

Plantaco

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Present and Justify a Problem and Solution Requirements

Egypt grand challenges:

Air pollution:

There are many sources of air pollution (illustrated in figure 1) in Egypt including factories, open-air burning of solid waste, and automobile exhaust. The main source of pollution in Egypt is the cement industry. This has led to higher levels of dust, small particles and soot in Egypt than other industrial countries. These problems have been known for about 31 years.



Figure 1

This pollution is increasing and causes the formation of a black cloud every year always on Cairo, this cloud is formed at the time of burning rice straw by farmers in the governorates of the Delta, especially those near Cairo (Dakahlia, Sharkia and Qalyubia).

Sources	Percentage
Burning of Agricultural	42%
Vehicles Exhaust	23%
Industrial Emissions	23%
Burning of Municipal Waste	12%

Air-polluting chemicals, chemical compounds that exceed the air quality limit value, are sulfur dioxide (SO₂), nitrogen dioxide (NO₂) and carbon monoxide (CO).

Firstly, sulfur dioxide gas (SO₂): There was an improvement in SO₂ concentration in air between 1999 and 2012 where it is about 47% compared to 2011 and 86% compared to the base year 1999 where, the general annual average was (59 µg / m³). The annual average concentration of year 2012 was (8 µg / m³) compared to the annual average for year 2011 about (15 µg / m³).

Secondly, nitrogen dioxide gas (NO₂): the average concentration in the air (300 mg / m³ / hour).

Thirdly, Carbon monoxide gas (CO): CO Gas Compatibility Rate was 85% for 8 hours on average, and the average concentrations of Heliopolis - Cairo stations in Greater Cairo exceeded 15% throughout the year, due to increased traffic rates in the regions (Downtown - East Cairo). The cost of environmental degradation in Egypt is of the order of 4.8% of Gross Domestic Products, or GDP. Of that total amount, 2.1% of GDP (an equivalent to 6.4 billion Egyptian Pounds) is attributed to the impacts of poor air quality on health and quality of life.

Effects of air pollution:

1. Pneumonia or bronchitis.
2. Irritation of the nose, throat, eyes or skin.
3. Long-term adverse effects include lung cancer and respiratory diseases such as emphysema, nerve damage, brain, kidneys, liver, and other organs.
4. Death of about 2.5 million annually
5. Sulfur dioxide and nitrogen oxide particles in the air, can create acid rain which destroys plants by changing soil composition, deterioration of water quality in rivers, lakes and streams, crop damage, and can cause damage to buildings and impacts.

Climate Change:

In 1900 there was a global drought and rise in temperature, that drought resulted from the rise of greenhouse gases caused by human activities, which started more than 100 years ago. As shown in figure (2)

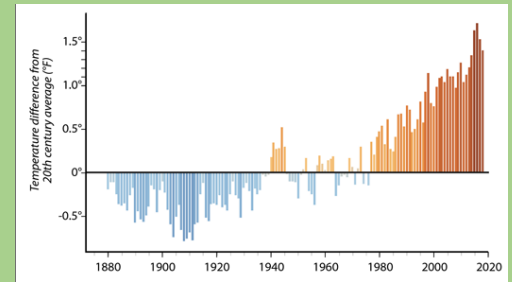


Figure 2

the period between 1950 and 1975 was worse as there was a lack of pollution control, car exhausts and burning fossil fuels were too much.

From 1981 to 2017, the human impact on humidity and drought was more pronounced for Egypt, large population density has a strong impact on climate change. The risk to the delta population is greater because of the rising in sea levels there.

Studies were undertaken to assess vulnerabilities in priority sectors as part of the NAP (National Action Plan) development process indicated that the most vulnerable to climate change are: agriculture, coastal areas, aquaculture and fisheries, water resources, habitats and human settlements, and human health.

There are indications that climate change will have a very significant impact on the Nile Basin, where water levels will fall along with the huge population density, which will make the impact on the Nile River drastic.



Figure 3

The effect of the climate changes

Pollution:

We can't deny that pollution is the most dangerous consequence for any grand challenge, if we look at things from a different perspective we will notice that if we solve pollution problem we will be on the road to solve more grand challenges as recycling, water problem, public health issues, etc.

Pollution is something that occurs when pollutants mess up with our natural clean environment or surroundings, in the earth, the



Figure (4)

Illustration of air pollution

pollution reached a very high level in our planet and one of the evidence is global warming. It happens in different way and effects many things like water, air, soil, etc. Pollution can occur due to natural or artificial events, forest fires, radioactivity, and active volcanoes are natural events. However, the pollution of air mostly happens due to burning of fuel that we need in our daily lives for cooking, driving and other domestic uses, as a result of this burning chemicals are released into the air.



