CHAPTER 1: INTRODUCTION

1.1 Background

Pollution is one of the emerging issues in the current era of 2018. There are different kind of pollutions such as air pollution, light pollution, water pollution, noise pollution and many others. Out of all these mentioned, the two immeasurably perilous ones are air and noise pollution. Few factors that ignite noise and air pollution such as burning of fossil fuels, industrial wastes and activities, vehicle emissions etc. Air pollution results in severe respiratory and cardiovascular diseases which can cause early death. Acid rains, water and soil quality are also caused by air pollution. According to European Union (EU), Europe is at risk of air pollution and does not meet air quality standards. (Europarl.europa.eu, 1780). Whereas noise pollution is having a rapid growth in the current world due to many different factors. The main factor that contributes to the rising audacity of noise pollution is the intensity and volume of traffic. With respect to EU findings, 20% of the world is over the standard threshold of noise pollution.

Hence, based on the above discoveries, a study of the polluting factors and their analysis is required to avoid the adverse health effects and keep the environment clean. In today's world when any organization or other sectors plans to construct an infrastructure, they take the environment clarity in stern deliberation. In Oman, the current deliberation of environment is done by experts in the market who monitor the construction site in perspective to air pollution. These experts possess ambient air quality monitoring station (AAQMS), Al Safa Environmental & Technical Services are the known experts in the field. (AETS - Oman Environmental Consultancy for audit, monitoring & EIAs, 2018). The technology used to collect the pollution statistical data is expensive, the proposed project will help produce a cost effective solution for the same increasing data efficiency and accuracy. Conversely, these experts lack technology to gather sound pollution data and perform analysis and solution to the same will prove beneficial to reducing the effects due to the same. Proposed project will aid drastically in monitoring the pollution of different areas in Oman. It will be a portable device, which can be placed at any remote location of Oman. The device will monitor the air and noise pollution of the particular area and transfer the readings to the user over the internet. This will ease the life of the individuals, government sectors and various organizations in order to monitor the pollution of Oman.

1.2 Project Motivation

The air and noise pollution analyser is being developed to improve the quality of environment. This solution will make the life easier for the organizations and government who are currently monitoring the air pollution of Oman by providing them a low cost and high efficiency work. Moreover, the project motivation is to help the people in order to have their own pollution monitoring system to live in a better and healthy environment. This will enable to user to overcome the pollutants which can cause severe diseases and secure their health life.

1.3 Aim

The aim of this project is to develop an IOT based air and noise pollution analyser using the Raspberry Pi for monitoring the hazardous air and noise pollution of a particular area in Oman in order to achieve a healthy environment.

1.4 Objective

- To review the current technologies used in Oman for monitoring air and noise pollution.
- To study the limitations of the current technologies and the challenges which were faced by the developers.
- To model the requirements needed to develop air and noise monitoring system and collect the pollution data of Oman via internet and surveys.
- To design and develop the air and noise pollution system using the Raspberry Pi and internet of things technology.
- To perform the complete testing of the system by implementing it in different areas of Oman like Ghala, Muscat and Sur in order to validate the results.

1.5 Project Feasibility

1.5.1 Technical Feasibility

The air and noise pollution analyser using IOT is taking the data from the surrounding and enable the users to overview the pollution in their respective environment. It displays the readings over the internet onto a web solution as well as onto the liquid crystal display which is implemented within the circuit. More details about the design and performance is available in Chapter 3. These requirements and functionality is feasible by using Raspberry Pi 3 with C programming. It can interrelate with all the components using the C programming language. This project will encourage and attract a lot of audience due to its uniqueness in the market and high efficiency that it offers.

1.5.2 Economic Feasibility

The project costing is done by using two costing methods analogous costing and expert judgement. Where the project costing is done by looking at the components available and asking the expertise about the expenditure of the project. Basic COCOMO model was used in order to analyse the time which will be taken for the development of project. The time which was calculated is 6.19 months which is suitable for the feasibility of this project. The resources that are required for this project are easily available online and few of them are available locally. The project costing is done and the evaluation is shown in the Appendix. After performing the costing analysis, it states that the project will cost around 97 OMR which is economically feasible.

1.6 Thesis Outline

This report emphasis on the different stages that will be undergone in the development of IOT air and noise pollution analyser system. The report possess 4 chapters. The first chapter focuses on the introduction of the air and noise pollution monitoring system. This chapter outlines aim, objectives, background motivation and feasibility. The second chapter is literature review which showcases the previous work done by other authors and researchers. This is done in other to overview the weaknesses, strengths and methods that were used by previous authors. Chapter three showcases the working principal of the proposed project and the pre design, which means that the tool which will be required for the project. Chapter four gives a brief summary about the overall project.

1.7 Project Challenges

In the development of this project there are many challenges that could arise. The core challenge that will be faced is in the implementation phase of air and noise pollution monitoring system. The components should be integrated with each other such as Raspberry Pi 3 should be communication with the air quality sensor, microphone, wifi module and the liquid crystal display. The circuit which will be developed to integrate all the modules together is complex, therefore the integration of all the components should be precise and robust. The transformer that is being used is converting 22V to 12V and Raspberry Pi 3 can only work with a maximum of 5V. In order to achieve the consistent 5V, there electrical circuit is quite delicate and any error will burn the entire Raspberry Pi 3. Another main challenge which will be faced is the performance of the project in regards to the coding done on the Raspberry Pi 3, the coding will be done in C programming and it should be without any errors and very precise in order to make

the communication of all the modules and the server smooth and enhance the overall performance of the system.

1.8 Summary

This chapter focused on the background of the project which states the need of air and noise pollution monitoring system. Along with the project motivation which sheds light in the project benefits towards the user and the environment. Aim of the project is stated in order to showcase the focal point of the project. Main objectives of the project are discussed in the chapter while discussing about the feasibility of the project in the current world scenario. Feasibility is further divided into two parts, technical feasibility which emphasis on technical support which will be needed for the project and economic feasibility which states that the project can be accomplished with suitable expenditure. Thesis outline discusses about the different chapters in the report and challenges which will be tackled in the project development are also stated in this chapter.

CHAPTER 2: LITERATURE REVIEW

Literature review is the deep study of previous work done by different scholars and authors about a specific topic. This study focuses on the project objectives, methodology and results that were generated in the study. This chapter consists of seven different journals about air and noise pollution monitoring systems, a critical analysis has been prepared in regards to the seven journals. This chapter states the methodology, working principle, weaknesses and the challenges which were faced by the authors in their projects.

