FIRE DETECTION AND NOTIFICATION APPLICATION

By

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ABSTRACT

This system is designing and developing to detect fire early through android based mobile application. This is an IOT based user friendly application. This application will be help to detect fire early and it will be more used to protect people and properties against a fire. Because although there are several kind systems in Sri Lanka, fire still occur today. This is a solution for that problem.

This system mainly can be divide into three categories. They are hardware, database and software. Hardware system will be used to take a real time temperature and the real time humidity because those are basic factors that has effected for the start a fire and spread a fire. Using Arduino, and sensor, take real time temperature and humidity then those real-time values sending to the database through Wi-Fi.

Second division (database) is the firebase and it is a real time database. This system provides lots of facilities to this system such as real time database, authentication. Mainly, it is used to store data and retrieve data through mobile application. The notifications will be send to the mobile application based on firebase real time data.

Third division (software) is a user friendly android based application and used to retrieve data for users. This system mainly gives two facilities such as retrieve temperature and humidity that are coming from firebase, gives probability of a start a fire and a spread a fire in a building based on user based questionnaires and their answers. Those questions will be create based on researching factors and their analysis based on criticality, that are effected for the start a fire and spread a fire.

After combining all the divisions, it provides great solutions to detect fire early and then can get actions against a fire occurring and spreading. It may be great support for all peoples to protect from a fire.

INDEX WORDS: - IOT, Arduino, Android application, Analyzing, Firebase database, Real-time, Authentication, User-friendly, Real time Temperature and Humidity, Notification, Probability,

DECLARATION

The work reported in this thesis was done by me in the Department of Statistics and Computer Science, University of Kelaniya, B.Sc. (Honors) Degree in computer studies. I hereby declare this thesis that I completed on my own work. It has not received any degree from this University or any other institution.

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DEDICATION

Providing very little knowledge to people for equipping with knowledge who seek knowledge.

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LHDC	Linear Heat Detection Cable
SIL	Safety Integrity Level
IEC	Electro-technical Commission
LHD	Linear Heat Detection
RTD	Resistance Temperature Detectors
DCP	Dry Chemical powder.
MCU	Microcontroller Unit
ARC	Alarm Receiving Centre
WiLD	Wi-Fi over Long Distance
IOT	Internet of things.
UI	User interface

CHAPTER 01

INTRODUCTION

1.1.Overview

Fire is the rapid oxidation of a material in the exothermic chemical process of combustion and it release heat, light, and various reaction products. The combustion of an inflammatory or combustible substance with an adequate amount of oxidation, such as oxygen gas or other oxygen-rich compound, begins when the fire is exposed to a heat source or ambient temperature. There is a fire ignition triangle. It includes three components. They are fuel, oxygen and heat. These three elements cause to starting a fire. But all three elements must be properly assembled to cause a fire. Removing at least one third of the element can prevent or minimize the onset and spread of fire. If we can control those three elements, this will help to prevent from a fire. But it is too difficult because these three elements expand to a wide range.

When to Fight a Fire before you begin to fight a fire:

- Make sure everyone has left, or is leaving, the building.
- Make sure the fire department has been called.
- Make sure the fire is confined to a small area and is not spreading.
- Be sure you have an unobstructed escaped route to which the fire will not spread.
- Be sure you have read the instructions and that you know how to use the extinguisher. (service., 2016).

The fire can be happen by a people, equipment and naturally.

Table 1: Main key to a fire

People	**Equipment**	**Naturally**
Careless behaviour	No proper maintain	Wildfire
No proper practice	Use improper equipment	Flood

Unawareness of fire	Use of equipment carelessly	Thundering
Confusion among people	Unaware of the use of equipment	Tsunami

The fuel, weather and topography that cause a fire.

Table 2: Main factors that are lead to a fire.

Fuel	**Weather**	
Wood, paper, cloths…	Temperature	
Flammable liquids	Wind (Direction & Intensity)	**Topography**
Flammable gasses	Stability of atmosphere	
Electrical equipment	Relative humidity	
Cooking oils and fats	Precipitation	

It is possible to classify the above mentioned fire into four classes.

Class A: Organic solid combustible materials such as Wood, Paper, Rubber, Plastics and etc.

Class B: Flammable liquids

Class C: Flammable gases under pressure consisting with liquefied gases.

Class D: Combustible metals such as Magnesium, Sodium, Potassium and etc.

Most people are spending a busy life. They do not care with the natural changes of the environment such as fire.But they awareness of technical equipment and their usage such as mobile phones. If we can discover things based on their habits and practices, it is best to make discoveries for the benefit of people.Nowadays the world is becoming smart and People are getting to work with technology. In here if we can detect a fire early by a mobile application or any other technical equipment. It gave lots of benefits related to this topic such as saved lots of people and properties from a fire. My attempt here is to give them an early solution to avoid a fire.

1.2.Aim of the Project

- The aim of this research project is that build an application to identify vulnerabilities of the building by checking current location using mobile application questionnaires.
- To aware high temperature and humidity in the current location by sending notification to the user.
- To avoid or minimize probability of a fire occurring.

There are several kind of objectives. The main objective is saved lots of people and properties from a fire. The other objectives are to detecting a fire early and then gain the desired outcomes in the event of a fire such as life safety, property protection, continuity of operations and limiting fire impact on the environment.

There is also a sub-set of sub-objectives. They are:

- To provide better safety for people.
- To provide better safety for properties.
- To develop a cost effective app with suitable design, equipment, installation, maintenance and etc.
- To increase the efficiency of the fire detecting.
- To develop a Smartphone based application for the Android platform mobile in order to come up with a solution for the above mentioned problem.
- To provide user friendly environment by adopting technology.
- To improve my knowledge and skills in the research area.
- To minimize the manual work.
- To compete with the market with confidence.

1.3.Benefits of the project

There are several kind of benefits. But the main benefit is that provide better protection for people and the properties from a fire.

- Can be save many person who were in the emergency situation.
- Improve the efficiency of the saving persons.

- Improve the efficiency of the saving properties.
- Lead time can be reduced to save the people and properties.
- The proposed app is very user friendly.
- It is reduced the destroying properties.

1.4.Project System Overview in Brief

This project system mainly is divided in to three sub parts. They are software, hardware and database. In here I provide a user friendly application to the user. This application mainly include two facilities.

01. First facility.

It includes more factors that has effect to the start a fire, spread a fire, stop start a fire, and stop spread a fire. Those factors are included into in order of the criticality. Then user can check current vulnerabilities for start a fire and spread a fire in the building or their company using this application. And also user can check current solution for stop start a fire and stop spread a fire in their building premises. Then user can get early actions for the vulnerabilities and the lack of solutions.

02. Second facility.

It includes real time temperature and real time humidity of the current location. If the current temperature and current humidity is greater than or equal to the founded Sri Lanka maximum average temperature and humidity. The system sends notification to the user by awareness rising about current situation. Then user can check the vulnerabilities by using the first facility of this application.

The categorized factors of this system.

- <u>Software part</u>

Mainly it consists of several pages such as login page, register page, dashboard, check safety page, temperature and humidity risk page, help page and no of Users page. Every page has its own function to accomplish target related to this topic. More information related to this software is given under the methodology.

- <u>Hardware part</u>

Mainly hardware parts are used to get real time temperature and humidity in to the application through a database. More information related to this hardware is given under the methodology.

- Database

In here, Fire base is used as a real time database. It is a cloud database and it is more preferred for this task. More information related to this database is given under the methodology.

1.5.Dissertation Outline

This dissertation is divided into five chapters.

Chapter 1: The first chapter gives an introduction to the dissertation where the project system overview is briefly discussed and the aim of the project and the benefits of the project; it also gives a short description of the dissertation.

Chapter 2: In second chapter gives a Literature Review. It has been done about fire alarm systems, fire extinguishers. This is a theoretical part of the dissertation.

Chapter 3: The third chapter is discussed the methodology of the research project. The parts of the Hardware Show this research project in more detail.

Chapter 4: The fourth chapter is discussed that the results of the research project

Chapter 5: The fifth chapter is discussed that the conclusions and the recommendations of the research project

CHAPTER 02

LITERATURE REVIEW

Fire can be happen by several ways and there are several type of fires. Chapter one was described about several kind of fires and their behaviours. This chapter is described about the existing fire detectors and fire prevention equipment. There are several kind of fire detectors and fire prevention equipment. All of those fire detectors and fire prevention equipment are manufactured by concerning the type of fires and behaviours of the fires. If the fire can be controlled at the time of a fire or when a fire is started, then the physical impact from a fire can be minimized. In this section is described about equipment that can be detected at the time of a fire, and equipment that can control the spread of fire.

2.1. Detectors that can be detected in the immediate event of a fire.

In here, this systems are help to prevent causing a fire. Nowadays there are several kind of fire detectors. Under each specific detector, different detectors are classified based on their behaviour such as efficiency, accuracy, size, price, etc. All detectors are installed according to the manufacturer's directions and the pertinent fire protection standards and close to the hazard where the fire is expected. Fire detection equipment is designed to respond during the early stages of a fire. But single type of detectors are not suitable for all environments. Therefore we have to careful about our options and then install the technology most appropriate for the application. It is a very important and understandable point.

Example: Although traditional point detectors are perfect solution for offices and class rooms they can be fail to cope in more demanding environments such as warehouses and factories. (group, n.d.)

2.1.1. Type of detectors

Fire detectors are used in residential, commercial and industrial use. There are several kind of detectors such as smoke, flame, heat and gas, etc.

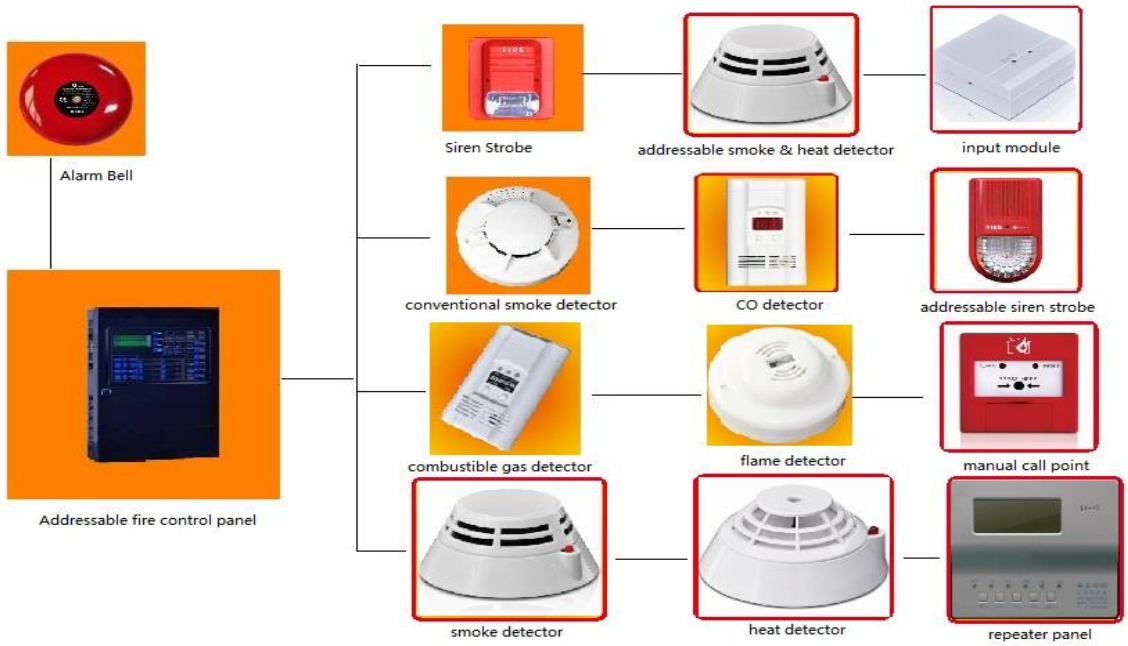


Figure 1: Type of detectors

2.1.1.1. Flame detectors (Radiation detectors).

Flame detectors are intended to protect areas where expected fire is growing rapidly with Smoldering stages. For example flammable liquids and combustible gas fires, explosions and flash fires. Flame detector is a sensor that is used to detect and respond to flames or fires. After detecting a flame, their responses depend on their installation. It may be include sounding alarm system, deactivating a fuel line such as natural gas line and propane, activating a fire suppression system, etc. Normally the flame detector can be respond faster and more accurately than a smoke and a heat detector since their mechanism which it is used to detect the flame (wikipedia, n.d.). Flame detectors has fast response for open fires. This detectors are used to prevent catastrophic fires. There are more flame detectors based on Infra-Red (IR) and Ultra-Violet (UV) and it can identify a flame very fast. Flame detectors execute in the worst environmental conditions. Those are automated devices designed to connection and control for alarm systems or automatic fire extinguishers. (spectress-US, n.d.). The spectrum of light is vast. Human bodies also generate some black body radiation, therefore flame detectors are designed to only respond to objects further along the spectrum.

High quality flame detectors are designed to monitor flicker patterns to avoid false alarms that made by sunlight or man-made flames from welding torches etc. When we are selecting a flame detector, we should also concern about the importance of the detection of hydrocarbons due to some detectors cannot detect fuels such as hydrogen and fluorine, through glass. (Hochiki, 2019).

This detectors are more suitable for supplementing heat and smoke detectors or as a general surveillance of a large switchyard area such as refineries, waste recycling facilities, biomass storage facilities, engine rooms, fuel stations and etc. (Hochiki, 2019).

- Infrared(IR) Flame detectors

The flame detectors of Infrared (IR) sense light at the extreme, high end and spectrum. The detector of flicker flame is an infrared detector. It is capable of sensing a flame's typical flicker. If the initial flames are directly hidden from the unit with the flicker flame unit, the flicking light or radiation that is reflected, such as off a ceiling or wall, is sufficient to initiate an alarm. (CONTROL, 2013).

- Ultraviolet(UV) light detectors

The sensing function of the Ultraviolet (UV) flame detector is typically either a solid-state device such as silicon carbide or aluminum nitride, or a gas-filled tube in which ultraviolet radiation ionizes the air. This causes the materials to become conductive, resulting in the initiating of an alarm. It allows the materials to be conductive, resulting in the initiating of an alarm. (CONTROL, 2013).

- Combination flame detectors

Combination flame detectors have designed to see parts of both light spectrums. Then resulting composite signal is used to initiate an alarm. Generally, these detectors require both UV and IR light sources that fit a particular frequency to trigger an alarm. This process gives results with fewer false alarms due to the finite combinations of frequencies accepted. (CONTROL, 2013).

- Spark detectors

Although not a true flame detectors, spark detectors identify radiant energy generated in closed environments, by sparks and embers such as air ducts. Sparks generate both IR and visual light, and as such, these detectors detect those light spectrums and, activate a signal based on concentrations of these two sources, through processing circuits. (CONTROL, 2013).

2.1.1.2. Heat detectors.

Heat detectors are an alternative to smoke detectors; for example, in an environment where you might find smoke, such as a theatre using smoke machines, a smoke detector would not be ideal.

This is a special safety device. Normally it is used in inside of a building. It is not responded to the smoke. Heat sensors trigger an alarm by either melting a low fusing alloy or bending a bimetallic strip. Based on their manufacturing, it can be electronic or mechanical. An electrical heat detectors consist with thermistors and they respond with changes resistance as the temperature increases. And also it contains LED indicators for proper thermal performance. (group, n.d.).

Heat detectors detect the presence of heat and increases of the temperature. It is also attached with alarm. These detectors have few false alarms and it also get longer time to identify a fire than smoke detectors. But those detectors are more suitable where smoke detectors may cause false alarms such as steamy, humid, dusty environments. This type of detectors use in infrequently occupied areas like storage facilities, warehouses and machine rooms. (experts, n.d.).There are two types of heat detectors.

- Rate of Rise detectors

A rate of rise detector not only consider the temperature, but also measures the speed at which it rises. The sensor will ignore slow temperature fluctuations. But it will respond to a rapid rise in temperature such as temperature increments of a fire. (Hochiki, 2019). This heat detectors respond to the rapid increase of temperature. This kind of heat detectors are called as Rate-of-Rise sensors (ROR). It is activated when the temperature increases by 12 ° F - 15

° F per minute. So it is not suitable in areas with a natural rapid increase in temperature. (group, n.d.)

- Fixed temperature

Fixed temperature heat detectors are designed to response to an alarm when the temperature exceeds a predetermined value. (Hochiki, 2019) Fixed-temperature heat sensors alert to the dangerous situation when the temperature rises above 135 degrees. This detectors are less reliable than ROR detectors. The detector may alert when the actual temperature is much higher than the pre-set threshold. Heat detectors are mostly installed in areas where smoke alarms cannot be installed such as kitchens, garages have fumes and attics might have an excessive number of particles of dust or moisture, etc. Because if something burns slowly and produce carbon monoxide, then they do not work. If we installed smoke detectors that type of areas, then there is a chance to receive false fire alarms and also it is unpractical from the standpoint of maintenance. The important point is that heat detectors are not enough for suffice to protect people's lives. For this purpose, smoke detectors are more suitable. Heat detectors are designed to protect properties rather than life (group, n.d.). It is used to identify potential fires that can generate large heat.

The response time of heat detectors depend on the amount of heat transferred from the fire to the detector. Therefore we should be consider about the positioning of detectors. The following should be considered.

- The height and depth of the ceiling that the detector projects below the ceiling.
- Ventilation patterns in the building.
- The disturbance of the heat flow to the detectors since the properties.
- Heat detectors are more preferred where a fire could be smoky or oxygen-limited. It consists with low false alerts rate but normally can be slow to respond and respond time can be longer. (Ian Sutton, 2015)
    - Linear Heat detector.

LHD is a line-type form of fixed temperature heat detection. In abundance, it is used in commercial and industrial environments. This linear cable can detect a fire along its entire length. It is available in multiple temperatures. (safefireDetectionStaff, 2018).

- Combination Rate-of-Rise/Fixed temperature detectors.

Combination detectors are made from combination of both Rate-of-Rise and Fixed temperature detectors. Both are included into a one unit. Rate-of-Rise detectors are not activated to the slow temperature fluctuations. Therefore excessive temperatures can be allow it to grow slowly without warning. For that situation, this detectors are most available. (CONTROL, 2013).

2.1.1.3. Smoke detector.

Smoke particles contains with carbon and other pollutants in the air. These particles are visually recognizable to the photoelectric smoke sensor.

In here, smoke detector is used for protect lives than objects from a fire. When it comes to personnel safety, it is most important to identify fire hazards in its early stages due to lack of toxic gases, lack of oxygen and escape routes. When these factors occur, smoke detection must be considered.

Smoke detectors mainly divided into three categories. They are Ionization Smoke detector, Photoelectric Smoke, Ionization/Photoelectric Smoke detector. All smoke detectors has an alarm with proper sound. Smoke detectors are classified based on way that they detect smoke. (experts, n.d.). Smoke detectors can sense small particles of air or smoke as the result of a fire. Smoke detectors response time is shorter than heat detectors response time. But the false fire alerts are more than heat detectors. Because of this and since prediction of the fire type may not be possible both types of smoke detector are often found in a single installation together with heat detectors. (Ian Sutton, 2015).

The mechanism of the smoke detectors:

When smoke enters to the chamber then current flowing through an ionization chamber is decreased. The electronic warning circuit detects this change and starts the alarm. Smoke detectors can identify generation of visible and invisible products of combustion before activate heat detectors because in that stage temperature changes are no sufficient to activate heat detectors. The ability of a smoke detector to response to a fire is depend on some factors.

They are rise, spread, and rate of burn, coagulation and air movement of the smoke itself. (Ian Sutton, 2015).

- Ionization smoke detector.