Figure 5

Shows one source of

Air pollution is considered the most dangerous form of pollution in the 2nd place we have water pollution, water represents about 70% of our planet, so when we pollute water by the industrial wastes that are dumped into the rivers every day we also pollute groundwater by spraying insecticides, pesticides like DDT on plants, and finally we have soil pollution which occurs due to incorporation of unnecessary chemicals in the soil due to human activities.

Public health issues/disease:

Egypt suffers from many diseases and the average health of the public is very bad (as shown in figure 6) due to the other problems like pollution and the dirty water, Egypt's health challenges disproportionately affect the rural poor and have the potential to impact the country's economic prosperity more broadly over the long term.

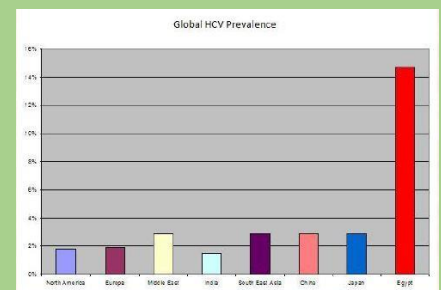


Figure 6

Poor women are 20 percent less likely to receive regular antenatal care than wealthy women, and under-five mortality

for children born in the wealthiest quintile is 19 deaths per 1,000 live births versus 42 deaths for the poorest. Current threats include high rates of childhood stunting and the highest rate of Hepatitis C in the world; seven percent of Egyptians between the ages of 15 and 59 suffer from chronic Hepatitis C.

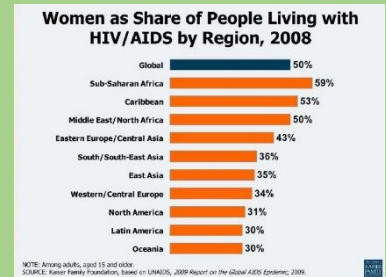


Figure 7

Represents north Africa as one of the highest continents that have a huge number of HIV patients

Recycle garbage and waste for economic and environmental purposes:

Recycling is the process of remanufacturing products to convert it into reusable products. Due to the global warming and continues widening of the ozone hole reducing the Environmental pollution has become a worldwide concern that's why recycling today has become big business. Recycling has so many positive impacts on both environment and economy such as:

- Provide employment opportunities.
- Avoiding and reducing environmental concerns, such as air and water pollution and truck traffic.
- Conserves forests which results in reducing the effects of global warming.
- Reducing greenhouses gas emissions, (carbon dioxide & methane) coming from rubbish and agricultural and industrial wastes.
- Reduce the consumption of natural resources.
- reducing the manufacturing costs as shown in figure 8 (because of skipping the expensive mining, processing and transporting)



Figure 8



Figure 9

One step in the recycling process

Problem to be solved:

Egypt is suffering from pollution every single moment in our life which makes living in Egypt now is like living in a factory. Egypt's ranking in Yale environmental index surges to 66th from 104th: Egypt vaulted from being ranked 104 out of 180 countries in the Yale Center for Environmental Law and Policy's 2018 Environmental Performance Index (EPI) to rank as number 66 and according to World Health organization (WHO) Cairo's air is 11.7 times more polluted than levels recommend.

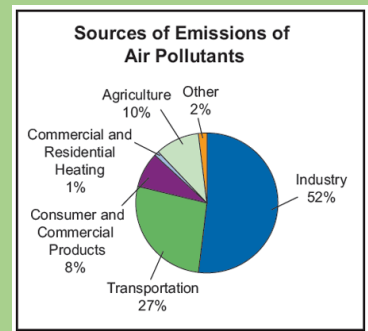


Figure 10

Although there are many factors effect air shown in figure 10, the main factor is industry which releases various gases which are:

- particulate matter lead (Pb)
- ground level ozone (O₃)
- carbon monoxide (CO)
- nitrogen dioxide (NO₂)
- Sulphur dioxide.(SO₂)

Identified by The World Health Organization

Air pollutions can have a serious heath impact on humans and the whole ecosystem, so rising in percentage of any factor will lead us to horrible challenge in many others fields like:

Health problem

there are many pollutants of suspended materials such as dust, fumes, smokes, mists, gaseous pollutants, hydrocarbons, volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), and halogen derivatives in the air which at the high concentrations cause vulnerability to many diseases including different types of cancers. Air pollution can also cause worsening of existing heart problems, asthma, and other lung complications.

Ground ozone level

O₃ can stimuli a variety of toxic. These toxic effects include morphologic, functional, immunologic, and biochemical alterations. O₃ can deep into the lungs and can also reduce carbon absorption in trees leading to deforestation.

