Aims, Objectives, and Rationale

The aim of this research project is to determine the air purification properties of algae, and the potential for creating a cost-effective algae air purifier to help reduce pollution in Jakarta, Indonesia. We intend to create an air purification system, manufactured under $30 USD that can be used around polluted areas in Jakarta, where a majority of people live in kampungs, or poverty stricken areas.

Our aim is to:

- Create a cost effective air purifier for local areas in South Tangerang for 500,000 IDR.
- Determine a viable form of algae that can be easily grown, along with having sufficient air purification properties.
- Record the effect of different pollutants on an algae solution, and determine which pollutants can be absorbed, and which can not (ie. can Spirulina reduce carbon dioxide, nitrogen oxide, and sulphur oxide in the air and generate oxygen, or will some compounds remain after going through the purifier)

Objectives:

- Research and choose the right type of algae for this project, and determine if there is a history behind using such algae for air purification;
- Research different types of air purification methods and determine whether algae may be able to match the quality of air purifiers on the market, or if the algae purifier can be created cheaper/more sustainable;

- Design a suitable, cost effective model for the algae air purifier, using sustainable and recyclable materials;
- Create our model, and grow the algae to a suitable level, and then run tests on the algae with different pollutants and determine which pollutants are successfully removed, along with if more oxygen was produced;
- Gather sufficient data;
- Analyse the data;
- Form any conclusions and discussion points from the data.

We feel this project is extremely important due to the situation of Jakarta's air. As of the 26th of July 2022, the PM2.5 concentration in Jakarta is currently 9.7 times the WHO annual air quality guideline value (IQAir), resulting in the suggestion of running an air purifier for all residents. Jakarta additionally contains great income inequity, a city where modern, high rise skyscrapers are a walking distance from the "kampungs" - Jakarta's densely populated areas which lack several basic necessities.

Cities, especially in rapidly developing economies tend to encounter a high level of air pollution. Caused by an increase in fossil fuel burning and vehicular population, Jakarta's air quality in certain areas is classified to be high enough to cause negative health effects. According to IQAir, "A PM2.5 reading of 67.2 $\mu g/m^3$ was recorded, putting that month's air quality into the "unhealthy" bracket (55.5 to 150.4 $\mu g/m^3$ to be classed as such)." Throughout the dry seasons, high concentrations of pollutive particulate matter - such as SO_2 and NO - result in concerning figures in Total Suspended Particles(TSP 20 to 50), PM10, and PM2.5. Jakarta's poor ambient air quality complications are exacerbated by the city's substantial income inequity; where "kampungs" - densely populated areas of the poor - can be seen near high rise skyscrapers. These kampung residents do not have the necessary infrastructure or resources to filter the considerable amount of air pollutants, resulting in potentially long term health effects.

Indonesia's air quality has consistently been of concerning conditions, ranked 6th most polluted country on the Air Quality Index (AQI) from 98 contenders worldwide in 2019, and 9th from 106 nations in 2020. South Tangerang, a region in the south of Jakarta (and one of the more polluted areas in Indonesia), had air quality classified as "Unhealthy" by the index for 10 months of the 2019 year, whilst the other 2 months were categorised as "Unhealthy for Sensitive Groups". Air is determined "Unhealthy" between 55.5 and 150.4 $\mu g/m^3$, whilst an AQI that is "Unhealthy for Sensitive Groups" is between 35.5 and 55.4 $\mu g/m^3$.

Main sources of this pollution include forest fires, transportation, and power plants. In October, 2015, there were approximately 5000 simultaneous fires burning down, causing 80 million tonnes of CO_2 to be emitted - 5 times more than the US economy as a whole. A prominent issue that arises with the procurement of this knowledge is that, with such poor air quality, health is an adamant concern. According to a study by Indonesia University, 60% of Jakarta residents suffer from breathing problems associated with poor air quality. In addition, the US embassy has stated that the AQI in Jakarta was only classified as "good", or otherwise, safe to breathe, for 14 days in the 2017 year. Coal-fired power plants (CFPPs) in Java and two thermal power plants (TPPs) inside Jakarta itself largely contribute to health and financial costs. According to analysts Lauri Myllyvirta and Isabella Suarez, in 2020, CFPPs within 100km of Jakarta were responsible for an estimated 2,500 premature deaths in the Jabodetabek area. The annual cost of transboundary pollution from CFPPs is estimated at IDR 5.1 trillion per year in Jabodetabek.

