THE GREEN GOBLIN

2024-2025

GRADE: 11

SEMESTER 1

Group 29230

Introduction

No doubt that Egypt that faces numerous problems that represent great challenges for our beloved country. These problems vary widely nearly in all fields in the daily life known as Egypt grand challenges like health, industrial, pollution, environmental, social, and economic problems. and stop the government from developing itself, making it considered one among the developing countries despite having the elemental factors alongside the acceptable human, natural and artificial resources giving it countless chances to stay up with the planet daily developing and provides it opportunities to steer the planet, so solving these challenges must be as fast and final as we will, there are about eleven grand challenges that force Egypt and that we are getting to discuss below.

Fig (1)

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Present and Justify Problem and Solution Requirements

Egypt Grand Challenges

Recycle Garbage and waste for economic and environmental purposes

Now, Egypt faces a huge waste recycling problem. The previous government tried to dismantle it with forced conscription, but it failed. Now it looks a lot like the mountains of trash that can be found everywhere. Egypt faces a big problem in the solid waste management crisis, for example:

-There are 14,000 quantities of daily waste produced in Cairo that are still not recyclable.

-The process of collecting and changing old paper, glass, plastic, etc.

-pursuing sustainable development through cleaning up the environment One of the most significant is Egypt's use of technology to convert garbage into energy. (EPA,2023)

-The reasons of recycling in Egypt

1) Although the amount of e-waste in the country is high, the number of formal e-waste recyclers is low, and these recyclers operate on a small scale

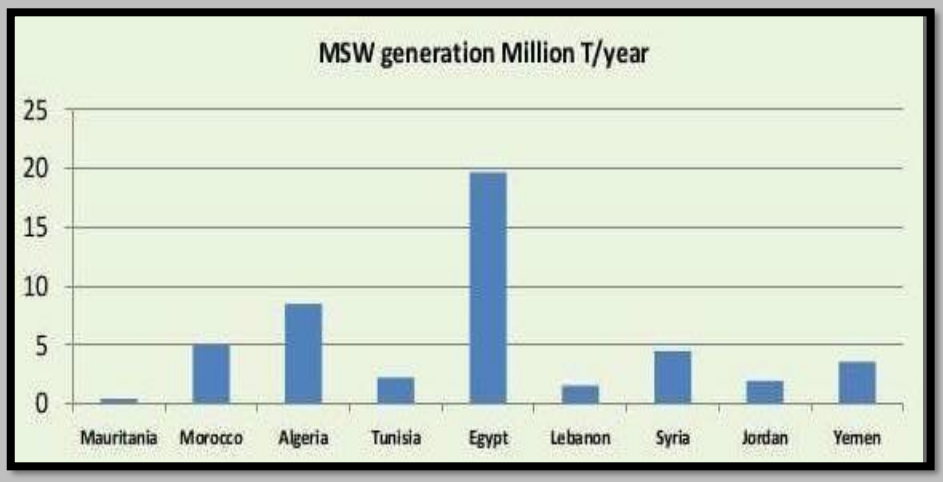
Fig (2)

2) There is no formal collection system of e-waste, no specific regulation or financing mechanism and the involvement of the producers is low compared to Europe.

3) Most of the e-waste is therefore collected and treated through informal channels, with poor health and safety conditions, and high environmental impact.

However, the Green ICT initiative has created some momentum and various initiatives to improve waste recycling have emerged that should be capitalized on. Also, the “Needs assessment of the e-west sector in Egypt (CEDARE, EMPA, 2011)” has revealed the necessity to support small and medium sized enterprises (SME) development by providing financial, administrative legal and technical support through a “youth incubator programs”.

Strategies aiming to improve the e-waste treatment in Egypt should therefore help formalizing recycling activities, with focus on building technology partnerships, implementing standards and improving conformity, developing a system for financing sound recycling, and training for the main stakeholders. (Mahmoud Bakr,2019)



fig(3)

Benefits

- A well-managed recycling program is associated with several advantages.

1. Environmental Benefits

• The ground space is saved because millions of tons of material are not allowed to end up in landfills and thus room will be preserved for trash that cannot be recycled.

Increased recycling can greatly reduce the number of pollutants that enter both air and water.

Protects the earth's natural resources, be it minerals, raw materials, trees, etc.

2. Economic Benefits

• Research has indicated that if good recycling behaviors are developed, the

country will generate more than a million jobs annually.

• Recycling offers a source of employment to all individuals who are involved in waste management.

• Promotes economic sustainability through utilizing a domestic supply of resources.

Recycling is the process of manufacturing new products from waste or used goods. After something has served its purpose, it gets thrown away; recycling is an effort to extend the life of a product usable, so it brings a lot of benefits to humanity and earth mother.

-Almost all things that exist in our environment are recyclable, even though someways to reuse the various components made from plastic, metal.

-There is a lot of waste that could be recycled and utilized as raw materials for various enterprises. (Las Cruces, 2014)

-Preserve your used materials and alter some of the hazardous raw materials.

types of recycling.

• Recycle glass products to make new glass items or bottles.

• Recycle paper goods like books to make newsprint and, at the least

costly books.

• Recycle tissues, including fabric, to make banner ads.

• Manufacturing other products from recycling tire rubber.

• Recycling aluminum-based materials to produce packaging-grade aluminum paper.

• Plastic products recycled for rubbish bags or other purposes in the packaging business.

• Recycling wastewater again to provide water for plant irrigation.

When was recycling invented?

