JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

SMART URBAN INFRASTRUCTURE MODELS USING IOT

[1]S Akhil Tej, [2]M Jyothika, [3]K Mukunda Krishna,[4]S Sahil,[5]E Harish Goud,[6]B N Sreedhar,[7] K Asher Joseph Kumar

[1]Assistant Professor, [2,3,4,5,6,7]Under Graduate Student
[1,2,3,4,5,6,7] Department of Civil Engineering
[1]G Pullaiah College of Engineering and Technology,Nandikotkur Road, Kurnool, AP, INDIA.

Abstract: **A Civil engineer is responsible for designing, constructing, and maintaining physical and naturally built environments such as roads, bridges, canals, dams, airports, etc. In urban planning and city management, smart ideas play a major role in people comforts and facilities. IOT smart systems are making city infrastructures eco-friendly. It also contributes to construction safety by detecting and alerting about hazardous conditions. With the help of IOT, we prepared models and developed technical innovations that can help the people in this developing society. They are automated car parking, smart bridge, water level controller and earthquake detector. this is a major innovation needed to solve transportation problems and everyday life.**

Index Terms - **Arduino IDE, Processing IDE.**

I. ABOUT THE PROJECT

Engineering has been around since the beginning of time, with civil engineering being one of the oldest. From the towering pyramids of Egypt to the modern marvels of skyscrapers and bridges, civil engineers have played a vital role in shaping the built environment and fostering human progress. This is the vision behind smart urban infrastructure, a concept that leverages the power of the IOT to create a more efficient, sustainable, and livable urban environment. City infrastructures are being made eco-friendly by implementing smart system using IOT. Its important to reduce costs, improve culture, and help the planet for sustainability. Among many of the smart systems we are implementing some of the models.

1.1 ROLE OF IOT IN CIVIL ENGINEERING CONSTRUCTION

The internet of things (IOT) is revolutionizing civil engineering construction. Sensors embedded in materials, equipment, and even workers themselves are creating a network of real-time data that empowers engineers. This data allows for enhanced monitoring of structures, improved material management through curing and tracking, boosted safety with wearable tech and environment sensors, and streamlined operations with optimized workflows. Ultimately, IOT paves the way for a future of “smart” infrastructure, where bridges self – diagnose and roads adapt to traffic, making construction not only more efficient but also safer and more sustainable.

1.2 PROPERTIES OF IOT IN CIVIL ENGINEERING

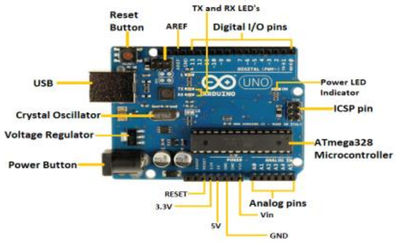
The internet of things (IOT) brings a unique set of properties to civil engineering, transforming how we design, build, and maintain structures.

- **Real – time Data collection:** It allows continuous monitoring and immediate response to changes in a construction project or existing infrastructure with IOT sensors.
- **Remote Monitoring:** By accessing data collected by IOT devices remotely, engineers are able to improve efficiency and reduce on – site presence while improving efficiency.
- **Scalability and Adaptability:** A Variety of sensors and devices are available to use in IOT systems, which can scale up and down depending on the project size and complexity.
- **Improved Decision – making:** Engineers can use IOT data to optimize construction processes, predict maintenance needs, and ensure the long – term health.
- **Integration with other technologies:** Building Information Modeling (BIM) combines IOT with other technologies to provide a comprehensive view of projects and infrastructures.
- **Predictive Maintenance:** Predictive maintenance is enabled by IOT by continuous monitoring. This saves costs and improves safety by addressing issues before they cause significant damage.

II. Components Used

2.1 Arduino Board

Arduino is an open – source electronics platform that makes it easy to learn coding and build interactive projects using a physical board and a software interface.



2.2 IR Sensor

An IR Sensor is an electronic device that detects infrared radiation, which is invisible heat coming from objects, and is used in application like motion detection and night vision.

2.3 DC Gear motor

An DC gear motor is a type of electric motor powered by direct current that uses gears to reduce speed and increase torque for various applications.

2.4 Sprockets and bearings

Sprockets are toothed wheels that mesh a chain or belt to transfer rotary motion, while bearings are friction – reducing components that allow smooth rotation on a shaft.

