, that is when ESP 8266 is working under the standard mode is connected to the router, programmable space should be accessible to user around 36kb.

2. There is no programmable ROM in the SOC therefore, user program must be stored in an external SPI flash.

An external SPI flash is used together with ESP 8266 to store user programs. Theoretically speaking, up to 16 M byte memory capacity can be supported.

1. OTA is disabled; the minimum flash memory that can be supported is 512 Kbyte.

2. OTA is enabled; the minimum flash memory that can be supported is 1 M byte.

3.5. ULTRA SONIC SENSOR:

The HCSR04 ultrasonic sensor uses sonar to determine distance to an object like bats or dolphins do. PIN details-

● Power Supply: +5V DC

● Quiescent Current: <2mA

● Working Current: 15mA

● Effectual Angle: <15°

● Ranging Distance: 2cm – 400 cm/1" - 13ft

● Resolution: 0.3 cm

● Measuring Angle: 30 degree

● Trigger Input Pulse width: 10uS

● Dimension: 45mm x 20mm x 15mm

3.6. FIRE BASE:

Firebase can power your app's backend, including data storage, user authentication, static hosting, and more. Focus on creating extraordinary user experiences. We will take care of the rest. Build cross-platform native mobile and web apps with our Android, IOS, and JavaScript SDKs. You can also connect Firebase to your existing backend using our server-side libraries or our REST API.

4. DATA ANALYSIS:

The ongoing project of sharda house is of a residential bungalow at near chopra lawns, Nasik. In this project they have G+2 building structure of private residential bungalow. From this study we get probable problems occurred during excavation, operations of loading and unloading of dumpers and billing operations.

4.1. SITE DETAILS:

1. Name of the site- Sharda house.

2. Owner- shriwang sharda.

3. Location- sharda house, near chopra lawn, Nasik.

4. Area of site- 25000 square feet.

5. Type of building- Residential bungalow.

6. Type of structure- G+2 RCC structure.

7. Name of contractor- Riddhi infrastructure.

After visit we got the most probable reasons of the work problem of construction machinery to the owner as well as to the contractor.

4.2. QUESTIONNAIRE ANALYSIS:

To study the use of IOT technology in the construction machineries, we have met different contractors. A user's feedback survey was taken out by the contractor. The questionnaire layout is an important volatile related to the objectives of the present study. A total of 10 samples were obtained out of which six samples of government contractor and four samples of private contractors were obtained from the survey.

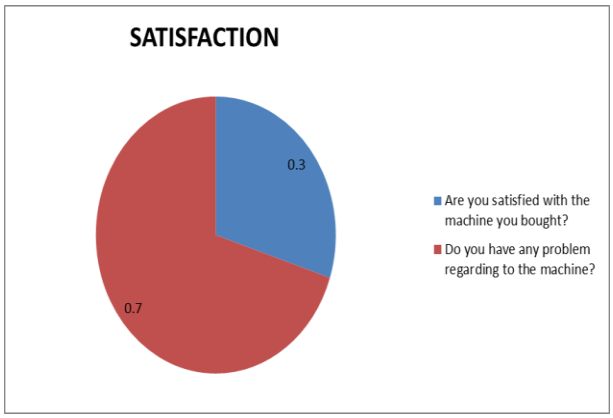


Fig.1 Figure showing the average value of the satisfaction group.

A. Satisfaction Related Factor

This pie chart shows the number of responses in terms of percentage. The first question where the survey conducted out of 10 person only 3 are satisfied by the machine and in second question 7 person have problem regarding to their machine.

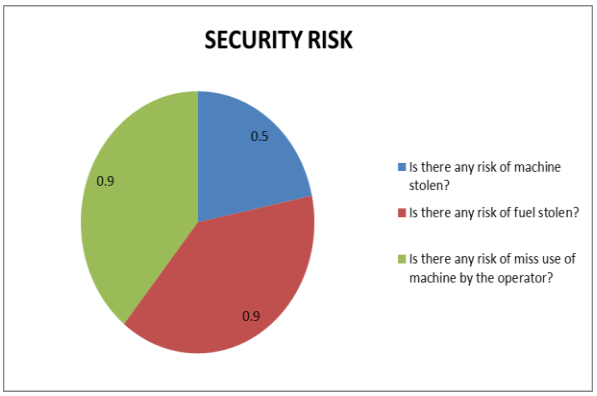


Fig.2 Figure showing the average value of the security risk group.