Rains

Acid rain contains high levels of nitric and sulfuric acids that are created by oxides and sulfur oxides released into the air by the burning of fossil fuels. Acid rain damages trees and acidifies soils and water bodies. These toxic substances come into contact with the human body directly and aqueous life.

Global Warming

greenhouses gases include:

Carbon dioxide is emitted into the atmosphere by burning fossil fuels it has the biggest effect on global warming. (illustrated in figure 11)

Methane is a major emission from coal plants and agricultural processes

Nitrous oxide is a common emission from industrial factories, agriculture, and the burning of fossil fuels in cars.

Fluorinated gases, such as hydrofluorocarbons, are emitted by industry.

Fluorinated gases are often used instead of gases such as chlorofluorocarbons (CFCs).

increase the temperature which will increase the global warming.

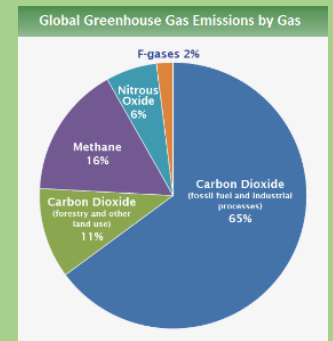


Figure 11

Research:

Topics related to the problem:

- A. Air pollution.
- B. Climate change.
- C. Greenhouse gases.
- D. Effects of air pollution.
- E. Neglecting growing plants indoor.
- F. Acid rain and its effects.
- G. Diseases caused by air pollution.
- H. Global warming.

Topics related to the solution:

- A. Android application.
- B. IOT (Internet Of Things).
- C. Android studio platform.
- D. Kotlin language.
- E. Arduino IDE.
- F. C++ language.
- G. Benefits of growing plants indoor.
- H. Take care of plants inside the house.
- I. Air purifying plants.
- J. The right temperature and humidity for each plant.
- K. Self-care of the plant.
- L. Moisture sensor.
- M. Wi-Fi module.

Other solutions already tried:

Air pollution consequences effect all human beings. A lot of solutions were suggested for solving it, some solutions were governorates' actions, others were individuals' actions.

Governorates' solutions

1- Laws and regulations

Quality air control protocols and standards such as the installation of pollution control devices or buying emission allowance can be used effectively as execution strategies for reducing the adverse effects of air pollution.

Strength: 1) limits the factories and grand institutions emissions.

Weakness: 2) the laws don't have a grand impact upon individuals' behavior.

2- Campaigns and Advocacy

Awareness creation is the number one factor to consider because it will make people realize and understand the sources and effects of air pollution. From this point, it makes it easier for people to take personal or collective initiatives to reduce air pollution.

Strength: 1) rising awareness in large percentages between people as those campaigns are highly effective.

Weakness: 2) people doesn't take long-term actions as they only start changing attitudes for a couple of days.

3- Minimize the Use of Fossil Fuels:

Burning of fossil fuels in one of the major reasons of air pollution due to all the greenhouse gases released during burning process.

Strength: 1) decreases the emission of greenhouse gases with high amounts

Weakness: 1) they need to be replaced with newer energy sources which require improved technologies to be used

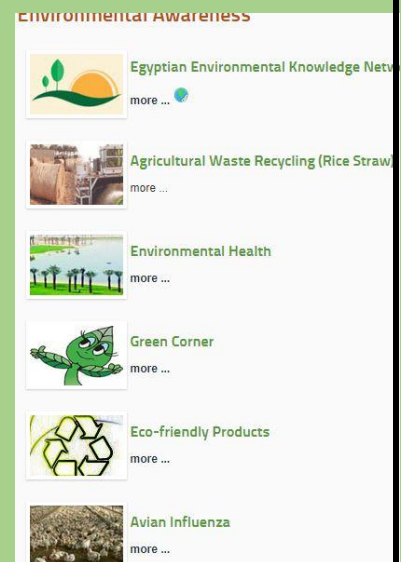


Figure 12

Examples of
campaigns made by
the ministry

Individuals' solutions:

1- Conserve energy

By turning off fans and lights when they aren't necessary used since a large number of fossil fuels are burnt to produce electricity by reducing the number of fossil fuels to be burned.

Strength: 1) they reduce the usage with high levels

Weakness: 2) they require a lot of manual work which is most of the times neglected

2- Recycle.

Instead of throwing away used containers and material, trying to reuse them or recycling them to be used again by someone else as some materials such as plastic takes decades to decompose

Strength: 1) reduce the number of undecomposed wastes

Weakness: 2) requires high energy most of the times



Figure 13

Conserving energy encouragement poster

Generating and Defending a Solution:

Solution and Design Requirements:

Applicable:

- application access to all the device which mean provides a full experience to the user on their iOS or Android smartphone.
- The (IOT) system uses small space with simple equipment.