Meteorological factors like wind trajectories affect the dispersion of pollutants like NO, SO_2, and PM2.5 In the dry months of May to October when overall pollution levels in the city are highest, sources from coal fired power and industrial plants to the east of Jakarta from Bekasi Karawang Purwakarta all the way to Bandung have more impact on air quality In the wet months December to March; sources to the west, specifically the Banten Suralaya power plants, are larger contributors.

Day	AQI
September 1, 2022	126
September 2, 2022	125
September 3, 2022	68
September 4, 2022	95
September 5, 2022	116
September 6, 2022	89
September 7, 2022	114
September 8, 2022	126
September 9, 2022	102
September 10, 2022	115
September 11, 2022	81
September 12, 2022	94
September 13, 2022	122
September 14, 2022	138

Table 1: AQI data from a sensor in South Jakarta for the first two weeks of September

Figure 1: ***Location of AQI measurement***

Therefore, our objectives are to:

(a) Create a cost-effective design which attempts to reduce certain particulate matter to a predetermined threshold.

(b) Explore the extent to which this design achieves reduction of certain particulate matter to a predetermined threshold in kampungs around Jakarta's Metropolitan Area.

Our main filtration method will be through the use of algae, as it purifies the air through its photosynthesis process, using nitrogen oxide and/or sulphur oxide as nutrients, purifying polluted air. This process produces Oxygen gas in addition to reducing the gaseous concentrations of CO_2 and SO_2.

Whilst coming up with the rudimentary design, we consulted our high school physics teacher Dr. Robin Carter with advice on what tests to carry out and general feedback on our design/proposal.

Experiment Data and Conclusions

Method:

- Research online on the best type of algae and overall materials to use.
- Create a basic 3D design for what the purifier could look like.
- Grow spirulina over two weeks.
- Purchase air pump, piping, airstones, minerals for algae and plastic bottles to build the design.
- Limewater Test - Begin testing using calcium hydroxide solution ($Ca(OH)_2$ (aq)). This is known as the limewater test, where a greater concentration of carbon dioxide gas bubbled into the limewater will create a larger amount of calcium carbonate precipitate, thus creating a murkier solution. The murkier the solution, the greater amount of carbon dioxide solution. If the solution is less murky than before, that means there has been a decrease in carbon dioxide concentration.
- Splint Test - Using a lit splint or piece of wood, we can see if the carbon dioxide levels have decreased by the rate at which the lit splint is extinguished when placed into a test tube containing our purified air. If the carbon dioxide levels have decreased, we can see how long the splint takes to extinguish. This can usually only be used where the carbon dioxide levels are astronomically high, however we will still attempt to use this technique.

- Cardon Dioxide Sensor - Using a carbon dioxide sensor, measure the total amount of decrease in carbon dioxide when the air purifier is kept running.
- Once the first design is tested, depending on the effectiveness of the purifier, we will alter the design if necessary.

Positives:

The method is straightforward, following a logical timeline, making it easier to keep track of our progress and focus wholly on each section. Our process allows us to figure out very quickly if our project will have any success at all through the effective proof of concept experiment that is the lit splint test for testing oxygen output. There is very little room for error since the design is air tight, and the small bottle size makes the purifier easy to manage.

Negatives:

We will only know if the purfier works properly after we have tested it as algae based air purifiers are not very common and although a proof of concept exists, it does not exist with the cost effective strategy we have attempted to employ. Additionally, the method only provides testing for the purification aspect of the filter, not the materials themselves and if there could be more efficient pumps (for example) that we could use instead of the one we are planning to use. Additionally, this method mainly seeks to answer the question of how well can algae purify carbon dioxide, not if it can rid the air of other pollutants such as sulphur dioxide, PM2.5 and PM10 particles.

There is no other way to truly approach this project rather than shifting the entire focus. We had tried to come up with other methods, yet this is the only one worth considering at all.