B. Security Risk Related Factor

This pie chart shows that in first question 5 people were agreed. In second question 9 person were agreed. And in the third question 9 person were agreed.

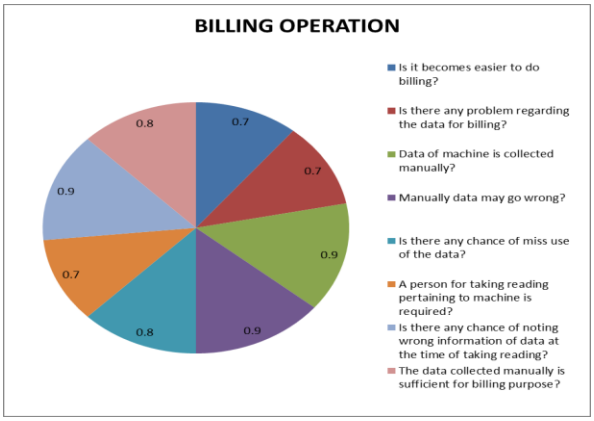


Fig.3 Figure showing the average value of the billing operation group.

C. Billing Operation Related Factors

In this chart for first question 7 people were agreed, in second question 7 people, in third question 9, in fourth 8, in fifth 7, in sixth 9, and in ninth 9 people were agreed.

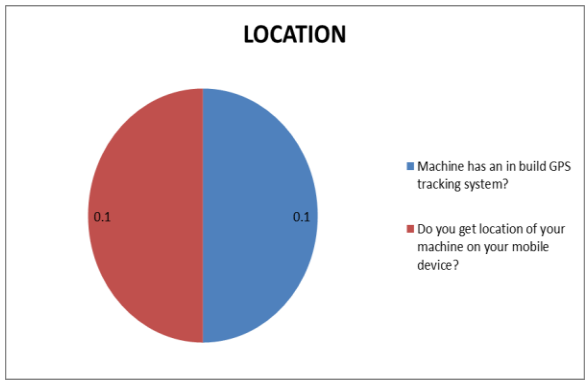


Fig.4 Figure showing the average value of the location group.

D. Location Related Factor

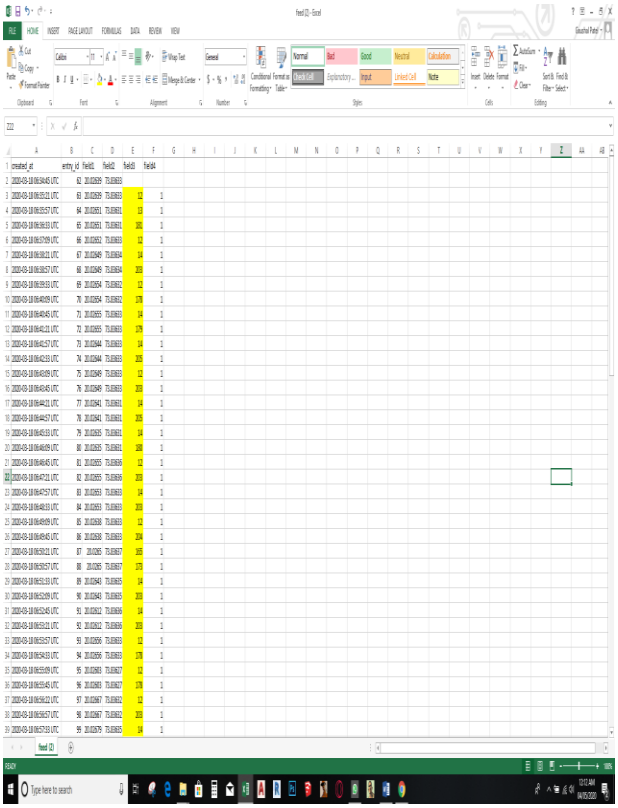
In this chart only 1 person is agreed for both the questions.