2.5 USB Cable

The USB cable used for Arduino is a standard A to B type cable. This is the kind commonly used for printers and other peripherals.

2.6 RELAY (5V)

A 5V relay is an electronic switch controlled by a low – power 5V signal, allowing you to turn on/off high – power devices with your Arduino or similar microcontrollers.

2.7 SOIL MOISTURE SENSOR

A Soil moisture sensor is a device that measures the water content in soil. They are typically used in gardening and agriculture to avoid over or under watering plants.

2.8 SERVO MOTOR

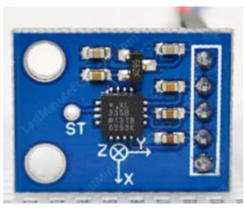
A servo motor is a special type of electric motor that can be precisely controlled to rotate to specific angles. This makes them ideal for robotics and automation application.

2.9 BUZZER

A buzzer is a small electronic device that emits a continuous or intermittent sound when activated. They are used in various applications to provide audible alerts or confirmations.

2.10 ADXL335 ACCELEROMETER SENSOR

The ADXL335 is a small, low – power accelerometer that measures acceleration in 3 axes. This makes it a popular choice for building projects that require motion sensing or tilt detection.



III. Software

3.1 Arduino IDE

Arduino IDE, or integrated Development Environment, is a free, open – source software application that lets you write code and upload it to Arduino boards. It simplifies the process of creating interactive electronics projects. IDEs come with text editors for writing code, compliers for translating code to Arduino – compatible languages, and debugging functions for identifying and fixing errors. Additionally, the Arduino IDE includes libraries that provide pre – written code for common functions, making it easier to control components like LEDs, Sensors, and motors. Overall, Arduino IDE is a user – friendly platform that makes learning electronics and coding accessible to beginners and experienced makers alike.

3.2 Processing IDE

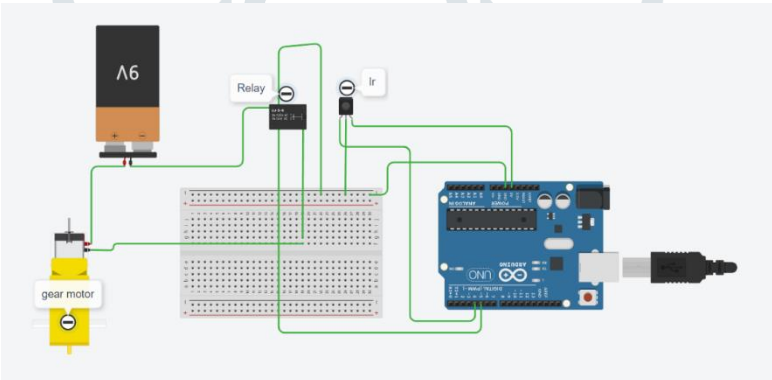
A simple programming environment for developing visually oriented applications, processing emphasizes animation and instant feedback through interaction with users. The developers wanted a means to "Sketch" ideas in code. Processing has come to be used for more advanced production – level work in addition to its sketching role. In addition to large – scale installations, motion graphics, and complex data visualization, processing was initially developed as an extension to java for artists and designers.

IV. Modelling

4.1 Automated rotary car parking

In this model, we had setup one sensor at the system entrance so that the sensor detects the vehicles entry, and the system operates as follows according to the code which we have uploaded in the connected Arduino uno board, so that the code reads the moment of the vehicle and immediately searches for an empty parking slot.