Previous Algae Based Air Purifiers:

There have been a few algae air purifiers in the past, but none of them have been as cost effective to the extent as the one that we wish to produce. The AlgenAir is a commercially available air purifier, retailing for $225 with a spirulina subscription service. This purifier claims to be able to reduce carbon dioxide more efficiently than many commercial air purifiers, stating that "the aerium is as effective as 25 natural air purifying plants for a fraction of the cost, time and space." This does not give any indication to how much the carbon dioxide ppm is actually reduced, but reviews seem to be positive. However, spirulina refills every month are not needed to maintain an algae air purification system. All that is needed to maintain the algae is a back up culture which can be rotated out once every thirty days, which we have found from our testing. Once switched out with the backup culture, the dead algae can be removed, and the living algae can be provided with more nutrients and the whole culture will soon return to full strength. Within thirty days, the cultures can be swapped out and the process can be repeated. In theory, this should be able to be repeated indefinitely, but to remain safe, a new culture should be implemented every three to six months. Also, there have been a few other DIY filters put on websites such as Instructables, but there are no concrete figures for a decrease in carbon dioxide.

We chose this approach because we planned to use materials which are both environmentally friendly and cost effective to combat the rising threat of air pollution in Jakarta. Jakarta has routinely been named as one of the most polluted cities on the planet, and thus the issue is very pertinent to us. In addition to that, air pollution and the increased presence of certain compounds such as carbon dioxide exacerbates existing issues, such as lung problems and rainwater pollution. The prevention of these issues is a nebulous task, and requires the combination of different approaches in order to fully alleviate them. With this in mind, after discussing ideas, we zeroed in on air purification. Air purifiers will help cleanse the air within a given space, especially an internal space, which will prevent serious health problems stemming from the polluted air. While this does not provide a broader solution to the larger problem, it helps solve a smaller-scale but equally important problem while contributing to the larger-scale solutions to the larger problem of excess carbon dioxide. Algae, like other plant life, helps absorb carbon dioxide and produce oxygen, which effectively cleanses the air in a given space. As such, the use of algae and other plant-based air filtration systems helps purify the air inside while also, albeit to a lesser extent, decreases the concentration of pollutants in the air. They are also more environmentally friendly and cost efficient when compared to the more expensive and industrial systems that are often employed. Algae additionally reduces NO_2 and SO2 gas concentrations in the air. The accumulation of these gases can react with water to form Nitrous Acid (HNO_2), Nitric Acid (HNO_3), as well as Sulfuric Acid(H_2SO_4). This causes acid deposition with Jakarta's waterways and ecosystems being affected by the accumulation of these strong acids".

We first created a 3d model found below to help visualize the process of the purifier setup:

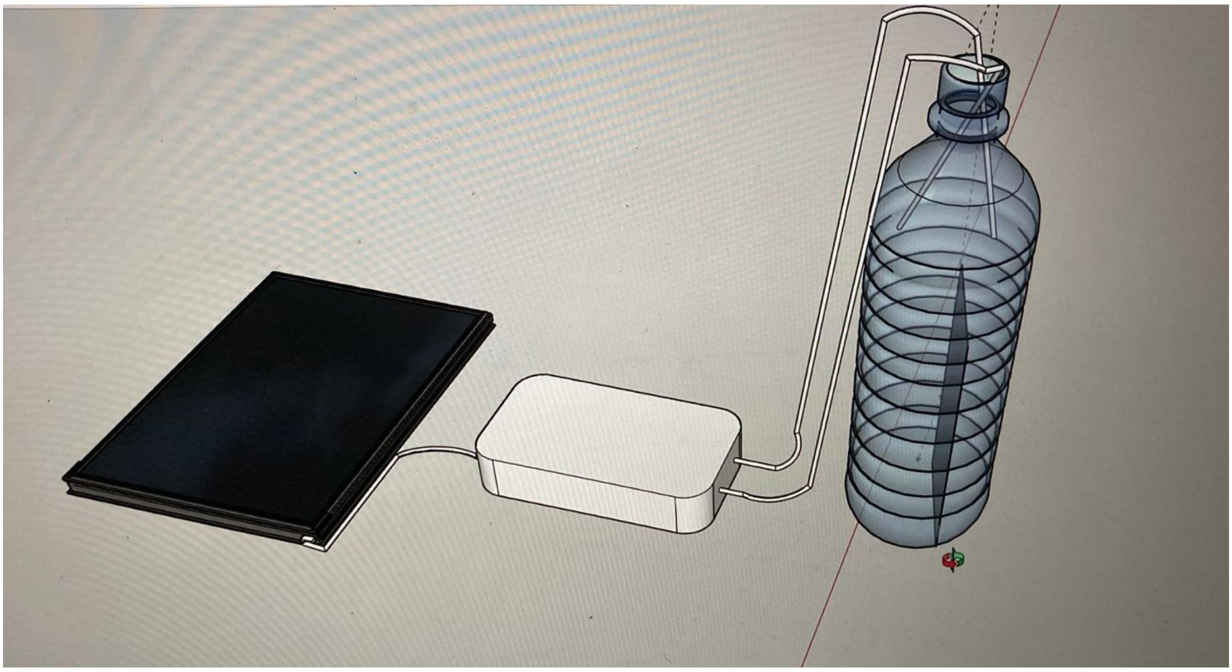

Figure 2:

3D Model of the Air Purifier + Solar Panel + Aerator (Note: Our testing was not done with a solar panel)

We began testing and used this procedure as our initial proof of concept:

1. Make sure to create a closed system inside the room, by ensuring no doors or airways are open. Additionally, another step taken to create this system is turning off any air circulation/air purification devices such as fans and air conditioners.
2. Use a carbon dioxide sensor to get a base reading of the lab/room we conduct the experiment in.
3. Run the air purifier and use Logger Pro or check air quality using a carbon dioxide sensor every minute to check progressive differences in air quality and the rate at which the carbon dioxide levels change.

4. After 30 minutes, stop running the aerator.
5. Redo experiment in a different location if the difference is not noticeable enough or modify design so more air can escape the bottle.

Our idea was to drill a hole into a plastic bottle cap and put a tube into it, and also drill in a second hole which will be for the exit pipe. This will allow us to run a pipe into a lime water solution to test if the carbon dioxide decreases. Of course, the second pipe will be removed when we try to test the whole purifier in a full room, since the air will leave the system passively.

Research & Background

Why did we choose algae, and what makes it so special for purifying air?
Algae, and more specifically Spirulina (*Arthrospira platensis*), are defined as a group of organisms that are often found in aquatic environments, capable of photosynthesis and are "nucleus-bearing organisms that lack the true roots, stems, leaves, and specialised multicellular reproductive structures of plants". (Laknath, 2022)

The fact that algae is so different from traditional plants has always been a fascination for the research community, and as such, many papers have been published on the topic of algae, including *arthrospira platensis*, and the potential air purification properties it may hold.

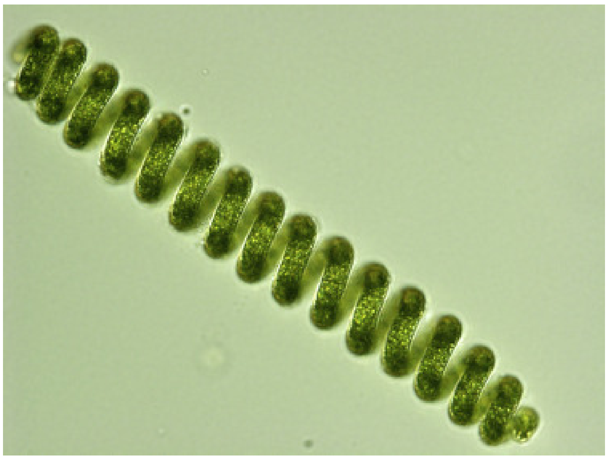

Figure 3: Arthrospira Platensis

Spirulina molecularly contains powerful oxidation chemicals such as “a selenium element (0.0488 mg/100 g) and many of the phyto pigments such as chlorophyll and phycocyanin (1.472% and 14.18%)” (Sharoba, Et Al, 2014). The photosynthetic process happens where “cyanobacteria converts light energy into the chemical energy that it needs to survive. Light energy is used to transport electrons from water to generate ATP and NADPH which are used to convert CO_2 to carbohydrates. The evolution of oxygen occurs as a byproduct of this process.” (Edwards, 2020)

The spirulina sample used had a liquid consistency, with a measured pH of 6.95. The algae additionally was found to have a high concentration of amino acids, which made up the bulk of the protein content.

Related work such as Srivasta, Gupta 2000 has found that spirulina algae at Room Temperature and Pressure can effectively absorbing SO_2 solutions containing H_3NSO_3 (Sulphamic acid), $C_{20}H_{20}N_3 \cdot HCl$ (Rosaniline Hydrochloride), and HCHO(Formaldehyde); Additionally, the 2020 study found that spirulina is effective in absorbing NO_2 solutions containing $C_6H_8N_2O_2S$ (Sulfanilamide/Sulphanilamide) and $C_{12}H_{14}N_2$, or N-(1-Naphthyl)ethylenediamine/NEDA.