Ionization detectors belong to smoke detector. It has a constant electrical current that occurs between two metal plates in the device. These detectors excellent to identify fires that burn fast. The mechanism of this detector is when smoke enters to the chamber then it disrupts the electrical current and result of that cause the alarm to sound. (experts, n.d.). The ionization smoke detectors more suitable for fast burning fires where small smoke particles are formed. (Ian Sutton, 2015).

Most of ionization smoke detectors belong to dual chamber type. One chamber is a reference chamber and the other chamber is a sample chamber. This detectors are effective for Class A fires (Ordinary combustibles) and Class C fires (electrical). (Ian Sutton, 2015).

- Photoelectric Smoke detector**.**

Photoelectric smoke detector belongs to smoke detector. They are in either spot type or light-scattering type. In general, photoelectric smoke detectors are more sensitive to smoke emitted from smoldering fires than smoke emitted from burning fires. Therefore, some installers install ionization smoke detectors in high risk area of fire (group, n.d.).They are more reliable and it produces few false alarms. It has a beam of light in the device. When smoke scatters the light then it causes the alarm to go off. This is the mechanism of this detectors. It should be installed in area where the maximum mounting heights are typically 10.5–15 m. (Ian Sutton, 2015).

- Ionization/Photoelectric Smoke detector.

Ionization/Photoelectric smoke detectors belong to smoke detector. This a combination of Ionization and photoelectric detector. This is more preferred than other smoke detectors. It is the best way to protect people and facilities from a fire. When there are two types of smoke detection on one device then it helps to ensure that no matter the type of fire. It also detect fire as soon as possible than other ones. Although a variety of heat and smoke detectors are installed throughout a facility then an expert provides best solution that our facility's needs. (experts, n.d.).

- Air Sampling detectors

Air sampling detectors attract a small amount of air from a target area into a detection device. Normally, these detectors use a light scattering detection method to analyze the found particles in the sampled air. These detectors can be calibrated based on the area protected for high degree of sensitivity. (CONTROL, 2013)

- Beam smoke detector. (Beam detectors).

Beam smoke detectors works on the same principle as the photoelectric detectors. There are two types of optical beam detectors. This is the difference between beam detectors and photoelectric detectors. (CONTROL, 2013)

01. Transmitter with a separate receiver.
02. Reflective beam detector.

But both detectors work on the same principle. It is called as obscuration.

Obscuration:

When sufficient smoke blocks the infrared light beam, it reduces the signal strength of the light beam. Then the obscuration threshold is achieved a fire condition is generated.

There is often very little unnecessary obscuration at height. But well-designed beam detectors use a sophisticated algorithm such as the SPCET and the FIRE beam that distinguishes between unwanted obscuration, such as a bird breaking the beam, and a genuine fire.

Optical beam detectors are most suitable for large open spaces such as Shopping Centers, Sports Halls, Museums, Cathedrals, Warehouses, Atriums and etc. It can be installed at a height of up to 40 meters. (Hochiki, 2019).

2.1.1.4. Multi-sensors Fire detector.

Multi-Sensors are used to determine a fire condition and it consists both optical technology and heat sensing technology. It provides an earlier response to a fire and it is still maintaining low-false alarm characteristics. Multi-sensor is an essential device that is operating as a photoelectric smoke sensor but the photoelectric sensitivity is enhanced when a temperature

rise above 40 degrees centigrade. It is detected by the heat sensing element. This detectors are more preferred for this kind of areas such as Hotels, Hospitals, Schools & Universities, Offices, Rail/ Tube Stations, Airports, Spa Facilities, Cinemas, Retail Units, Museums, Show Rooms and etc. (Hochiki, 2019).

2.1.1.5. Aspirating detectors.

Where high sensitivity is desired and a large volume is to be required, then an aspirating system can be a viable option. Air sampling systems contains with lengths of pipes. Sampling holes are strategically placed along its length. Then an air impeller is used to draw air along the pipes from the sampling holes and through the detector measuring chamber. Most of high sensitivity aspirating detectors use the obscuration method. When a pre-defined density of smoke fills the chamber, then system will warn using an alarm. It is most suitable for Clean Rooms, Computer Rooms, Prisons, Animal Enclosures, Large Storage Facilities or Cold Storage and etc. (Hochiki, 2019).

2.1.1.6. Gas detectors.

Gas detectors are used to detect fire-generated gases. The presence of certain gases, or aerosols, causes a decrease in the sensor's surface resistance, resulting in an increased current flow used to activate an alarm. The system can detect only fires burning with complete combustion and creating very few or no gasses. (CONTROL, 2013).

2.1.1.7. Ionization current flame detectors.

This detectors are used to verify the flame presence and their quality. This type of detectors are used in large industrial process and gas heaters for measuring hydrocarbon gas concentration. Those are connected to the flame control system. They are also used in household gas furnaces and boilers. (wikipedia, n.d.). This is a standard equipment. But it has poor response for compounds such as H2S, CCL4 and NH3.This detector is a mass sensitive equipment. But it is not a concentration sensitive one. It is most suitable to detect hydrocarbon analysis with varying detection ranges. (S.K. Chaulya, 2016). It has only one disadvantages that it destroys the sample. (Group, 2019).

2.1.1.8. Thermocouple flame detectors.

This is an electrical device and it produces voltage based on temperature as a result of a thermoelectric effect. Thermocouples are used as a type of temperature sensor. It consists with two electrical conductors forming electrical junction. Commercial thermocouple are inexpensive and can measure a wide range temperature. (wikipedia, n.d.)

Thermocouple are used to monitoring flame presence in combustion heating systems and gas cookers .It is widely used for temperature measurements in science and other industrial processes. The common facility of this detectors are to cut off the supply of fuel if the flame fails. This detectors measure the heat and therefore it is used to decide the absence of a flame and also it is used to verify the presence of a pilot flame. (wikipedia, n.d.).

2.1.1.9. Wireless detectors.

A fully wireless system uses radio technology instead of cabling. It makes it as a flexible and versatile solution. Wireless devices are selected for use in buildings where the aesthetics cannot be compromised or when a historic building has been legally protected (listed). Less cabling can also reduce installation times. Therefore, wireless systems can be more preferred solution if the project has a tight time scale.

In some cases, it may be necessary to create a hybrid wireless solution where wireless devices are connected with a wired system via a module. For example, wireless detectors can be installed in a remote school building or a doctor's office. Then it may be interconnected with the existing wire system in the main building.

This is more suitable in Castles, Cathedrals, Museums, Remote Buildings, Banks, Prisons, Hotels, and Offices, etc. (Hochiki, 2019).

Figure 2: Wireless detectors

2.1.1.10. Linear Heat Detection Cable

LHDC is designed to provide early detection of fire and overheating in circumstances where other forms of detection would not be feasible, either due to inability to sustain the environment requirements or through prohibitive costs.

There are two types of LHDC. They are analogue and digital. LHDC is designed to trigger alarms for hot spots occurring on very small sections of the overall distance in an environment such as a tunnel, where the distance could be vast. Extensive single zonal lengths of the digital cable would be suitable for this. It allow you to pinpoint the location of the heat source.

It is more suitable for Tunnels, Car Parks, Recycling Plants, Food Processing Facilities, Conveyor Systems and etc. (Hochiki, 2019).

2.1.1.11. Marine Approved Devices

Marine approved devices are independently assessed by third parties such as a German Mr. Lloyd and LPCB to the MED approval scheme. Devices are tested to ensure that they can withstand the requested marine environments. Companies have comprehensive ranges of both addressable and conventional fire detection equipment to ensure the rapid and reliable detection of a genuine fire at the earliest stage.

This devices are more suitable for Container Ships, Yachts, Submarines, Off-Shore Installations, Oil and Gas Platforms, Wind Farms etc. (Hochiki, 2019).

2.1.1.12. Carbon monoxide detectors.

There are several kind of carbon monoxide sources. We are most vulnerable to carbon where there is faulty fuel burning equipment such as Fireplaces, heaters (kerosene, Gas or oil water), furnaces, vehicles, engines, generators, leaking chimneys or vents, gas dryers, gas or wood stoves, Charcoal grills, Lawn mowers, leaf blowers, snowmobiles. And also it can be near

petrol or diesel driven generator or other engine driven appliance, gas heater or other unflawed appliance, poorly maintained, damaged, blocked or sealed flues, concrete cutting saws, power floats, floor grinders, small mobile plant, diesel forklift trucks, compressors and generators in poorly ventilated areas or confined spaces, cab of vehicles with defective exhaust systems. (healthAndSfetyAuthority, 2001).

There are several kind of carbon monoxide detectors.

- Biomimetic sensor

The gel changes color when carbon monoxide is absorbed.Then the warning is caused by th is color change. (healthAndSfetyAuthority, 2001).

- Metal oxide semiconductor

This decreases the electrical resistance when the circuitry of the silica chip detects carbon monoxide Then this change activates the alarm. (healthAndSfetyAuthority, 2001).

- Electrochemical sensor

Electrodes submerged in a chemical solution detects changes in electrical currents when they come into contact with carbon monoxide. Then this change activates the alarm.

When the alarm sounds once, the carbon monoxide detector must be in a carbon monoxide-free environment in order to reset itself. (healthAndSfetyAuthority, 2001).

2.1.1.13. Temperature detectors.

Temperature sensors are important for a number of everyday products. For example, in order to function properly, household ovens, refrigerators and thermostats rely on temperature management and control. There are also applications in chemical engineering for temperature control. Temperature detectors are used to maintaining an optimal set-point temperature of a chemical reactor, controlling the temperature of a potential runaway reaction to ensure employee safety, and regulating the temperature of streams released into the environment to reduce adverse environmental impact. Although temperature is generally sensed by humans as "hot," "neutral," or "cold," specific, the quantified chemical engineering is needed.

Temperature sensors are device that are used to measure the temperature. There are two types of temperature sensors. (idconline, 2009).

- Contact Sensors.

Contact temperature sensors calculate the temperature of the object. The sensor is in contact with by assuming or realizing that the two (sensor and object) that are in thermal equilibrium. In other words, there is no heat flow between them. (idconline, 2009).

There are several kind of contact sensors.

- Thermocouples.

Thermometers are the most common sensors of temperature. In basically, it is used for regular temperature measurements. The Filled System and Bimetal thermometers are tw o examples of thermometers. (idconline, 2009).

- Resistance Temperature Detectors (RTDs).

The resistance temperature detector is another widely used temperature sensor. It is also called as also resistance thermometer. The RTD offers an electronic means of temperature measurement unlike filled tube thermometers, making it more convenient for use with a computer system. The RTD uses the relationship between electrical and temperature resistance. It can be either linear or nonlinear. Traditionally, RTDs are used for high precision and accuracy. But, due to the degradation of the outer sheath, which consists the thermometer. They become very unreliable at high temperatures (above 700 ° C). RTD use is also favored at lower temperature ranges, where the temperature is lower. There are two types of RTD.

They are known as traditional RTD and the thermistor. (idconline, 2009).

- Full System Thermometers.

The common liquid thermometer consists with liquid that is stored in a tube. The volume of the fluid varies as a function of temperature. Increased molecular motion with rising temperature allows the fluid to expand and travel along on the side of the tube along measured markings. The fluid should have a relatively large coefficient of thermal expansion.

Therefore small temperature changes can lead to detectable volume changes. Glass is a common tube material, and also alcohol is a common fluid. Until its toxicity was known, mercury used to be a more natural gas. While the thermometer filled device is the simplest and cheapest way to measure temperature, its precision is limited by the calibration marks along the tube length. (idconline, 2009).

- ❖ Bimetallic Thermometers.

Two metals (usually steel and copper) with different thermal expansion coefficients are fixed with rivets or by welding in the bimetal thermometer. When the strip temperature rises, the metal with the higher coefficients of thermal expansion expands to a higher degree. It is caused to stress in the materials and deflection in the strip. The amount of this deflection is a temperature measure. The temperature ranges to use these thermometers are limited by the range over which the metals have significantly different coefficients of thermal expansion. Bimetal strips are commonly woven into coils and placed in thermostats. (idconline, 2009).

- ➢ Noncontact Sensors.

Many commercial and scientific non-contact temperature sensors measure the thermal radiant power of the infrared or optical radiation that are obtained on its surface or volume from a known or measured region.

For example of non-contact temperature sensors is a pyrometer at the bottom of this section. (idconline, 2009).

2.1.2. System type and Zoning

2.1.2.1. SIL Approved System.

This SIL approved systems are used to quantify and qualify the requirements for safety instrumented systems. All fire detection products have been assessed independently and approved by the International Electro-technical Commission (IEC). Then products will be awarded a SIL approval level such as SIL1, SIL2, SIL 3 and SIL4.

For example, if we consider, SIL products of a specific company have been awarded SIL2, which means that they are approved for use in a SIL2 low demand safety function.

But the important point is that SIL approved products are not completely identical with Intrinsically Safe Products. SIL approved products can be used in high risk industries. Intrinsically Safe products can be used in classified hazardous areas.

This systems are more suitable for High risk areas that have specified SIL approved products.

2.1.2.2. Conventional Systems (Non-Addressable)

This system is also known as non-addressable system. Fire detectors are wired to the panel in groups and it is known as zone. In here it is identified of alarm status by zone. Fire detectors indicate either “Fire” or “Regular” status only. System shows only events but without event recording feature. (Mr. David Goh, 2005).

2.1.2.3. Addressable systems

In here, all fire detectors are supplied with an address. It is identified by zone and address of alarm status. Fire detectors show various kind of conditions such as the level of smoke and also it indicates records system events. (Mr. David Goh, 2005).

2.1.2.4. Hybrid systems

This system is a combination of features of both addressable and non-addressable systems.

It is either designed with addition of a basic conventional framework. It is also designed addressable hardwire features or from an addressable system with conventional. It is included an event recording and alarm management feature (Mr. David Goh, 2005).

2.1.2.5. Fire detection zones.

Buildings are divided into detection zones to give a clear indication of fire location respectively. Zones consisting only call points are usually limited to a maximum 2000m2 of floor area. If there is a conventional fire alarm system for example, fitted with non-

addressable detectors, then the single zone floor area should not exceed 2000m2 and also the search distance should be less than 60m. (Reform, 2005).

2.1.3. RED & BLUE light scattering ASD technology

In here, it distinguishes between dirt typical large particles and the small smoke particles typical in initial fires better than red infrared based technology alone. (iitb.ac, 2012).

2.1.4. Smart Fire Alarm System Based of Wi-Fi over Long Distance (WiLD)

This research is designed for the users to sense the occurrence of fire using fire detecting systems at various kind of locations such as factories, houses and etc. The fire detectors show the position of fire and generate warning in the fire location and WiLD based firefighting center. The signal transmitted from fire position to the firefighting center, where a fire sensor connected to the microcontroller was interfaced to the local server would continuously transmit the location status to the central fire station in the firefighting center (Radhi, 2016).

2.2. Equipment that prevents the spread of fire at the start of a fire.

In here, this system help to protect objects from a fire and avoid spreading a fire. Fire spreads is a great important thing when we are considering the safety of the assets. Nowadays there are several kind of methods of preventing the spread of fire. Under each methods, there are several kind of sub methods. All systems and methods are classified based on their behaviour such as efficiency, accuracy, size, price, etc. All systems are installed according to the manufacturer's directions and the pertinent fire protection standards and close to the hazard where the fire is expected. Fire equipment is designed to respond during the early stages of a fire. Therefore we have to careful about our options and then install the technology most appropriate for the application. It is a very important and understandable point.

2.2.1. Fire Hydrant System.

Figure 3: Dry barrel

Figure 4: Wet barrel

Fire hydrant pump systems also called as fire pumps, hydrant boosters, firewater pumps. They are high pressure water pumps that are designed to increase the firefighting capability of a building by enhancing the pressure in the hydrant service when mains is not sufficient, or when tank is filled. They can be used in applications of water transfer and irrigation. (S.Kalidasan, 2018).

Fire hydrant system is a large fires extinguish system that is an effective and efficient way. Hydrant system allows the firefighting to attack the fire seat from a distance. Hydrant valves are outlets for delivering water with huge pressure to prevent the fire. The water can also be used under pressure as a “sheet” to push the smoke for entering a burning building. It is a discreet use of special branch pipe. There are lots of components of fire hydrant system such as Pumps(Jockey pump Electrical pump Diesel Pump), Heavy or Medium Grade MS or GI PIPES, Hydrant Valves, Hose boxes, Hoses, Nozzles and Branch pipes, Fire brigade inlet, Isolation valves, Air release valves and etc.

There are several other types of Fire Hydrant System such as Double Hydrant System, Butterfly Valve, Non-Return Valve, Submersible Pump, Mono Block Pump, Jockey Pump, Booster Pump, Hose Reel Drum, Single Door Hose Box, Double Door Hose Box, Canvas Hose Pipe, Rubber Hose Pipe, Branch Pipe, Single Hydrant Valve and etc. (S.Kalidasan, 2018).

Mainly there are two types of fire hydrant systems.

- dry barrel hydrants

After the source of water is closed, dry barrel hydrants are drained. This kind of fire hydrants systems are used most of the time. There are three types of wet barrel hydrant systems such as slide-gate, toggle, and compression.

A vertical stem acts like a piston in a **compression hydrant**. It moves towards or away from a seat to close and open the main valve.

Slide Gate Fire Hydrants are designed to prevent contact of seat surfaces during opening and closing and it reduce wear of the seating surfaces.

A vertical stem with two toggle arms rotates to open the main valve at the base of the hydrant in **Toggle** type of dry barrels.

- Wet barrel hydrants.

This is only used in those places where temperature doesn't fall below 32 degrees. This kind of fire hydrant systems are always filled with water.

2.2.2. Extinguishers.

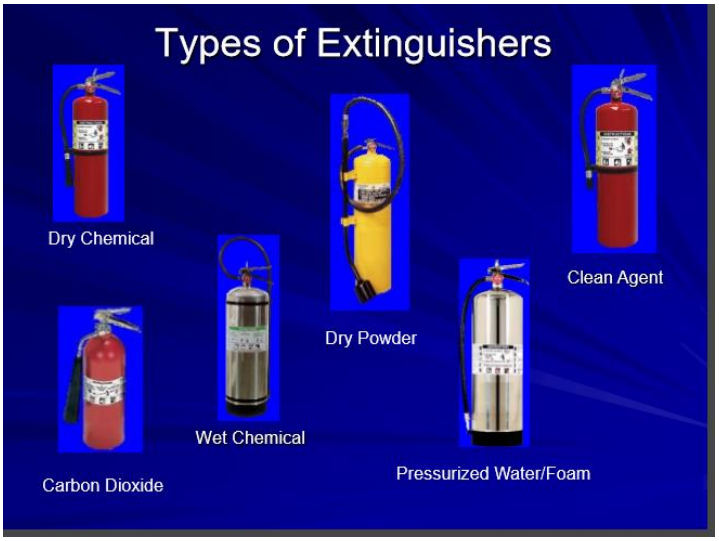


Figure 5: Types of extinguishers

Fire can extinguished removing heat by adding water to cool the fire. And also Fire can extinguished by cutting off supply of oxygen by applying foam and carbon dioxide to smother. It can be extinguished by starving the fire by eliminating the fuel by stopping gas flow during a pipeline fire and inhibition by stopping the chain reaction by applying dry chemical powder. (iitb.ac, 2012).

When we use fire extinguishers, we should careful about these things.

- The extinguisher is ideal for fire related materials.
- You have checked whether or not electricity is involved and, if so, that the available extinguishing agent is non-conductive.
- You may extinguish the fire quickly.
- You do not jeopardize your health by staying close to the fire.
- All other persons have been evacuated from the region. (service., 2016).