Human recycling dates way back to ancient times. While the first recorded case of recycling paper could be dated back to 1031 in Japan, ancient societies usually reused everyday items long before this time, partly because of a shortage of resources and long periods of time that were required to manufacture the products.

What is the solution to recycling waste?

1) Plan a recycling campaign for your school or area. Gather and deliver used bottles, glass, plastic, newspapers, and books to a local charity or recycling facility.

2) Establish a communal computer drop-off location at a nearby school.

3) Create a composting program for your community or educational institution. (San Jose Recycle, 2021)

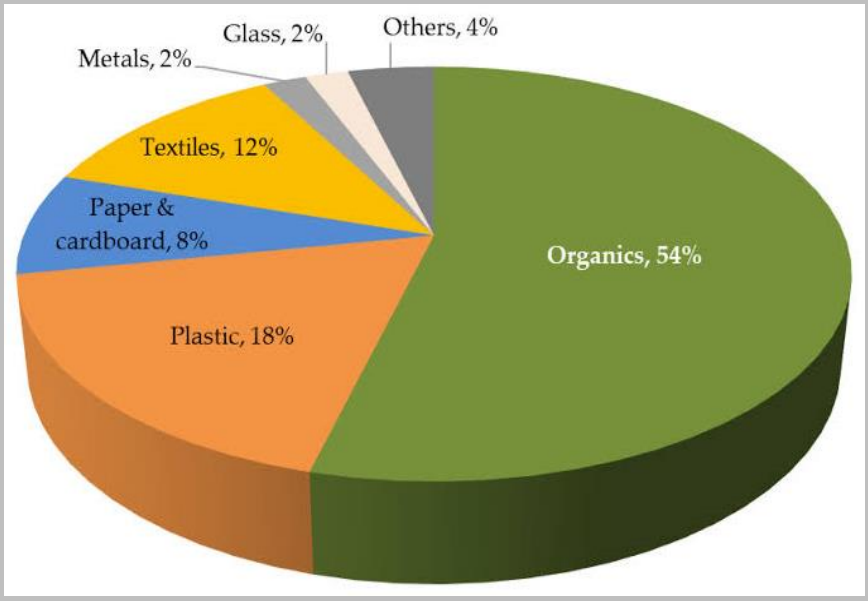


Fig (4)

Reduce and adapt to the effect of climate change

Climate change is among one of the worst problems we have. This problem affects all countries on Earth. The causes of climate change are many. The principal cause is pollution. The gases that come from pollution heat the earth's temperature. Cutting trees down is another cause. Even though that is a dangerous problem, it's very easy to solve. We should decrease pollution. One should no longer depend on the use of Fossil fuels. Clean renewable energy sources should be used. Deforestation should be stopped. More and more trees should be planted on the sides of streets. (NASA, 2023)

History of climate change

If that is so, the 20th century has Observed changes over the 20th century include increases in global air and ocean temperature, rising sea levels, long-term sustained widespread reductions in snow and ice cover, and changes in atmospheric and ocean circulation as well as regional weather patterns, which affect seasonal rainfall conditions. These changes are ultimately caused by the added heat to the climate system coming from the accumulation of greenhouse gases in the atmosphere. Human activities of burning fossil fuels-primarily coal, oil, and natural gas-biomass burning, deforestation, agriculture, and land-use changes-all are significant sources of these added greenhouse gases. The pattern in the climate changes observed is in tandem with a stronger greenhouse effect. Other climatic factors, such as this problem will be quickly solved. Human activity leads to changes in the atmosphere. (Climate Central, 2023).

Reduce and adapt to the effect of climatic change:

The sixth phase of the coupled model intercomparison project (CMIP6) Comprises 23 individual MIPs.

Future climate change simulations are coordinated within 'scenario IP', for which around 30 climate models contributed results. Besides, the Diagnostic, Evaluation and Characterization of Klima (DECK) experiments are central to CMIP6 in that the experiments involve the historical simulations, i.e., from 1850 to near present, allowing evaluation of the model simulation of past climate. While CMIP prioritizes MIPs, and organizations can participate in as many or

few as they are capable of, the DECK experiments are mandatory for any model to enter the CMIP. The figure above shows the elaborate structure and inter-linkages involved in the CMIP6.

Climate Change Beneficial Impacts:

1-Contributing to preventing runaway costs from climate change.

2-Job creation.

3-Competitive advantage internationally.

4-Improve public health.

5-Saves money for households and businesses.

6-Enhances national and global security.

7-provide benefits to the farmers

8-Delivering benefits to low-income.

9-keep crucial ecosystems and species

10-conservation of water resources as well as clean water.

Solution:

1-use of less fossil fuel.

2-Dependency on renewable sources of energy that do not pollute the environment.

3-crops variation and drip irrigation for farming.

4-Sea wall construction, relocation from the coast that are vulnerable will protect from high levels of water as well as storm surges. (Adapting to climate change,2022)

Deal with population growth and it is consequences

Population is the most important topic which we should notice to it because it has super effects on our country and in our world. (Khalifa, 2000)

What is the meaning of the population?

Population means the number of people who are living in a country, a city, a town, and a village. And they are using the facilities of these areas to be alive in this huge world. (Khalifa, 2000)

Fig. (5)

What is wrong with the population in our country?

The population is a good thing which can help the country to grow and to be on top but when the population increases to more than the normal limit, that will be the problem. (Khalifa, 2000)

Why is increasing more than normal limit of population will be problem?