Due to the extensive nature of Jakarta's air problem being a long term solution to effectively fix, we focused on trying to improve the air quality. Poor air quality is a trait attributed to several large, developing cities, and using a cost-effective purifier can allow for better air quality, and potentially citizen health. Using algae would be a sustainable practice as algae can be used as biomass after being utilised as an air filter, which would additionally allow for better fertilisers, one of the pollutants contributing to the poor air quality; nothing goes to waste. Additionally, materials such as plastic bottles are recycled and are used to prevent the bottles from being a part of the plastic waste trash, and thus these actions reduce plastic waste running into the waterways.

As a group, at first we thought that we would use an electronic fan and install it in the body of the purifier (the plastic bottle), but eventually we realised that the consumers we are targeting for this purifier may not have access to electricity. If we want to make our design eco-friendly – using recyclable materials and a natural air filtration system – it makes more sense ethically and for the sake of the consumer that the aerator used is solar powered, or can be charged in some way that doesn't require constant energy. This is why we leaned towards solar panels for our final design. However, the tests were done to obtain a proof of concept and show that our model works. Later applications of a similar solar-powered product will produce similar results compared to what we have already gathered.

Additionally, we initially wanted this to be an air filter that captures many different types of particles, but we decided to fully focus on carbon dioxide. This is because we met with the CEO of Jakarta's leading air quality company, Piotr Jakubowski, who informed us that while the idea for our project was interesting, algae is extremely inferior when compared to basic

HEPA filters. It is, however, still effective at filtering out carbon dioxide. Thus, we decided to forego the idea of filtering out PM10 and PM2.5 particles and stick solely to purification.

For the experiment, we utilised the procedure from above and performed 3 trials in the same lab conditions, measuring the ppm of the room before and after filtration. We ran the purifier for 20 minutes at a time and the results were encouraging.

First, we tested with a 1.5 L bottle, with 750 mL of algae solution. The results, when average, showed a decrease of 79 ppm and an overall decrease is shown on the graph below:

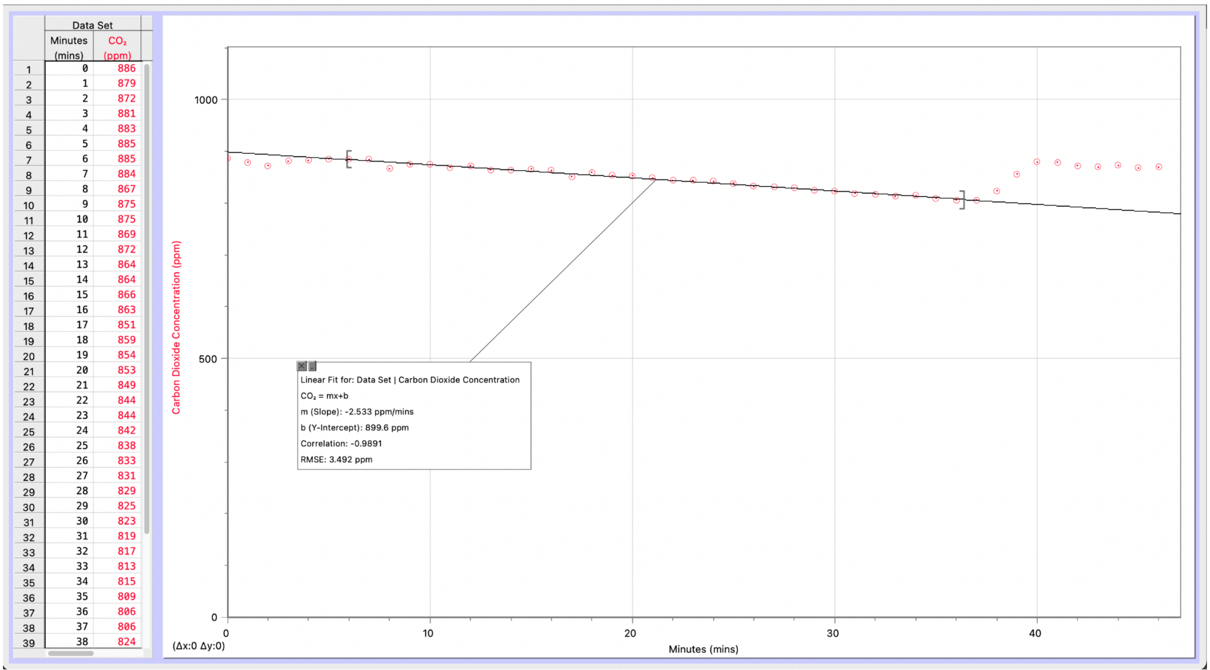

Figure 4

Graph of carbon dioxide levels (trendline represents the duration of the purification process)

The graph shows a linear decrease in ppm at an average rate of 2.533ppm/min, with the starting point at 886ppm, and after 40 minutes of running the filter, ending at approximately 824ppm. The data ranges from 890-800ppm and the decline while the purifier's running is seen through the negative linear trendline.