The provided article by (Chandana, 2017) emphasizes on designing and implementing an effectual monitoring system which can utilize the internet and technology to its full potential in order to monitor the needed parameters of air intensity remotely, stores the obtained data on the cloud, and to project the observed and gathered trends on the website. The authors shed light on the rising issue of the current age, which is pollution. Moreover, the authors also highlighted the importance of controlling the pollution in order to attain better health conditions and a sustainable future. The proposed system can monitor the quality of the air, as well as the sound pollution within a specific area using the IOT. In addition to that, the system will also be able to track the air and noise pollution, and to store the results on the cloud. Moreover, the authors suggested that this system can be implemented in the areas surrounding schools and hospitals, and once the increased levels of sound or air pollution are detected, the authorities can be notified so that essential measures can be taken to prevent the further issue of pollution. The article began with the brief description of the latest technological innovations that can be utilized in order to measure the pollution, and the smart environment, where the environment is equipped with the sensory and monitoring devices and become self - monitoring. A literature survey has been provided that discusses the implications of using the technology in enhancing the quality of life, and how the technology can be used to prepare the air pollution monitoring devices for effective controls. (Chandana, 2017) In addition to that, a brief description of carbon mono – oxide has been given which highlights the adverse effects of the gas on the environment and the human health. A brief overview of the proposed model which consists of 4 tiers, including environment in the first tier, sensor devices in the second tier, sensor data acquisition and the decision making in the third tier, and the intelligent environment in the fourth tier. The systems used to process the data and its transmission on the cloud, and on the application in the later stage are Arduino and Raspberry pi. (Chandana, 2017) These systems enable the authorities to get notified

about the alarming rates of noise and air pollutions and take the required initiatives to combat the issue. The rest of the article discusses the working of the modules and the simulation outcomes.

Figure 2.1 Simulation Outcomes (Chandana, 2017)

The article provided an innovative and effective system that can be used easily to monitor the air and sound pollution on the mobile phones. In addition to that, the system also has a distinct feature to notify the authorities about the alarming pollution rates. The article provided comprehensive information about the threats of pollution along with the proposed solution. (Chandana, 2017) The technologies used in the article are innovative, latest, and advanced, and can address the problem in an effective manner. However, there is a lack of discussion about the currently existing systems that can be used for similar purposes. The authors could have provided an overview of the existing instruments along with their short comings, and how the proposed system can address to them.

The paper by (Saha, 2017) is stating the importance of observing the pollution before it exceeds the safe threshold. In this journal, a monitoring system is showcased which can monitor the pollution by using Raspberry Pie and IOT sensors. This project is evaluating three different kind of pollutions which are air pollution, noise pollution as well as water pollution. Due to the vast measurement of different kind of pollution in this project there are various number of sensors that are used in this project. To evaluate air pollution, the sensors that are used are air pressure sensor (BMP085), air quality sensor (MICS-2710), ultra violet radiation sensor and etc. These sensors allow the author to achieve a better result for the analysis of air pollution in the surrounding. (Saha, 2017). To evaluate the water pollution in the water, this project aims to check the pH value, ammonia, temperature and etc. In order to read all these values separate sensor for all are proposed. Along with the air pollution additional

sensing of noise pollution in the environment is performed by using a microphone and analysing the decibels. By using a microcontroller, the author is communicating to the sensors and obtaining the results in real time. (Saha, 2017). The data obtained from the analysis is uploaded on the cloud so that it can be saved in the database. Having a cloud database allows the author to review the readings and imply the measures that are to be taken in the provided readings. If in case the readings that are being monitored by the system surpasses the safe threshold of below 10% air pollution and 20 kHz of noise pollution an alarm will be turned on to gain the attention of the control unit. (Saha, 2017) The microcontroller has a Bluetooth module embedded in itself in order to transfer the data from the microcontroller to the mobile device. Along with the Bluetooth module, GPS module is also embedded onto the microcontroller in order to get the coordinates of the location. The author faced some crucial difficulties in the development of this project. One of the challenges faced by the author was to make the components convey the data autonomously to the internet. As many different sensors are being implemented for monitoring the different genre of pollution.(Saha, 2017) Using Raspberry Pi allows the developer to work in any operating system and the coding can be done on Matlab using the c programming language. The context model of this project is given below:

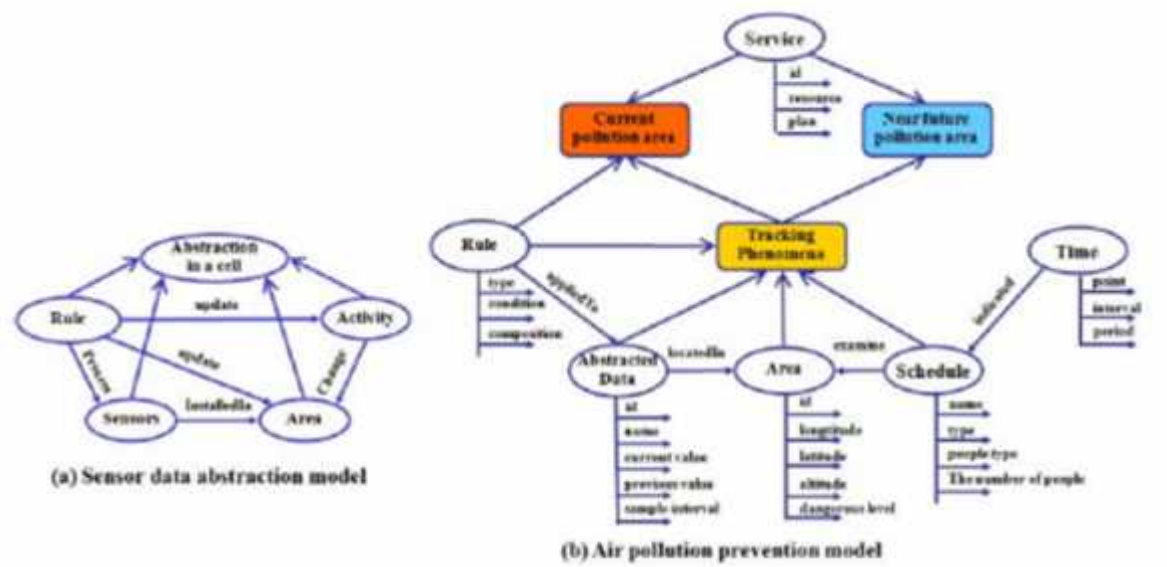

Figure 2.2 Context Model (Saha, 2017)

In comparison with the project by authors (Sivaraman, 2016). This paper by author (Saha, 2017) is better in terms of microcontroller as this project is using the top quality microcontroller which is Raspberry Pi 3. This project is also using better sensors as compared to the metal oxide sensors used by (Sivaraman, 2016). BMP085 and MICS-

2710 sensors delivers better quality results and can sense the pollution of a wider range than metal oxide sensors. Instead of using Bluetooth, the authors (Saha, 2017) have improvised the project by using Bluetooth as well as the WIFI. In contrast with the proposed project by (Sivaraman, 2016), the paper by author (Saha, 2017) is only performing the monitoring of the pollution and is not generating the interpolation graphs and maps to overview the areas which are under the risk.