There are a lot of reasons about it like:

- Because that will affect the facilities and materials of our country.
- The government of our country won't be able to provide materials and facilities to all these people.
- There will be people who can’t live because there aren’t enough materials for them. (Khalifa, 2000)

Work to eradicate public health issues/disease

The lack of appropriate and affordable healthcare could be the number one killer in Egypt. The country is full of patients dying or suffering because they cannot afford surgeries or medicines (reaches 42.000 pounds). Even worse, there are well-documented stories of patients who could afford the services but died due to the irresponsible care providers. Millions of Egyptians suffer from Hepatitis C, a disease that spreads through blood due to the negligence of private and public healthcare providers. The hospital buildings look like a huge pile of rubbish. Grey paint was peeling off the walls, stone stairs are broken, and dirt blackens green walls. As a result, doctors don't want to work in these conditions, the health ministry's nursing administration was dealing with a shortage of 40,000 nurses in the nation's hospitals and clinics. The Medical Association says as many as 230,000 doctors are Fig. (4) registered with them, but around 30,000 have left to work in other countries because of the money they get paid. Doctor's salaries in the public sector start at less than 500 Egyptian pounds ($73) per month.

Fig (6)

Address and reduce pollution fouling our Air and water

air:

There are numerous sources to air pollution in Egypt, as in other countries. However, the formation and levels of dust, small particles and soot are more characteristic in Egypt than presently found in industrialized countries. Some of the sources for these pollutants, such as industries, open-air waste burning and transportation, were also well-known problems in most countries only 10 to 20 years ago. Another important source for particulate matter is the wind-blown dust from the arid areas. These particles are, however, to be found in the larger particle fraction. We will show, for instance from data collected at Tabbin in southern Cairo, that the inhalable (thoracic) particles (diameter less than 10 micrometer, PM10) are mainly generated from industrial processes.

Water:

The Nile River has been subjected to different sources of pollution and contamination through several complicated routes. Industrial effluents constitute a real threat to The Nile River. Recently, the risk of water pollution with toxic chemicals is not limited to the public health and veterinary public health only but extended and joined as toxic chemicals causing zoonotic diseases.

Soil:

The content of available harmful elements in the soil is increased by several orders of magnitude in the industrial areas. Results of El-Desoky and Ghallab on the industrial area near Assiut city indicated that plant damage was not only a matter of toxic concentration of heavy metals in plant tissue, but also instead it was a direct mechanical effect of dust particulates that continuously covered the above ground plant organs. In Upper Egypt, the ferrosilicon alloys factory uses quartz, coke coal and iron oxide as row materials. These materials contain several elements, Al, P, S, K, Ca, Mg, Mn, Ni and Cr. Some toxic gases also evolve to the atmosphere when ferrosilicon alloys are exposed to water and water vapor. The deposition of air-borne particulates of the factory on plants and soils nearby the area as well as the huge quantities of gases and fumes emitted from the

factory probably cause contamination problems, especially with heavy metals. The present study aims to evaluate the pollution status of the agricultural area around the Edfo ferrosilicon alloys factory with respect to some soil properties, macronutrients and heavy metals contents.

Problem to be solved

Air pollution is one of the most dangerous things that faces Egypt in long time, it also considered as one of Egypt Grand Challenges.

Air Pollution: is contamination of the indoor or outdoor environment by any chemical, physical or biological agent that modifies the natural characteristics of the atmosphere.

What are the causes of air pollution?

Household combustion devices, motor vehicles, industrial facilities and forest fires are common sources of air pollution.

Pollutants of major public health concerns include particulate matter, carbon monoxide, ozone, nitrogen dioxide and sulfur dioxide. Outdoor and indoor air pollution causes respiratory and other diseases and are important sources of morbidity and mortality.

WHO data show that almost all the global population (99%) breathe air that exceeds WHO guideline limits and contains high levels of pollutants, with low- and middle-income countries suffering from the highest exposures.

Air quality is closely linked to the earth's climate and ecosystems globally. Many of the drivers of air pollution (i.e. combustion of fossil fuels) are also sources of greenhouse gas emissions.

Policies to reduce air pollution, therefore, offer a win-win strategy for both climate and health, lowering the burden of disease attributable to air pollution, as well as contributing to the near- and long-term mitigation of climate change.

What happens if we don't solve air pollution?

- illnesses (pneumonia or bronchitis)
- irritation to the nose, throat, eyes or skin.
- Headaches, dizziness and nausea.
- Asthma, Heart disease, lung cancer and respiratory disease (such as emphysema).
- Damage to people's nerves, brain, kidneys, liver and other organs.
- Changing soil composition degrades water quality in rivers, lakes and streams, and harm crops, obscures shapes and colors.
- Increasing the Global warming

What happens if we solve air pollution?

- Better cardiovascular and respiratory health of populations,
- Reduce emissions of carbon dioxide (CO_2) and short-lived climate pollutants.
- Lower risks of premature death and other serious health effects.
- Environmental damage from air pollution is reduced
- The value of clean air act health benefits far exceeds the costs of reducing pollution
- The temperature of the earth would continue to rise but with smaller amount
- Reducing the risks of getting infection and has a better health

Research

Topics of problems:

- Types of waste-material
- Types of air filters
- Process of air filters
- What's the most efficient air filter?
- Biological air filter
- The containments of air
- What is air containment?
- Classification of air containments
- The chemical containments of air
- How to purify the air?
- How do you make prototype low cost and ecofriendly?
- What is a sensor to measure CO_2 concentration?
- What percentage of CO_2 is in the air?