Figure 14

Cost:

- using materials with low price that achieve the same results or better than high materials price.
- Making the application free to download from app store or play store.

The most common design requirement

Effectiveness:

- Application's output must be bigger than input compared to the latest solution already tried.
- Increase the awareness than previous solution which can be tasted from surveys.
-

Requirements selected

- Applicability
- low cost
- high effectiveness

Reasons

- We chose these previous requirements because it is easy to achieve, measurable and tested through working.

Selection of solution:

As the percentages of greenhouse gases increase significantly in the air the climate changes risk, global warming, ozone hole (as shown in figure 15) and health risks increase as well leading to a lot of diseases and icebergs melting which have more consequences on human beings.

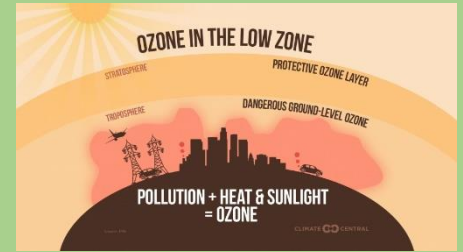


Figure 15

Plants are indispensable to human life. Through photosynthesis, they convert the carbon dioxide – a greenhouse gas- we exhale into fresh oxygen, and they can also remove toxins from the air we breathe.

In NASA's Study about Interior Landscape Plants for Indoor Air Pollution Abatement 1989, it was stated that indoor plants can scrub the air of cancer-causing volatile organic compounds like formaldehyde and benzene. It also stated that the amount of leaf surface area influences the rate of air purification.

Our solution focuses mainly on indoor planting, in order to decrease the impact of carbon dioxide gas produces from factories, burning fossil fuels, etc. in addition to that it takes care of the plant watering and gives tips and notes for planting it.

The solution was chosen because it aids in increasing the awareness about home planting and waters the plant in order to prevent its death. It's also ecofriendly and based on previous studies it is effective

Firstly, the user chooses whether he'll search for a plant or takes care of it after he -manually or automatically- inputs the humidity and temperature. Some suggestions will appear, the user is able to choose a plant and connect it was the application kit.

The kit is mainly responsible for watering the plant by a pump after it receives the data from the moisture sensor inserted in the soil of the plant pot.

Selection of prototype:

Electronics are complicated in their construction; this is because they have complex connections with each other, our prototype was constructed by connecting various systems to each other.

1- We developed the application

- using kotlin language via android studio which provides a feature that codes a xml sheet
- adding a convenient, easy-to-use interface to allow the users to use it comfortably. As shown in figure (16)

- This achieved applicability as android studio allows
- the application to be installed on android devices and IOS

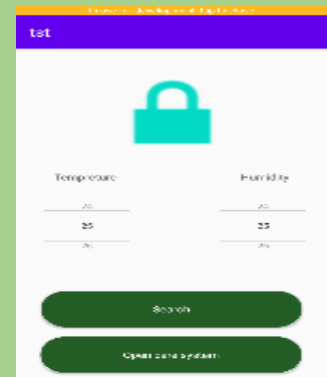


Figure (16)

2- We developed the open care system by:

- Connecting the Arduino with the pump and the pump to the water source and battery as shown in figure (17)
- Connecting the moisture sensor with the Arduino and put the sensor in the plant pot as shown in figure (18)
- connecting the pump with the relay in order for the code to work properly
 - low cost was achieved by using personal belongings and cheap materials, the pump aided in saving water as it consumed water less than that used in the traditional irrigation ways

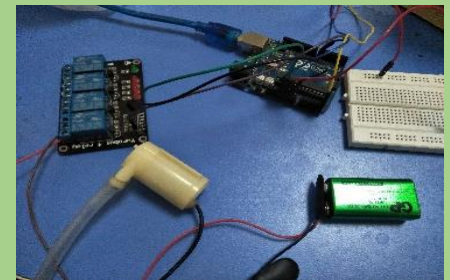


Figure (17)

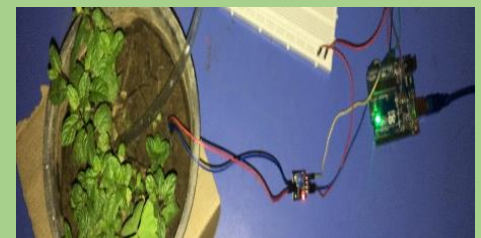


Figure (18)

3- we connected the care system with the application through a server

The application:

- 1- suggests plants to the user based on the temperature and humidity of the surroundings as shown in figure 19
- 2- provides information about each plant suggested that helps the user in growing them as shown in figure 20
- 3- provides an open-care system

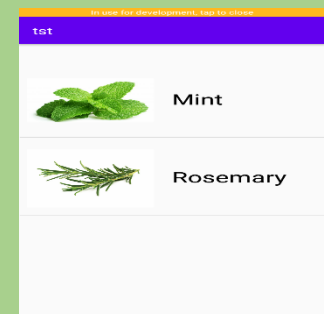


Figure 19

The open care system:

- 1- provides care and waters the plant whenever it needs water based on the readings of the moisture sensor the prototype can be tested via various methods
- 1- testing the care system by watching the growth of the plant daily and comparing the amount of water used by the pump to that by the traditional irrigation ways
- 2- testing the code by running it more than once and examining each function
- 3- making a survey to see if the users are satisfied with the features of not

the final prototype was an application connected with an open-care system that includes a pump to take care of the plant watering. Shown in figure (21)

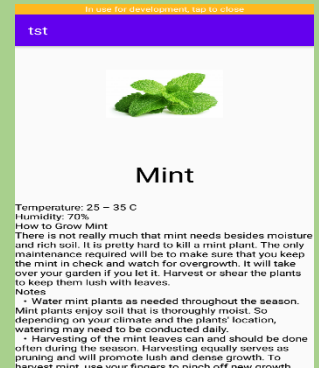


Figure 20



Figure (21)

Materials and methods:

Materials:

Item	Description	Quantity	Cost	Pictures
Pot	A container used to plant in	1	10 L.E	
Breadboard	Board for extra pins	1	Personal tool	
Moisture sensor	Sensor that reads the moisture value	1	Personal tool	
Arduino board	Used for coding and performing function	1	Personal tool	
Jumpers	Connected pins with the other tools	10	Personal tool	
Pump	Pumps water	1	Personal tool	
Dt-06 WIFI module	Module that Connects the system with the server	1	175 L.E	

Table 1

Methods:

Developing the application: -

- 1- We used android studio as a platform.
- 2- We developed the application using kotlin coding language and xml.

We included:

- A feature that allowed the user to find plants according to the temperature and humidity which he inserted
- Various plants with different humidity and temperature Information
- related to each plant
- User interface.

3. We connected the application with open care system.

Developing the open care system:

- 1- We used C++ language to write the code of the care system and used Arduino as IDE.
- 2- We connected the moisture sensor and the pump with the Arduino and coded them.
- 3- We connected the Arduino with the application through an IoT system (the pump waters the plant after the moisture sensor reads a specific range of values)

Testing methods:

- Testing the care system:

We watched the plants growth for several weak and calculated the amount of water used then compared it with the traditional irrigation ways amounts.

- Testing the other design requirements:

- 1- we made a survey to determine what needs improvements from the perspectives of users.
- 2- We modified the flaws in the application.
- 3- We launched it again.

Application coding:

In Andriod studio code is divided to 3 classes (Main activity, items, zar3a)

1. Main activity class: includes the code of the interfaces design, text boxes, images, initial values and so on.

```
// setting initial data for number pickers
nptemp.minValue = 0
nptemp.maxValue = 70
nptemp.value = 25

btnS.setOnClickListener {
    //Setting the On Click Listener for the button
    val intent = Intent(this, Items::class.java)
    intent.putExtra("tt", nptemp.value) // passing the temperature
value
    intent.putExtra("hh", nphum.value) // passing the humidity
value
    startActivity(intent) // starting the new window
}
```

2. Items class: it includes most the functions needed in the application.

```
// creating a variable for each zar3a
val mint = Zar3a("Mint", 27, 60, info1, R.drawable.mint)
val rosemary = Zar3a("Rosemary", 25, 60, info2,
R.drawable.rosemary)

// filtering data
for (i in 0 until arr size) {
    if ((temp < (arr[i].t!! + 5)) and (temp > (arr[i].t!! - 5)) and
(hum < (arr[i].h!! + 30)) and (hum > (arr[i].h!! - 30))) {
        arrlist.add(arr[i])
    }
}
```

`inner class PlantAdapter: BaseAdapter { } //includes the code that will show specific plants.`

3. zar3a class: includes the definition and type of every variable in the code.
4. Plants class: connects all the faces together

```
class Plant : AppCompatActivity() {  
    override fun onCreate(savedInstanceState: Bundle?) {  
        super.onCreate(savedInstanceState)  
        setContentView(R.layout activity_plant)  
        //receiving and reading data from the prev window  
        val name = intent.getStringExtra("name")  
        val info = intent.getStringExtra("info")  
        val image =  
        intent.getStringExtra("image").R.drawable ic_launcher_background)  
        tvname.text = name  
        tvinfo.text = info  
        imagemain.setImageResource(image) }  
    }
```