In journal by author (Jutzeler, 2014) is highlighting on using the regional based approach in order to evaluate the air pollution in the areas. In this approach there is no requirement of a physical model in regard to predict the pollution in the environment. This approach focuses on modelling a large area into separate regions keeping the traffic level of the analogous type, which means the traffic volume remains the same in all the regions. (Jutzeler, 2014) This approach uses formal methods in the software development process as it requires a lot of mathematical formulas that are supposed to be used in the project and the accuracy should not be compromised. This approach that is being used by the author is quite similar to land-use regression (LUR), which estimates the results using parameters. (Jutzeler, 2014) LUR in air pollution estimation is done by estimating the mass in the building and the volume of the traffic on the road. Similar concept is implemented in the region based approach except that the region based approach does not practice the idea of parameters for its analysis. In the proposed project by (Jutzeler, 2014) the author is using the stochastic process but as compared to the other land-use regression models, this project does not only focuses on the volume of traffic as the parameter, it also considers the space of the road in terms of the lane sizes on the road. The implementation of this project is done in java programming language with the use of efficient java matrix library (EJML) to retrieve the algebraic formulas. (Jutzeler, 2014) Matlab was also used in this project to generate the Gaussian process with the help of machine learning. The main objective of this project is to provide their users a platform where the user can assess the air pollution in the certain areas and can avoid those areas for travelling and staying safe from the air pollution. (Jutzeler, 2014) The results that are generated from this project are displayed on as a root mean squared deviation, as shown below:

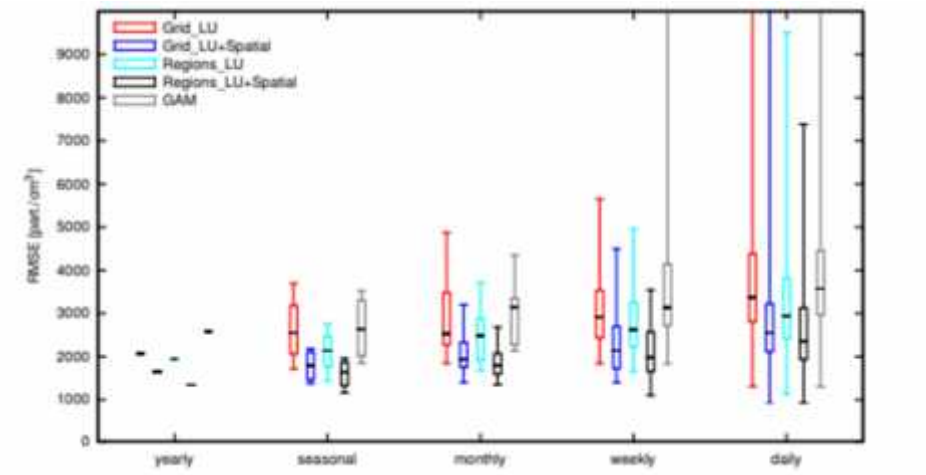

Figure 2.3 RMS (Jutzeler, 2014)

The results that are retrieved from this application can be further processed in other applications for but this data is only the estimation of pollution as no real time hardware sensor was involved in this application.

In assessment with the project by (Sivaraman, 2016) and (Saha, 2017), this project by author (Jutzeler, 2014) is not using a measuring hardware or a microcontroller to communicate with the users. This project by author (Jutzeler, 2014) is extremely delicate and complex to be understood by users. This will reduce the usage of the application in the current market. Also, it is an estimation of the pollution based upon the data acquired of traffic on a road. This limits the application to be widely used in the current market and users. The bright side of this application is that it can be used by the pollution monitoring and pollution control companies and organizations to review the areas which are estimated to have high intensity of air pollution.

In this paper by author (Deshmukh, 2017) is implementing an IOT based system which will monitor the sound quality and the air quality of the environment. This journal is focusing on aiding the loggers who used to manually go for a site visit and analyse the pollution. This data was then added to the database in order to review and given for further work. (Deshmukh, 2017). The proposed project in this journal will increase the efficiency of the data loggers and consume less of their time, as the hardware can be placed at the location and the data will be transferred to the data logger over the internet. This system can be implemented on the remote locations that are used by the industries and manufacturing factories. (Deshmukh, 2017). Author is emphasising on measuring the air and sound pollution of each day, so it can be represented on a better scale keeping in regards of the day where the pollution was at most. This system is using sensors to detect the audacity of air pollution while measuring harmful gases

such as carbon dioxide, fumes, temperature and carbon monoxide. (Deshmukh, 2017). In order to obtain the data for sound pollution, the level sensors are used which will detect the decibel level of sound which will be processed and validated if the sound is suitable for human ears. Data obtained from the sensors are converted to digital values by using built in analogue to digital converter in the microcontroller. This data is displayed on the liquid crystal display (LCD) embedded onto the microcontroller as well as this data is sent to the user over the internet by using WI-FI module connected to the microcontroller. Microcontroller in this system acts like the control unit for monitoring air and sound pollution. (Deshmukh, 2017). The microcontroller sends the data that is being retrieved from sensors over the internet. This allows the user to process the data and overcome the pollution in the affected areas. All the components are integrated with the microcontroller. (Deshmukh, 2017). The WI-FI module that is used in the system is ESP8266 which grants the microcontroller the access of internet and allows it to send the readings via internet. The microphone module was integrated with the system to read the decibels of sound pollution. This system was deployed in one of the cities India for testing purposes. The results that were generated upon the deployment are as follows:

Table 2.1 Results (Deshmukh, 2017)

Pollutants	Standard Value (%)	Observed Value (%)
CO	63	44
CO2	60	48
Temperature	36	34.1
Gas	68	70
Sound	40	36

In conclusion, the proposed project by author (Deshmukh, 2017) is better in terms of portability, reliability and efficiency than the projects by authors (Sivaraman, 2016), (Saha, 2017) and (Jutzeler, 2014). The journal by author (Deshmukh, 2017) is showcasing a model which can be deployed in any part of the world and the data can be accessed all over the world by the use of internet. Instead of using the timeworn Bluetooth modules which are restricted to provide the data within the given range, the author (Deshmukh, 2017) is using WI-FI module with IOT, which gives the flexibility of range to the clients. Organization who are working on monitoring pollutions can make use of this system and can reduce the complexity of their work by cancelling out the

travel towards the sites and perform the evaluation of everyday pollution at their work station. The sensors that are used by the author (Deshmukh, 2017) are restricted to measure the common gases whilst there are numerous other harmful gases which are remained unmonitored.