Topics of solutions:

- Types of microorganisms feed on air pollutants?
- Types of algae microorganism feed on CO_2?
- The properties of chlorella.
- What are the advantages and disadvantages of chlorella?
- How do you keep chlorella vulgaris to live more time?
- What is the environment of chlorella vulgaris?
- What's the efficiency of absorbing CO_2 in 1 liter of Chlorella
- The density of Chlorella
- Is chlorella harmful to the environment
- The requirements needed to save chlorella
- The minimum-maximum light intensity can chlorella tolerate
- The pressure effect on the chlorella
- The nutrients required for chlorella

Other Solutions Already Tried

HEPA filter:

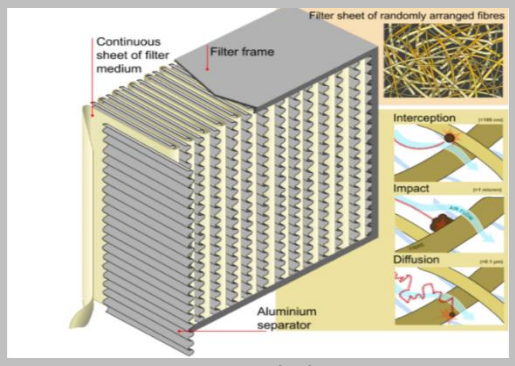


Fig (7)

HEPA is a type of pleated mechanical air filter. The acronym means "high efficiency particulate air [filter]" officially defined by the U.S. Dept. of Energy. This is typically an air filter which can theoretically remove at least 99.97% of dust, pollen, mold, bacteria and any other airborne particles with a size of 0.3 microns (µm). This 0.3-micron diameter specification represents the worst case, i.e., the most penetrating particle size. Particles of larger or smaller size are captured at an even greater efficiency. Testing with this worst-case particle size yields the worst-case efficiency rating, e.g., 99.97 percent or better for all particle sizes. All air cleaners must be cleaned, and filters replaced from time to time to operate effectively. Follow the maintenance and replacement schedule recommended by the company.

Advantages of hepa filter :

- The technology HEPA: has a number of advantages it gives to the customers who would want to buy an air purifier.
- No By-products are Produced or Emited: Most technologies of air purification, including PECO, Ozone, and Ionizers, all produce and emit a hazardous by-product into the air when these are used within an environment. HEPA, however, does not produce any by-products or Ozone as their competitors do.
- Efficient Particulate Removal: HEPA filtration can filter particulate matter as small as 0.3 microns in size with a pretty excellent efficiency of 99.97%.
- Ideal for Allergy Sufferers: HEPA filters will remove most of the air particles in your home or office that could become the culprit for negative allergic reactions.
- Long Life: it expectancy of a HEPA lasts for roughly around 2 to 3 years. These filters, in comparison to other rivals such as Carbon, stay in longer.

Disadvantages of HEPA filter:

- As far as the flaws of HEPA filtration are concerned, there are a few that can worry the buyers even before they make their purchase.
- Smaller particles may get through the filter: As much as these filters catch and filter out all particles larger than 0.3 microns, smaller ones may bypass this filter into your air and become harmful to you.
- Mold & Bacteria Growth in a Filter: As the bacteria and mold build upon the inside of the air system on the HEPA filter, these types of organisms can grow right through the filter itself. They are microorganisms, and once they become collected, they can multiply to become released back into the atmosphere.
- HEPA technology: in air cleaners is very effective and helpful. HEPA is efficient at removing larger particulates such as pet dander, pollen, and dust mites. If there is a technology that could do the job of particulate removal efficiently without emitting by-products or any other dangerous chemicals into the air, it is the HEPA technology.

pleated filter:

A pleated filter is an air filter that is made out of a pliable material-being polyester, cotton, or paper folded to look like an accordion-and is housed in a cardboard frame.

Fig (8)

Advantages of pleated filter:

• Higher Surface Area: Because of the pleated design, the surface area becomes higher; therefore, it has better filtration efficiency and it can also last longer than flat filters.

• Better Filtration Efficiency: Finer mesh and higher density enable them to capture even smaller-sized particles, which include dust, pollen, and pet dander.

• Longer Life: Their construction allows them to last longer than other filters, thus decreasing replacement frequency, hence saving money and time.

• Improved Airflow: Most of the pleated filters are designed in such a way that they can offer good airflow with effective filtration to enhance the efficiency of an HVAC system.

• Variation in Ratings: These are available in a range of MERV ratings; hence, one is at will to choose the filter that shall suit their expectations of quality in the air.

Disadvantages of plaeted filter:

• The Cost: In most instances, the pricing of pleated filters is relatively higher compared to flat filters, which may be considered a factor by some clients.

• Pressure Drop: Some of the pleated filters can result in a higher pressure drop within the system, which can make systems less efficient or even overload an HVAC system if not chosen appropriately.

• Needs Regular Replacement: Still, these filters need to be replaced regularly, unlike flat filters, but a bit longer.

•Installation Challenges: Some of the pleated filters could be bulkier, thus resulting in harder installation for some systems.

Fiberglass filters:

These glass mat filters are made up of 15-60 µm glass fibers and are of high porosity. The most used filters in residential furnace and air conditioning systems. Fiberglass filters are reasonably low in cost.

Fig (9)

Advantages of fiberglass filter:

• High Filtration Efficiency: Fiberglass filters have the capability to capture particles and aerosols in more detail, hence good in removing pollutants from both air and liquids.