Coding the care system:

1. Hardware:
 - a. Soil moisture was connected to analog pin A0 in Arduino board Uno to sense whether the plant needs water or not.
 - b. Pump was connected to digital pin 7 to water the plant when it needs.
 - c. dt-06 wifi module was connected to pin 1 (RX) and pin 2 (TX) IN the Arduino board to send a notification to the application if the water ran out.
2. Software:

```
// read the input on analog pin A0:  
val = analogRead(Moisture);  
if (val <= 320)  
{
```



```

    digitalWrite(pump,LOW); // if Soil moisture reads any values less
    than or equal 320 then the pump will not work
  }
  else
  {
    digitalWrite(pump,HIGH); // if Soil moisture reads any values more
    than 320 then the pump will work
  }

  // print out the value you read:
  Serial.println(val);
  digitalWrite(pump,LOW); // switch the pump off.
  delay(120000);
  val = analogRead(Moisture); // after 2 minutes read the values from
  sensor again
  if (val > 320)
  {
    Serial.println("I'll DIE, WATRE RAN OUT!");
    // if the sensor still read values more than 3, it means that the water
    ran out so it will send a notification to the user says "I'll DIE,
    WATRE RAN OUT!"
  }

```

Safety precautions:

- 1- we made sure that the connections were right in order to prevent electrical accidents
- 2- we made sure that the water was away from the jumpers
- 3- we made sure there was no open circuits

Test plan:

To make sure that our prototype is successful we had to test some requirements that are essential to determine the effectiveness of any project, in this semester we decided to test

- 1- Water saving:
 - calculating the amount of water used to irrigate any plant by the traditional way
 - calculate the water consumed by the pump
 - comparing them with each other
- 2- Eco- friendly:
 - Use materials that doesn't aid in polluting the environment and recyclable
- 3- Low cost
 - use cheap and available materials
- 4- Effectiveness
 - Surveying users
 - Considering their comments
 - Updating the application
 - Survey again
- 5- Sustainability
 - Determining how long can the system work without errors or problems.
- 6- Applicability:
 - Use the application on android and IOS and examine its processing

Data collection:

Collection of all the data found during the research and constructing the project is extremely important, as it summarizes the results of all the steps and function as the project background.

Data related to the grand challenge: -

Observed:

Air pollution is one of the leading risk factors for death. In low-income countries it tops the list. In 2017, it was responsible for an estimated 5 million deaths globally. That means it contributed to 9% – nearly 1-in-10 – deaths.

concluded:

air pollution is a problem that demands solving because it threatens our life and environment

Data related to the chosen problem: -

Observed:

- Co₂, amounts increased highly in the recent years, which accounts for approximately 80% of the greenhouse effect (the greenhouse effect is one of the major contributors in air pollution).
- indoor plants can scrub the air of cancer-causing volatile organic compounds like formaldehyde and benzene. It also stated that the amount of leaf surface area influences the rate of air purification (according to a NASA's study).

Concluded:

- We need to decrease the amount of co₂ in all the world countries to save the environments and lives.
- These amounts can be decreased by increasing the planted sector

Data related to the test plan: -

Determining how to test each requirement is very valuable in any project as it aids in allowing other young researchers to try it again. Each design requirement is tested different than the others as shown in the table

Design requirement	Testing method
Water saving	Comparing the traditional ways to the pump
Eco-friendly	Determining whether the materials are polluting the environment or not
Low cost	Calculating the cost of the used materials to their function
Effectiveness	Using a survey to determine the opinions of the users and testing the pump and IoT system
Sustainability	Long-lasting of the system
Applicability	Its processing on android and IOS

Table 2

Data related to the results of the testing:

We tested all of the past requirements and collected the results which are illustrated in the following diagrams:

1- Water saving

It was estimated that people consume 210 milliliters to water each plant daily so we focused on saving it by using a moisture sensor and a pump

Amounts were measured using a graduated cylinder

Trial	Amount of water used daily
1	250 milliliters
2	180 milliliters
3	140 milliliters

Table 3

There was a problem with the code as the pump pumped water even if the moisture sensor outcome was less than that demanded, updates in the code were made.

2- IoT testing

Moisture sensor output	Pump output
Less than or = 320	No
More than 320	Yes

Table 4

We had problems with the pump at the beginning so the results are shown after update

3- Survey results

The chart below illustrates the answers of 10 of our application users on a survey composed of 5 features that the user can rate on the scale from 1 to 3 in addition to a comment section.