4.1.1 Circuit Diagram



4.1.2 Coding

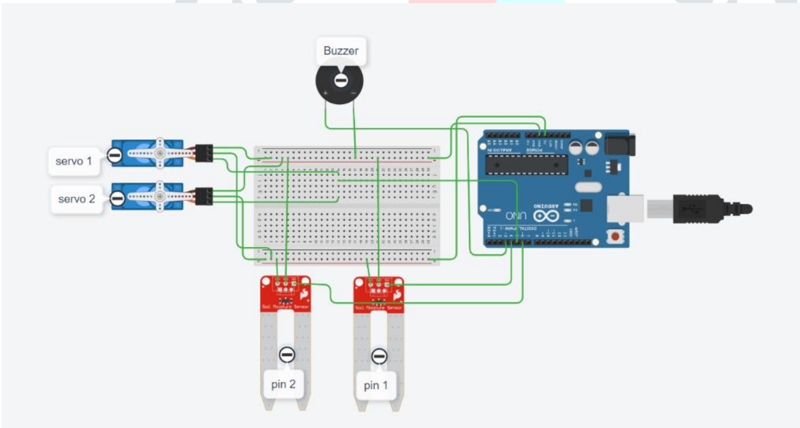
```
int ir = 4;

int relay =5;

int val;

void setup () {

  pinMode(ir, INPUT);

  pinMode(relay, OUTPUT);

}

void loop () {

  val = digital Read(ir);


  if (digital Read(ir)==LOW)

  {

    delay (5000);

   digital Write (relay, HIGH);
```

```
 delay (420);
 digital Write (relay, LOW);
 delay (5000);
 }
 else
 {
  Digital Write (relay, LOW);
 }
}
```

4.2. SMART BRIDGE

In this model we came with an idea that raising the deck of the bridge height in two intervals during the heavy floods occurred. For this we installed two servo motor at the two entries of the bridge and two soil moisture sensors in the river bank at two levels of height. We already have an Arduino connected to the sensor, so when floods increase, the moisture sensor receives an alert, then the Arduino gives control to the servo motor, which rises the deck of bridge for a specific height and buzzer will sound to warn travelers. This mechanism will applicable for next level also, and the deck of the bridge decreases its height automatically when the water flow gets normal.

4.2.1 CIRCUIT DIAGRAM



4.2.2 CODING

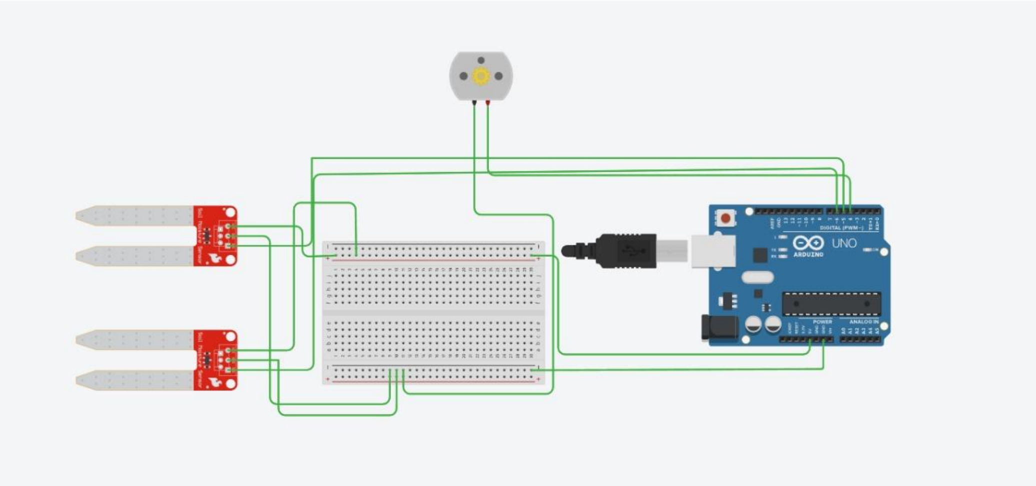
```
#include < Servo.h >
    Servo tap_servo;
    int sensor_pin1 = 4;
    int tap_servo_pin =5;
    int sensor_pin2=6;
    int buzzer=3;
    int val;
    int val1;
    bool buzzersound1=false;
    void setup(){
      pinMode(sensor_pin1,INPUT);
```

```
  pinMode(sensor_pin2,INPUT);
  pinMode(buzzer,OUTPUT);
  tap_servo.attach(tap_servo_pin);
}
void loop(){
  val = digitalRead(sensor_pin1);
  val1= digitalRead(sensor_pin2);
    if(val==1 && val1==0){
      if(!buzzersound1){
        digitalWrite(buzzer,HIGH);
        delay(2000);
        digitalWrite(buzzer,LOW);
        buzzersound1=true;
      }
      tap_servo.write(45);
    }
    if(val==1 && val1==1){
      tap_servo.write(90);
    }
    if(val==0){
      tap_servo.write(0);
      buzzersound1=false;
    }
}
```

4.3 WATER LEVEL CONTROLLER

In this model the water level controller is promotes conservation in individual situations. Here we are using two soil moisture sensors to detect lowest and highest level of water in tank. To prevent the waste of water, when the water level reaches lowest level of the tank the sensor will detects and turns on motor pump, similarly motor turns off when the water level reaches the highest level of the tank.