• Large surface area: The construction of fiberglass allows a larger surface area that might increase the capacity of the filters and reduce the clogging thereof.

• Durability: Fiberglass is resistant to chemical corrosion, thus withstanding harsh conditions that would make such filters long-lasting for a great number of applications.

• Low Pressure Drop: Most of the time, they present a lower pressure drop with many other types of filters, hence increasing the flow of air or liquid, therefore improving the efficiency of the system.

Disadvantages of fiberglass filter:

• Poor Reusability: Most fiberglass filters are disposable, and this may be costly due to replacements in many applications.

• Particle Release: Once it attains the saturation point, some of the captured particles are released into the air by the filter itself or into the liquid. This further deteriorates the quality of the air or adulterates the liquid it is filtering.

Not ideal for all contaminants: it is highly effective while dealing with particulates but may not have the same adequacy for other gases and vapors and very fine particulate matter, since there have been designs that specialize in other kinds of filters.

• Ecological Impact: It is somewhat of a concern to dispose of used fiberglass filters because of an overall lack of recyclable materials that would further contribute to landfill sites.

Generating and Defending a Solution

Solution and Design of Requirements

Solution of requirements

- ***Efficiency:***

The reason we have designed an air filtration system was due to our urge to make something very effective yet cost- and labor-effective. This thing will ensure sleek designs using waste materials.

- ***Effectiveness:***

Our target is over 85% system effectiveness. To realize this, emphasis shall be placed on the main goals of the project and the exact action that will be required for such goals.

- ***Low Cost:***

The cost of materials of construction that are proposed to be used in the project must be low and within reach. This ensures ease of replication of the project at minimal cost.

- ***Ease of Application:***

The implementation of this project should be straightforward, with clear documentation so that anyone can implement it just by following the instructions.

- ***Ecofriendly:***

Chlorella vulgaris is not harmful for humans because this algae are like any plants not harmful humans.

Design Requirement

- We should use our waste-derived material to reduce air pollutants by 20%
- Time needs to be less than 10 minutes.
- The air sample volume to be analyzed must be in between 600 - 1500 mL.
- Material should be durable and can handle higher levels of pollution.
- We must follow ALL school safety rules and documents in our capstone portfolio.
- All materials should be natural or waste materials
- Using sensor to measure of air pollutants

Selection of solution

Biofilter:

It is one of the oldest bioremediation techniques that uses organic and biological elements or organisms like(bacteria, fungi, algae, and protozoa)in its medium to filtrate organic compound from water and also from the air by absorption or destroying bonds between them , we developed this technique to filtrate the air using (**Chlorella Vulgaris**) that absorb CO_2 after it dissolves in water by pumping it directly through the liquid medium and decrease its percentage after period of time.

Advantages:

1.Safe for humans: this biofilter specifically these bacteria (Chlorella Vulgaris) are safe for humans and doesn't have any side effects.

2.Doesn't harmful for environment: doesn't emits any harmful gases or any doesn't have any probability to be danger for the environment.

3. Effective Fixation of CO_2: Chlorella vulgaris shows highly efficient photosynthetic activity: it absorbs CO_2 from the atmosphere and transforms it into organic matter. In this context, it might be very useful for controlling the concentration of CO_2 in confined atmospheres, both industrial, under glass, and in urban areas.

Disadvantages:

1.take relative time: it absorbs about 0.006L of CO_2in one hour of one liter of Chlorella Vulgaris solution.

2.Adaption: it doesn't adapt with all environments I have specific environment that adapt with that contains for example (Urea, Citric Acid, Boric Acid, Zinc Sulphate, and ……etc.)

Selection of prototype

The prototype focuses on purifying the pollutants from the air using biofilter which is one of the oldest bioremediation techniques that uses organic and biological elements or organisms like (**algae**) in its medium to filtrate organic compound from water and also from the air by absorption or destroying bonds between them, we developed this technique to filtrate the air using (**Chlorella Vulgaris**) that absorb CO_2after it dissolves in water by pumping it directly through the liquid medium and decrease its percentage after period of time.

Fig (10)

After a lot of research, we decided to choose Chlorella Vulgaris as it doesn't have any side effects, and it doesn't emit any harmful gases, or any probability to be danger for the environment. The prototype would be able to meet the design requirements as it could be able to decrease the percentage of CO_2 by 20% in 1500 ml of air in 10 minutes by absorbing at least 2ml of CO_2 in 1500 ml of air. The solution of chlorella could be able to absorb 0.006 L of CO_2 in one hour. So, absorbing the CO_2will help in decreasing the pollutants from the air which leads to decrease the effect of the greenhouse gases in the air as it supposes the world to dangerous as it melts the ice of the two poles.

The designed solution to absorb the CO_2 is using a system consisting of 5 wasted plastic bottles as a biofilter connected each other by plastic pipes which is full by the solution of chlorella using the mechanism of syringes to pump the polluted air through the solution to increase the rate of absorbing CO_2 in the solution capturing the purified air from a special hall in the system and storing it in syringe.