In the paper by (Ezhilarasi, 2017) the main objective of the author is to provide a system that is smart, compact and is communicating with the computer in real time. As the author in (Ezhilarasi, 2017) has mentioned the classic methods which were using radio frequency identification (RFID) for obtaining the data from the sensors. This obsolete method of taking the data from the sensors was restricting the client to be in the certain range of the device. This method is not feasible in the current lifestyle as no client would want to be exposed to the pollutants while having the analysis of the pollution. This journal, is using the latest technology with is IOT. The main advantage of using IOT is that the client is not compelled to be at the site for monitoring the air and sound pollution. Basically only the hardware is built which has WI-FI module and pollution sensors integrated onto it. The hardware which is used in the proposed project by author (Ezhilarasi, 2017) is Arduino. Arduino is a microcontroller which acts as a medium between the sensors and the computer. Arduino converts the analogue values that are being generated by the sensors with its built in analogue to digital converter and transfers the value to the computer via internet. In order to transfer the values using internet an addition WI-FI module is attached to Arduino, which enables the internet access for the microcontroller. A lot of different electrical components are used in the proposed project by (Ezhilarasi, 2017) as the Arduino is only able to handle the voltage of 5 volts. Components like step down transformer to bring the voltage down to 12 volts, bridge rectifier, voltage regulator which makes the voltage to be consistent of 5 volts. One more voltage regulator is attached to the system as the wifi module can only take upto 3.3 volts. The integration of all the components is showcased using a block diagram as follows:

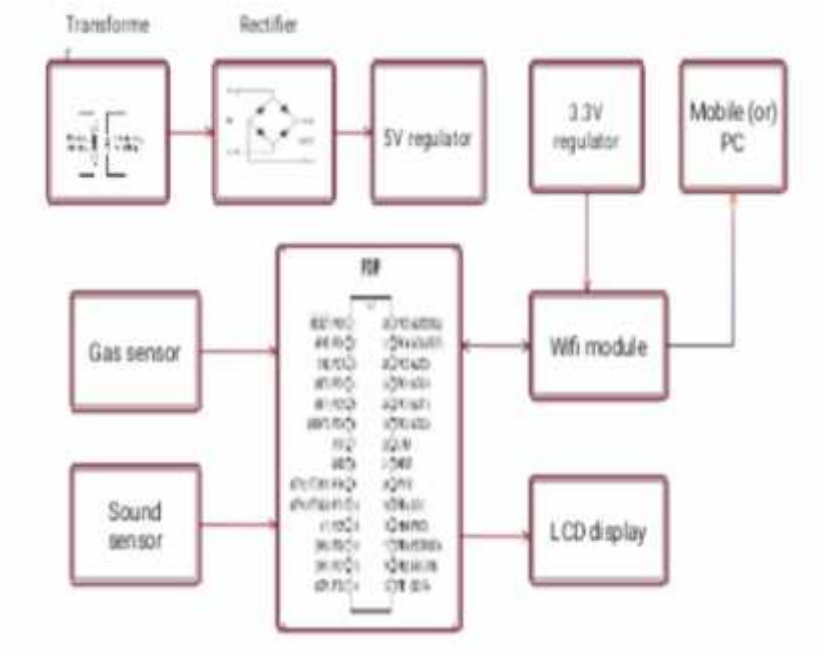

Figure 2.4 Block diagram (Ezhilarasi, 2017)

This diagram provides a deep understanding of the working principle of this system. This project can be implemented in different places around the world and it can be used easily by any organizations and different bodies for monitoring the environmental pollution. This system can be used by individuals to ensure their health safety in the environment. The main lead of this model is that it can be implemented in the buildings, small work zones and other under minor development zones. This will help the companies who are associated with these areas to ensure their area lies under the safety threshold stated by WHO. This system cannot be used on a bigger scale due to the size constraint of the system. The sensors that are being used in this system are restricted to work on a smaller range. The main con is Arduino, this particular microcontroller is now obsolete. It is well known in the business to have restricted their performance due to poor efficiency and only can perform certain task unlike other microcontrollers.

In contrast with other system developed by authors (Deshmukh, 2017) and (Saha, 2017) which are also using internet of things as well. In the journal by author (Saha, 2017) Raspberry Pi was being used which is more efficient and powerful as compared to Arduino. Raspberry Pi has a better load handling and better performance which makes it one of the best microcontroller in the current market. The proposed project by author (Ezhilarasi, 2017) could have used Raspberry Pi as their controller in order to achieve enhanced quality. This journal had improvised the system with enhanced results in contrast with the journal by author (Deshmukh, 2017).

The provided article by (Revathy, 2016) attempted to provide an effective solution in order to address the critical issue of air pollution. The given paper aimed to design a solution for the air pollution by using a wireless sensor network. The research paper provided a detailed overview about the identified problem (air pollution) which has been an outcome of enhanced industrial growth throughout the world as well as the means of road transport. Air pollution has several negative implications on the environment, including global warming and acid rains. The primary aim of the research paper is to develop an air monitoring system which is not only effective, but is also comprehensive, affordable, and autonomous. The authors began the paper with the description of the problem, and their proposed system. Furthermore, a brief overview of the existing instruments and systems that have been used for the air pollution monitoring has also been given. In addition to that, the description of the harmful gases present in the air, the trends of the gases' level in the air, along with their adverse effects on the environment and health has also been given in the research paper.