4.3. DEVICE DETAILS:

Working of fuel level-

An Ultrasonic sensor is used which helps in detecting the actual level of fuel in the fuel tank of the machine. The Ultrasonic sensor used in the device measures the level of the fuel present in the tank in centimeters.

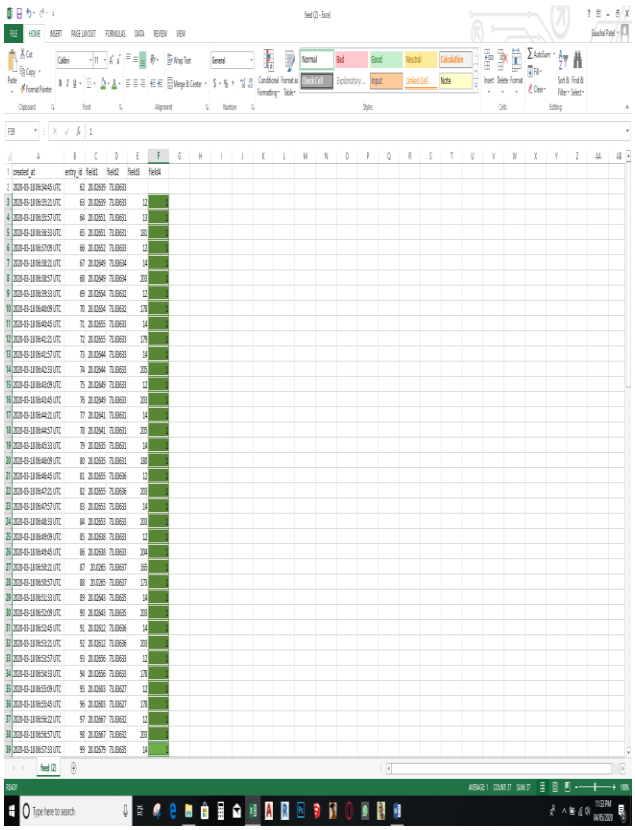
This ultrasonic sensor is to be installed in the fuel tank of the machine which will then help in measuring the level. This sensor work as how much time taken by the frequency between deflect and received by the sensors in centimeters.



The field 3 column marked in fluorescent yellow color are the details of the fuel present in the tank. This readings are in centimeters.

Working of machine running status-

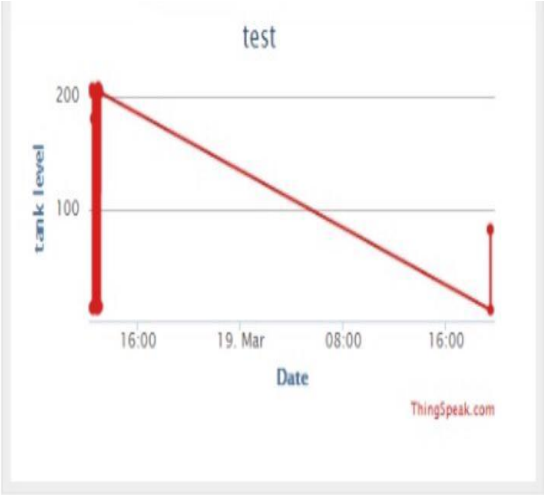
Machine running status is basically a thing in which the present situation or status of machine is known. It means at the present time the machine is in ON condition or it is in OFF condition.



In above Microsoft excel sheet the machine running status can be determined. Machine running status is present in column field 4 which is marked in green color. If the machine is in ON condition it will represent by denoting as 1 in the column. The time and date of that entry is shown in the column A.