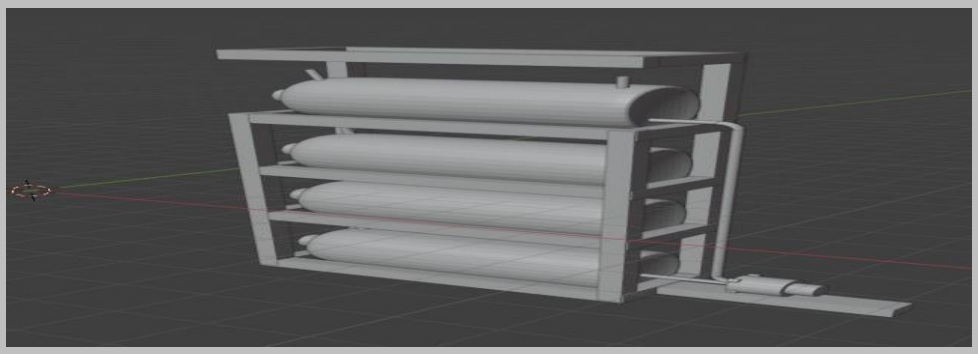


Fig (11)

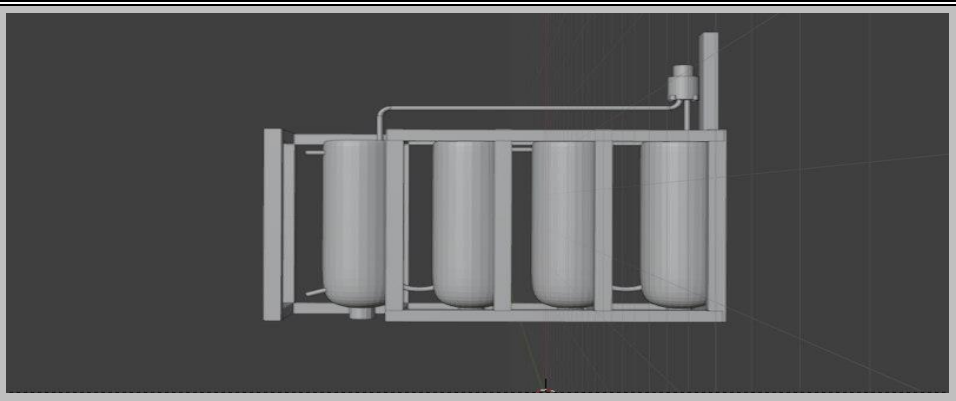


Fig (12)

The prototype humans on Environment and construction as it is built from waste materials which are the bottles and the canola in addition to the chlorella that doesn’t harm the human and the environment, and this is the required as the main goal of the prototype is decreasing the pollutants from the air so the prototype must be eco-friendly to the environment not helping in polluting the air.

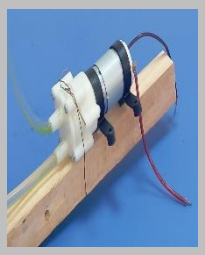
Constructing and Testing a Prototype

Materials and Methods

We used some materials in constructing our prototype and we chose them carefully as we chose the materials with low cost and high quality as shown in the table below.

Table. (1): materials used for prototype.

Item	Image	Function	Cost per one	Quantity	Source
Bottles of water		To put the algae and to keep the algae	…….	4	Waste materials
Silicon		To connect horses between bottles	40L.E	1	Out school
Chlorella vulgaris		Used to purify the air from CO_2	80L.E	4	Research center
Hoses transparent		For attaching water bottles	10L.E	3	Waste materials

Water pump		To push water in our system	100L.E	1	Recycled materials
Pipe solution		To push CO_2 in our project	5L.E	2	pharmacy
Syringe		To push CO_2 in our project	5L.E	4	pharmacy

❖ ***Methods:***

The methods which are followed are as follow:

1) Perforates bottles of chlorella vulgaris

2) Connect the Hoses transparent from one bottle to another

3) Link the hoses and bottle holes together with wax gun sticks.

4) One side of the hose transparent in the chlorella and the other side in the other bottle above the chlorella

5) Make a hole in the bottles of chlorella and insert the syringes

6) The last hose is connected to the water pump

7) The water pump is connected to the first hose from beginning and starts the cycle.

8) React HCL with $ClCO_3$ to produce CO_2 and connect it to the air pum

The safety precautions we took in constructing prototypes:

- ❖ Wearing masks to avoid strong smells.
- ❖ Wearing gloves because it isn't a good conductor of electricity and the reaction between the polyester and its hardener.
- ❖ Is an exothermic reaction.
- ❖ Working under supervision.
- ❖ never work alone.

Fig (13)

Fig (14)

Test plan

Our test plan divides into two parts and each part should achieve the design requirements that filtrate air in specific time, so we predict some results for each test.

1.Absorption:

-we must absorb about 20% of the chemical pollutant from the air.

This will be achieved by pumping CO_2directly into the Chlorella Vulgaris solution and dissolves in it and absorbs the amount that it possible to absorb

This will be done by using:

1.syringe to pump CO_2 into the solution.

2.caniola to connect the syringe with the system

2.Time of absorption:

-we must absorb this amount of carbon dioxide in about 10 minutes.

This will be done by measuring the initial concentration and then the final concentration of CO_2 and calculate the time frame of 10 minutes.

This will be done by using Timer

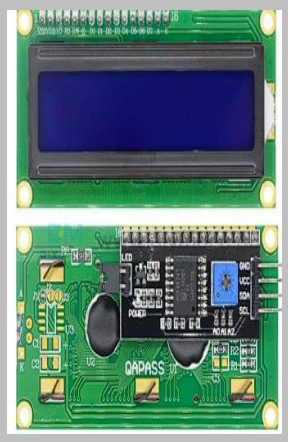
3.sensor:

-we must measure the concentration of CO_2 before and after filtration.