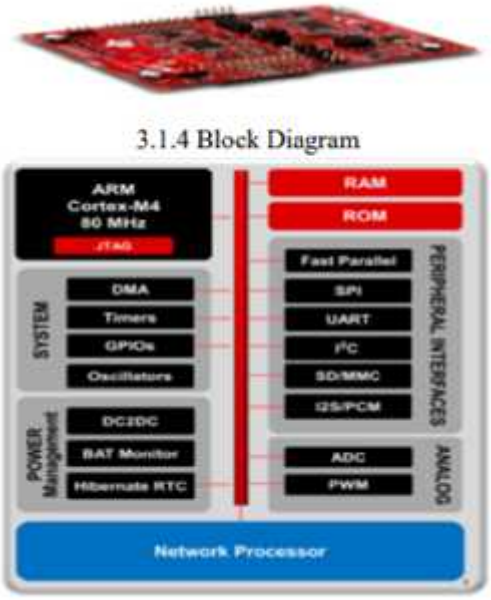

Figure 2.5 Block diagram MSP430 (Revathy, 2016)

The system proposed by (Revathy, 2016) is cost effective, easy to use, and reliable. The authors also emphasized on the need of a wireless and effective system to monitor the air pollution in the light of technical and economic challenges. The rest of the research paper provided an overview of the experiments that have been carried out in order to design the system. The system consisted of a software and utilized the World Wide Web in order to

avail the maximum benefits from the latest technology. In addition to the air pollution, the system also analyses the other factors such as humidity, and temperature along with the gas concentrations with the help of data fusion techniques. The article provided a detailed overview of the problem, the carbon dioxide and other gases present in the air that play a crucial role in polluting the air and the environment. This overview set out the foundation of the dire need of developing a system which is not only efficient, but is also cost effective and sustainable and measures the air pollution in an accurate manner. The article also discussed the existing system Fourier Transform Infrared (FTIR) that is used to monitor the level of air pollution. It has also been mentioned in the article that the existing system monitors the air pollution in an effective manner, however, it functions on a large scale, and therefore, there is a dire need to develop a system that is portable and robust. The designed system aimed to detect gases as well as parameters like the temperature and humidity. However, only one existing instrument and system has been discussed in the article and the authors could have elaborated the pros and cons of the previous systems more explicitly, along with the justification of the new proposed system. The rest of the article discusses the overall details of the proposed system, including its components, features, and applications. Pictorial references have been given for the convenience of the readers to better comprehend the overall process and functions of the system.

The author (Sivaraman, 2016) in this journal is focusing on evaluating the air pollution by the use of sensors. The author has showcased the current scenario of the world under the risk of air pollution. Many areas in the world are currently known to be below the safe threshold of air pollution stated by the world health organization (WHO). Main concept of this project is to use crowd sensing in order to obtain the results. Crowd sensing is a way to achieve data by involving enormous number of people and gathering the results from different areas in order to generate a better understanding on air pollution. Interpolation graphs will be generated with the use of the data analysis, this can be used to understand the areas affected by air pollution. The application that the author is developing in this project is known as ‘HazeWatch’. (Sivaraman, 2016). HazeWatch is an application that will be

installed on the user's mobile device. It will take the input from the air pollution sensor hardware which the author constructed on their own. The data from the application is sent to the database on cloud, the data consists of sensor readings, time of the sensor reading and the location coordinates. This data is then utilized to generate the interpolation graphics. (Sivaraman, 2016). The architecture that for this application is:

Figure 2.6 Haze Watch Architecture (Sivaraman, 2016)

The author had to face some very challenging factors with the development of the hardware. As the hardware should be portable for any user to carry it along, so the main challenge was to restrain the hardware from becoming colossal. As the author stated that the device will work autonomously, this requires data to be transferred time to time. In order to obtain this system, the programming used should be complex. (Sivaraman, 2016). The sensors that were used for this project are the metal oxide sensors (MOS). There are three MOS sensors in order to sense the different gases such as carbon dioxide, carbon monoxide and nitrogen dioxide. Author is also using the electro chemical sensors (EC) which are relatively expensive and accurate. This project is also emphasising on using a third party sensor which is sensor drone. Sensor drone's devices are compact and they have about 11 sensors in a single device and the device can be connected to any mobile device via Bluetooth. The integration of the

components is done by using mathematical formulas, hypertext markup language (HTML), cascading style sheets (CSS), JavaScript (JS) and personal home page (PHP) as the server side coding. (Sivaraman, 2016).

In conclusion, the author is focusing on engaging the general public to acquire the air pollution readings from different parts of the world and generate the graphs and maps accordingly. HazeWatch is a productive interface that will help in order to evaluate the air pollution in the surrounding but it could've been improvised by the use of internet of things (IOT). As compared to the proposed project which is using IOT sensors, this project is using the obsolete sensors which are not the finest in terms of efficiency, accuracy and quality. The author in this project is evaluating the areas which are below the stated threshold by WHO but the author could've also analysed the measures to be taken in order to overcome this hazardous factor. Also, this project has intended to have different hardware by different manufactures embedded into the same platform, this will result in an ambiguity for the user to understand the architecture of the overall system. As this project is using Bluetooth module instead of Wi-Fi module, this will restrict the user to be in the Bluetooth range of the device to obtain the readings. Wi-Fi module would allow the freedom of obtaining results regardless of the location of the user while connected to the internet.

2.2 Literature review in comparison with the proposed project

Table 2.2 Comparison between literature and proposed project

Features	(Chandana, 2017)	(Saha, 2017)	(Jutzeler, 2014)	(Deshmukh, 2017).	(Ezhilarasi, 2017)	(Revathy, 2016)	(Sivaraman, 2016)	Proposed Project
Noise Monitoring	✓	✗	✗	✓	✓	✗	✗	✓
MQ 135 Sensor	✗	✗	✗	✗	✗	✗	✗	✓

Microphone Sensor	✓	✗	✗	✓	✓	✗	✗	✓
Raspberry Pi	✓	✓	✗	✗	✗	✗	✗	✓
Hardware used	✓	✓	✗	✓	✓	✓	✓	✓
Internet of things	✓	✓	✗	✓	✓	✗	✓	✓

2.3 Summary

In inference to literature review, seven different methods of air and noise pollution system done by different authors and researchers are reviewed. These different methods are using different technologies in order to perform the monitoring of air and noise pollution. All of the above mentioned projects are providing a solution which will monitor the environments purity in terms of pollution. These projects are analysed in terms of their methodology and tools that they have used to develop the project. This analysis assisted in choosing the best tools for the proposed project and overcome the weaknesses of the previous projects by developing a better solution in terms of performance and productivity. After the research done, it was found that none of the seven mentioned projects had a solution that gives the guidance on overcoming the pollution. The projects mentioned above are using microcontrollers like Arduino which depreciated their projects efficiency. So in order to overcome this weakness found in previous work, the proposed project is using Raspberry Pi 3, which will not compromise the performance of the project. The sensors that were being using the seven generals are obsolete sensors and their capability to monitoring the air quality is insignificant as compared to the sensor which is being used in the proposed project. The hardware which was built in these journals are bulky and heavy, which restricts the user to carry it along with them. The proposed project aims to achieve a sleek and slim hardware which will make it portable and handy for the user to carry.