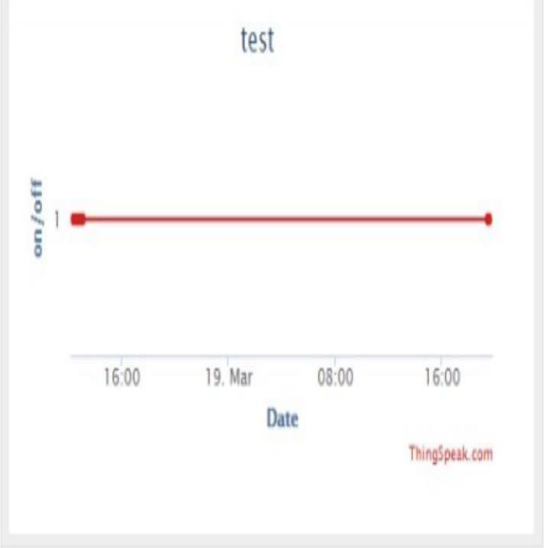
Use of Thing speak Application-

Thing speak app is a platform which helps in maintaining construction devices without any misuse or without any occurrence of any problem. It can be access by any type of Android and IOS operated devices.



All graph details are explained below-

- Above graph is of tank level in centimeters.
- Whereas in X axis date is represented and in Y axis tank level in centimeter is represented.
- The values in graph 1 are obtained from field 3.



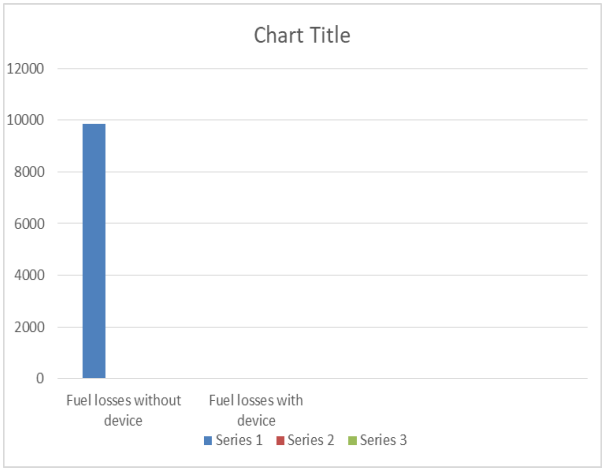
All graph details are explained below-

- Above graph is of machine running status.
- X axis shows the date while Y axis shows that the machine is ON or it OFF.
- The values in graph 2 is obtained from field 4.

Thing speak platform allows any user to view or get the details of machines without any hassle. A user ID with password is to be created first. After login to the application details of machinery. This can be done on any type of Android or IOS mobile devices. Problems occurred during billing operation is minimized.

5. RESULT AND DISCUSSION:

- Fuel level monitoring-
  - This features was most of the various demand taken under consideration after the questionnaire survey.
  - Many of cases on site are related to fuel storage.
  - This can be minimized by using such devices.
  - Considering the amount of fuel storage of machinery on site is around 5 to 5.5 liters per day. (Fuel stolen data is taken by visiting construction site).
  - 5 x 30 (5 is the stolen fuel in liters per day and 30 are the days in a month). = 150 liters per month.
  - 150 x 65.6 (150 is the total liters of fuel stolen per month and 65.6 is the average price of fuel per liter). = 9840 rupees.
  - As we can see around 9840 rupees are the losses occurred by the owner or the contractor in fuel stolen.
  - It's a huge amount and can cause more loss to the owner or the contractor.



- As we can see in the bar chart comparison between fuels losses using with device and without using device.
- Without using the device it cost around 9840 rupees of losses per month.
- Whereas by using the device the cost of losses of fuel per month reduces to zero.

- It's a clear picture that benefits are definitely.
- This device can also help in billing purposes.
- Total amount of fuel usage and payment against the work can be calculated.
- This helps the owner or contractor a hassle free billing operation.

- M/C running status-

  •This feature is a significant outcome of the project.

  •Monitoring of each and every activity of construction machinery working on site becomes very difficult to the owner or the contractor.

  •To overcome this feature is added.

  •Miss use of machinery working time generally occurs on construction site.