Other important thing is that all Extinguishers have limits.

- The extinguisher must be easily accessible in working order and it should be in fully charged.
- The extinguisher should be kept close the exit and the user has an escape route that is not blocked by fire.
- The extinguisher must match the type of fire that you combat. Water extinguishers are unsuitable for use on oil or electrical fires.
- The extinguishers must be sufficient to reveal the fire. Most portable extinguishers discharge absolutely.

The user must be able to operate extinguishers because during an emergency there is no time to read instructions. (service., 2016).

In here, there are several kind of fire fighting media and the classes of fire for which they can be used. (S.Kalidasan, 2018).

Table 3: Fire fighting media

Classes of fire	**Types of fires**	**Suitable media**
A	Wood, Paper. Cloth, Trash and Other ordinary materials.	Water
B	Gasoline, Oil, Paint and other flammable liquids (Petrol, Diesel, Paraffin).	Foam
C	Flammable gases (Methane, Propane, Hydrogen, Natural gas).	Gas
Class is change	Electrical equipment without danger to the operator.	CO2, Dry powder
D	Combustible metals and combustible metal alloys. (Magnesium, Aluminium, Lithium etc.)	DCP, Special Dry Powder
F	Cooking media (Vegetable or Animal oils and fats, Grease).	Wet Chemical

The following table shows the Different types of extinguishers related to the Classes.

Table 4: Different types of extinguishers related to the Classes

Fire Extinguishers	**Colour of the band**	**Classes of fire**
Water	Red	A
Foam	Blue	A, B
Dry Powder	White	A, B ,C, D, Electrical equipment.
Monnex Dry powder	White	B,C
Special Dry powder	White	D
CO2 Gas	Black	B, Electrical equipment
Wet Chemical	Oatmeal	F

How to use extinguishers

- Keep your back to an escape and stand from the fire six to eight feet away. Then follow the PASS procedure in four steps. But if the fire doesn't immediately start to go out, leave from the area at once.
- **P**ull the pin at the top of the extinguisher to prevent accidental pressing of the handle.
- **A**im the nozzle's low point toward the base of the fire.
- **S**tand about eight feet away from the fire and squeeze the handle for the extinguisher to discharge. The discharge will stop, if you release the handle.
- **S**weep the nozzle at the base of the fire back and forth and move slowly forward to extinguish the remaining fire. Monitor it closely after the fire appears to be out as it may re-ignite. (FireRescue, 2015).

Repeat the process due to fire may be reignite. Always be aware that the fire department checks the fire site, even though you believe the fire has been extinguished. (service., 2016).

- Water Extinguisher

Water extinguishers are used only for Class A fires (ordinary combustibles such as paper and cardboard, fabric and textiles, wood and coal). These are most common type of extinguishers and most buildings should have either water or foam extinguishers. This extinguishers consist of water and compressed gas. Water extinguish the fire and removes heat. Water must not be used on live electrical equipment fires because it can cause electrocution. Water extinguishers must not be used on metal fires, kitchen fires, and flammable gas and liquid fires. The label colour is bright red. The water has a cooling effect on the fire, allowing it to burn much more slowly until the flames are extinguished eventually. Normally this extinguishers are located near the exits where a class A risk has been identified. (SurryFire&SafetyLtd, 1997).

There are several kind of premises or businesses that may need water extinguishers such as buildings made of wood or other organic materials-premises where organic materials are to be found like Offices, Hospitals, Residential property and Warehouses. (SurryFire&SafetyLtd, 1997).

There are different kind of water extinguishers such as spray extinguishers and Water mist extinguishers. (SurryFire&SafetyLtd, 1997).

- Spray extinguishers

Water spray extinguishers are fitted with a spray nozzle instead of a jet nozzle. It ensures a larger surface area that can be protected quicker and the fire can be put out sooner. (SurryFire&SafetyLtd, 1997).

- Water mist extinguishers

Water mist extinguishers have different type of nozzles and it releases particles of microscopic water. These particles breathe in the fire and also build a wall of mist between the fire and the individual using the extinguisher which decreases the heat sensation. (SurryFire&SafetyLtd, 1997).

- Carbon Dioxide Extinguisher

Carbon dioxide extinguishers provide an effective agent to respond quickly to Class B fires such as flammable liquids like paint and petroleum and fires of electrical equipment. They are usually the main fire extinguisher type provided in computer server rooms. The extinguishing gaseous agent is non-corrosive, non-conductive and leaves no traces for washing. The principal advantage of this does not leave any residue. These extinguishers can be used indoors where winds and drafts do not affect discharge. (Joherson, 2019). By displacing oxygen in the surrounding air, CO2 extinguishes the fire. CO2 extinguishers are not preferred for metals involving fires, kitchen fires especially chip-pan fires and fires of combustible materials such as paper, wood or textiles. The colour of label is black. (SurryFire&SafetyLtd, 1997).

CO2 extinguishers work how it suffocates fires by displacing the oxygen that the fire requires to burn. There are several kind of premises or businesses with electrical equipment that may need CO2 extinguishers such as Offices, Kitchens, Construction sites, Server rooms. A smaller 2 kg CO2 extinguisher should also be carried by all operating vehicles. Normally this extinguishers are located near the exits where the region near to the source of the fire risk or near the fire exits. (SurryFire&SafetyLtd, 1997).

- <u>Foam Extinguishers</u>

Foam extinguishers are most commonly used for Class B fires. But It also operate on Class A fires due to they are water-based.

In fact, most buildings require either water or foam extinguishers. The color of label is cream. This is used for Organic materials such as Paper and cardboard, Fabrics and textiles, Wood and coal and Flammable liquids, like paint and petrol. This extinguishers are not preferred for Kitchen fires, Fires involving electrical equipment, Flammable metals. Foam extinguishers work how the effect of foam extinguishers on the fuel is cooling like water extinguishers. The foaming agent creates a barrier between the flame and the fuel on burning liquids while extinguishes the fire. There are several kind of premises or businesses that may need CO2 extinguishers such as buildings constructed of wood or other organic materials and premises where there are organic materials to be found such as Offices, Schools, Hospitals, Residential properties, Warehouses that buildings where flammable liquids are stored. Normally this extinguishers are located near the exits on a floor where a Class A or Class B fire risk has been identified. (SurryFire&SafetyLtd, 1997).

- AFF Foam Type Extinguisher

The extinguishing agent is an aqueous film forming concentrate in water that, when discharged through an aspirating nozzle, forms air foams. When it spreads on the fuel, it has a blanketing effect excluding oxygen from the fuel surface. It prevents creation of vapour from the burning fluid surface. It produces a floating aqueous film of solution on fuel surface under the foam and also cool the burning surface. AFF extinguishers are not appropriate to use on electrical and metal fires. (Ihasco, 2009).

- Dry Powder Extinguisher

Generic dry powder extinguishers are also called as ABC extinguishers as they deal with class A, B and C fires. However they are not intended for use in enclosed spaces. The reason is that the powder can be easily inhaled, and after that the substance is also very hard to clean. ABC powder extinguishers are possible to use on some electrical fires. For flammable metals, Special dry powder extinguishers are used. The label of color is blue. This is used for organic materials such as Paper and cardboard, Fabrics and textiles, Wood and coal and flammable liquids, like paint and petrol flammable gases, like liquid petroleum gas (LPG) and acetylene

and also fires involving electrical equipment up to 1000v. Dry powder extinguishers must not be used for fires involving cooking oil, fires involving electrical equipment over 1000v or in enclosed spaces, such as offices or residential properties.

Dry powder extinguishers work how it smother fires by creating a buffer between the fuel and the oxygen source. There are several kind of premises or businesses that may need dry powder extinguishers such as businesses using flammable gases for chemical processes, premises where welding and flame cutting takes place, garage forecourts, liquid petroleum gas (LPG) dispensing plants, premises with large, commercial boiler rooms. Normally this extinguishers are located near to the source of the fire risk. (SurryFire&SafetyLtd, 1997).

i. Special Dry Powder Extinguisher

For extinguishing metallic fires, Special extinguishing agents are used. Special dry powder extinguishers are used only on flammable metals, such as titanium and magnesium. Dry powders extinguish the fire by creating a surface on metal surface by removing air and also it absorbs heat from the surface of metal such as blended sodium chloride based dry powder, ternary eutectic chloride (TEC) powder, graphite and etc. (SurryFire&SafetyLtd, 1997).

ii. Dry Chemical Powder(DCP) Extinguisher

Sodium bicarbonate and potassium bicarbonate are the main base chemicals used in DCP extinguishers. DCP extinguishers extinguish fire by covering the fuel surface using chemical powder. It removes the gasoline from the oxygen and then it avoids the production of vapour. Dry Chemical extinguishers are usually classified for multiple uses. They have an extinguishing agent and use a compressed, non-flammable gas as a propellant. (FireRescue, 2015).

In here, the powder disrupts the chemical chain reaction of fire. But in case of sensitive equipment, it leaves residue particularly making it difficult to clean up. This is the main disadvantage of this extinguisher. Dry Chemical is the most commonly used fire extinguisher type. It is also recognized as an ABC fire extinguisher for multipurpose applications. It also creates a barrier between the fuel and the oxygen on a class A fires. (FireeEquipmentAssociation, 2006).

- Halogenated or Clean Agent extinguishers

The Clean Agent Extinguisher uses both halon and halocarbon by disrupting the chemical reaction component of a fire. Primarily, this extinguishers are used on Class B and C fires and also larger Clean Agent extinguishers can be used on Class A, Class B, and Class C fires. These are either based on halocarbon agents or on the older halon 1211 agent, which can no longer be used for instruction. Halocarbon agents have replaced halon 1211 and are more environmentally acceptable within the last 8 years. Commercialized halocarbon agents remove heat from the combustion zone to extinguish the fire. However, halon 1211 extinguishers are chemically active. And also it is interfered with the chemical reactions occurring in the combustion zone. Halocarbon and halon 1211 extinguishers are successful on fires of Class A, B, and C, although very small sizes do not achieve the lowest UL Class A, 1-A ranking. (FireRescue, 2015).

Halon extinguishers consist with a gas that interrupts the chemical reaction that happens while fuels burn. These types of extinguishers are often used to secure sensitive electrical equipment as they don't leave any residue to be clean up. There is a limited range of halon extinguishers, usually 4cm to 6 cm. Even after the flames have been extinguished, the initial application of Halon should be made at the base of the fire.

- Wet Chemical

The Wet Chemical Extinguisher extinguishes a fire by eliminating heat and then avoiding barriers between oxygen and fuel so a fire cannot be re-ignited. Wet Chemical extinguisher belongs to Class K that includes cooking oils, greases, animal fat and vegetable fat. If you are in the commercial cooking industry, this extinguishers are a must-have. Some Wet Chemical extinguishers can also be used on Class A fires although it is more usual to have a foam or water extinguisher for this type of fire risk. They can also be used on Class A fires although foam or water extinguisher is common for this type of fire hazard. It works by making a soap foam blanket over the combustible material and cooling it below their ignition temperature.

Their color of label is yellow. It is designed for Commercial kitchens like restaurant type kitchens, Canteens. Wet chemical extinguishers are used only for cooking oil/fat fires, Organic materials such as paper and cardboard, Fabrics and textiles, Wood and coal. This extinguishers are not preferred for flammable liquid or gas fires, electrical fires and flammable metals involving fires. Wet chemical extinguishers work how it creates a layer of foam on the surface of the burning oil or fat to avoid oxygen from fuelling the fire. The spray has a cooling effect as well. Normally this extinguishers are located near to the source of the fire risk. (SurryFire&SafetyLtd, 1997).

2.2.3. Sprinklers.

Figure 6: Type of sprinklers head

Fire sprinklers are more commonly popular than fire suppression systems. It is also one of the most effective methods of controlling or suppressing a fire. They depend on a steady water supply provided by the public water supply or by fire pumps to contain and extinguish any fires that ignite around them. The glass rod in the heads of fire sprinkler will break when there is heat from a fire and that releases pressure and activates the sprinkler system. Wherever the flames are concentrated, this will spray water. We can choose several types of sprinklers such Wet pipe, Dry pipe, Pre-action, Deluge depending on the needs of your building and industry.

However, there are some cases when they are not appropriate to set fireworks. Then, they will do more harm than good. That is the reason for coming fire suppression systems. It is an innovation that help protect our building from water damage. These are specialized systems that focus not only on life safety but also on equipment safety. (Fireline, 2019).

Sprinkler systems consist of a network of pipes in the walls and ceilings with sprinkler heads providing protection for a building's hallways, rooms, stairways and other areas. In most systems, the pipes are always filled with water under pressure, and then system is ready to do its job of rapidly extinguishing a fire. In the walk, sprinklers are sometimes concealed in the walls and ceilings under tiny metal plates. Even if you don't see the head of sprinkler, they are still there and can spray on a fire. Normally, sprinklers are at a building's ceiling level. Normally only one or two sprinklers open up during a fire. Normally a single sprinkler head will spends about X gallons per minute. If we compared with a fire hose which can run 150 gallons a minute or more, but this is not much. The water loss from a sprinkler head is significantly lower than a fire extinguisher. Sprinklers are very rugged devices and should not be confused, misused or destroyed since the heat getting to the sprinkler and then its opening will be delay. (U.S.fireAdministration, 2001).

- Wet sprinkler System

Water is always in the branch lines and at the sprinkler heads. Wet Systems cannot be in places that can freeze. The pressure of water must be maintained at all times. Water Pumps are designed to keep water pressure at a certain PSI. There is no hesitation in pouring water on the fire. It requires the minimum maintenance (Department, 2015).

- Dry sprinkler System

Branch Lines needs air pressure instead of water. The Air Pressure holds down a Clapper Valve, so that, unless the air pressure is lost, water cannot be pumped into the system, unless the air pressure is lost. It is used freezing areas. An air compressor keeps the system under a constant pressure. When a Fire opens a sprinkler head, then stops holding down the valve that are holding the water back, and water is released. Standpipes are used in stairwells to set up a water way for hand lines. These systems consist with high maintenance cost as corrosion in the pipe with only air, and a bit of water. (Department, 2015).

- Deluge sprinkler System

Deluge Valves are used in special regions. Sprinkler heads are always open. It is used in High Hazard areas. Deluge Valves open during a smoke or heat detection. Deluge systems are

needed where high speed suppression is necessary to prevent spread of fire. (Department, 2015).

- Pre-Action sprinkler System

This system is same as a Dry System. An electronically controlled valve holds back water. There are two things need to happen before water is released. First thing is that the detection system must identify a smoke or flame problem. Then water is released into the piping. Second thing is that it is necessary to activate and release the sprinkler heads to put water on the fire. (Department, 2015).

- Water mist sprinkler system

Water mist systems are used for extraordinary applications where it is chosen that the essential purpose that is to create a warmth retentive vapour. This kind of system is widely used where water damage might be a problem, or where water supplies are small. Due to an uncovered surface area, a water fog, that ingests warmer than water per unit of time, will cool the room even more effectively, thus reducing the fire temperature.

Water fog frameworks can operate from downpour, wet pipe, dry pipe, or pre-activity frameworks with an indistinguishable utility. The difference is that a water mist utilizes a packed gas as an atomizing medium, and pumps it through the sprinkler pipes. Instead compacted gas, several frameworks utilize a high weight pump to apply pressure to the water which atomizes because it exits the nozzle of the sprinkler. Systems can be linked using nearby application technique or aggregate flooding strategy such as clean agent fire protection systems. (AlSuliaman, 2017).

- Water spray sprinkler system

Although frameworks for Water spray are operationally indistinguishable from a storm framework, the designs for channelling and release spout splash designs are intended to secure an exceptionally extraordinarily organized threat, because a rule being three-dimensional parts or gear. The dangers protected by water splash frameworks that are electrical transformers containing oil for cooling or turbo generator heading for hazard covering. Water splash frameworks can be used remotely on the tank surfaces that containing

combustible fluids or gases such as hydrogen. The water splash is intended here to cool the tank and its material to forestall tank break/blast and fire spread. (AlSuliaman, 2017).

A Foam water fire sprinkler framework is an exceptional application framework, producing a combination of water and low production froth think allowing the sprinkler to splash. Such systems are usually used with extraordinary hazards associated with high test fires suc h as fuel fluids and storage of aircraft terminals. Task is as mentioned above, depending on the writing of the frame in which the froth is poured. (AlSuliaman, 2017).

2.2.4. Suppression.

Figure 7: Fire suppression system

Fire suppression systems don't need to use water. This is because they dispense foam or gas instead. Whether you are operating a data center or a museum, you will probably have assets, equipment, and exhibits that can be damaged or destroyed by water but will remain unaffected by other fire suppression methods. Some of the examples of these fire suppression systems include FM200, NOVEC1230, CO2, wet chemical, and dry chemical delivery systems. Getting the best return on your investment involves predicting the future and anticipating any fire emergencies that can happen. That means turning to a trusted fire protection partner to help you prepare for the next disaster. A fire protection engineer or specialist can advise you if a suppression system will be useful in protecting your building and company assets. (Fireline, 2019).

- . Gas System – FM200

Gas systems are stored in liquid foam with nitrogen. It is used to pressurize. When the FM200 chemical is released, there is a chemical reaction in chemical agent with the fire and

extinguishes it. This systems are more suited for rooms such as data, switch or communication. There are several kind of advantages by using this system such as need only less space because of a liquid, easy to install due to normally cylinder is located in same room, Nor any reduction with oxygen. And also there are several kind of disadvantages such as cylinders need to store closer to the application as possible and a hydro fluoride chloride (HFC) may be a potential future banned gas. (AssuredFireAndSecurity, 2019).

- Kitchen Fire Suppression – Chemical Foam (Amerex, Ansul)

This system is developed exclusively for commercial kitchens. The nozzle is arranged under the cooker canopies and also propel a chemical foam type mixed water-based agent over the risk. Normally the trigger is a heat link or hand-held switch. There are several kind of advantages using this system such as easy to use, no damage and no electrical work on most systems. And also there are several kind of disadvantages using this system such as expensive, take longer to clean up, have to use stainless steel pipe-work and fittings, no British standards to work and when the kitchens are not working, normally the installation takes place slowly at night due to some kitchens get more hours to cool down. (AssuredFireAndSecurity, 2019).

- Water mist System

Water mist systems are commonly used in large data rooms, other large areas and local applications to replace sprinklers. These systems can used for burning liquids and electrical rooms, the mist evaporates causing oxygen to starve rather than cool. There are several kind of advantages by using this system such as not expensive to cover a large area, quick and easy to replace after discharge, no mess and flooding when compared to chemical kitchen fire suppression and sprinklers, no large water storage or pump power requirements. And also there are several kind of disadvantages by using this system such as not widely recognized as a sprinkler and gas alternative and also there are no British standards and distributors are present. (AssuredFireAndSecurity, 2019).

- Foam Deluge System

Primarily, foam deluge systems are more preferred for large applications where water or gas cannot be used. These happen to be external like transformers, oil tanks and silos for oil storage. A simple application of the sprinkler type disperses a concentrate of foam mixed with the water to supply the usual expanding agent. It is same as with extinguishers. There are several kind of advantages by using this system such as good for external areas, covers large areas, protects flammable liquids like airports, aircraft hangers, oil storage. And also there are several kind of disadvantages by using this system such as clean-up is required due to messy and need to consider the electrical risk due to wet agent. (AssuredFireAndSecurity, 2019).