CHAPTER 3: DATA ANALYSIS / PRE DESIGN

Pre-design is the basic overview on the methodology which will be used in other to implement this project. This chapter showcases the working principle of the entire project by using the block diagram along with the components which are going to be used in the project and their functionality towards the project. In this project it portrays the design which will be followed for the project, this is analysed by having the high optimization, less expenditure, high performance and efficiency while saving the energy resources of the environment.

3.1 Block Diagram

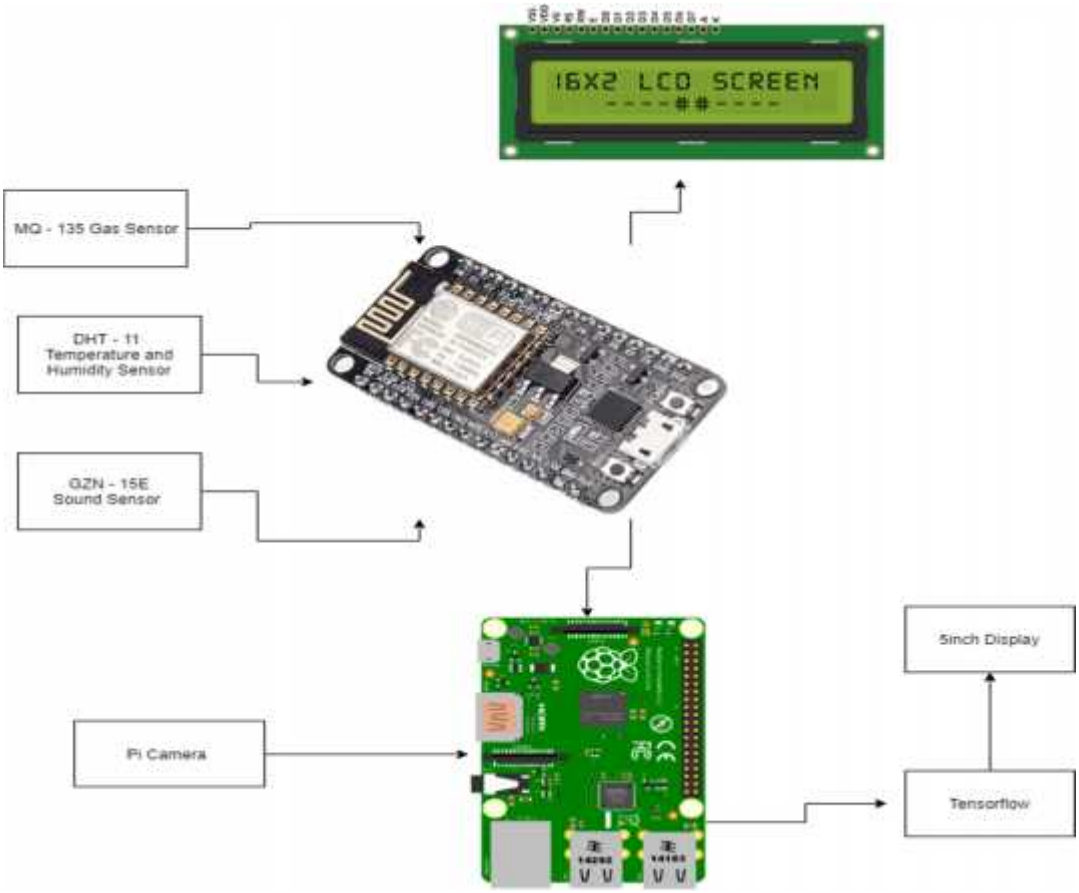

Figure 3.1 Block Diagram

This block diagram that is showcased is portraying the working principal of the proposed project. The diagram is showing the connection of each module with the general purpose computer and internet of things. The general purpose computer is connected to the power and the modules are integrated onto the general purpose computer which are the air

quality sensor, microphone, Wi-Fi module and the liquid crystal display. The air quality module and the microphone module are used to sense the pollution from the surrounding and transfer the values to the Raspberry Pi 3, Raspberry Pi 3 takes the analogue output from the modules and converts them into digital values, these values are displayed onto the liquid crystal display as well as by using the Wi-Fi module, it transfer the digital values to the server host. Server host further performs the work on these values and displays onto a web solution. The power supply as of Oman is 220V. This is the power supply that will be given to the hardware of the proposed project. As we are familiar that the microcontrollers are not able to handle the voltage of 220V or 120V. Raspberry Pi 3 is only able to cope up with 5V. Therefore, a 12V step down transformer will be used to convert the 220V to 12V. Post conversion, there is still a need to further step down it to 5V. Therefore there was a need of bridge rectifier and voltage regulator in order to keep the consistency of 5V. Post required voltage accusation, Raspberry Pi 3 will be able to work without being damaged. There are few other additional components used in the proposed project in order to perform the air and sound pollution analysis. Air quality sensor which is an IOT sensor, this sensor is able to detect carbon dioxide (CO2), benzene, alcohol, carbon monoxide (CO) as well as smoke. This is one of the most efficient air quality sensor available in the current market which also works with an input of 5V. (Waveshare.com, 2018). In order to perform the noise pollution analysis there is a microphone module used. This module will read the voice input of the surrounding and transfer the reading onto the Raspberry Pi 3. The sound sensor that is being used in the proposed project is the 2 pin microphone which is a microcontroller module. This module has the most enhanced performance and it can be used due to its flexibility in platforms. The sound can be converted to be used over smart phones, laptop and other devices without damaging the quality of sound. (Nevonexpress.com, 2018). In order to display all the data which is being interpreted by Raspberry Pi 3, there is a liquid crystal display attached integrated within the hardware. Wi-Fi module is being used to transfer all the readings to the server over the internet.