4.3.1 CIRCUIT DIAGRAM



4.3.2 CODING

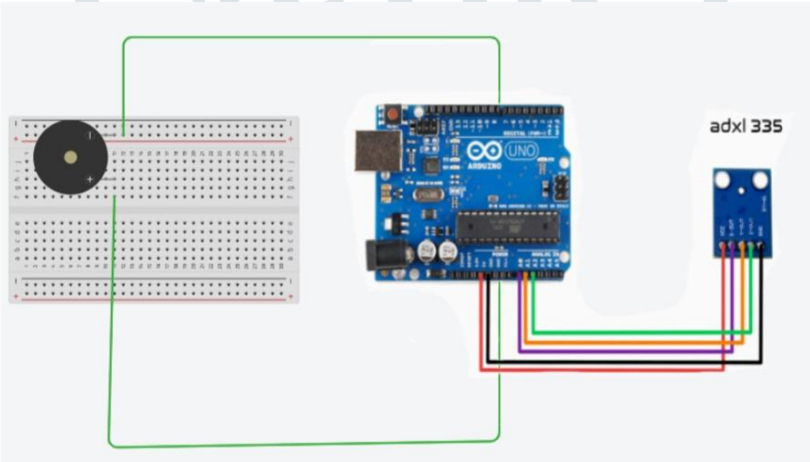
```
int motor =4;
 int bottom = 5;
 int top=6;
 int bottom_value;
 int top_value;
 int flag;
 int reads;
 void setup() {
   // put your setup code here, to run once:
   pinMode(motor,OUTPUT);
   pinMode(bottom,INPUT);
   pinMode(top,INPUT);
 }
 void loop() {
   // put your main code here, to run repeatedly:
   bottom_value=digitalRead(bottom);
   top_value=digitalRead(top);
   if(bottom_value==HIGH){
     flag=1;
      digitalWrite(motor,HIGH);
     while(flag==1){
       reads=digitalRead(top);
       if(reads!=HIGH){
         digitalWrite(motor,LOW);
```

```
          flag=0;
        }
      }
    }
    }
```

4.4 EARTHQUAKE DETECTOR

In this model we have taken an initiation to make a model on the basis of determining earthquake impact. For this we installed one Adxl335 accelerometer sensor to detect the motion of the earth and to analyze these motion waves we connected to Arduino uno board. Using processing IDE software to run and execute the code by using java script, whenever the sensor detects the motion of the earth through the arrangement of the system, data is collected. Arduino board reads these data and analyze through the code entered in the software and the results has been showed up in the form of seismograph.

4.4.1 CIRCUIT DIAGRAM



4.4.2 CODING

```
#include <Wire.h>
#define BUZZER_PIN 9 // Define the pin for the buzzer
int ADXL345 = 0x53;
int X_out, Y_out, Z_out;
void setup() {
  Serial.begin(9600);
  Wire.begin();
  // Configure ADXL345
  Wire.beginTransmission(ADXL345);
  Wire.write(0x2D); //talk to POWER_CTL Register - 0x2D
  Wire.write(8);    // Bit D3 High for measuring enable (8dec -> 0000 1000 binary)
  Wire.endTransmission();
  delay(10);
  // Configure buzzer pin
  pinMode(BUZZER_PIN, OUTPUT);
```

```
}
void loop() {
  Wire.beginTransmission(ADXL345);
  Wire.write(0x32);
  Wire.endTransmission(false);
  Wire.requestFrom(ADXL345, 6, true);
  X_out = (Wire.read() | Wire.read() << 8);
  Y_out = (Wire.read() | Wire.read() << 8);
  Z_out = (Wire.read() | Wire.read() << 8);
  // Print accelerometer readings
  Serial.print("X: ");
  Serial.print(X_out);
  Serial.print(" Y: ");
  Serial.print(Y_out);
  Serial.print(" Z: ");
  Serial.println(Z_out);
  // Check if any of the axes exceed a threshold (adjust threshold as needed)
  if (X_out > 5 || Y_out > 40 ||Y_out<20 || Z_out > 250) {
    // If the threshold is exceeded, activate the buzzer
    digitalWrite(BUZZER_PIN, HIGH);
    delay(100); // Buzz for a short duration
    digitalWrite(BUZZER_PIN, LOW);
  }
  delay(100);
}
```

V. Results

In this project, innovative technologies making our infrastructure smarter.