- Pneumatic Heat Detection Tube

Basically, this is an extinguisher with a valve and a length of heat detection tube. It acts as the agent's detection and propellant feed. When the temperature around the tube reaches a certain level then it blows a small pressurized hole in the tube. Then it directly pushes the agent onto the risk. This suppression system is suitable for boats, vehicles, small machinery, electrical switch cabinets and fume cupboards. There are several kind of advantages by using this system such as Low install and maintenance cost as no moving or electrical parts, no pipe work, need only small amount of agent as it's assumed it will attack the fire at smoldering stage, can take out and install elsewhere and can install in small intricate areas such as machinery. And also there are several kind of advantages by using this system such as cannot guarantee of work for the large fires, No standards for designing and installation, not a high spec solution and difficult to cover large area like high ceilings and rooms. (AssuredFireAndSecurity, 2019).

2.2.5. CCTV Systems.

Figure 8: CCTV system

A CCTV systems monitor activity on-site. It also can used both as a surveillance tool and a method of identifying and prosecuting thieves. The best location of CCTV system depends on what you want to take from it. To order to gain best coverage, it is used to monitor on-site activity that should be located at a higher level. And also to order to view faces more clearly, CCTV used to detect criminal behavior should be located at eye level. Guaranteed Fire & Security installs and maintains a wide range of CCTV systems to fit a specific site and supply a safer and more secure environment for employees. It will be cause to control bad behavior of people because those incorrect behaviors may be cause to start a fire. Then in here, CCTV systems act as a security system. There are several kind of advantages by using CCTV systems such as business protection, deter potential break, supply protection and support for your staff when working on-site alone, can identify the cause of incidents and provide evidence by reviewing footage. (AssuredFireAndSecurity, 2019).

2.2.6. Intruder Alarm Monitoring

We can connect intruder alarm through the DualCom or other signaling network to Alarm Receiving Centre (ARC) . DualCom certify a protected signaling path for the alarm activations and although the communications line is attacked or a failure occurs, then an ARC alert is generated to alert you.

Other alarm systems such as fire alarms can be wired to the ARC. This will not only protect against theft, but also protect against fire. (AssuredFireAndSecurity, 2019).

2.2.7. Hose Reels System

Fire Hose reels systems are installed at strategic locations in buildings. It provides a reasonably accessible and controlled supply of water for the fire extinction. Fire hose reel systems are made up of pumps, pipes and supply of water. And also hose reels are strategically located in buildings, ensuring sufficient coverage of water to fight a fire.

This system is manually operated and activated by opening a valve that allows water to flow into the hose. Normally it is 30 meters in length. The pump can operate automatically by opening the valve.

2.2.8. Manual fire alarm call point.

This fire alarm call points operate by manually. Warn workers in the area have to come to our assistance and inform the security unit. They determine burning materials and use the correct type of extinguishers for fighting with the fire. But you only use the fire extinguishers if you have been training in practice Always put yourself behind you with an exit or escape device before you attempt to use a p extinguisher. (Reform, 2005).

Figure 9: Manual Call points

2.3. Smart Technology Concept

Figure 10: Smart technology concept

Smart technology concept is a generalization of the concept of smart structures. In normally, this is the sending and receiving information of users to on and off IOT systems. And other hand, it can be declare as more interaction and control of systems through wireless communication. Smart technologies include mechanical systems with sensors, actuators and

pre-programmed controls that allow a structure to respond to unpredictable external loading conditions. The idea of smart technology needs knowledge of the mechanical system itself, built-in sensors and controllable devices and advanced electronics driving. Normally it should be based on smart materials. Those are enhance the intelligence to the system. (Anon., 2008)

The smart technology provides easier methods and it save money. And also this concept assists to manage time, cost, risks, and resources better than earlier. This can be used in field and any time and no limitations. There are several kind of advantages by using this system such as energy efficiency, security and safety, comfortable living, convenience, ensures the sustainability, saves money & time, healthcare, household management, entertainment and enjoyment and assisted living. This is very user friendly concept. Information analysis declares that the whole world will be fully connected through this concept within a few years. There are several kind of concepts such as smart university, smart Home and smart City. In here, all devices are connected according to this IOT technology in both physically and logically. Lots of IOT based smart concepts are using sensor systems to reach technical success easily. Consumers will have the control capacity of everything in their hands, according to these Smart Technology. These can also be managed orally by the user in advance. (Holnicki-Szulc, 2008).

2.3.1. Smart Home

Figure 11: Smart home

Smart home systems reached to the great popularity and it enhances the comfort and quality of life. There are several kind of smart home systems and normally they are controlled by smartphones and microcontrollers. Using wireless communication methods, a smartphone application is used to manage and track home functions. More researchers explore the idea of smart home by incorporating IOT technologies and cloud computing into it. For any users of user-friendly UIs, this control and monitoring system is easily understandable. The integrated sensor systems or different types of micro-controlling systems are used by each of the control and monitoring systems. This concept makes the man simpler and comfortable. Anyone can operate their home operations faster than earlier with a single click or touch. Instead of using his voice without any effort, the man should manage certain operations. (Domb, 2019).

2.3.2. Smart City

Figure 12: Smart city

There are many definitions for smart city. In simply, smart city is that “a range of conceptual variants is often obtained by replacing “smart” with alternative objects”. This term was used firstly in 1990s. This concept is more popular in the last two decades. This smart city concept has been created by combining the smart homes. This smart city gives lots of advantages to the public such as residents, public safety, public health, transportation and etc. This smart city has been converted more cities around the world smarter than earlier. By adopting these Smart City concepts, the quality of our lives was automatically improved. We all now live in a smart and advanced world of these Smart City concepts being improved. (Winkowska, 2019).

2.3.3 IOT Technology

IOT stands for Internet of things and it means network connectivity and computing capabilities extend to objects, sensors and other hardware rather than computers. The IOT refers to a type of network for connecting anything to the Internet based on stipulated protocols via information sensing equipment for sharing and communicating information. Then we can achieve in order to smart identification, locating, tracking, monitoring and management. Nowadays, IOT has become a popular technology describing scenarios about the wireless communication of objects. The founder of IOT was British technology pioneer Kevin Ashton in 1999. Today, in earlier times, when IOT is fairly new to the world, the idea of using computers and internet to track and control devices has been very advanced. (Salazar, 2016).

2.4 Related Research Studies

2.4.1. Temperature Humidity Meter

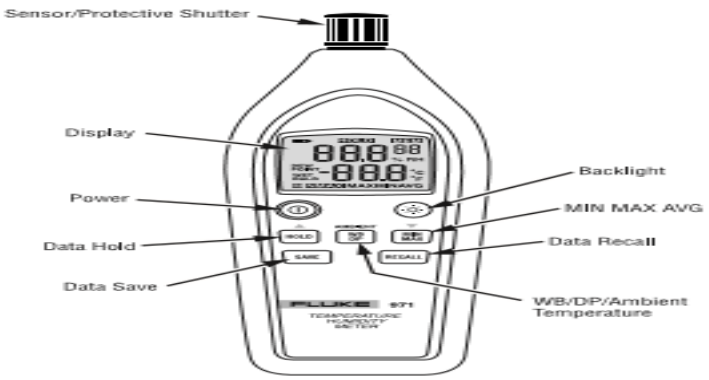


Figure 13: Temperature and humidity Meter

This meter measures temperature-Humidity using a sensor and display it. It has dew Point display, RH led alarm, max/min push button, Reset push button, storage of sensor cable, tilt stand, humidity calibration adjust, temperature units switch (ºF/ºC), wall hanger, battery compartment, and audible Alarm on/off switch.

Humidity warns alerts when limit of pre-set HI or LO is reached by the percent RH. The remote probe installs easily on the meter or extends in ducts or remote locations for measurements. It also requires changes to the humidity and temperature. Using the fold-out

stand, the device can be wall mounted or located on a flat surface. With proper care, this skilled meter will provide long safe and reliable service. (extech, 2006).

2.4.2. An Android Application Based Temperature and Humidity Monitoring

Nowadays, there are several kind of applications based on temperature and humidity. An android application has been created by using MIT App Inventor for the projected circuitry. This Application can controlled through any mobile phone. And also it shows the sensor output result and two load or incubator switching buttons to turn the ON OFF heater. MIT App Inventor is an intuitive, visual programming environment that enables everyone to develop smartphone and tablet apps fully functional. (Nadi, 2018).

2.4.3. System Design Temperature and Humidity Control Room with Android

Figure 14: Room control app view

The purpose of this study is to control the temperature and humidity in a room using Arduino microcontroller. That is controlled with Wi-Fi media in android smartphone. Test results show through android smartphone applications. It can inform a room's temperature and humidity status. Cold, hot and hot and manual (fans and heaters) control room app on Android. Approximately, the distance of remote control of android app Arduino microcontroller is 150 meters. When Arduino Uno processes the android command at a

distance of 0-80 meters is 0.5-1 second and 2-3 seconds at a distance of 90-150 meters, the delay duration occurs. (Sawidin, 2018).

2.4.4. Temperature and humidity notification with android

According to 2.4.2(a) figure, this application is also created based on IOT. In here, particular applications identify and show the temperature and humidity. Then whenever it is implemented, notifications will be come to this application. This notifications only give the current temperature and humidity.

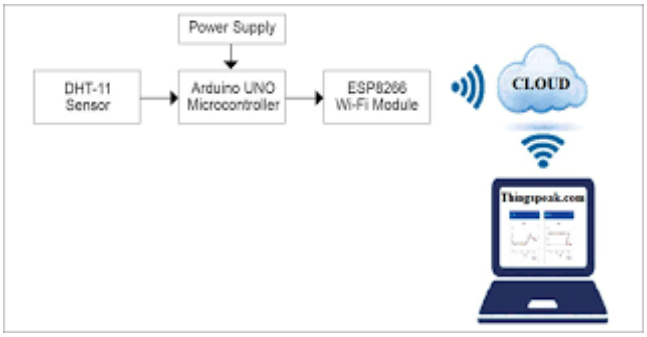


Figure 15: processing structure of mobile application

2.4.5. Fire Rescue application

This applications has been created focus on fire fighters. It is the best way to keep up-to-date fire coverage, tips, videos and articles up-to date while on the go. This application is available the go on IOS and Android devices free of charge.

2.4.6. Fire inspection

This application has been created based on fire inspectors. It is a great application for them. It can be a more useful tool for people who conduct regular fire inspections. It is developed to assist businesses ensure and they have all fire safety equipment on site in working order. As well as it help businesses to meet the proper fire safety guidelines. It includes fire hydrants, fire extinguishers, fire prevention, and more. All of the checklists and forms are customizable and giving the control that they need while performing inspections. It is more possible for IOS and Android devices.

2.4.7. Smoke alarm messenger

Smoke Alarm Messenger sends SMS to the phone number or email address that you choose when a smoke detector goes off in your home. The main goal is to inform users that they may be at risk. In here, it monitors the smoke alarm signal and then sending a message to the user to prevent false alarms to the fire department. It is more possible on IOS and Android devices.

2.4.8. FIRE SAFETY E-LEARNING

This application provides guidelines to the user in the case of an emergency. It consists with evacuation procedures and what to do when you discover a fire.
It's a free download, with a more fleshed-out pro-version. It is more possible on IOS, Android and Windows phones.

2.4.9. NFPA Journal application

This official application created by the National Fire Prevention Agency. It has a user friendly interface that gives a mobile version of the NFPA Journal. In here, user can view all of the in-depth features of the magazine with all of the important news and updates. It is a fantastic tool for fire safety professionals. It is more possible for IOS and Android devices.

CHAPTER 03

METHODOLOGY

3.1. Introduction

This study consists of three main categories. They are Database (firebase), Hardware system (temperature and humidity hardware system) and Software system (mobile application). In here fire base is used for update, store and retrieve data. The temperature and humidity hardware system is used for get a current temperature and the current humidity. Lastly mobile application is used for retrieve data and analyze them. And also in the mobile application consists with other additional facility that the mobile application has a weakness checking facility of a building. This facility is also given a guidance to detect early factors that are effected for the start a fire and the spread a fire. Not only that it also provides guidance to check existing factors of a building that are effected for the preventing the stop start a fire and stop spread a fire. As well as that, there is another facility that the system provide connection between user and the fire brigade to establish efficiency.

In the next sections, this facilities will be described with more details. Combining all the systems, it provides a most valuable facility to the users. Then user can protect from the fire and gain early actions against the fire by using this system. This is a main purpose of this system.

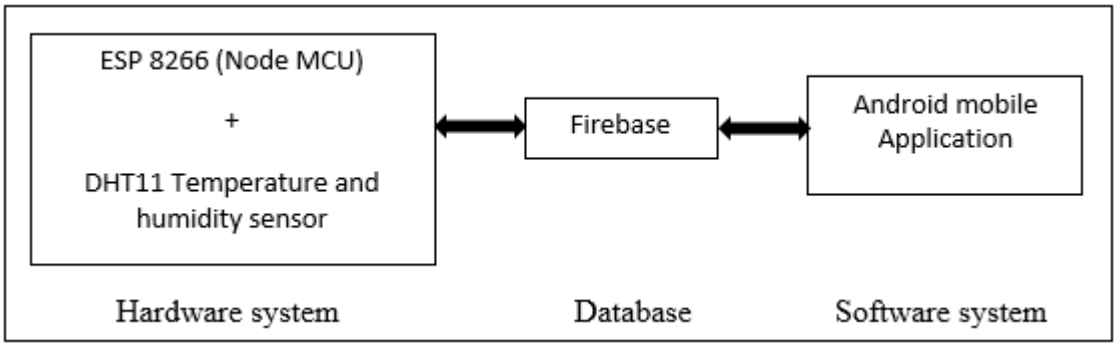


Figure 16: The main structure of the system

If we get fire base, it is known as a real time database. For most of the systems, the database facility is an essential thing. Therefor this real time database facility also needs for this system. This system provides lots of facilities to the users such as real time database, authentication, hosting, storage, notifications, app indexing, cloud massaging, testing, analyzing and advertising facility, etc. And also firebase is a latest and most important platform that has effective tools to develop mobile and web application especially for android mobile applications. And not just that, this real time database is also supported to the IOS. It consist with fully features to develop mobile applications.

Secondly if we consider hardware system, this is also essential part to successes this system. In here the main task is that take a real time temperature and the real time humidity. Generally, temperature and humidity are basic factors that has effected for the start a fire and spread a fire. Although there are few kind of other factors that are involved to this fire staring, in this stage I consider only these two factors. In the future I will develop this system with other factors. According to this section, the name of the main hardware parts are DHT11 temperature and humidity sensor and ESP8266 Wi-Fi module (Node MCU). The other sub hardware items are bread board, resistor and jumping wires. The entire hardware system is programmed by using Arduino language and Arduino IDE as it is a most helpful Arduino to transfer real time through wireless connections. In here DHT11 temperature and humidity sensor is used to detect real time temperature and humidity.

Third system is software system. This is an android mobile application that is used to retrieve data for users. This applications retrieve data to the users by using interfaces. This is a user friendly mobile application and it is designed and developed by using android studio IDE. The entire system output has showed to the user through this mobile application. This application is included several kind of interfaces such as Login page, Register page, Dashboard, Check safety page, Temperature and humidity page, Help page and No of users page. All of interfaces has included their own task and further details related to those task are described in next sections. All the available android versions are more helped to reach this aim of the system.

3.2. Database system

3.2.1. Overview of the system

The firebase has lots of facilities. But in here mainly firebase is used as a cloud-hosted database because it is a real time database. In additionally, user authentication and cloud massaging system facilities also take at this firebase to successes this system and it provides a great help to reach the system requirements.

In here, this is a backend part of the mobile application. The data of the Node MCU stores and updates in the firebase. This process can easy to learn and firebase has suitable functionalities to do that task. Data is stored in the firebase as JSON file and those are synchronized to every connected client in real time. When a mobile application creates with android, all clients are shared this one real time database and also it updates and receives with newest data automatically.

3.2.2. Used functionalities of the System

3.2.2.1. User Authentication

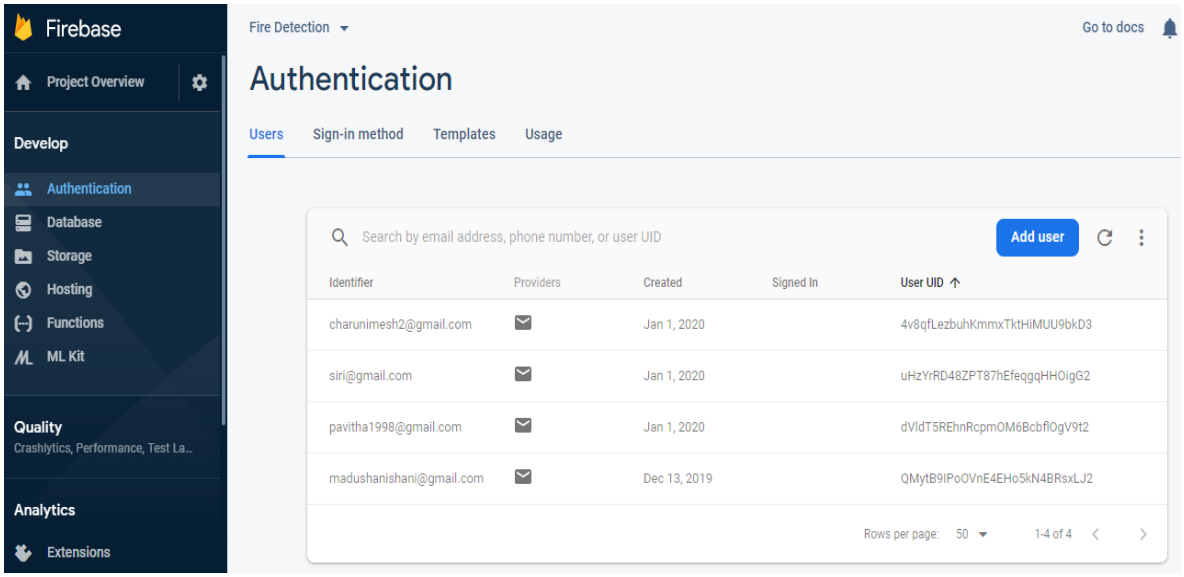


Figure 17: Authentication window of the system

In above figure, it shows the registered users with their details such as identifier, created date, last sign-in date and their User IDs. In the beginning, the address of the email account, password and other primary details includes to the firebase through mobile application registration as the mobile application is linked with firebase and then automatically this analyzed details are stored in real time database of the firebase. Those details are more helpful to develop mobile application. After registered to the page, any registered users can gain access of the entire system. Those registered users only need email and password to approach to the system.

This mobile application uses this user authentication function for register and login. Using this authentication function, the new users and number of users of the system can be identified. And also this process provides a privacy to users.

