"SITE AND WORKERS SAFETY BY USING INTERNET OF THINGS ON CONSTRUCTION SITE"

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Abstract : Civil construction sites are considered as one of the riskiest environment where many potential hazards may occur. To protect construction worker and prevent accidents on such sites. We are going to propose a novel design for an autonomous system that monitors, localizes, and warns site labors who avail within danger zones. The proposed system is user friendly, and its architecture is based on internet of things. The heterogeneous components of this architecture are seamlessly integrated into a middleware backend online server. To accurate detect and identify construction worker, the proposed system employs three combine techniques. They are 1) the 868 MHz radio frequency, 2) directional antennas, and 3) the 40 kHz ultrasound waves. Vehicles rear is secured by a sensing unit that ensures good coverage along with wearable devices for worker. RFID tag will be to the vehicle then it will detect that any human being is there or not. Our system will provide a safety at construction sites which will save labors life and also provide safety at site.

***Index Terms -* Arduino Uno, ultrasonic sensing module.**

I. INTRODUCTION

As we know construction sites are one of the riskiest place for the workers. life with risks, potential hazards are numerous. Construction sites are very complex working environments, due to their dynamic nature and the concurrent involvement of numerous resources and supply components Accidents on construction sites are a scourge throughout the world The European construction sector has registered that falls from heights cause the highest number of fatalities, accounting for 52% of all accidents. Second on the list is the number of fatal accidents due to objects falling from overhead accounting for 36% of all accidents occurring on construction sites This plague also causes other repercussions, such as the socialcostsentailed as a result of disabilities and the financial burden attributable to early retirement Studies showed that threat of injury at the construction industry is higher than other industries. The studies also added that fatal accidents with vehicles
are among the most frequent causes of death on construction sites In 2012, the rate of accidents related to vehicles (trucks)having caused in France a permanent disability or death is 2.7%and 14.5% respectively In the UK, an average of 7 workers die
annually as a result of accidents involving vehicles on constructionists; further 93 workers are seriously injured The
Occupational Safety & Health Administration in the US stated that vehicle related accidents are the second top cause of death for construction workers resulting in more than 800 deaths annually Many factors make construction work challenging for workers and engineers such as weather and safety. Considering the Gulf Corporation Council (GCC) region for example with temperatures That exceed 40o C and very long working hours, the construction workers are barely able to focus on their surroundings. Tired and distracted workers around the operation of heavy machinery at the construction site along with unaware drivers are sometimes recipe of bad accidents. On most construction sites, trucks another vehicles move in and out regularly for different purposes, but unfortunately, there are seldom any systems in place to manage all the traffic. As a result, the risk of injury in a construction site motor.
vehicle accidents can be significant In this paper, a fully automated, standalone, and accurate system is proposed to monitor, locate, and alert construction workers in noisy environment sites. It allows the detection of laborers behind vehicles and therefore potentially at risk. The proposed sensor enhances the safety features with simple installation. Moreover, the WSDS system is immune to effects of weather, dust, and night vision due to the use of a combination of three seamlessly integrated technologies which are radio frequency, directional antennas, and ultrasound The goal of the proposed system is to measure emissions continuously in real-time with a low-cost networked platform distributed across the building site area as shown in The main task of the proposed system is to monitor all emission and warn the operator quickly when limits are exceeded. The operator can immediately react upon this information and adjust his actions quickly

Objective of Study

- To provide safety from colliding objects like machines, cranes, tools, vehicles etc. to workers in construction sites.

II. LITERATURE REVIEW

The main aim of this study is to prevent accidents at construction site by providing backover accident detection system. The general duty of employer is to each of his employee the work place which should be free from hazard which may causes physical harm or death. The construction industry is a very dangerous industry. The performance of the industry in occupational health and safety is very poor. Even though by using manual safety there are still some chances of happening accidents at site. So we are going to provide IOT based sensor module system.

A. CONCEPT OF HAZARD ENERGY AND SAFETY BARRIER

An accident was defined as an unscheduled, unexplained random effect in several decades before [11]. Among many accident causation theories, EBA model was originally based on the successive works of Hienrich's domino theory back in the 1930s, Haddon in 1966 and Gibson in 1961 [6]. EBA models an accident as a contact between a hazardous agent (HA) and a target (a vulnerable and valuable object), by transferring from one domino to another [12]. The target notion is used generally, for people, the environment or physical assets and so on. The HA may be any danger source, usually expressed as “hazard energy”, which can damage a target [13]. For example, an abnormal exchange of energy exceeding the body's resistance was seen as the cause of accidents and the basis for an injury.