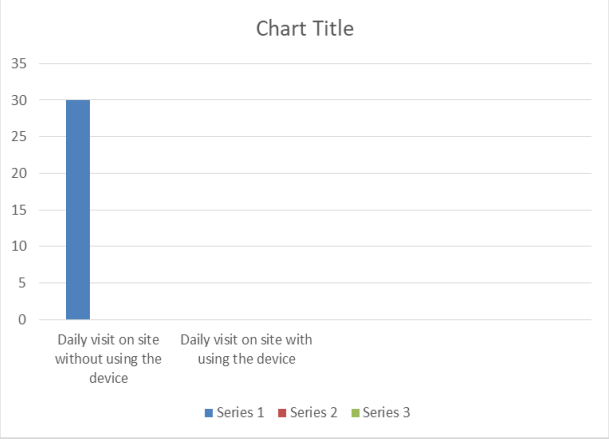
  •This drawback was came under consideration by visiting construction site.

  •A feature of real time monitoring the machine ON and OFF status has been added.

  •This can be done by using any type of mobile devices.

  •Thing speak platform helps in monitoring machine running time.

  •Daily visit on site of the owner or the contractor reduces to zero, because monitoring of machine can be done by sitting in the office.



- As we can see in the above chart comparison of daily visit on site with and without use of device.
- Without using the device visit on site has to be done on daily basis.
- Whereas by using the device the daily basis visit reduced to zero.
- One more cause of misuse of machine by the driver is reduced.
- If daily visit has not been done to monitor causes losses.

6. CONCLUSIONS:

1. Different problem are arising with the construction equipment during working on site and at the time billing and other operation.

2. To overcome the problems and to increase the efficiency of contractors and the owners we have design a device accordingly.

3. It will help in determining different parameters of construction equipment such as fuel usage, machine running status etc. and all this can be done through a mobile phone.

4. On an average, if 5 liters of fuel is being miss used, then according to its average cost around 9840 ₹ loss is to be bared to the owner or the contractor.

5. Monitoring of machine by visiting site is totally minimized due to the things speak platform.

6. The use of IOT technology on site may reduce the chances of miss-interpreting of data and miss-use of machine by the operator.

7. The initial cost of the device is around 11000 ₹ which becomes more useful and technology oriented.

REFERENCES

[1] Aron Costin, "Need for Interoperability to Enable Seamless Information Exchanges in Smart and Sustainable Urban Systems ", ASCE, Vol. 33, pp.51-52, 2019.

[2]Weiling Lil, Kewen Liao2, Qiang He3 and Yunni Xia4, "Performance-Aware Cost-Effective Resource Provisioning for Further Grid IOT-Cloud System", ASCE, Vol.145 (5), No.52-53, 2019.

[3]Yuhan Niul, Chimay Anumba, F.ASCE2, and Weisheng Lu3, "Taxanomy and Deployment Framework for Emerging Pervasive Technologies in Construction Projects", ASCE, Vol. 145 (5), No.51-54, 2019.

[4]Rich Lommock, The Internet of Things, Big Data, and the Connected Transportation System, ASCE, Vol.4 (4), No.232, 2018.

[5]Jinying Xul and Weisheng Lu2, Smart Construction from Head to Toe: A Closed-Loop Lifecycle Management System Based on IOT, ASCE, Vol.328, No.58, 2018.

[6]Jingbo Zhang, Hui Hu, Hai Ma, and Dongdong Zhang, Adaptibility Evaluation of Internet of Things in

Transportation Management, ASCE, Vol.137 (2), No.51-54, 2018.

[7]Yuhan Niu, Weisheng Lu, Ke Chen, George G. Huang, and Chimay Anumba, Smart Construction Objects, ASCE, Vol.138(11), No.1239-1250, 2015.

[8]Xue DENG, Min ZHANG and Feng XIAO, Design And Apllication Of Intelligent Transportation System Based On The Internet Of Things, ASCE, Vol.63 (2013), No.114-121, 2014

[9]Xiao-Hong ZHONG, Hui DING, XIAO-Ming ZHANG and Fei ZHANG, Research on the Construction of IOT System in the Field of Military Logistics, ASCE, Vol.30, No.114-121, 2014.

[10]huiqi ZHU, Hanping HOU, Mingyao HU, Yong GENG, Things Identification Support Sytem Based on IOT, ASCE, Vol.3203(19), No.20,2012.

[11]Yingping LI, Guangqi SUN, Xiangwen LI, Wenfei MU, Research for Advanced Public Transport Solutions Based on the IOT, ASCE, Vol.18, No.0360-5442, 2010.