3.2.2.2. Real time database

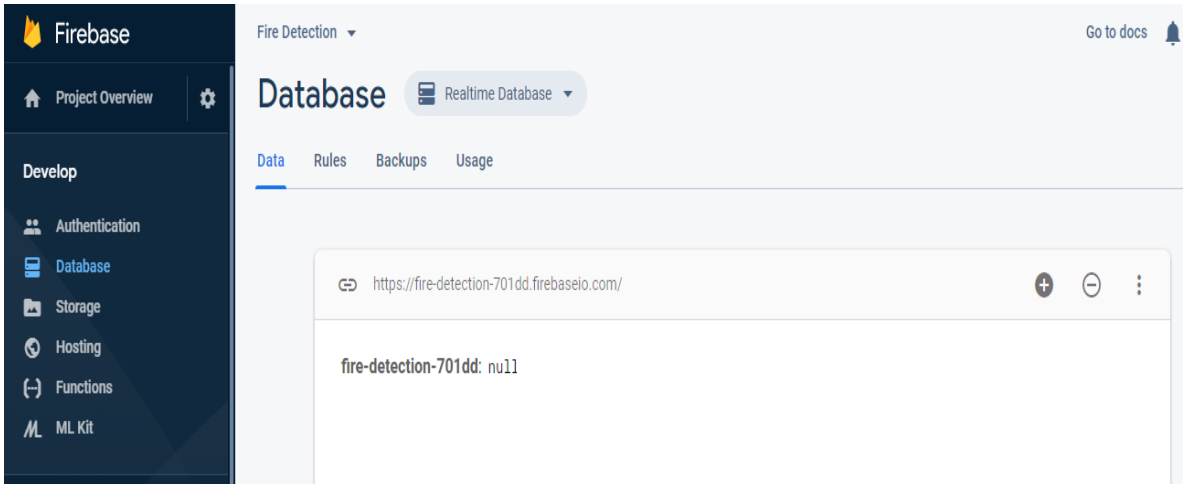


Figure 18: Real time database window of the system

According to the above figure, it shows the real time database. This is the main special facility of this system. This real time database is used to store and update data related to this software and hardware components. It is updating and storing data every 5 seconds of interval. . And also those updating data can observe using this mobile application in any time. Then user can observe the current temperature and humidity and also their changes from time to time. This facility is useful to users for recognize and aware regarding any increases of temperature and humidity of the current locations of the users because as I mentioned previously increases of

this two factors are mainly effected to set off a fire. This real time database is providing a great facility and doing a main task to success for this system. It supplies a grate support to users for prevent from a fire.

In this system, there is a notification system and this process is also a main component of the system. Because the aim of this system is that protect people from a fire by early detection notifications. Notification system is working based on changes of this real time database. Therefore this real time database handles main part of this system that cannot be success without this database. This smart based system gives a good solution to this identified problem (Fire detection) by alignment with the modern world and their needs.

- Structure of the database System

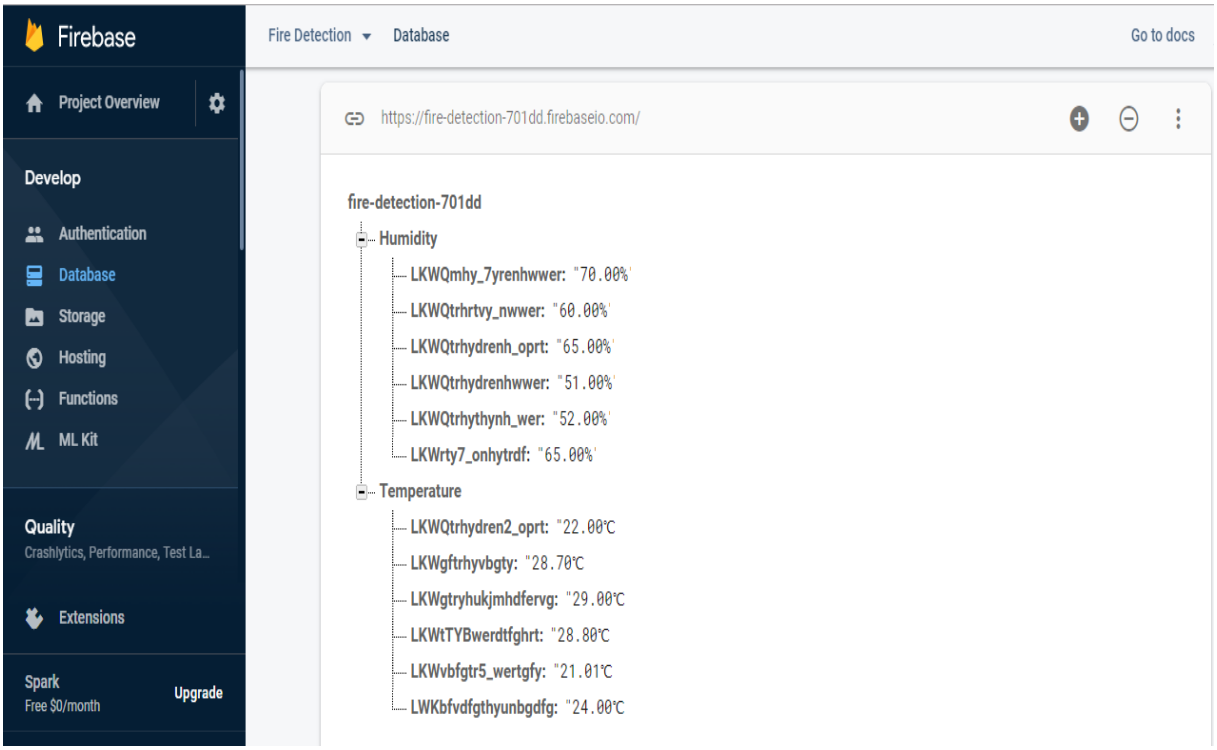


Figure 19: Structure of the database system.

The above figure shows that the data stored structure of the database for the entire system. The structure of the database was created as a hierarchy system and all the real time data is saving in this database in hierarchical. In here, the main parent is the username and all the parent has respectively own data set in a sub-parents manner. All of those details are made as hierarchical system then this structure can easy to understand. This system secure the privacy of the users. As I mentioned previously all the real time data can retrieve from the mobile application. This data can be used for analyzing operations because they are stored in hierarchical manner based on username.

3.2.2.3. Notification system

In here, if there is an increase in fixed temperature and humidity given to the system, then a fixed scheduled notification system sends notifications daily by making people aware of it. That fixed temperature and humidity is found based on previous research articles and fire departments statistics. All the daily awareness process provide and operate by the scheduled notification system of the firebase. This process is also an important to handle this system. Without this notification process, user cannot get an idea regarding the increases of the current temperatures and humidity. It may cause a fire. (If we have early awareness, then we can be get early actions against the occurrence of fire to protect people and properties).

According to above figure, it represents a notification that is included regarding an awareness of temperature and humidity increases. And also it shows a short guidance massage. All the processes operate automatically. The fully system will be more important one after combining this notification system.

3.3. Hardware System

3.3.1. Overview of the system

This system is used to get current temperature and humidity accurately to the database. Using this hardware system, this current temperature and humidity can measure every 5 seconds of interval and it is adding to the database. Then all the data stores in the fire base by using this setup. And also those data is unique for each other. All the data shows in the firebase under their user name and then any users can retrieve only their own data through mobile application. In this stage, particular data appear only the firebase. After that the firebase

storing data will be linked with mobile application and then user can retrieve their unique data through this mobile application.

In here, I have been programmed a NodeMCU to get readings of the DHT11 sensor. Then those data is pushing to firebase every 5 seconds of interval. The path for pushing data is set. Then the temperature and humidity data are displayed in the database in same parent path and different child path. Setting these parameters enables data exchange between and NodeMCU and firebase. This is basic scenario of the hardware system.

3.3.2. Used hardware system

3.3.2.1. Node MCU (ESP8266)

Figure 20: External view of Node MCU

MCU stands for Microcontroller Unit that is a computer on a single chip. A microcontroller consists with one or more CPUs along with memory and programmable I/O peripherals. Node MCU helps to build IOT base products. This is an open source firmware. It includes firmware running on the ESP8266 Wi-Fi SoC from Espressif Systems. And also it includes hardware based on the ESP-12 module. Node MCU uses instead of the Ardunio board as it has a fast and low cost Wi-Fi module, high technology, more storage and smaller size board. This ESP8266 module is easy to program than other ones and it has more facilities and separate libraries to link with firebase.

The USB port supply power to the Node MCU ESP8266 via the USB port and it use a bench top supply unit. It is connected 3.3V input and wall wart. 9V Battery and the ESP-12E Development Board with 3.3V Regulator is supplied power to it. So this is a most preferred and useful Ardunio board.

- Pin Structure of the Node MCU

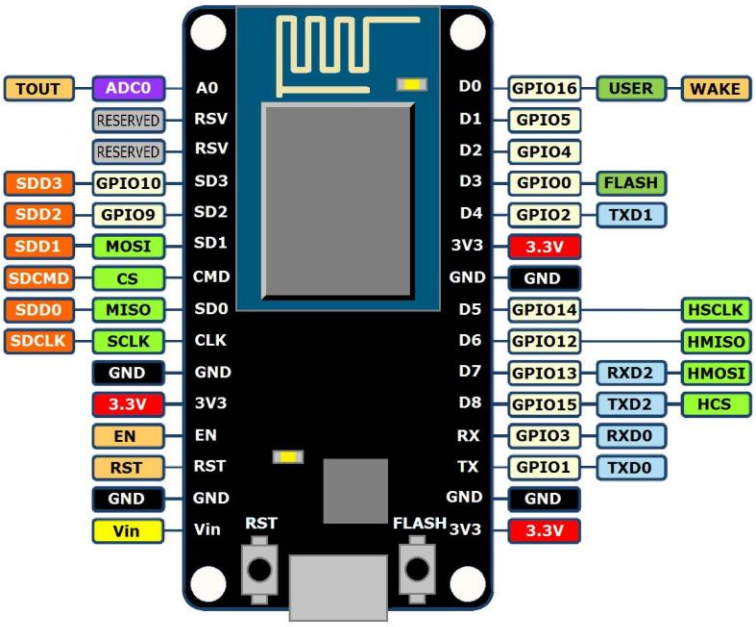


Figure 21: Pin structure of the Node MCU

The Node MCU (ESP8266) has 17 GPIO pins and it is numbered from 0 to 6. But we can use only 11 pins among them as 6 GPIO pins are used to link with flash memory chip and those are numbered from 6 to 11.

Table 5: Mentioning the I / O pins on the Node MCU

Label	**GPIO(Function)**	**Input**	**Output**
D0	GPIO16	No interrupt	No PWM or 12C support
D1	GPIO5	OK	OK
D2	GPIO4	OK	OK
D3	GPIO0	Pulled up	OK
D4	GPIO2	Pulled up	OK
D5	GPIO14	OK	OK
D6	GPIO12	OK	OK
D7	GPIO13	OK	OK
D8	GPIO15	Pulled to GND	OK
RX	GPIO3	OK	RX pin
TX	GPIO1	TX pin	OK
A0	ADC0	Analog input	X

3.3.2.2. DHT11 Temperature and Humidity sensor

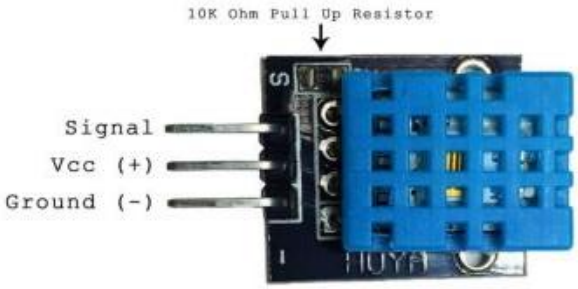


Figure 22: External view of the DHT11 sensor

The above 3.3.2.2(a) figure shows three pin DHT11 temperature and humidity sensor. It has three pins. They are known as signal, Vcc (+) and ground (-). The module of DHT11 sensor is a combined one with temperature and humidity that gives a digital signal as an output. This sensor provides precise value, high accuracy and long term stability of temperature and humidity. This sensor has a humidity measurement component that is in resistive type. And also it has temperature measurement component of NTC type with an 8-bit microcontroller inbuilt. It has a 4-pin single row package with fast response, cost effective and available.

This DHT11 sensors has features of extremely accurate humidity calibration chamber. Single wire serial interface combines to make the system quick and easy. Smaller size, low power, up to 20 meters signal transmitting, enables a variety of applications and most demanding ones. The product is a 4-pin single-line pin package.

- The ranges and accuracy of this DHT11 sensor

Humidity range:	20-90% RH
Humidity accuracy:	±5% RH
Temperature range:	0-50 °C
Temperature accuracy:	±2% °C
Operating voltage:	3V to 5.5V
Interface:	Digital

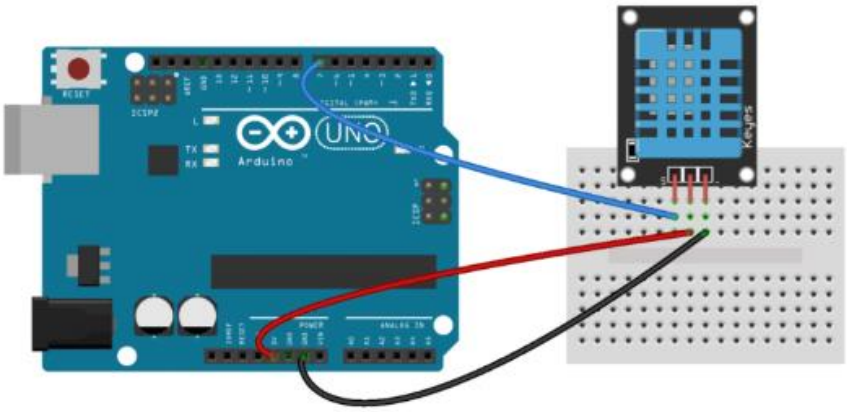


Figure 23: set up the DHT11 on an Ardunio

The DHT11 sensor measures temperature with a NTC thermistor mounted on the surface. But it detects water vapor (humidity) through measuring the electrical resistance between two electrodes. In here, the main task is that should be linked Ardunio board with DHT11 sensor correctly to continue this process. In the above section, that has been described well.

3.3.2.3. Resistor

A resistor is an electrical component of passive two-terminal. It implements electrical resistance as a circuit element. In here, this circuit is used a 47k resistor to get accurate values. This is the purpose of using this resistor. And also resistors are used in electronic circuits to minimize current flow, change signal rates, divide voltages, bias active elements and terminate transmission lines, among other applications.

Figure 24: 47k resistor

3.3.2.4. Bread board

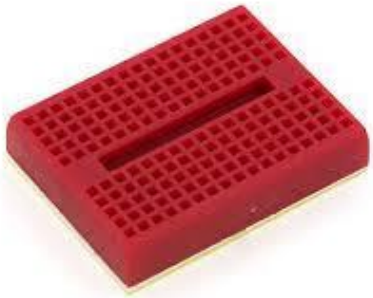


Figure 25 : External view of the small bread board

In figure 3.3.2.4 shows a small bread board. There are several kind of bread boards with several types. All the electronics projects life have been started on a breadboard that can be used to check the circuit working as intended. And also this is a platform that is used to make up temporary circuits for testing. In here soldering is not an essential thing. Then circuit components can easy to replace and also connection can easy to change. Component can be re used for after works. In this system is used a bread board to build a temporary circuit with other components.

3.3.2.5. Jumping wires

Figure 26: Jumping wires

There are two types of jumping wires named as male and female. This wires have connector pins at each end that are used to connect two points to each other without soldering. Normally Jumping wires are used with breadboards and other prototyping tools to change a circuit as needed in order to make it easy. In here, it is doing that mentioned work to connect two points of the system.

3.3.3. Wiring diagram of the system

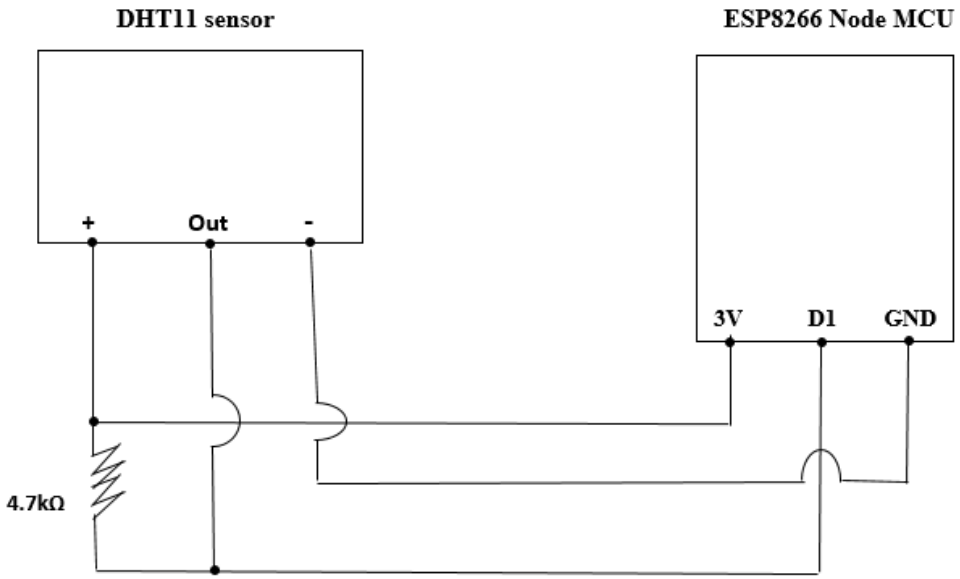


Figure 27: Wiring Diagram of the system

The figure 3.3.3(a) shows the wiring diagram of the hardware system. It shows how to connect the hardware parts to get accurate results. In here, DHT11 temperature and humidity sensor detect real time data and those data send to the ESP8266 Node MCU. Then all the real time data send to the real time database in firebase. Likewise, all the systematic data store in the cloud database. And also, the 4.7kΩ resistor is used get accurate real time values.

The other important point is that this hardware system must be connected to the Wi-Fi connection to do their task. If not, this real time data cannot send to the firebase. But there may be not Wi-Fi connection all day long. Then after the connection is there again, the data will be updated. This hardware system is a useful, cheap and accurate system for all users. This system can be develop by adding new features to this system for improve their accuracy and efficiency. All these things will be discussed in next chapters under recommendations sections.

3.4. Software system (Mobile application)

3.4.1. Overview of the system

This system is a more user friendly system. User can approach to the system with minimum inputs. According to this mobile application, mainly there are three facilities are included to it.

1. Check weakness of the building for start a fire and the spread a fire.
2. Display current temperature and humidity and notify their increases to the users.
3. Provide connection between user and the fire brigade to establish efficiency.

- Check weakness of the building for start a fire and the spread a fire.

In here, the mobile application has a weakness checking facility of a building. This facility is also given a guidance to detect early factors that are effected for the start a fire and the spread a fire. Not only that it also provides guidance to check existing factors of a building that are effected for the preventing the stop start a fire and stop spread a fire. This facility proceeds by getting user inputs for the simple questions that are based on early innovations and fire departments statistics. Then system calculates probability of a fire occurring and spreading in a building. This is the summary of this facility. It is described in next sections with more details.

- Display current temperature and humidity and notify their increases to the users.

In here, the current temperature and the humidity is displaying in the mobile application. To successes for this facility, the hardware components and real time database (firebase) also are combined together. Those components are described in previous sections. And also it gives a notification to the user to inform the increases of this factors. Because increases of this factors may cause the start a fire. If the system generate a massage to the user, then user can check weaknesses of the locations to avoid a fire starting. Because this massage is not sent to the user in high critical stages. Then users have time to prevent it. If the system conditions are satisfied then the massage is sent to the user in temperature greater 32 Celsius and humidity lower than 74% (Both conditions should be satisfied). Because those are the average high temperature and humidity of the Sri Lanka. If the system reaches to this measurements then there is a possibility to cause a fire. But it is not a critical stage and user

has time. This measurements found in previous innovations and fire department statistics. This is the summary of this facility. It is described in next sections with more details.

- Provide connection between user and the fire brigade to establish efficiency.

In here, the mobile application consists with fire brigades number. If there is a critical stage, user should only need to do click the particular button. Then automatically the call sends to the fire brigade due to the system is linked with fire brigade via phone number. If you want send a message to the fire brigade with more details, this facility is also provided to the user within this system. The users should only need to do that the massage is typed in relevant boxes and click the particular button. It is also sent to the fire brigade because the system is linked with fire brigade via phone number. It should be easy to identify because of user friendly application. This is the summary of this facility. It is described in next sections with more details.