A barrier can be defined as a physical and/or non-physical means planned to prevent, control, or mitigate undesired events or accidents [14]. In the simplest way, safety barrier is a protector of a target from an HA impact. Using this definition, knowledge and information, and the distance warning between energy and target are also considered as safety barriers [15]. A safety barrier system is a system that has been designed and implemented to perform one or more barrier functions, such as a pressure protection system [15, 16]. A safety barrier system will sometimes have several safety barrier elements that perform one or more barrier sub-functions. Safety barrier systems can also be characterized by their nature, such as technical, operational, and organizational [16]. Technical systems can in turn be divided into safety monitoring systems, safety warning systems and automatic risk reduction facilities [17]. Operational barrier systems are tasks performed by a manager, or team of managers, such as to manually operate open a valve or a door [18]. Organizational barrier systems are personnel responsible for, and directly involved in, realizing one or more barrier functions [19].

B. IoT-based hazard energy monitoring framework

Efforts to assess the monitoring performance of workers, equipment and construction environment are vital in creating a safe-working environment and in reducing casualties during the conduct of construction projects. One hundred and thirty-six articles published during 2006 to July 2014 focused on IT applications in the field of computer-based construction safety engineering management were analyzed sophisticatedly [8]. The result shows that information technology has been applied in a wide array of applications to provide solutions to construction safety problems. However, how to monitor and control hazard energy on site in real-time remain a problem in construction industry. The basic reason is that the environment of different construction projects is variously and changing at any time during the whole construction phase, comparing with other industry. The work environment and workers are largely stationary in non-construction work tasks in nuclear, transportation and petrochemical processing industries, which is opposite in construction industry. For that reason, it is difficult to set the safety barriers on site effectively and timely to adapt the changing of construction environment and workers.

C. Sensor technology

A wireless sensor is a device which is composed of a microprocessor, radio trans-receiver, a memory, a power source, one or more sensors. , it is important that the measurements are geo localized in many WNS application. When sensors are randomly deployed, sensor nodes may also feature a geo positioning system (GPS) to obtain the location information.

D. Safety policies and laws

In India, departments under the Ministry of Labor and Employment deal with OSH issues in construction sector under the head of Chief Labor Commissioner. Directorate General Factory Advise Service Labor Institute (DGFASLI) provides technical support in drafting model rules, carrying out surveys, and conducting training programmers in construction sector. A number of Labor Laws are applicable to the workers engaged at construction sites.

These are as follows:

(i) Contract Labor (Regulation & Operative) Act, 1970,
(ii) Minimum Wages Act, 1948,
(iii) Payment of Wages Act, 1936,
(iv) Equal Remuneration Act, 1976,
(v) Inter-State Migrant Workmen (Regulation of Employment and Condition of Services) Act, 1979,
(vi) The Building and Other Construction Workers Act,
1996.

E. Sensor network application

Sensor networks may consist of many different types of sensors such as seismic, low sampling rate magnetic, thermal, visual, infrared, acoustic and radar, which are able to monitor a wide variety of ambient conditions that include the following

- temperature,
- humidity,
- vehicular movement,
- lightning condition,
- pressure,
- soil makeup,
- noise levels,
- the presence or absence of certain kinds of objects,
- mechanical stress levels on attached objects, and