3.2 System Design

In order to achieve the enhanced system design for the project, a lot of research was done in Chapter 2. The research concluded the requirements of the proposed project. Components that will be used in the proposed projects are: Raspberry Pi 3, Wi-Fi module, voltage regulator (5V), bridge rectifier, liquid crystal display, transformer (12V), sensors

for air quality and microphone for the monitoring of noise of the surrounding. This entire system will be controlled by the microcontroller which is Raspberry Pi 3. Raspberry Pi 3 is most efficient microcontroller as of the current research done. It allows the flexibility of working in any environment and can be integrated with more components than the other microcontrollers like Arduino Uno. Arduino is a microcontroller which can only perform one task at an instant whilst the Raspberry Pi 3 can perform multitasking and multithreading. Internet of thing is a complex structure which requires a general purpose computer which can cope up with multifaceted calculations and various task at one instant. Which makes Raspberry Pi 3 fit right in the picture. (Right Board, R, 2015). As per the coding aspect of the proposed project, it will be accomplished by using the C programming language. The rival of C programming language is Python. As per the statics, in the proposed project C is being used instead of Python. Python is an interpreted language while C is a complied language, which states that using Python requires a heavy load on the system as compared to C. As the proposed project is an embedded system which means using C will be a better option in regards of performance while being able to perform the same task as Python. As Python programming has more line of code in contrast with C programming while performing the same task, this increases the overhead on the system. More overhead makes the system slower and less efficient. (Verma. M, 2017). There is a requirement of laptop or any other device to overview the system over the internet. As the data will be transferred to the server using the Wi-Fi module. There must be a host to corporate with the data and display the data to the user. The laptop will have a web solution which will display all the data to the user synchronized with the hardware which is reading all the data using sensors.

3.3 Tools/Technologies

3.3.1 Raspberry Pi 3 B+

It will act as control unit for the proposed project. It will be integrated with different modules like WI-FI module, air sensor module and microphone. It will collaborate with all these modules in order to perform the task required. Raspberry Pi 3 will take the output from the air sensor module and the microphone. As the sensors will be generating output in analogue signals, it will convert these analogue signals into digital signals in order to further work on these readings. Raspberry Pi 3 will display these readings on the liquid crystal display which is implemented onto it as well as transfer these readings to the internet by using the WI-FI module. This particular general purpose computer is elected

from all the other microcontrollers available in the market because it fulfil the need of the proposed project as well has the complexity and flexibility required to work with internet of things. Raspberry Pi 3 will be encoded with the C programming language in order to incorporate with the components and IOT.

3.3.2 MQ 135 Sensor

This is the sensor which will be used to obtain the air quality reading from the surrounding. This particular sensor is used for the proposed project as this is the top notch in quality with its compactness and portability. MQ 135 has a wider range than the other air quality sensors like MQ2, MQ9 and PMS3003. (LamC. C, 2018). MQ 135 provides a better sensitivity and quick response in comparison with other compact sensors. The life span of MQ 135 is longer and has a better stability throughout its life. The main quality of this sensor is that it can be integrated with Raspberry Pi 3 due to the simple circuit and can also handle the voltage of 5V. MQ 135 has the ability of detecting more gases than the other mentioned sensors such as ammonia (NH3), alcohol, smoke and many more. (Olimex.com, 2018). This makes MQ 135 the paramount air quality sensor for embedded systems.

Table 3.1 MQ Sensor Features (Olimex.com, 2018)

Parts	Material
Gas sensing layer	SnO2
Electrode	Au
Electrode Line	Pt
Heater Coil	Ni-Cr alloy
Tubular ceramic	Al2O3
Network	Stainless steel guaze
Clamp ring	Copper platted Ni
Tube pin	Copper plater Ni

This table shows the structure of the MQ 135 sensor and the materials the structure is composed of. It provides a brief summary of the MQ 135 sensor and the quality of the

sensor. In order to look at the sensitivity sensor of the MQ 135 sensor the below diagram gives a summary of the sensitivity with different gasses:

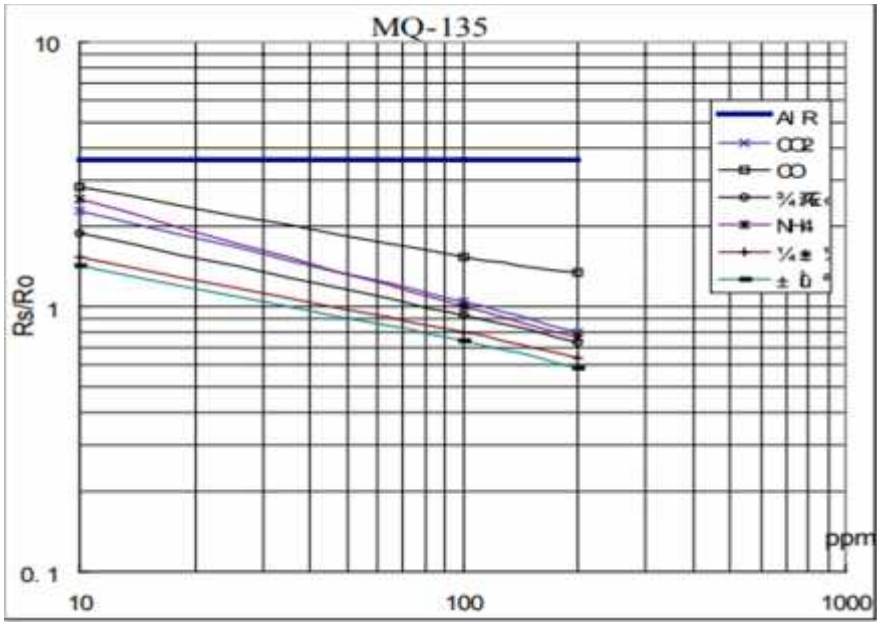

Figure 3.2 MQ 135 Sensitivity Graph (Olimex.com, 2018)

3.3.3 2 Pin Microphone Capsule

Figure 3.3 2 Pin Mic (Amazon.com, 2018)

As the proposed project analyses the sound pollution of the environment, there is a requirement of reading the sound as an input from the surrounding. In order to perform this particular task, the proposed project is using 2 pin microphone capsule. This is the compact and most commonly used microphone sensor for the embedded systems. This 2 pin microphone capsule performs acoustic to electric transducer which means it converts

the sound input from the surrounding into an electrical signal for the Raspberry Pi 3. This is known to be microphone which is flexible with the platform and compact so it suits the proposed project. The structure of the 2 pin microphone can be understood from the table below:

Table 3.2 Features of 2 Pin Mic (Nevonexpress.com, 2018)