This will be done by using MQ-135 sensor

Data collection

Table. (2): tools used for measuring prototypes.

Item	Image	Function	Quantity	Source
Arduino uno		microcontroller board used for building and controlling electronic projects.	1	HD electronics
MQ-135		gas sensor that detects harmful gases like ammonia, carbon dioxide, and benzene in the air.	1	HD electronics
LCD 1602 LLC/2C		display screen used to show text, numbers, or other information from an Arduino or microcontroller.	1	HD electronics

After finished prototype, we tested the prototype.

The results were as follow:

negative result:

1.first the mechanism of the prototype wasn't stable and leaking of the air and chlorella solution, and this was effect negatively on the efficiency of pumping the water and passing it through the system.

Solution: this problem solved by using strong base.

2.Exposure to light, the first test was in closed place that did not expose to light so, the readings were not satisfying that it absorb about $\frac{180-159}{180}$ =12% of CO_2.

Solution: we fixed this problem by exposing the solution to source of light.

Positive result:

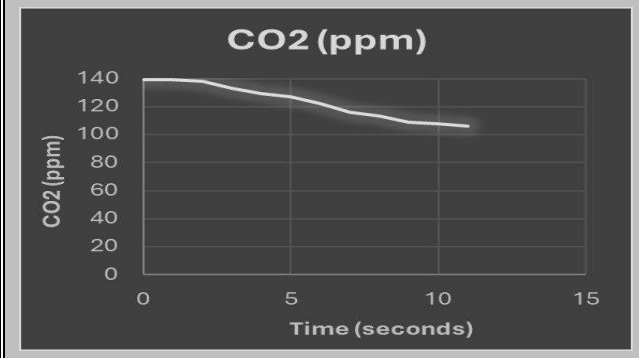
- **After making sure that the problems of stability,** leaking and light were fixed completely, we tested the prototype by using MQ-135 sensor that it detects the pollution in the air and to pump CO_2 directly in front of the sensor.

our trails:

First trail: the readings were 180 ppm of carbon without filtration and then after filtration it reached to 152ppm. we calculated it and found that the efficiency of the carbon absorption was $\frac{180-152}{180} \times 100$ = 16%

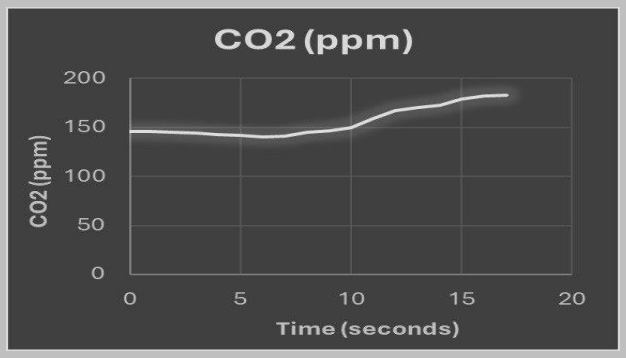
Second trail: the readings were 180 ppm of carbon without filtration in normal air and then after filtration it reached to 144 ppm, and it was $\frac{180-144}{180} \times 100$= 20% that it achieved the design requirements.

Third trail: this trail was the best trail as 180ppm of Normal air with CO_2 pollution and it reached to 106 ppm after filtration of CO_2 and it was $\frac{180-106}{180} \times 100$= 41% of pure air with decreasing the concentration by 41% of carbon dioxide



Graph (1)

The reading of amount of CO_2 after filtration



Graph (2)

The reading of amount of CO_2 before filtration

Table.2 shown in Graph.1

CO2 in ppm	146	146	145	144	143	142	140	141	145	147	150	159	167	170	173	179	179	180
Seconds	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

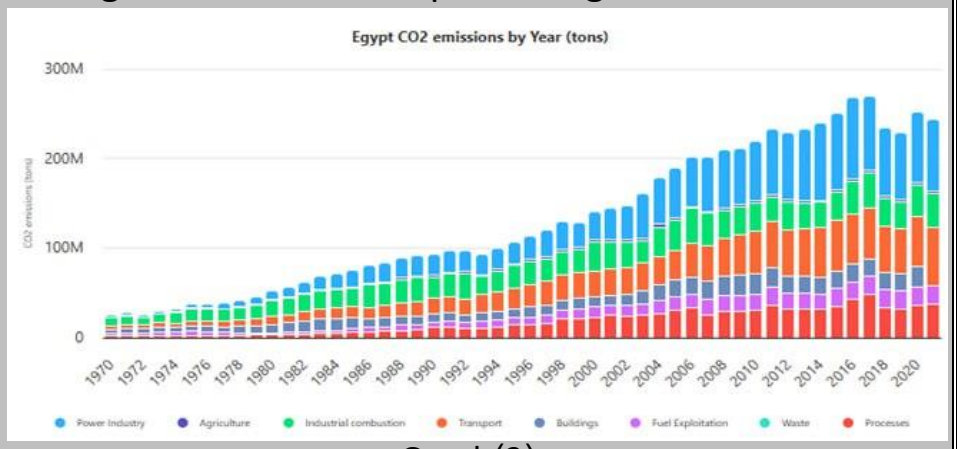
Table.3 shown in Graph.2

CO2 in ppm	140	139	138	133	129	127	122	116	113	109	108	106
seconds	0	1	2	3	4	5	6	7	8	9	10	11

Evaluation, Reflection, Recommendations

Analysis and Discussion

Egypt has a huge problem dealing with CO_2. As the percentage of CO_2 increases every year. In 2022, Fossil CO_2 Emissions 265,961,280 tons. CO_2 emissions increased by 6.54% over the previous year, representing an increase by 16,318,820 tons over 2021, when CO_2 emissions were 249,642,460 tons. CO_2 emissions per capita in Egypt are equivalent to 2.40 tons per person an increase by 0.11 over the figure of 2.25 CO_2 tons per person registered in 2021; this represents a change of 5.0% in CO_2emissions per capita.