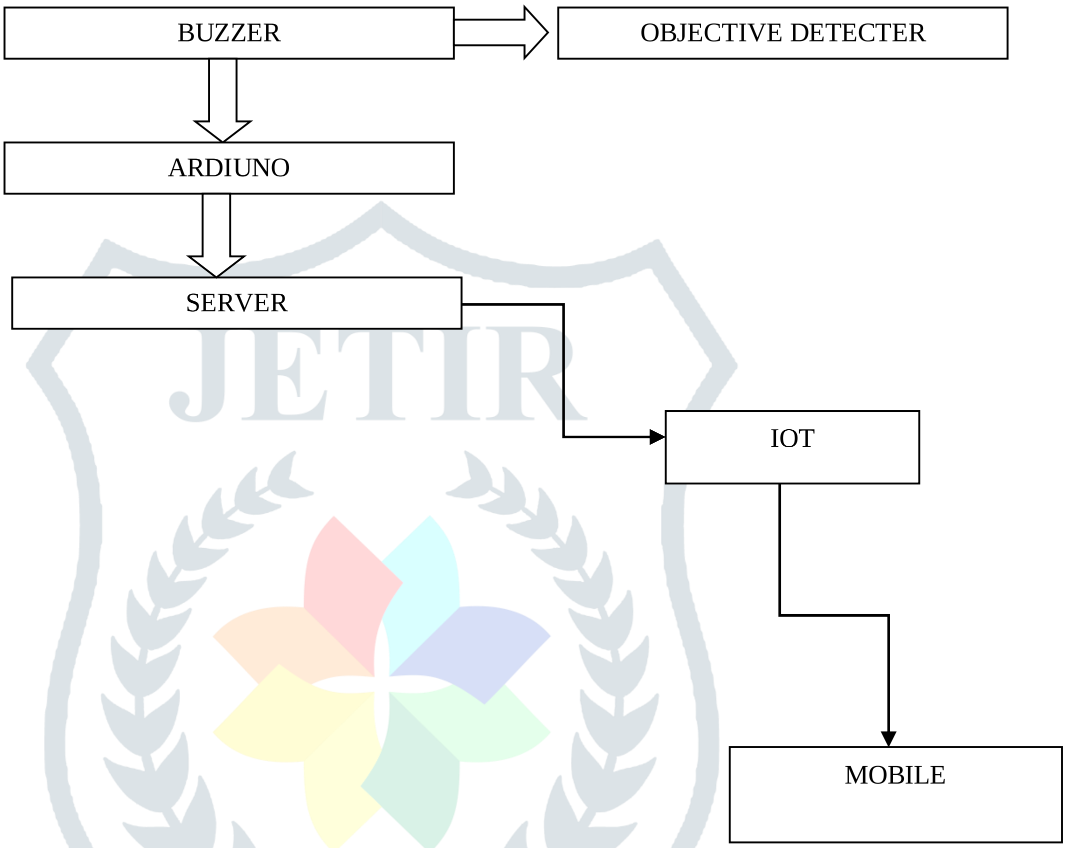
• the current characteristics such as speed, direction, and size of an object.[6]

III. METHODOLOGY

Propose System

Ultrasonic ranging module power supply gives to pi it will run and after that it continuously check the sensor status means it's check any unwanted situation occurred or not at construction site. It detects the person and if he is in risk zone or standing very close to the vehicle which might be risky then that time sensor will buzz and give warning to the person standing near it. At night time what happened mostly, the labors sometime working in dark area where light is not there at same time if any vehicle based activity is going at site (e.g. transit mixer, road roller, dozer, truck, crane, jcb) there might be chances of colliding these vehicles to the labor in which he might get temporary or permanent damaged. So in this system we are going to provide a trans-receiver system to vehicle and a labor which buzzes before collision.

Flow Chart



1) Hardware details:

The Arduino uno is a microcontroller board based on the ATmega328 (datasheet).It has 6 analog inputs, a 16 mhz ceramic resonator, a USB connection, a poer jack,
It has 14 digital input/output pins (of which 6 can be used as PWM outputs),
It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.
The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter. Revision 2 of the Uno board has a resistor pulling the 8U2 HWB line to ground, making it easier to put into DFU mode. Revision 3 of the board has the following new features.

a) **PIR Sensors** : A passive infrared sensor (PIR sensor) is an electronic sensor that measures infrared (IR) light radiating from objects in its field of view. They are most often used in PIR-based motion detectors. PIR sensor detects a human being moving around within approximately 10m from the sensor. This is an average value, as the actual detection range is between 5m and 12m.PIR are fundamentally made of a pyro electric sensor, which can detect levels of infrared radiation. In this project PIR senor used to detects helmet and person while unman area.