5.1 Automated Rotary Car Parking:

It uses a mechanized system to stack cars vertically, maximizing space in crowded urban areas.

Fig: 5.1.1. ARCP Side View

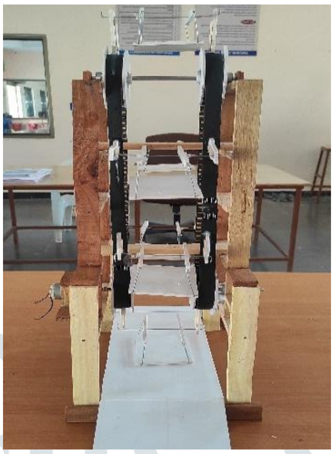


Fig: 5.1.2. ARCP Front View

5.2 Smart Bridge:

This employs sensor to optimize risk caused by floods and reduce the structural damages.

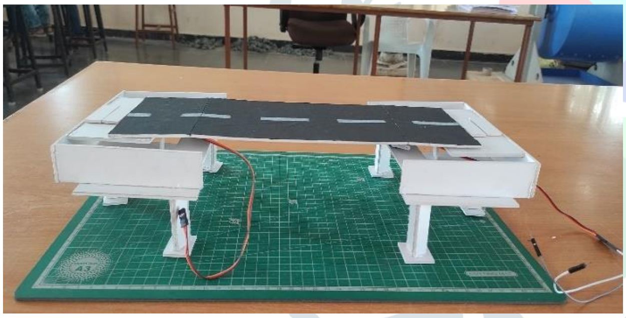


Fig: 5.2.1. Smart Bridge Front View

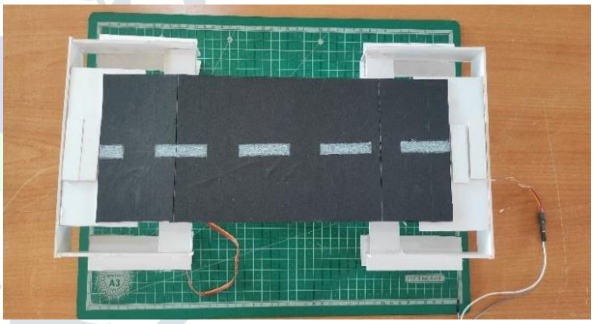


Fig: 5.2.2. Smart Bridge Top View

5.3 Water Level Controllers:

It equipped with sensors automatically regulate water flow in commercial and residential areas, preventing overflows or wastage.

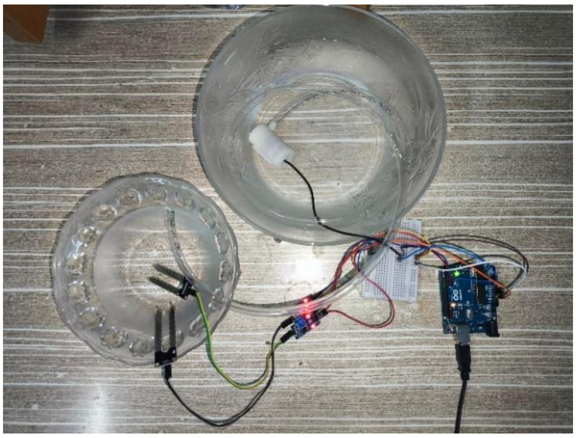


Fig: 5.3.1. Water Level Controller Top View

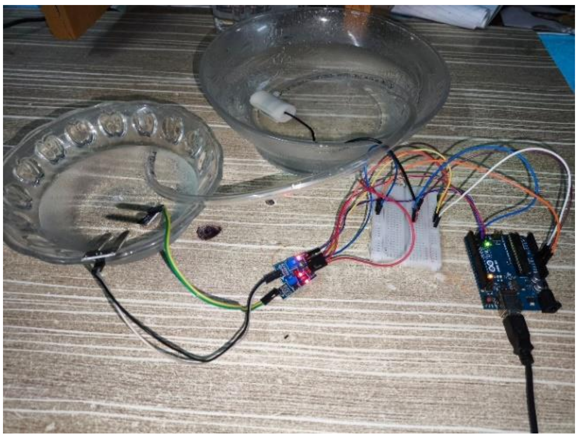


Fig: 5.2.2. Water Level Controller Front View

5.4 Earthquake detectors:

It is using sensitive instruments, can measure ground movement and issue timely warnings before a major tremor strikes, saving lives and property.