Graph(3)

Here is how to solve these problems eco-friendly to purify the air and decrease the percentage of pollutants like the living organisms based on the pollutants that can be exploited to purify the air like (Chlorella vulgaris), this type of algae is one of the best solutions to purify the air from carbon dioxide gas (CO_2) because it depends mainly on the CO_2 as a source of nutrition, In addition to it is eco-friendly and does not harm the living organisms. Also, it can adapt with any environment does not need specific standards. So, purifying the air from CO_2 will solve many problems such as global warming that affect the two poles negatively and harming the living organisms.

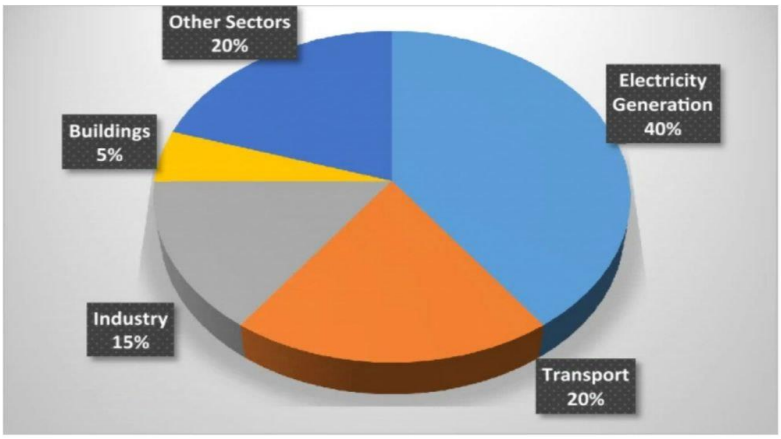
The designed solution to purify these pollutants is using this type of algae (Chlorella vulgaris) as a biofilter where the polluted air passes through it using water pump to ensure that the air will pass through all the solution to absorb the maximum amount of the CO_2. We could use our method in areas with high concentrated CO_2. So, our team based on essential testing results and calculations several times to get the most accurate results with precise and intensity with some scans about polluted areas.

- **About the variables that we achieved:**

1. filtration of the air by Chlorella Vulgaris
2. Eco-friendly and safe for environment
3. low in its cost by using waste materials

- ***Advantages of constructing prototype:***

1. Purifying the polluted air naturally.
2. Eco-friendly (Safe for Environment)
3. Constructed by wasted materials (Costless).
4. Biologically not using any chemicals.



Sources of CO_2 emissions in Egypt in 2018

Graph (4)

Disadvantages of constructing prototype:

1. *Need specific environment.*
2. *Need permanent source of electricity.*
3. *Chlorella is not safe after death.*

The laws:

We used the following laws in constructing and testing:

Number of moles $= \frac{mass}{molar\ mass}$ *To determine the grams of hydrochloric acid and sodium carbonate that needed to prepare* CO_2.

percentage of CO_2 *produced* $= \frac{concentration\ of\ CO_2\ before - concentratiof\ CO_2\ after}{cocentration\ of CO_2\ before} x\ 100$

Absolute Error of sensor readings:

Absolute Error = | Observed Value − True Value |.

Recommendations

For any team who is interested in complete developing on our project here are the main points to focus on achieving them:

- Increasing the amount of chlorella solution used as it will increase the rate of absorbing the CO_2 in the solution resulted in an increase in the concentration of the chlorella.
- Using plower to pump the air faster to decrease the time of CO_2 absorption in the solution.
- Construct the prototype vertically to make the air go down through the solution resulting from the effect of the pressure on the air column.
- Adding another filter like a chemical filter to absorb another pollutant non-CO_2 not depending only on one type of pollutant.
- Using a tighter storing system to store the purified air in, preventing it from leaking out to the pollutant air and giving more efficient readings in the MG-811 sensor.
- Using the frame made of glass because the chlorella vulgaris needs sunlight or light 12 hours per day.

By following these recommendations and focusing on achieving them, this project can be more likely to succeed both technically and socially, while also contributing positively to environmental sustainability.

Learning Outcomes

Subject	Connection
Math (lo1)	Algebraic functions helped us to make an equation to calculate the efficiency of the system.
Math (lo2)	Vertical and Horizontal asymptotes where the graph can't be happened.
Computer science (lo2)	Doing simple date base to put our inputs of concentration and outputs to measure the Efficiency easily.
Computer science (lo1)	Different types and designs of connections as the design of the system is the same.
Chemistry (lo1)	Quantitative analysis demonstrated the units of the concentration of CO_2 and various ways to measure it.
Earth science (lo1)	Water cycle gave us the idea about doing a closed system where the inputs = outputs.
Physics (lo1)	the concept of gravity and inverse square law helped to understand the relation when the air follows against the gravity and with it.
English	Different Vocabularies for the environment of water.
Mechanics (lo1)	Understanding why the flow of the air is slower than the expected flow due to friction.
Mechanics (lo2)	CO_2 particles as a vector.

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