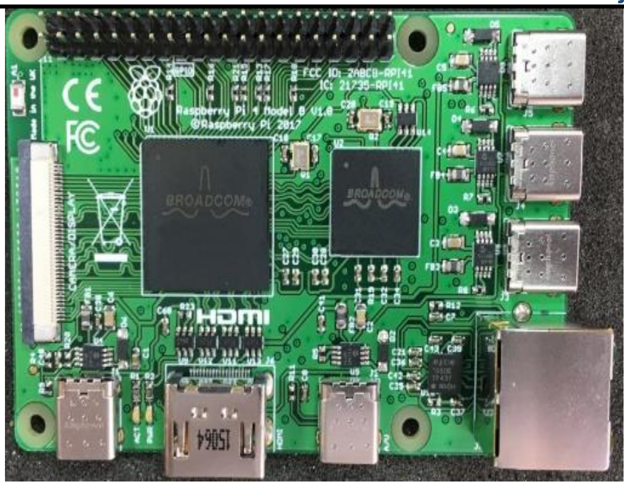
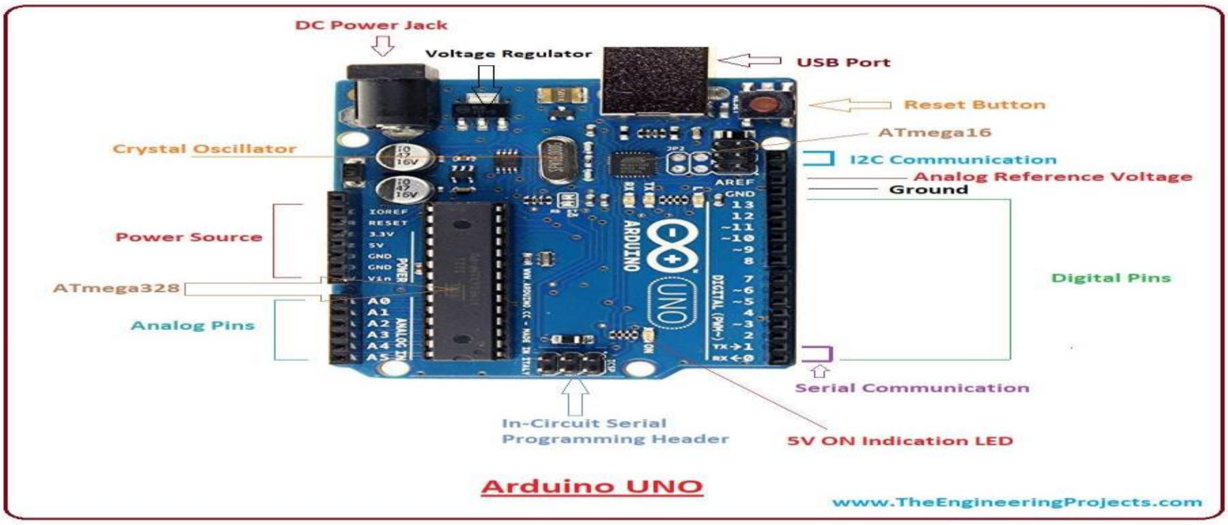


Figure 1 PIR Sensor

Specification:

- It is an ATmega328P based Microcontroller
- The Operating Voltage of the Arduino is 5V
- The recommended input voltage ranges from 7V to 12V
- The i/p voltage (limit) is 6V to 20V
- Digital input and output pins-14
- Digital input & output pins (PWM)-6
- Analogue i/p pins are 6
- DC Current for each I/O Pin is 20 mA
- DC Current used for 3.3V Pin is 50 mA
- Flash Memory -32 KB, and 0.5 KB memory is used by the boot loader
- SRAM is 2 KB
- EEPROM is 1 KB
- The speed of the CLK is 16 MHz
- In Built LED
- Length and width of the Arduino are 68.6 mm X 53.4 mm
- The weight of the Arduino board is 25 g



Application:

- Low cost PC/tablet/laptop
- IoT applications
- Media centre
- Robotics
- Industrial/Home automation
- Server/cloud server
- Print server
- Security monitoring
- Web camera
- Gaming
- Wireless access point
- Environmental sensing/monitoring (e.g. weather station)

b) Buzzer

A buzzer or beepers an audio signaling device, which may be mechanical,electromechanical, or piezoelectric. Typical uses of buzzers and beepers include alarm devices, timers and confirmation of user input such as a mouse click or keystroke.