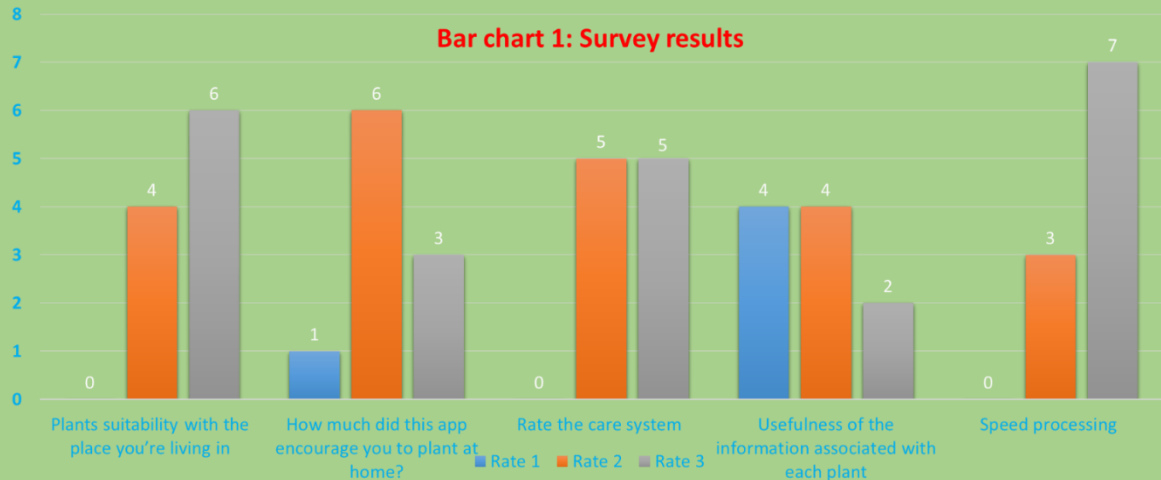


Chart 1

We updated the information and asked again to make sure the users are satisfied and calculated the effectiveness to be 90%

We used precise tools like graduated cylinders and sensors in measuring our quantities as they have a random error of only 1.5%

4- Other design requirements:

Design requirement	How we tested it	Was it accomplished
Applicable	The application works properly on android and iOS	Yes
Eco-friendly	It supports growing more plants and reducing greenhouse gases	Yes
Low cost	The whole system costs less than 200	Yes
Sustainability	The system works without errors for a long time	Yes

Table 5

ANALYSIS:

According to IPCC's Fifth Assessment Report on Climate Change, we need to decrease the amounts of greenhouse gases emissions by 40% to 70% in order to limit the global mean temperature increase attendant on climate change to two degrees Celsius, which is considered a safe limit. This global temperature increase lead to a significant decline in the levels of water in the Nile river which is the main source of water and demanded for almost all the agricultural and industrial activities in Egypt. Co₂, amounts increased highly in the recent years as shown in figure 22, which accounts for approximately 80% of the greenhouse effect, can be reduced by increasing the planted sector in each country.

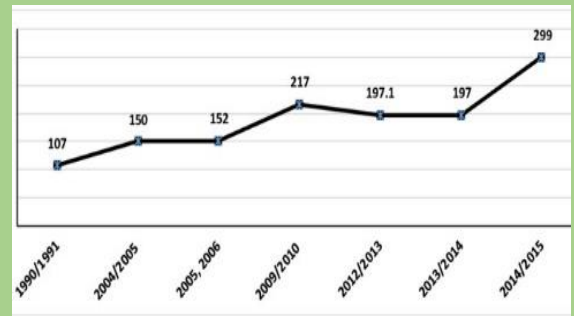


Figure 22

The amount of emissions
in Egypt million tons of
carbon-dioxide

Home-planting was proven to be a significant method when it comes to increasing the planted sector and consequently to reduce the amounts of dangerous gases and purify the air by a NASA's research summarized in figure 23.

Plants mainly uses carbon dioxide in order to make their own energy through photosynthesis process, they end up releasing oxygen instead of the used gas.

Our application briefly functions to choose a plant suitable for the surrounding conditions of the user (temperature and humidity) and to take care of the plant through an IoT system that waters the plant and notifies the user when the water in the container is fully consumed.

Developing an effective application required a lot of testing to achieve various design requirements

- Testing the water care system demanded various connection codes, the moisture sensor with Arduino, -the Arduino with the Wi-Fi module and finally the server with the module. That granted a properly working system.