3.4.2. User interfaces and its functionalities

3.4.2.1. Register UI and its functionalities

Figure 28: Register UI

The figure 3.4.2.1 (a) shows the registration UI. Normally this registration UI is also created based on users' primary details with traditional functionalities. In here, firebase authentication is created an empty database to store current registered users' details. Providing basic details such as full name, email, password and phone, then user can registered

to the page. Then all the provided details of users are stored in a created real time database (firebase). After registered to the page, the user can reach to the other facilities that are provided by the mobile application. If the existing users approach to the system, they only need to do that click on the text view in the top of the registration UI. Then it goes to the Login UI. It will be described in next section. We can count number of users using this register and Login UI and also it gives the privacy for each other regarding a mobile application usage.

3.4.2.2. Login UI and its functionalities

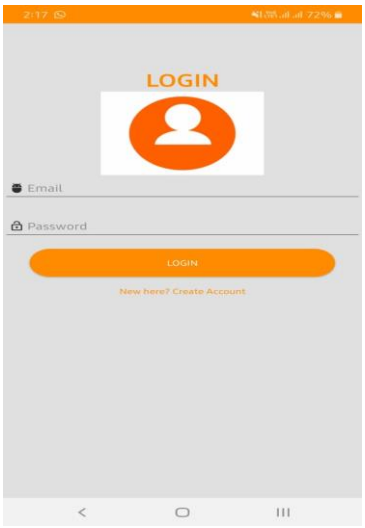


Figure 29: Login UI

The figure 3.4.2.3(a) shows the Login UI of the mobile application. After register to the mobile application through registration page once, any users can login to the application through Login UI. This login page is also created with traditional functionalities. Once a user is registered then he or she doesn't need to provide primary details and directly they can gain access of the mobile application facilities through login UI. Because all the primary details of existing users have been stored in firebase.

3.4.2.3 Dashboard UI and its functionalities

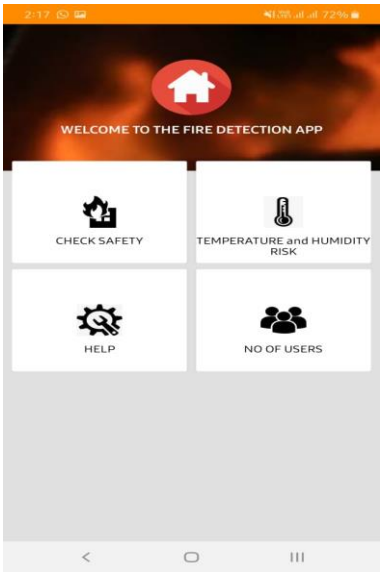


Figure 30: Dashboard UI

The figure 3.4.2.3 (a) shows the dashboard UI of the mobile application. It is also created based on traditional functionalities. This is the main body of this application. All the buttons represent as card view. And also all the buttons provide facilities of its unique. To get those facilities, users only need to do that click the particular button according to their requirements. This process can be easy to identify due to user friendly system.

3.4.2.4. Check safety UI and its functionalities

Figure 31: Check safety UI

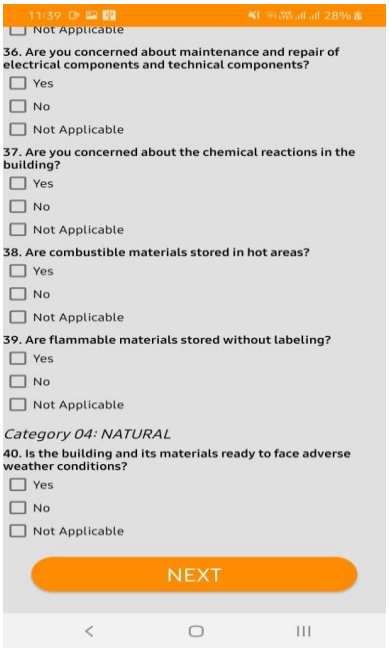


Figure 32: Safety 01

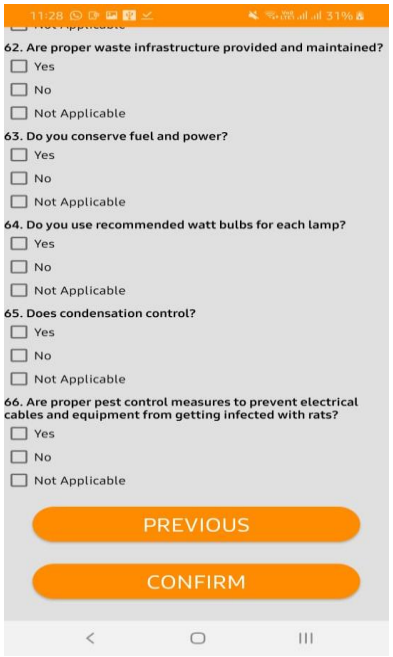
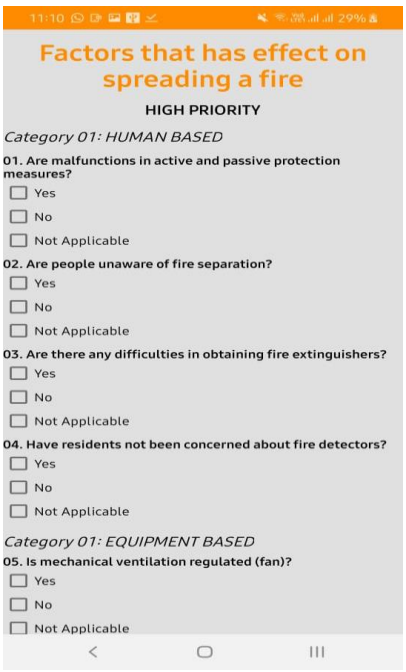


Figure 33: Safety 02



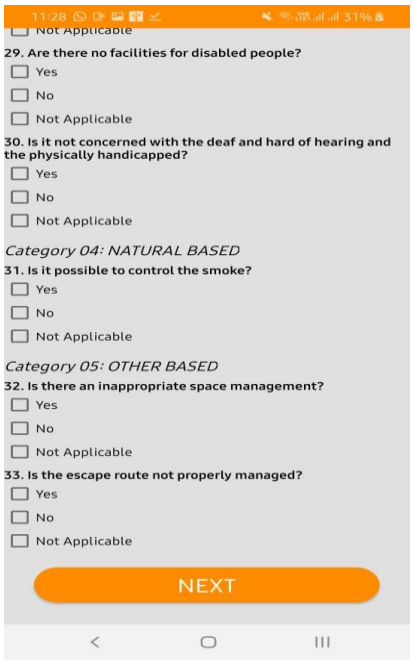
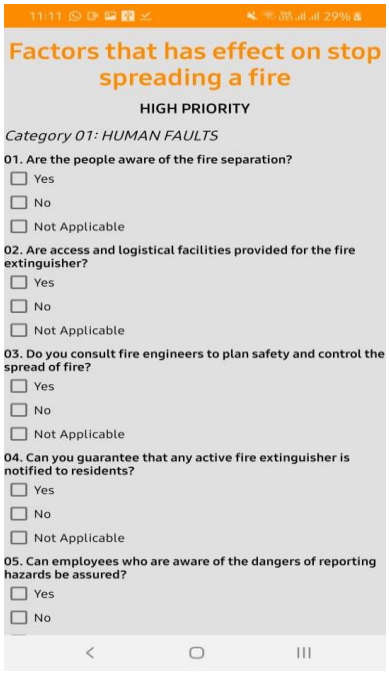


Figure 34: Safety 03



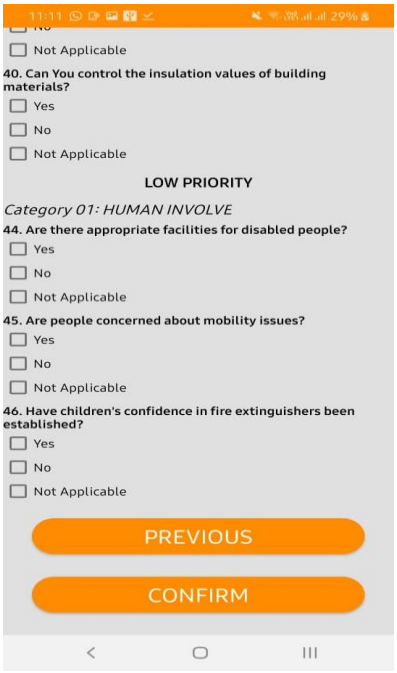


Figure 35: Safety 04

The figure 3.4.2.4 (a) shows the Check safety UI of the mobile application. And also there are four UI such as figure 3.4.2.4(b): Safety 01, figure 3.4.2.4(c): Safety 02, figure 3.4.2.4(d): Safety 03, figure 3.4.2.4(e): Safety 04, are included in to this figure 3.4.2.4 (a) UI. Using this UIs, user can get idea about weaknesses in a building. As I mentioned previously, This UI includes basic questions regarding the factors that are effected for the start a fire, spread a fire and stop start a fire and stop spread a fire in a building. Those question based factors represents in mobile application using separate 4 UIs. User only need to match those questions with their building and input suitable answers by selecting suitable check boxes. Then system calculate the probability of a fire occurring and spreading in a building based on user inputs. All the questions are arranged based on their critical stages and give weights according to their criticality. By using those user inputs and their weights, the system calculates final probability of the risk for start a fire and spread a fire. If it is greater than 50%, then the building is in a critical stage. Then user can be rectified the mistakes to avoid a fire occurring and spreading in a building. This is the main scenario of this UI.

All of those questions have been created based on factors that are effected for the start a fire, spread a fire and stop start a fire and stop spread a fire in a building. Those factors found using fire departments statistics, early research articles and companies of fire caused. Then all the factors are analyzed according to criticality. The questions display in a mobile application and its process can be easy to understand due to a user friendly and useful mobile application.

- The preliminary and analyzed factors for creating problems

Factors that has effect on starting a fire

HIGH PRIORITY

HUMAN FAULS

1. People unattended with stoves, ovens, toasters, clothing irons, barbecues, candles.
2. Barbecue grilling in a building.
3. Careless use of cooking appliances.
4. Smoking in a building.
5. Careless disposal of flammable garbage.

EQUIPMENT

6. Hot work.
7. Keep torn sockets, wires or other parts.
8. Improper installations of boilers, chimneys, flue sources, heaters, fuel sources, candles, matches, ovens.
9. Main switch does not turn off in critical stages.
10. Non maintenance and non-repairing electrical components and technical components.

MATERIALS

11. Chemicals reaction.
12. Combustible materials in heating areas.
13. Non-labeling and storing of flammable materials.

NATURAL

14. Adverse climatic condition.
15. Lightning.

SECONDARY PRIORITY

HUMAN FAULS

16. Improper cording for temporary installations.
17. Unqualified electricians.
18. Keep children pets in heating areas.
19. Ignorance of technical equipment cleaning.

EQUIPMENT

20. Turn on, electronic devices even when they are not needed.
21. Rodent damage to electrical wiring and equipment.
22. Nonuse of lightning conductors.
23. Ignorance of longevity of electrical components and technical components.
24. Portable heaters.

MATERIALS

25. Burning materials in sunburned area.
26. Unlimited use of flammable materials.

REGULATIONS

27. Improper regulations of temperature and moisture in a buildings.
28. Incorrect guidance about all technical and electrical usage.
29. Improper guidance for technical equipment cleaning.

LOW PRIORITY

HUMAN FAULS

30. Improper short term services
31. Improper practice of short term employees.
32. Improper Space Management.
33. Employee Congestion.

EQUIPMENT

34. Isolation of heating areas.
35. Keep electronic accessories unclearly.
36. Low quality technical and electrical accessories.
37. More plugs in a buildings.
38. Use plug in power bars.

MATERIALS

39. Smoking materials on the floor.

NATURAL

40. Sun burn
41. Condensation.
42. Flood risk.

OTHER

43. Generate of grease in sewage pipes (Cleanness sewage pipes.)
44. Unauthorized access of the building.
45. Low Security.

Factors that has effect on stop starting a fire

HIGH PRIORITY

HUMAN

1. Workers of building design consist with proper skills and abilities (mason, carpenter, electrician).
2. Awareness of all the people about fire safety.
3. Appoint knowledge team to determine fire risks and distribute it.
4. Regularly advertise via leaflets or electric media on fire safety.

EQUIPMENT

5. Cover construction, installation and use of boilers, chimneys, fuel sources, heaters.
6. Control heating efficiency of boilers.
7. Attend with ovens, stoves, toasters, clothing irons, barbecues.
8. Heat equipment well away from walls, furniture, curtains and other combustion materials.
9. Careful about overheating equipment.

MATERIALS

10. Remove combustion material in sunburned area.
11. Control ignition and fuel sources.
12. Labeling the combustion materials using measurable property.
13. Careful use candles, matches, cooking appliances related to fire.
14. Store containers of cooking oil, combustion materials well away from heating sources.
15. Use fire resistance materials.
16. Use right amount of flammable materials and Store excess properly.

NATURAL

17. Adverse climatic condition.

REGULATIONS

18. Proper Regulations for temperature, moisture and humidity in a building
19. Gain advices from fire engineers to identify risk.

OTHER

20. Ensure all the utilities, gas lines, circuit breakers, appliances, shutoff fuses.
21. Wire cords do not run across doorways, under carpets.
22. Inspect about broken light wires torn sockets before install a light.
23. Use fire resistance protective clothing for hot work.
24. Testing space heating.

SECONDARY PRIORITY

HUMAN

25. Remove children and pets away from cooking areas, heating areas and electrical accessories.

EQUIPMENT

26. Cover the design, installation, inspection, and testing of electrical components.
27. Use lightning conductor.
28. Repair and replace electrical cords and components.
29. Use alternatives for portable heaters.
30. Turn off technical equipment after using it.
31. Concern longevity of electrical and technical equipment.
32. Good quality technical and electrical accessories.

MATERIALS

33. Turn off heating sources away from burning materials. (Heaters).
34. Use highly flammable materials with less flammable ones as it can.

NATURAL

35. A wall that is planted to improve air quality.

REGULATIONS

36. Building follow Green principals.
37. Standards for ventilation and air quality in a building.
38. Guidance and awareness to the cleaning section about equipment.
39. Guidance about all technical and electrical usage.
40. Standards for number of plugs in a buildings.
41. Standards for outlet extenders (plug in power bars)
42. Regulations for barbecue grilling.

OTHER

43. Consider structure of a building.(resistance to collapse, resistance to fire penetration, resistance to transfer excessive heat.)
44. Use proper lights minimally and turn it off after using.
45. Do hot work if no satisfactory alternatives. (welding, flame cutting, soldering, brazing, grinding)

LOW PRIORITY

HUMAN

46. All the employees have proper knowledge of their duty.
47. Properly designed short term services and installations.
48. Give proper practice for short term employee of their duty.
49. Tighten up security to avoid unauthorized access.
50. Install employee to minimize congestion.

EQUIPMENT

51. Controls hot water storage of hot water system.
52. Clean around heat sources and electrical components.
53. Install CCTV camera to detect unnecessary activities.
54. Control Air cooling or Air conditioning systems.
55. Properly install of temporary installations.

NATURAL

56. Gain actions for natural disasters. (Flood risk).

REGULATIONS

57. Standards for washing facilities, bathrooms and hot water provision.
58. Proper Standards for beautification lights, fans, lamps, and temporary installations.
59. Check standard time period of constructing.

OTHER

60. Create movable walls to gain effective space.
61. Proper space management.
62. Supply proper sewage infrastructure and maintenance.
63. Conservation the fuel and power.
64. Use light bulbs with recommended wattage for each lamp.
65. Control condensation.
66. Maintain proper pest control to avoid rodent damage to electric wiring and equipment.

Factors that has effect on spreading a fire

HIGH PRIORITY

HUMAN

01. Incorrect operations of active and passive protection measures.
02. People ignorance of fire separation.
03. Inconvenience for firefighting.
04. Occupants not concern about fire detectors.

EQUIPMENT

05. Mechanical ventilation. (Fan)
06. Absence of fire detectors.
07. Fire alarms in incorrect positions.
08. Disconnected batteries in fire alarm systems.

09. Incorrect usage of oxygen equipment.

MATERIALS

10. More Chemicals and combustion materials.
11. More size, concentration, composition, incorrect location of fuel sources.
12. Having additional fuel sources.
13. Non heat insulated goods.
14. More fuel loads. (Fabric and contents)
15. Extensive decoration and objects block the interior doors.
16. Use of heat conductive materials.

NATURAL

17. Natural ventilation.
18. Weather conditions.

REGULATIONS

19. Improper standards of the building.
20. Not regulations for fire safety.

OTHER

21. Adjoining properties in the building.
22. Adjoining buildings.
23. Too deep buildings.
24. Sizes of openings are high.
25. Poor arrangement of communication to a control and response center.
26. Absence of fire barriers.
27. Block entrance of the buildings.
28. Broken items in a buildings.

SECONDARY PRIORITY

HUMAN

29. Not facilities for disable people.

30. Not concern about hearing and visual impairment persons and people with physically disabled.

NATURAL

31. Unable to control smoke.

OTHER

32. Improper space management.
33. Not properly manage the escape routes.

LOW PRIORITY

REGULATIONS

34. Improper guidance for escape.

Factors that has effect on stop spreading a fire

HIGH PRIORITY

HUMAN

01. People awareness of fire separation.
02. Access and supply facilities for firefighting.
03. Gain advices from fire engineers to design safeguards and control the spread of fire.
04. Ensure occupants are informed any active fire systems.
05. Ensure employees that are aware of their responsibility to report dangers.

EQUIPMENT

06. High pressure laminate panel.
07. Control mechanical ventilation and air conditioning system. (Fan)
08. Ensure fire detecting systems are available. (Sprinklers, fire detection and alarm systems, smoke detectors, carbon monoxide detectors)
09. Fire detection systems link with fire brigade or a remote monitoring center.
10. Provide additional facilities to the firefighting. (Firefighting lift, Firefighting lobby).
11. Keep fire extinguishers handy.

12. Check for lost or disconnected batteries in fire alarm systems.
13. Set fire alarms in right position. (Not heating area).
14. Correct and careful operation with oxygen equipment.

MATERIALS

15. Proper materials in the buildings parts.
16. Limit the fuel load in a buildings. (Fabric and contents of the buildings)
17. Use the fire resistance to the materials. (Timber, other suitable contents)
18. Control flammable materials and fuel in the store.
19. Use fire insulation, electric insulation and thermal insulation.
20. Control sources of ignition.
21. Reduce the use of heat conductive materials.

NATURAL

22. Control the high smoke in a building (using high pressure).

REGULATIONS

23. Building follow a proper standards for materials and technical.
24. Provide guidance about regulations in a fire situations in a building.
25. Provide minimum fire safety standards for building premises.

OTHER

26. Compartment in a building. (Barrier to spread of smoke, heat, toxic gasses).
27. Cavity fill insulation systems. (Insulation of thermal)
28. Non-structural cladding system for the external walls.
29. Control oxygen supplying to an internal building.(Limit the opening to the out)
30. Check arrangement of communication to a control and response center.
31. Manage and maintain fire barriers. (Fire door: resistance, proper lacking)
32. Avoid extensive decoration of interior doors to block entry.
33. Don’t put objects interfere with the corridor and block the exit.
34. Don’t set outside environment as it will block the entrance.

35. Renew broken items in a building (broken windows and doors, hole in ceiling, broken walls).

SECONDARY PRIORITY

HUMAN

36. Make everyone in a building aware the escape plan.

EQUIPMENT

37. Installations of warning devices for hearing and visual impairment persons.
38. Installations of remote controls door opening equipment for people with physically challenges.
39. Keep extra battery to a fire detecting systems.

MATERIALS

40. Control the insulation values of the building materials.

OTHER

41. Proper space management.
42. Make an escape route to the final exit.
43. Escape routes should be easily access.

LOW PRIORITY

HUMAN

44. Provide facilities for disabled people.
45. Concern people with mobility problems.
46. Make sure children's belief in fire hoses.