The first electric buzzer was invented in 1831 by Joseph Henry. They were mainly used in early doorbells until they were phased out in the early 1930s in favor of musical chimes, which had a softer tone. Piezoelectric buzzers, or piezo buzzers, as they are sometimes called, were invented by Japanese manufacturers and fitted into a wide array of products during the 1970s to 1980s.

Specification of buzzer

Ratings * Operating Temperature Range: **-** 20°C ~ + 105°C

Storage Temperature Range: **-** 40°C ~ + 105°C *

Operating Voltage: 3.0 to 30.0 VDC *

Case material: PC UL 94HB

2) Software details

- **SQLyo*g***

SQLyog is the most powerful manager, admin and GUI tool for MySQL, combining the features of MySQL Query Browser, Administrator, phpMyAdmin and other MySQL Front Ends and MySQL GUI tools in a single intuitive interface. SQLyog is a fast, easy to use and compact graphical tool for managing your MySQL databases. SQLyog was developed for all who use MySQL as their preferred RDBMS. Whether you enjoy the control of handwritten SQL or prefer to work in a visual environment, SQLyog makes it easy for you to get started and provides you with tools to enhance your MySQL experience.

- **MYSQL**

MySQL the most popular open source SQL database management system is developed distributed and supported by Oracle corporation. The MySQL website provides the latest information about MySQL software.

- **Eclipse**

The ESP8266 is a low-cost Wi-Fi microchip with full TCP/IP stack and microcontroller capability produced by manufacturer Express if System. Eclipse uses plug-ins to provide all the functionality within and on top of the run-time system. Its run-time system is based on Equinox, an implementation of the OSGi core framework specification. In addition to allowing the Eclipse Platform to be extended using other programming languages, such as C and Python, the plug-in framework allows the Eclipse Platform to work with typesetting languages like Latex and networking applications such as telnet and database management systems.

IV. DATA COLLECTION

1.1.1 Case study details-

The ongoing project of Jaikumar construction is of high-rise residential mass-housing project of PARKSYDE HOMES at Adgaon, Nasik. In this project they have total 5 phases of construction. They have handed over or we can say fully constructed 3 phases out of total 5 phase. The 4th phase is about 90 percent completed and last phase is under construction. There are total 27 building is going to be construct some of 2bhk and some of 3bhk so from this study this paper is included calculation of whole site construction equipment used on site

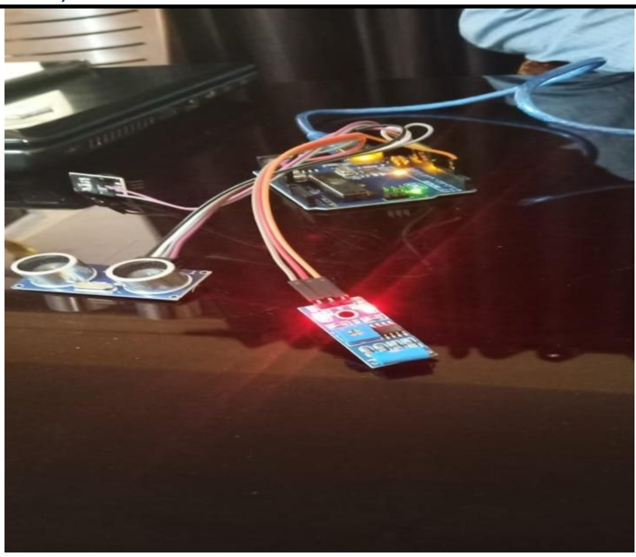
They have used on site autoclaved aerated concrete blocks. Also they have their own RMC plant on site

Site details-

Name Of Company	: Jaikumar construction LLP. Nasik
Project Name	: Parksyde Homes
Owner	: Mr. .Gopal Atal and Mr. Manoj Tibriwala
Location	: Parksyde Homes, Hanuman Nagar, Opp. Rasbihari High School, Adgaon, Nasik.
Area Of Site	: 25 acres
Type of Building	: High-Rise Structure
Type of Structure	: G+ 15 RCC Constructions
RCC consultants	: J.W. Consultants
Architect name	: Mr. Umesh Bagul

Figure site visit photos

Figure labors improper attention at site while working.



B. Accident cost and probable injuries for construction work.

Let us take a building construction site example. If accident happens at a site due to improper attention. For calculation of accident cost the monthly wages were considered as Rs.9000/-(according to WCA 1923) depending upon the type of injured person. Also by considering direct cost and indirect cost of accident or injuries. Relevant factor is an age based multiplier defined in schedule IV; here we considered RF is 207.98 for 30 age group. Calculate the total cost with multiply by RF. One of the calculation activity as shown below.