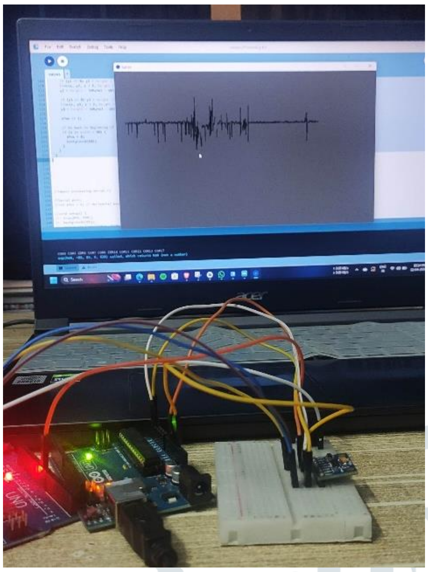


Fig: 5.4.1. Earthquake Detector Front View

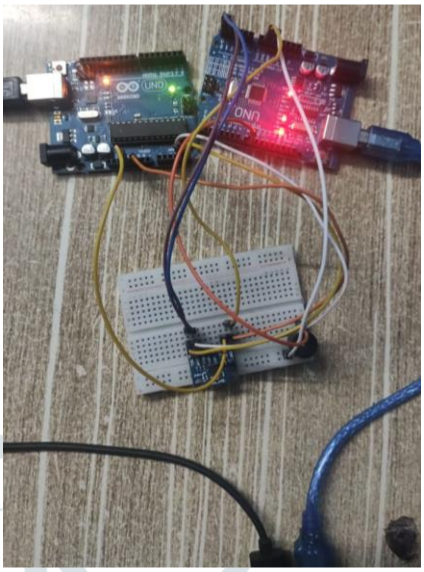


Fig: 5.4.2. Earthquake Detector Connections

VI. Conclusion

In this project Integrating these smart technologies can create a more robust and efficient infrastructure system in urban areas. Automated rotary car parking system can optimize space utilization in urban areas, while smart bridges can provide early warning of potential issues. Water level controller can ensure efficient water management and prevent wastage, while earthquake detector can provide crucial lead time for safety measures in earthquake prone regions. By working together, these smart components can contribute to safer, more sustainable, and well managed infrastructure.

VII. References

[1] A. Mathijssen and A. J. Pretorius, "Specification, Analysis and Verification of an Automated Parking Garage", vol. 40, **(2005)**.

[2] P. Joshi, M. R. Khan and L. Motiwalla, Global Review of Parking Management Systems and Strategies, **(2012)**.

[3] Darshan B., Shashank M.K., Srihari K., Srinidhi K., "Smart Bridge", Journal Paper, IRJET-**2020, 2000**.

[4] Andrew Gastineau, Tyler Johnson, Arturo Schultz, "Bridge Health Monitoring and Inspections" A Survey of Methods, Journal Paper, September **2009.**

[5] Ria Sood, Manjit Kaur, Hemant Lenka, "DESIGN AND DEVELOPMENT OF AUTOMATIC WATER FLOWMETER", Mohali, India.

[6] Sanam Pudasaini, Anuj Pathak, Sukirti Dhakal, Milan Paudel,"Automatic Water Level Controller with Short Messaging Service (SMS) Notification", Kathmandu University, Nepal

[7] Abdalzaher, M. S., Sami Soliman, M., El-Hady, S. M., Benslimane, A., & Elwekeil, M. (2022). A Deep Learning Model for Earthquake Parameters Observation in IoT System-Based Earthquake Early Warning. *IEEE Internet of Things Journal*, *9*(11).

[8] Adhikari, M., Paton, D., Johnston, D., Prasanna, R., & McColl, S. T. (2018). Modelling predictors of earthquake hazard preparedness in Nepal.