All the system is created based on those factors. And also this is the main research components of this system.

3.4.2.5. Temperature and humidity risk UI and its functionalities

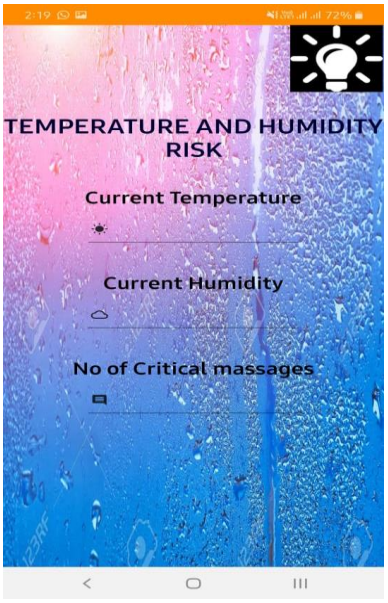


Figure 36: Temperature and humidity risk UI

The figure 3.4.2.5(a) shows the temperature and humidity risk UI. As I mentioned previously, the current temperature and humidity is displayed in this system. If the current temperature and humidity is greater than or equal to the system conditions such as temperature greater than 32 Celsius and humidity lower than 74% (Both conditions should be satisfied), the system is sent a message to the user by informing the situation. And also the white bulb in the upper right corner of the UI turns red in this moment. Those are the average high temperature and humidity of the Sri Lanka. If the system reaches to this measurements then there is a possibility to cause a fire. But it is not a critical stage and user has time to get actions against it. And also then user can check and easily identify weakness of a building using check safety UI because there is enough time to get actions to avoid it. This measurements found in previous innovations and fire department statistics. This is the main scenario of this system.

3.4.2.6. Help UI and its functionalities

Figure 37: Help UI

The figure 3.4.2.6 (a) shows the help UI of the mobile application. As I mentioned previously, Using this UI, user can connect fire brigades directly because the mobile application has been linked with fire brigades via phone number. If there is a critical stage, user should only need to do click the particular button. Then automatically the call sends to the fire brigades. If you want send a message to the fire brigade with more details, this facility is also provided to the user within this system. The users should only need to do that the massage is typed in relevant boxes and click the particular button. It is also sent to the fire brigade because the system is linked with fire brigade via phone number. It should be easy to identify because of user friendly application. This is the main scenario of the help UI.

3.4.2.7. No of users UI and its functionalities

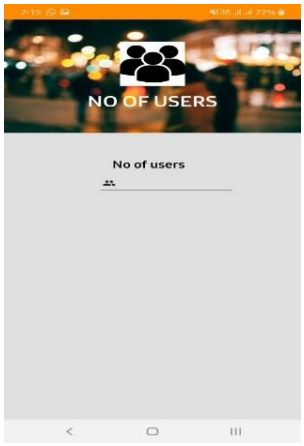


Figure 38: No of users UI

The figure 3.4.2.7 (a) shows No of users UI of the mobile application. Using this UI, user can get an idea about number of users of the application. Then it may be important to users to get an idea about mobile application success.

In the future, this application will be improve using other factors such as wind (direction and intensity).

CHAPTER 04

RESULTS AND DISCUSSION

4.1. RESULTS

In here, the results come under two main topics. They are check safety UIs and temperature and humidity risk UI. I n this research, the main aim is that provide a great safe for all people and properties from a fire before it is happen by detecting fire early using this system which is based on hardware and software.

4.1.1. Check safety UI

This process has been described in previous chapters. According to this section, the following found results will be described. In here, this is an example of result which is got based on a particular building. And also there are several kind of results got based on more building. Those results will be analyzed in the next sections.

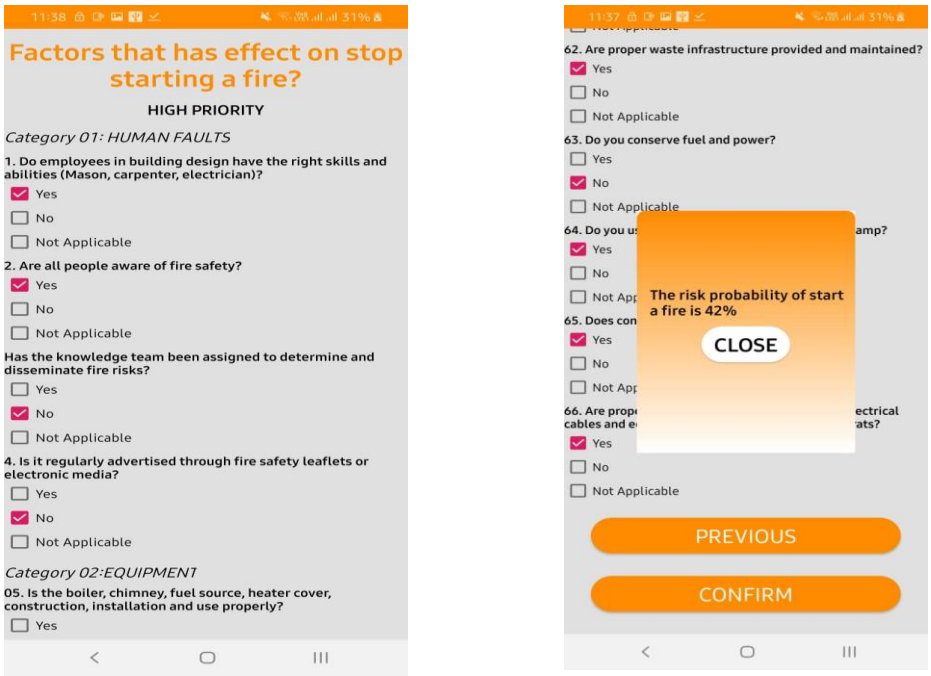


Figure 39: Results for probability of start a fire

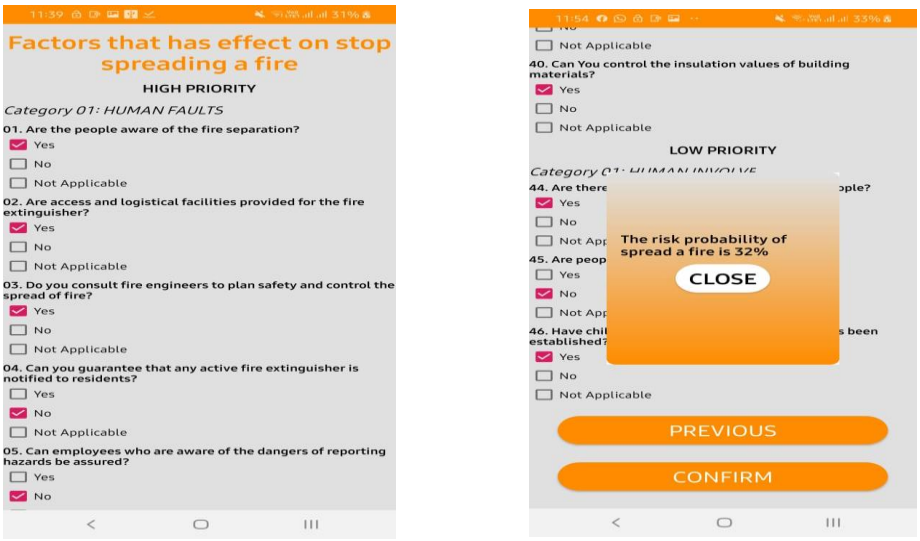


Figure 40: Results for probability of spread a fire

According to figure 4.1.1(a) and figure 4.1.1(b) results, it shows the probability for start a fire and a spread a fire based on that particular function.

Table 6: Analyze of probabilities

	No of buildings (probability>=50%)	No of buildings (probability<50%)
probability of start a fire	6	14
probability of spread a fire	5	15

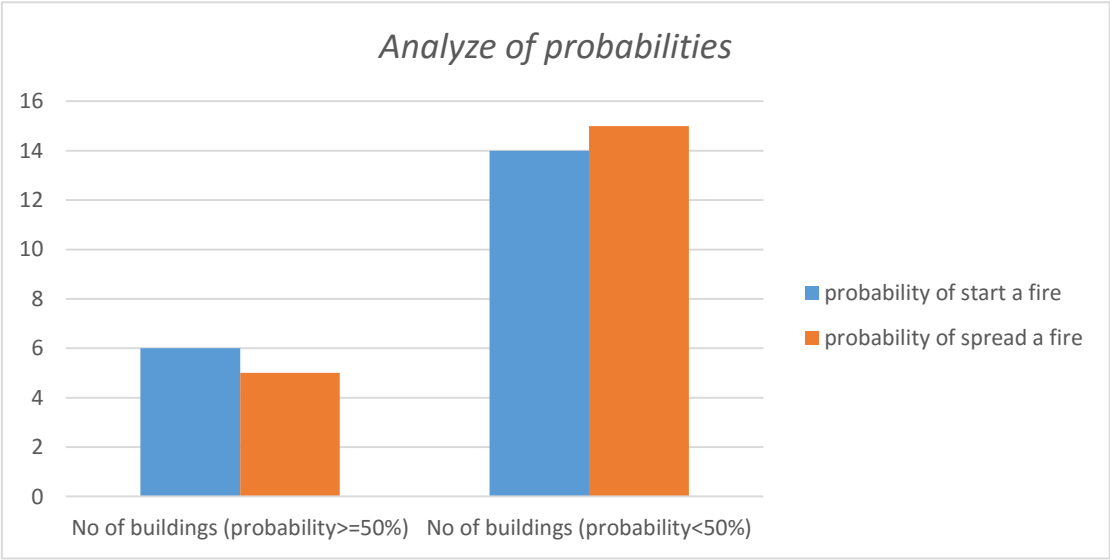


Figure 41: Analyze of probabilities

According to above analysis, it shows the summary of results that are taken from using the system. All the building in some risk from a fire but it is too small. But the main point is that we can reduce those risk by y becoming aware of the surroundings. For that purpose, this application may be more help.

4.1.2. Temperature and humidity Risk

Figure 42: Results of temperature and humidity risk

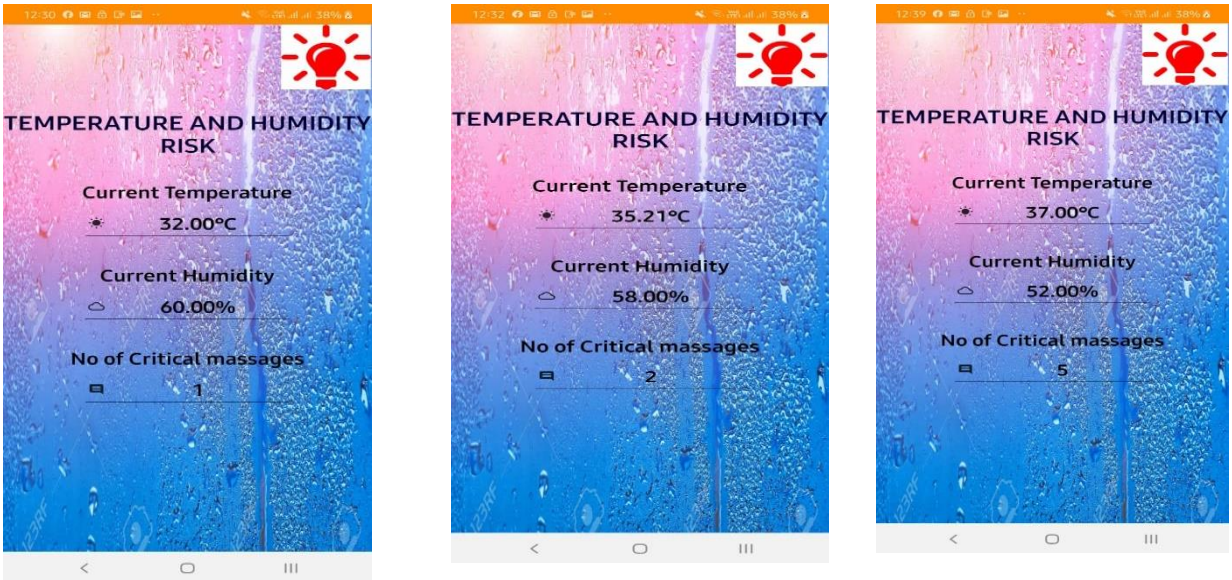


Figure 43: Results of temperature and humidity risk

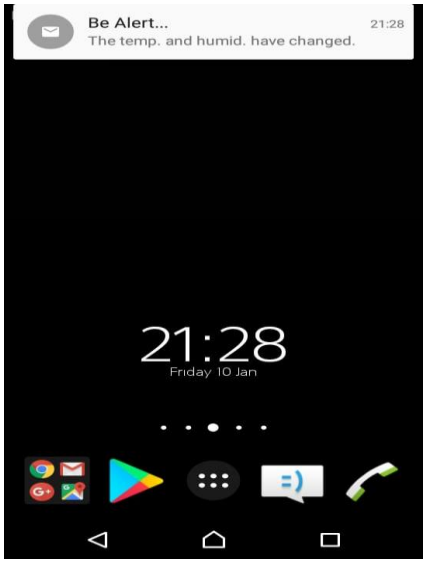


Figure 44: Notification of temperature and humidity risk

According to above results, the system show notifications that the temperature greater than 32 Celsius and humidity lower than 74%. If the user login in to the system, all the update details come to the particular mobile phone and those risk level can identify using bulb of the right corner of the application (white bulb turns red in the risk level). And also user can identify fire risk, Then the users can get early actions against the fire occurring.

4.2. DISCUSSION

As I mentioned previously, the main aim of research is that find a solution for the fire prevention. If we get first facility, first challenge is that find all the factors that are effected for the fire. Using fire department statistics and past research articles, found all kind of factors and analyze them according to criticality. This analyze part is done very carefully. Because it is affected deeply for entire process. According to all the final results and their analysis, the fire risk can be reduce by using this application.

If we get second facility which is the temperature and humidity risk notification, it also has emerged some problems related to the hardware. When hardware parts comes to choosing, we should consider efficiency and accuracy of the hardware. We should choose related

hardware parts by considering above mentioned qualities. To get accuracy and efficiency values, the basic stuff is to choose well hardware parts. Then using software and database, the final output can be get successfully.

Other application facilities such as help facility that is also help to get a call to the fire brigades in a critical situation. Combination of all the facilities give users to genius support to protect from a fire.

CHAPTER 05

CONCLUSIONS AND RECOMMENDATIONS

5.1. CONCLUSIONS

According to complete system, I concluded that all the building are in some fire risk but it is not a critical stage. Therefore, they can be make those mistakes and then can protect from a fire. The main important thing is that they should need to be taken care of the environmental changes. It can be done by using this system.

And also according to these results, temperature and humidity is changing all the times. But, if those values increase within a short period of time, directly there is a main reason in environment for that change.

Wireless technology such as Wi-Fi and cloud networking are used in communication between devices and user interfaces to avoid the drawbacks of wired communication which in turn reduce costs. Due to the use of the cloud network, automation systems can be managed from anywhere in the world. Final conclude is that people can be control the fire occurring by taking care of changes in the environment.

5.2. RECOMMENDATIONS

The following recommendations are suggested for future implementation based on the resul ts of experimental and theoretical analysis of fire detection and notification applications. This system is only consider the humidity and the temperature for fire changes in addition to the factors that are effected for the fire starting and fire spreading. To extend this system,

- I will be decide to add other things such as wind direction and wind speed to this system. Then we can be get more accurate values than this system values. Because wind speed and direction is also effected to the fire occurring and fire spreading.
- And also we can control equipment such as heaters, fans according to their changes to minimize severity.
- We can active sprinklers to reduce the fire. In the future works, I will be add those kind of features to this system.
- And also the check safety facility will be extend by adding locations of the criticality.

APPENDIX

Appendix - A

01. Register page

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
    xmlns:app="http://schemas.android.com/apk/res-auto"
    xmlns:tools="http://schemas.android.com/tools"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    android:orientation="vertical"
    tools:context=".Register"
    android:background="#E0E0E0"
    >
    <TextView
        android:id="@+id/textView2"
        android:layout_width="match_parent"
        android:layout_height="wrap_content"
        android:layout_marginTop="76dp"
        android:text="REGISTRATION"
        android:textAlignment="center"
        android:textStyle="bold"
        android:textColor="#FF8C00"
        android:textSize="30dp"
         />
    <ImageView
        android:id="@+id/imageView"
        android:layout_width="120dp"
        android:layout_height="150dp"
        android:background="@drawable/register"
        android:layout_gravity="center"
        android:layout_marginTop="10dp"
         />
    <EditText
        android:id="@+id/fullName"
        android:layout_width="match_parent"
        android:layout_height="wrap_content"
        android:layout_marginBottom="10dp"
        android:ems="10"
        android:hint="Full Name"
        android:inputType="textPersonName"
        android:textColor="#000000"
         />
    <EditText
        android:id="@+id/Email"
```

```
    android:layout_width="match_parent"
    android:layout_height="wrap_content"
    android:layout_marginBottom="10dp"
    android:ems="10"
    android:hint="Email"
    android:inputType="textEmailAddress"
    android:textColor="#000000"
     />
<EditText
    android:id="@+id/password"
    android:layout_width="match_parent"
    android:layout_height="wrap_content"
    android:layout_marginBottom="10dp"
    android:ems="10"
    android:hint="Password"
    android:inputType="textPassword"
    android:textColor="#000000"
  />
<EditText
    android:id="@+id/phone"
    android:layout_width="match_parent"
    android:layout_height="wrap_content"
    android:layout_marginBottom="10dp"
    android:ems="10"
    android:hint="Phone"
    android:inputType="textPhonetic"
    android:textColor="#000000"
    />
<Button
    android:id="@+id/registerBtn"
    android:layout_width="match_parent"
    android:layout_height="wrap_content"
    android:layout_marginTop="10dp"
    android:layout_marginLeft="20dp"
    android:layout_marginRight="20dp"
    android:background="@drawable/button_boader"
    android:text="REGISTER"
    android:textColor="#FFFFFF"
    android:layout_gravity="center"
  />
<TextView
    android:id="@+id/createText"
    android:layout_width="wrap_content"
    android:layout_height="wrap_content"
    android:layout_marginTop="10dp"
    android:text="Already registered?Login here."
    android:layout_gravity="center"
```

```
        android:textColor="#CC6600"
         />
    <ProgressBar
        android:id="@+id/progressBar"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:visibility="invisible"
        android:layout_marginTop="5dp"
        android:layout_gravity="center"
        />
</LinearLayout>
```

02. Login page

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
    xmlns:app="http://schemas.android.com/apk/res-auto"
    xmlns:tools="http://schemas.android.com/tools"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    android:orientation="vertical"
    tools:context=".LoginActivity"
    android:background="#E0E0E0"
/>
    <TextView
        android:id="@+id/textView"
        android:layout_width="match_parent"
        android:layout_height="wrap_content"
        android:layout_marginTop="76dp"
        android:text="LOGIN"
        android:textAlignment="center"
        android:textStyle="bold"
        android:textColor="#FF8C00"
        android:textSize="30dp"
        />
    <ImageView
        android:id="@+id/imageView2"
        android:layout_width="187dp"
        android:layout_height="143dp"
        android:background="@drawable/login"
        android:layout_gravity="center"
        />
    <EditText
        android:id="@+id/Email"
        android:layout_width="match_parent"
```

```
    android:layout_height="wrap_content"
    android:layout_marginBottom="20dp"
    android:drawableLeft="@drawable/ic_action_user"
    android:ems="10"
    android:hint="Email"
    android:inputType="textEmailAddress"
    android:textColor="#000000"
    />
<EditText
    android:id="@+id/password"
    android:layout_width="match_parent"
    android:layout_height="wrap_content"
    android:drawableLeft="@drawable/ic_action_lock"
    android:ems="10"
    android:hint="Password"
    android:inputType="textPassword"
    android:textColor="#000000"
    />
<Button
    android:id="@+id/loginBtn"
    android:layout_width="350dp"
    android:layout_height="wrap_content"
    android:layout_marginTop="16dp"
    android:layout_marginLeft="20dp"
    android:layout_marginRight="20dp"
    android:background="@drawable/button_boader"
    android:text="LOGIN"
    android:textColor="#FFFFFF"
    android:layout_gravity="center"
    />
<TextView
    android:id="@+id/createText"
    android:layout_width="wrap_content"
    android:layout_height="wrap_content"
    android:layout_marginTop="16dp"
    android:text="New here? Create Account"
    android:textColor="#ff8C00"
    android:layout_gravity="center"
/>
<ProgressBar
    android:id="@+id/progressBar"
    android:layout_width="wrap_content"
    android:layout_height="wrap_content"
    android:visibility="invisible"
    android:layout_marginTop="5dp"
    android:layout_gravity="center"
```

```
    />
</LinearLayou
```