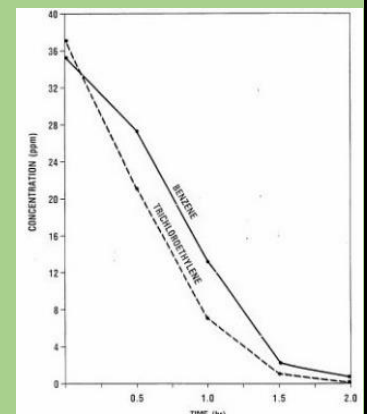


Figure 23

The decrease in benzene and
trichloroethylene in a sealed in door
planting chamber

- The application was developed using kotlin language, it has a lot of pros such as it is processed fast on IOS and Android devices, fills a little storage which is less than 10 mb and doesn't consume much energy, through this applicability was achieved.
- The application is free to download on play store and app store and the associated kit costs only about 185 L.E in addition to that it doesn't consume any fossil fuels which assigns it as an eco-friendly app that raises the awareness about a global problem.

There was a sub-problem associated with home-planting as the planters consume more water than needed for each plant, therefor Plantaco application open-care system focuses on reducing water waste, by using a moisture sensor and a pump, when the sensor reads a certain value it supports the plant with an appropriate amount of water, we faced some problems because the pump was pumping water even if the moisture sensor reads a value less than the certain value so we checked the code again and made modifications then it worked properly, however, like any application it has an error percentage of 1.5%

Finally, we surveyed 10 users about the opinions and whether it worked properly or not, the questions were testing various features in application to determine what is convenient for the user and modify the debugs. According to the results most users were satisfied with the features they have tested. There was an additional comment section in the survey, 4 of surveyed users thought the application information wasn't enough so we made an update with more information and asked them again and they were finally satisfied.

STEM subjects has always represented a huge part of our daily lives, everything we learn is somehow connected with what we do and how we create things and solve problems. In developing this application, we mainly focused of what we learned in:

- 1- Biology: we learned about photosynthesis (fig 24), cellular respiration and the organelles of the plant, it was very useful as we understood the mechanism of every process in the plants that we support growing.
- 2- Physics: we learned about communication and networks which was very useful in the IoT system which is mainly about connecting two systems through Wi-Fi, it widened our horizon and allowed us to understand how Wi-Fi modulation work.
- 3- Chemistry: we learned about gases concentration and their increase risks, especially fossil fuels.

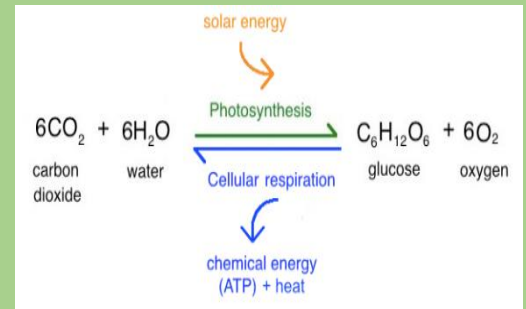


Fig 24

Photosynthesis

Discussion:

We concluded that:

1. According to the survey, people were more involved, in solving the problem after the application offered suggestions and care, than ever
2. The care system save much more water than the traditional irrigation ways.
3. Using kotlin language is better than using java and easier
4. Android studio is an extremely useful platform as it provides an xml sheet that is self-coded
5. Native applications, which takes less space, process faster on all mobile phones

Recommendations:

The world evolves so rapidly by science because knowledge never stops at a certain point; we should benefit from the experiences of others in the development of these experiments to discover what is new. We used some means that helped us to develop the project and we recommend with:

- 1- Linking the application with an indoor plants store.
- 2- Making researches about each country and recommend the available plants in this area.
- 3- Adding more plants to increase the range of the users around the world.
- 4- Making the robot detect whether there is any insect destroy the plant and kill it.

Learning transfer:

Subject	How it related to our capstone	Learning outcome
Biology	Learning about plants needs and their properties.	10&11 Grade 1 semester 2
Chemistry	Using of quantitative and qualitative instruments, reporting and analysis of findings	1&2 Grade 12 semester 1
Chemistry	Learning how to do a design experiment.	3 Grade 12 semester 1
Physics	Learning about wifi, transmitter, and receiver which helped us to construct our prototype.	4 Grade 12 semester 1
Physics	Learning about communication system which helped us in constructing out prototype	3 Grade 12 semester 1
English	Learning about organization and punctuation which helped us to write posters and portfolio.	4 Grade 12 semester 1
English	Identify and correctly use idioms, phrasal verbs, collocations and affixes. In their oral and products	8 Grade 12 semester 1
Earth science	Learning about types of pollutants which helped us in our research	4 Grade 2 semester 1
Earth science	Learning about soil and their properties which helped us in planting	8 Grade2 semester 1
Statistics	Explain and apply the principals of survey design and data collection to estimate population parameters	1 Grade 3 semester 1

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