1) **Building work:**

i) Temporary injuries: 25% of monthly wages = 25/100 X 9000=2250/-

ii) Permanent injuries: 60 % of monthly wages X RF / Rs.9000 whichever is more
=60/100 X 9000X 207.98
=11, 23,092/-

iii) Death: 50 % of monthly wages X RF /Rs.9000 whichever is more
=50/100 X9000 X 207.98
=9, 35,910/-

Table 4:1: Cost of Compensation as Per WCA 1923

SR.NO	TYPE OF WORK	TYPE OF DISABLEMENT	COMPENSATION PERCENTAGE (%)	CALCULATION OF COMPENSATION (RS)	ACCIDENT COST (Rs)
1	**Building Construction Work**	Temporary	25% OF M.W.	25% of 9000/- = 2250/-	2250-1123092
		Permanent	60% OF M.W. X R.F./R.S.90000 Whichever is more	60% of 9000/- X 207.98 = 11,23,092/-	
		Death	50% OF M.W. X R.F./R.S.80000 Whichever is more	50% of 9000/-X 207.98 = 9,35,910/-	
2	**Road Construction Work**	Temporary	25% OF M.W.	25% of 9000/- = 2250/-	2250-1123092
		Permanent	60% OF M.W. X R.F./R.S.90000 Whichever is more	60% of 9000/- X 207.98 = 11,23,092/-	
		Death	50% OF M.W. X R.F./R.S.80000 Whichever is more	50% of 9000/-X 207.98 = 9,35,910/-	
3	**Bridge Construction Work**	Temporary	25% OF M.W.	25% of 9000/- = 2250/-	2250-1123092
		Permanent	60% OF M.W. X R.F./R.S.90000 Whichever is more	60% of 9000/- X 207.98 = 11,23,092/-	
		Death	50% OF M.W. X R.F./R.S.80000	50% of 9000/-X 207.98	

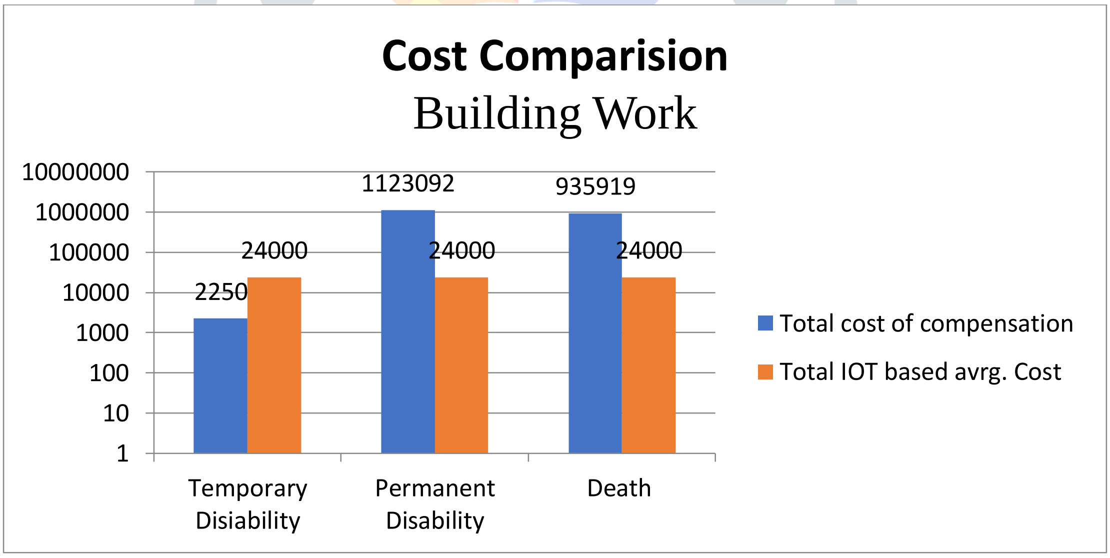
			Whichever is more	= 9,35,910/-	
4	**Tunnel Construction Work**	Temporary	25% OF M.W.	25% of 9000/- = 2250/-	2250-1123092
		Permanent	60% OF M.W. X R.F./R.S.90000 Whichever is more	60% of 9000/- X 207.98 = 11,23,092/-	
		Death	50% OF M.W. X R.F./R.S.80000 Whichever is more	50% of 9000/-X 207.98 = 9,35,910/-	