Diameter	0.9cm
Height	0.7cm
Size	Compact (Small)
Performance	High

3.3.4 ESP8266 WI-FI Module

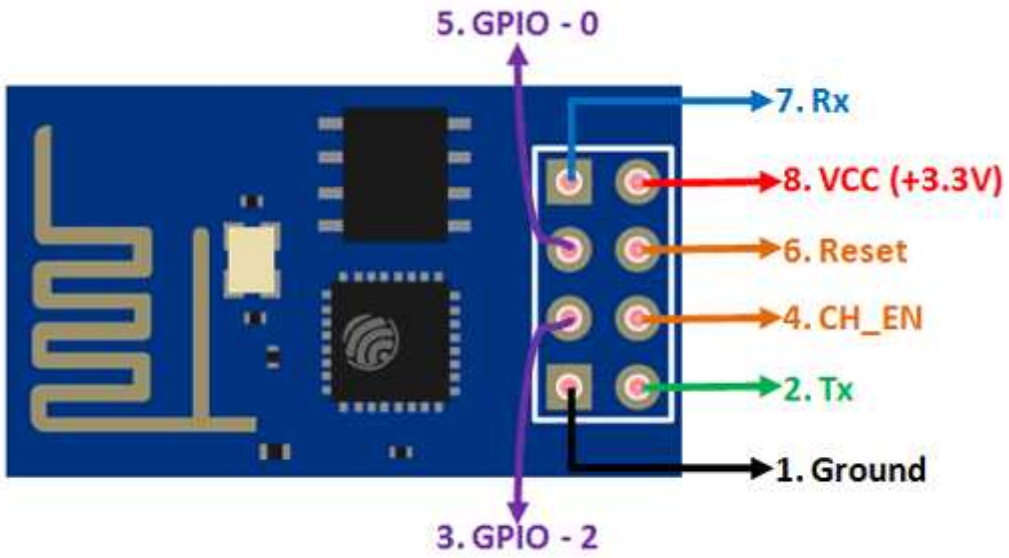

Figure 3.3 ESP8266 WI-FI Module (Espressif.com, 2018)

ESP8266 is a WI-FI module which allows the Raspberry Pi 3 to be able to access the internet. Even though Raspberry Pi 3 has a built in Ethernet ability still there is a need to have WI-FI access to operate the proposed project with internet of things (IOT). ESP866 is chosen for this project because of the durability of ESP866. Its performance under high and low temperature conditions is much appreciated. It is a very robust technology within

a compact body. The power saving and power management feature of ESP8266 is remarkable. It is developed to be worked in the IOT based projects and the maximum clock clicks at 160 MHz. (Espressif.com, 2018). The pin configuration of ESP266 is shown in the table below:

Table 3.3 Pin Configuration (Espressif.com, 2018)

Pin Number	Pin Name	Purpose
1	Ground	To ground the circuit
2	TX	To upload the program
3	General Purpose Input Output – 2	-
4	CH-EN	Active High
5	General Purpose Input Output – 0	-
6	Reset	Resetting
7	RX	-
8	Vcc	Connected to voltage input of 3.3V

3.3.5 Liquid Crystal Display

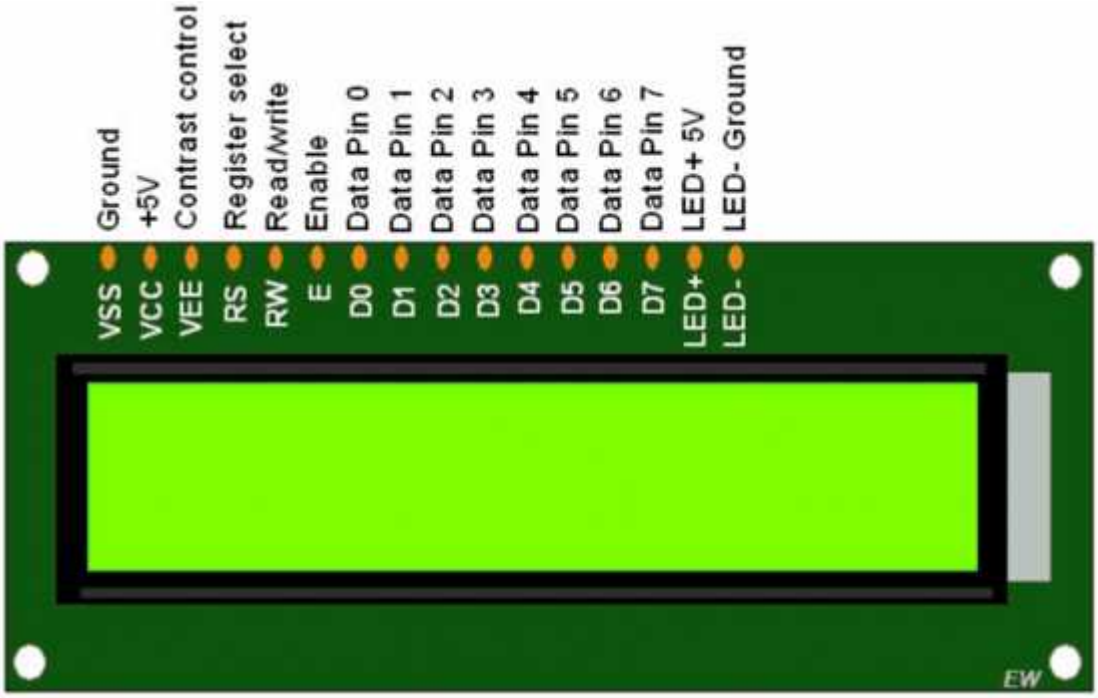

Figure 3.4 Liquid Crystal Display and Pins (Viruchi, 2018)

This liquid crystal display (LCD) is used to display pollution reading to the user. This is a 16x2 dimension LCD which means it has 16 columns and 2 rows to display the readings. This LCD is being used because the readings are displayed on the laptop over IOT but for the instance a user would like to check the reading without having a laptop or a smart phone, this LCD will be able to entertain that user. This liquid crystal display is integrated with the Raspberry Pi 3 and the coding of Raspberry Pi 3 is done accordingly. (Viruchi, 2018)

3.4 Summary

In conclusion of pre-design, various components that will be implemented in this project are observed and discussed in depth. These components are showcased and the purpose of the components are stated in this chapter. These components are selected due to the need in the system. A major help was done by performing the literature review as it has comprehend the components are lead to choose the best suitable components for the proposed project. Chapter two provided an overview of the components which were

lacking few features and then the research was done in order to find out the component through which the project could a