03. Main page

```
<?xml version="1.0" encoding="utf-8"?>
<RelativeLayout xmlns:android="http://schemas.android.com/apk/res/android"
    xmlns:app="http://schemas.android.com/apk/res-auto"
    xmlns:tools="http://schemas.android.com/tools"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    android:background="#E0E0E0"
    tools:context=".MainActivity">

    <ScrollView
        android:layout_width="fill_parent"
        android:layout_height="fill_parent"
        android:layout_alignParentTop="true"
        android:layout_alignParentLeft="true"
        />
        <LinearLayout
            android:layout_width="fill_parent"
            android:layout_height="fill_parent"
            android:orientation="vertical">
            <RelativeLayout
                android:layout_width="fill_parent"
                android:layout_height="fill_parent">
                <LinearLayout
                    android:layout_width="match_parent"
                    android:layout_height="230dp"
                    android:orientation="vertical"
                    android:gravity="center"
                    android:background="@drawable/back">
                    <ImageView
                        android:layout_width="90dp"
                        android:layout_height="90dp"
                        android:src="@drawable/building"
                        android:layout_gravity="center"/>
                    <TextView
                        android:layout_width="wrap_content"
                        android:layout_height="wrap_content"
                        android:text="WELCOME TO THE FIRE DETECTION APP"
                        android:textColor="#ffffff"
                        android:layout_gravity="center"
                        android:textSize="18sp"
                        android:textStyle="bold"
                        android:layout_marginTop="10dp"
```

```
/>
            </LinearLayout>

            <LinearLayout
               android:layout_width="match_parent"
               android:layout_height="wrap_content"
               android:orientation="vertical"
               android:layout_marginTop="215dp"
               android:layout_marginLeft="10dp"
               android:layout_marginRight="10dp">
               <LinearLayout
                  android:layout_width="match_parent"
                  android:layout_height="160dp"
                  android:orientation="horizontal"
                  android:layout_marginBottom="10dp">
                  <androidx.cardview.widget.CardView
                     android:layout_width="0dp"
                     android:layout_height="match_parent"
                     android:layout_weight="1"
                     android:layout_gravity="center"
                     android:layout_marginRight="5dp"
                     >
                     <RelativeLayout
                        android:layout_width="match_parent"
                        android:layout_height="match_parent">
                        <ImageView
                           android:layout_width="50dp"
                           android:id="@+id/imageView1"
                           android:layout_height="50dp"
                           android:src="@drawable/buildfire"
                           android:layout_centerInParent="true"/>
                        <TextView
                           android:layout_width="wrap_content"
                           android:layout_height="wrap_content"
                           android:text="CHECK SAFETY"
                           android:textSize="16sp"
                           android:textColor="#000000"
                           android:layout_below="@+id/imageView1"
                           android:layout_centerHorizontal="true"
                           android:layout_marginTop="10dp"
                           android:layout_marginBottom="10dp"/>
                        <Button
                           android:layout_width="match_parent"
                           android:layout_height="match_parent"
                           android:id="@+id/btnSafe"
android:background="@android:color/transparent"/>
```

```
        </RelativeLayout>
    </androidx.cardview.widget.CardView>
    <androidx.cardview.widget.CardView
        android:layout_width="0dp"
        android:layout_height="match_parent"
        android:layout_weight="1"
        android:layout_gravity="center"
        android:layout_marginLeft="5dp"
        >
        <RelativeLayout
            android:layout_width="match_parent"
            android:layout_height="match_parent">
            <ImageView
                android:layout_width="50dp"
                android:id="@+id/imageView2"
                android:layout_height="50dp"
                android:src="@drawable/temperature"
                android:layout_centerInParent="true"/>
            <TextView
                android:layout_width="wrap_content"
                android:layout_height="wrap_content"
                android:text="TEMPERATURE and HUMIDITY RISK"
                android:textSize="16sp"
                android:textColor="#000000"
                android:layout_below="@+id/imageView2"
                android:layout_centerHorizontal="true"
                android:layout_marginTop="10dp"
                android:layout_marginBottom="10dp"
                android:gravity="center"/>
            <Button
                android:layout_width="match_parent"
                android:layout_height="match_parent"
                android:id="@+id/btnTemp"
            android:background="@android:color/transparent"/>

        </RelativeLayout>

    </androidx.cardview.widget.CardView>
</LinearLayout>
<LinearLayout
    android:layout_width="match_parent"
    android:layout_height="160dp"
    android:orientation="horizontal"
    android:layout_marginBottom="10dp">
    <androidx.cardview.widget.CardView
        android:layout_width="0dp"
        android:layout_height="match_parent"
```

```
                android:layout_weight="1"
                android:layout_gravity="center"
                android:layout_marginRight="5dp"
                >
                <RelativeLayout
                    android:layout_width="match_parent"
                    android:layout_height="match_parent">
                    <ImageView
                        android:layout_width="50dp"
                        android:id="@+id/imageView4"
                        android:layout_height="50dp"
                        android:src="@drawable/help"
                        android:layout_centerInParent="true"/>
                    <TextView
                        android:layout_width="wrap_content"
                        android:layout_height="wrap_content"
                        android:text="HELP"
                        android:textSize="16sp"
                        android:textColor="#000000"
                        android:layout_below="@+id/imageView4"
                        android:layout_centerHorizontal="true"
                        android:layout_marginTop="10dp"
                        android:layout_marginBottom="10dp"/>
                    <Button
                        android:layout_width="match_parent"
                        android:layout_height="match_parent"
                        android:id="@+id/btnHelp"
android:background="@android:color/transparent"/>

                </RelativeLayout>

            </androidx.cardview.widget.CardView>
            <androidx.cardview.widget.CardView
                android:layout_width="0dp"
                android:layout_height="match_parent"
                android:layout_weight="1"
                android:layout_gravity="center"
                android:layout_marginLeft="5dp"
                >
                <RelativeLayout
                    android:layout_width="match_parent"
                    android:layout_height="match_parent">
                    <ImageView
                        android:layout_width="50dp"
                        android:id="@+id/imageView3"
                        android:layout_height="50dp"
                        android:src="@drawable/users"
```

```
                    android:layout_centerInParent="true"/>
                <TextView
                    android:layout_width="wrap_content"
                    android:layout_height="wrap_content"
                    android:text="NO OF USERS"
                    android:textSize="16sp"
                    android:textColor="#000000"
                    android:layout_below="@+id/imageView3"
                    android:layout_centerHorizontal="true"
                    android:layout_marginTop="10dp"
                    android:layout_marginBottom="10dp"/>
                <Button
                    android:layout_width="match_parent"
                    android:layout_height="match_parent"
                    android:id="@+id/btnUsers"
android:background="@android:color/transparent"/>

                </RelativeLayout>

            </androidx.cardview.widget.CardView>
        </LinearLayout>
    </LinearLayout>
  </RelativeLayout>
 </LinearLayout>
</ScrollView>
</RelativeLayout>
```

Appendix – B

04. Check safety page

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
    xmlns:app="http://schemas.android.com/apk/res-auto"
    xmlns:tools="http://schemas.android.com/tools"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    tools:context=".CheckSafety"
    android:orientation="vertical"
    android:background="@drawable/back"
/>
    <TextView
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_marginTop="50dp"
        android:textAlignment="center"
```

```
    android:layout_gravity="center"
    android:text="CHECK SAFETY"
    android:textSize="30dp"
    android:textColor="#FF8C00"
    android:textStyle="bold"
    />
<Button
    android:layout_width="300dp"
    android:layout_height="wrap_content"
    android:id="@+id/BtnSafe01"
    android:text="SAFETY O1"
    android:textColor="#000000"
    android:textStyle="bold"
    android:textSize="25dp"
    android:textAlignment="center"
    android:layout_gravity="center"
    android:layout_marginTop="80dp"
    android:background="@drawable/button_border2"
    />
<Button
    android:layout_width="300dp"
    android:layout_height="wrap_content"
    android:id="@+id/BtnSafe02"
    android:text="SAFETY 02"
    android:textColor="#000000"
    android:textStyle="bold"
    android:textSize="25dp"
    android:textAlignment="center"
    android:layout_gravity="center"
    android:layout_marginTop="80dp"
    android:background="@drawable/button_border2"
    />
<Button
    android:layout_width="300dp"
    android:layout_height="wrap_content"
    android:id="@+id/BtnSafe03"
    android:text="Safety 03"
    android:textColor="#000000"
    android:textStyle="bold"
    android:textSize="25dp"
    android:textAlignment="center"
    android:layout_gravity="center"
    android:layout_marginTop="80dp"
    android:background="@drawable/button_border2"
    />
<Button
    android:layout_width="300dp"
```

```
        android:layout_height="wrap_content"
        android:id="@+id/BtnSafe04"
        android:text="SAFETY 04"
        android:textColor="#000000"
        android:textStyle="bold"
        android:textSize="25dp"
        android:textAlignment="center"
        android:layout_gravity="center"
        android:layout_marginTop="80dp"
        android:background="@drawable/button_border2"
        />
</LinearLayout>
```

05. Temperature and Humidity Risk page

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
    xmlns:app="http://schemas.android.com/apk/res-auto"
    xmlns:tools="http://schemas.android.com/tools"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    tools:context=".TemperatureAndHumidityRisk"
    android:orientation="vertical"
    android:background="@drawable/temperature_humidity_back"
/>
    <ImageView
        android:id="@+id/imageView"
        android:layout_width="100dp"
        android:layout_height="100dp"
        android:background="@drawable/redbulb"
        android:layout_marginLeft="310dp"
        />
    <TextView
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:text="TEMPERATURE AND HUMIDITY RISK"
        android:textStyle="bold"
        android:textSize="30dp"
        android:textAlignment="center"
        android:textColor="#000033"
        android:layout_marginTop="30dp"
        />
    <TextView
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
```

```
        android:text="Current Temperature"
        android:textSize="25dp"
        android:textColor="#000000"
        android:textStyle="bold"
        android:textAlignment="center"
        android:layout_gravity="center"
        android:layout_marginTop="35dp"
        />
    <EditText
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_gravity="center"
        android:layout_marginTop="5dp"
        android:drawableLeft="@drawable/ic_action_temp"
        android:ems="8"
        android:text="38.70℃"
        android:textAlignment="center"
        android:textColor="#000000"
        android:textSize="25dp"
        android:textStyle="bold"
/>
    <TextView
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:text="Current Humidity"
        android:textSize="25dp"
        android:textColor="#000000"
        android:textStyle="bold"
        android:textAlignment="center"
        android:layout_gravity="center"
        android:layout_marginTop="35dp"
        />
    <EditText
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_gravity="center"
        android:layout_marginTop="5dp"
        android:drawableLeft="@drawable/ic_action_humidity"
        android:ems="8"
        android:text="48.50%"
        android:textAlignment="center"
        android:textColor="#000000"
        android:textSize="25dp"
        android:textStyle="bold"
/>
    <TextView
        android:layout_width="wrap_content"
```

```
        android:layout_height="wrap_content"
        android:text="No of Critical massages"
        android:textSize="25dp"
        android:textColor="#000000"
        android:textStyle="bold"
        android:textAlignment="center"
        android:layout_gravity="center"
        android:layout_marginTop="35dp"
        />
    <EditText
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:textColor="#000000"
        android:textStyle="bold"
        android:textAlignment="center"
        android:layout_gravity="center"
        android:layout_marginTop="5dp"
        android:ems="8"
        android:text="6"
        android:textSize="25dp"
        android:drawableLeft="@drawable/ic_action_massages"
        />
</LinearLayout>
```

06. Help page

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
    xmlns:app="http://schemas.android.com/apk/res-auto"
    xmlns:tools="http://schemas.android.com/tools"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    tools:context=".Help"
    android:orientation="vertical"
    android:background="@drawable/back"
/>
    <TextView
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:text="HELP"
        android:textStyle="bold"
        android:textSize="30dp"
        android:textAlignment="center"
        android:layout_gravity="center"
        android:textColor="#FF8C00"
```

```
    android:layout_marginTop="40dp"
    />
<Button
    android:layout_width="wrap_content"
    android:layout_height="wrap_content"
    android:id="@+id/BtnEmergency"
    android:text="Emergency Call"
    android:textColor="#000000"
    android:textStyle="bold"
    android:textSize="25dp"
    android:textAlignment="center"
    android:layout_gravity="center"
    android:layout_marginTop="80dp"
    android:drawableLeft="@drawable/ic_action_call"
    android:background="@drawable/button_border2"
    />
<TextView
    android:id="@+id/TxtMoreInfo"
    android:layout_width="wrap_content"
    android:layout_height="wrap_content"
    android:layout_marginTop="20dp"
    android:text="For More Information"
    android:layout_gravity="center"
    android:textColor="#FFFFFF"
    android:textSize="20dp"
    android:textStyle="bold"
    />
<EditText
    android:id="@+id/EtMoreInfo"
    android:layout_width="match_parent"
    android:layout_height="wrap_content"
    android:layout_marginBottom="10dp"
    android:lines="10"
    android:hint="send a massage to a fire department by describing situation"
    android:textColor="#FFFFFF"
    android:textColorHint="#FFFFFF"
    android:layout_marginLeft="30dp"
    android:layout_marginRight="30dp"
    />
<Button
    android:layout_width="150dp"
    android:layout_height="wrap_content"
    android:id="@+id/BtnMasseges"
    android:text="Send Massage"
    android:textColor="#000000"
    android:layout_gravity="center"
    android:textStyle="bold"
```

```
        android:background="@drawable/button_border2"
        />
</LinearLayout
```

07. No Of Users page

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
    xmlns:app="http://schemas.android.com/apk/res-auto"
    xmlns:tools="http://schemas.android.com/tools"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    tools:context=".NoOfUsers"
    android:orientation="vertical"
    android:background="#E0E0E0"
/>
    <RelativeLayout
        android:layout_width="fill_parent"
        android:layout_height="fill_parent"/>
        <LinearLayout
            android:layout_width="match_parent"
            android:layout_height="230dp"
            android:background="@drawable/userback"
            android:gravity="center"
            android:orientation="vertical"
/>
            <ImageView
                android:layout_width="90dp"
                android:layout_height="90dp"
                android:layout_gravity="center"
                android:src="@drawable/users"
/>
            <TextView
                android:layout_width="wrap_content"
                android:layout_height="wrap_content"
                android:layout_gravity="center"
                android:layout_marginTop="10dp"
                android:text="NO OF USERS"
                android:textColor="#ffffff"
                android:textSize="30dp"
                android:textStyle="bold"
 />
        </LinearLayout>
        <TextView
            android:layout_width="wrap_content"
            android:layout_height="wrap_content"
            android:id="@+id/TvUser1"
```

```
        android:text="No of users"
        android:textSize="20dp"
        android:textColor="#000000"
        android:textStyle="bold"
        android:layout_marginTop="280dp"
        android:layout_marginLeft="150dp"
        />
    <EditText
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:id="@+id/EtUsers"
        android:textColor="#000000"
        android:textStyle="bold"
        android:textAlignment="center"
        android:layout_gravity="center"
        android:ems="10"
        android:drawableLeft="@drawable/ic_action_users"
        android:layout_marginTop="310dp"
        android:layout_marginLeft="130dp"
        />
  </RelativeLayout>
</LinearLayout>
```

Appendix – C

08. Safety 01 page

```
<?xml version="1.0" encoding="utf-8"?>
<RelativeLayout xmlns:android="http://schemas.android.com/apk/res/android"
   xmlns:app="http://schemas.android.com/apk/res-auto"
   xmlns:tools="http://schemas.android.com/tools"
   android:layout_width="match_parent"
   android:layout_height="match_parent"
   tools:context=".Safety01"
   android:orientation="vertical"
   android:background="#E0E0E0">
   <ScrollView
      android:layout_width="wrap_content"
      android:layout_height="wrap_content"
/>
      <LinearLayout
         android:layout_width="wrap_content"
         android:layout_height="wrap_content"
         android:orientation="vertical"
/>
   <TextView
```

```
        android:id="@+id/txtSafe01"
        android:layout_width="match_parent"
        android:layout_height="wrap_content"
        android:layout_marginTop="10dp"
        android:text="Factors that has effect on starting a fire"
        android:textAlignment="center"
        android:textStyle="bold"
        android:textColor="#FF8C00"
        android:textSize="30dp"
        />
            <TextView
                android:layout_width="wrap_content"
                android:layout_height="wrap_content"
                android:layout_marginTop="10dp"
                android:text="HIGH PRIORITY"
                android:textSize="18dp"
                android:layout_gravity="center"
                android:textColor="#000000"
                android:textStyle="bold"
/>
            <TextView
                android:layout_width="wrap_content"
                android:layout_height="wrap_content"
                android:layout_marginTop="12dp"
                android:text="Category 01: HUMAN FAULTS"
                android:textSize="18dp"
                android:textColor="#000000"
                android:textStyle="italic"
/>
            <TextView
                android:layout_width="wrap_content"
                android:layout_height="wrap_content"
                android:layout_marginTop="10dp"
                android:text="01. Are you alert to the use of stoves, ovens, toasters, clothing iron,
barbecue, candles?"
                android:textSize="15dp"
                android:textColor="#000000"
                android:textStyle="bold"
/>
            <CheckBox
                android:layout_width="match_parent"
                android:layout_height="wrap_content"
                android:id="@+id/Q1_1"
                android:text="Yes"
                android:textSize="15dp"
/>
            <CheckBox
```

```
            android:layout_width="match_parent"
            android:layout_height="wrap_content"
            android:id="@+id/Q1_2"
            android:text="No"
            android:textSize="15dp"
/>
        <CheckBox
            android:layout_width="match_parent"
            android:layout_height="wrap_content"
            android:id="@+id/Q1_3"
            android:text="Not Applicable "
            android:textSize="15dp"
/>
                    <Button
                    android:id="@+id/Safe01NextBtn"
                    android:layout_width="350dp"
                    android:layout_height="wrap_content"
                    android:layout_marginTop="20dp"
                    android:layout_marginLeft="20dp"
                    android:layout_marginRight="20dp"
                    android:layout_marginBottom="30dp"
                    android:background="@drawable/button_boader"
                    android:text="NEXT"
                    android:textSize="25dp"
                    android:textColor="#FFFFFF"
                    android:layout_gravity="center"
                    />
            </LinearLayout>
        </ScrollView>
    </RelativeLayout>
```

Other pages such as Safety 02 page, Safety 03 page and Safety 04 page are similar to the Safety 01 page.

REFERENCES

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