Table 4:2: Cost of Ultrasonic Ranging Module (PIR Sensor)

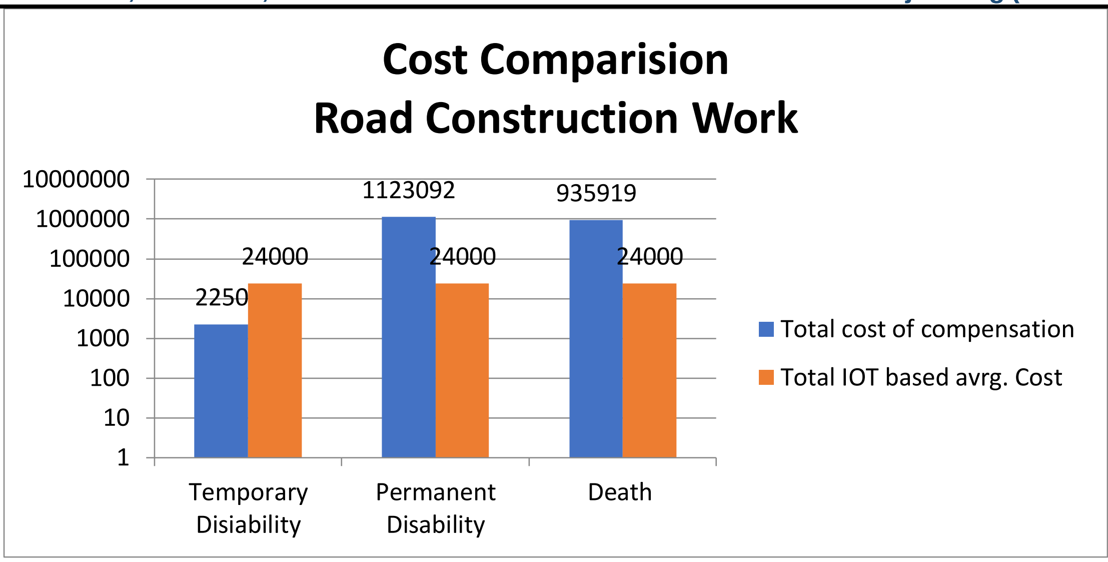
SR.NO	EQUIPMENT'S/ MACHINARY USED	HARDWARE USED	IOT COST (HARDWARE COST + SENSOR COST + IMPLENTATION COST)(Rs)	TOTAL AVG.COST (Rs)
1	Earth moving equipment's	Ultrasonic Ranging Module (PIR Sensor)	(12000-15000)+4000+5000	24000 RS /-*

V. Result & Discussion:

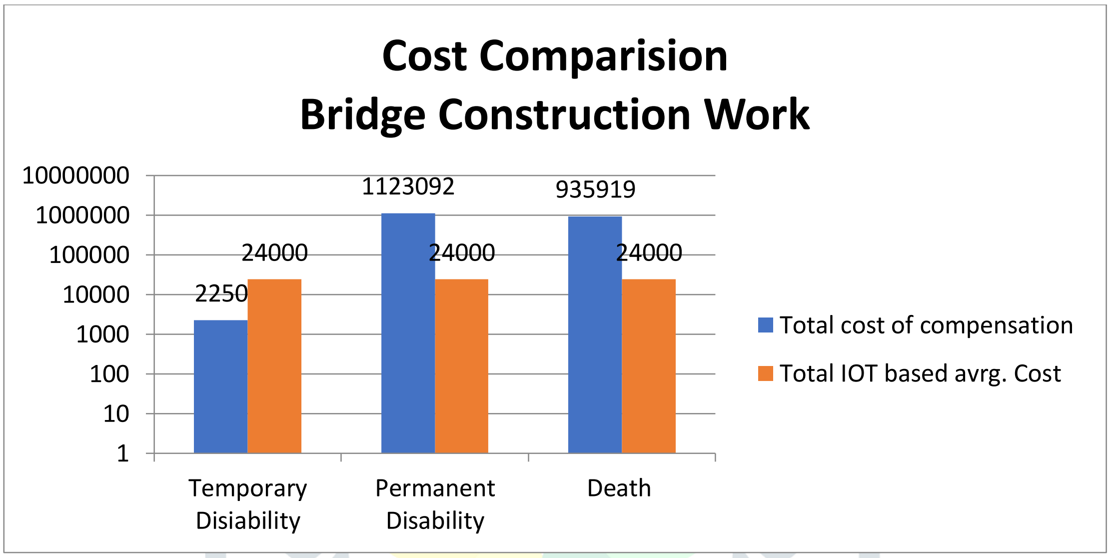
5.1: Cost comparison between Accident cost and cost of safety provided by using IOT:



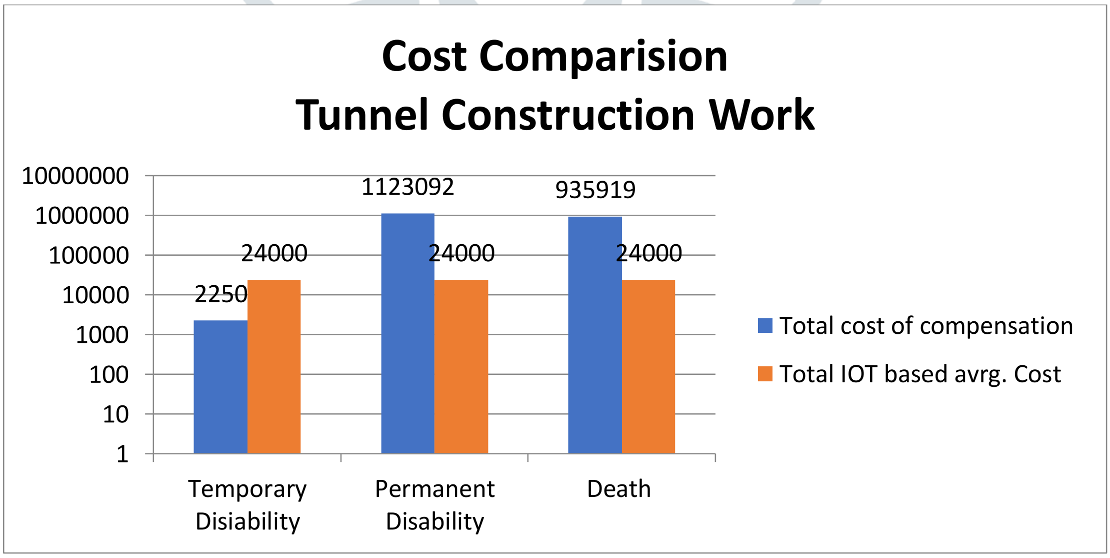
Graph 5:1: Cost Comparision For Building Construction Work



Graph 5:2: Cost Comparision For Road Construction Work



Graph 5:3: Cost Comparision For Bridge Construction Work



Graph 5:4: Cost Comparision For Tunnel Construction Work

5.2 Discussion:

1. From the collected data and sensor cost we get total cost of worker compensation along with market values of hardware we used. Though it is seen than accident cost is more than safety cost.

2. Insurance doesn't keep workers healthy or saves workers lives.it only ensures the owners to transfer the financial risk against workers accident,

3. From the above calculations, graphs, and tables it is clearly seen that the cost of accident is more than the IOT based safety provided at site.

4. Maximum cost of the death and permanent accident are in range of 9, 35,910-11, 23,092 Rs.

5. But the maximum cost of the sensor is 24,000 /- or may be up to 30,000 as per safety provision and sensor used but this technology is one time investment. We can reuse them.

6. Accident cost is maximum than IOT based sensor cost, hence we can provide safety by using internet of things at minimum cost.

VI. CONCLUSION:

1. Many labor safety laws are available but still many accidents are happening at site. People don't follow safety laws.

2. We have designed a PIR sensor which we are going to implement on vehicle which is connected to Wi-Fi system. If any worker working in hazardous condition it will give alarm to the driver. Readings will directly come on mobile phone or on pc.

3. in future scope we can added that this sensors can help to find obstacles in the way when machinery, tools are working in no light area.

4. We concluded that the cost of accident is more than the IOT based sensors safety provided. We can provide safety by using internet of things at site.

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