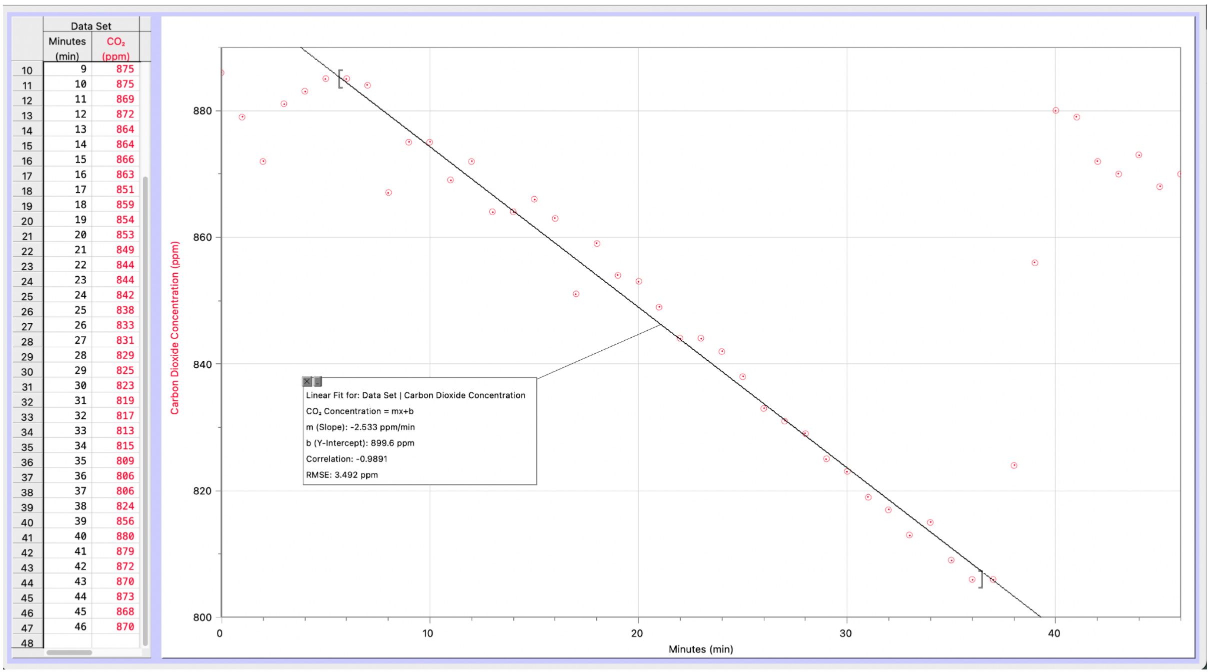

Figure 5

Graph of carbon dioxide levels (trendline represents the duration of the purification process)

Another formatted graph of the same data. The data here is around the 800-900ppm range, and thus shows the difference between when the purification process was happening and when it was not, as indicated by the roughly linear decrease in CO_2 concentration and rapid increase after turning the purifier off.

In our second and third trial, we used the bigger 6L bottle (which we plan to use for the actual purifier) and the results were similar. The carbon dioxide decreased by 80 ppm and measuring the ppm in the room afterwards showed a significant decrease after running the purifier.

By keeping a lit match-stick next to the output pipe of the air purifier, the basic, qualitative lit splint test could be taken. In the presence of oxygen gas, a faint crackling sound can be heard near the lit match stick. After performing this test fifteen times at a 2 cm distance from the output pipe, the matchstick produced a faint crackling sound in every trial. Five trials were carried out for the 750 mL algae solution, 1.5L solution, and 6L Solution. The crackling noise could be heard more audibly as the volume of algae solution was increased, which is expected due to a higher amount of oxygen gas mols being outputted from the algae system.

Figure 6: Pouring the algae solution into a smaller container to measure out an exact amount to transfer to the other bottle (front). We used roughly 750mL during our tests.

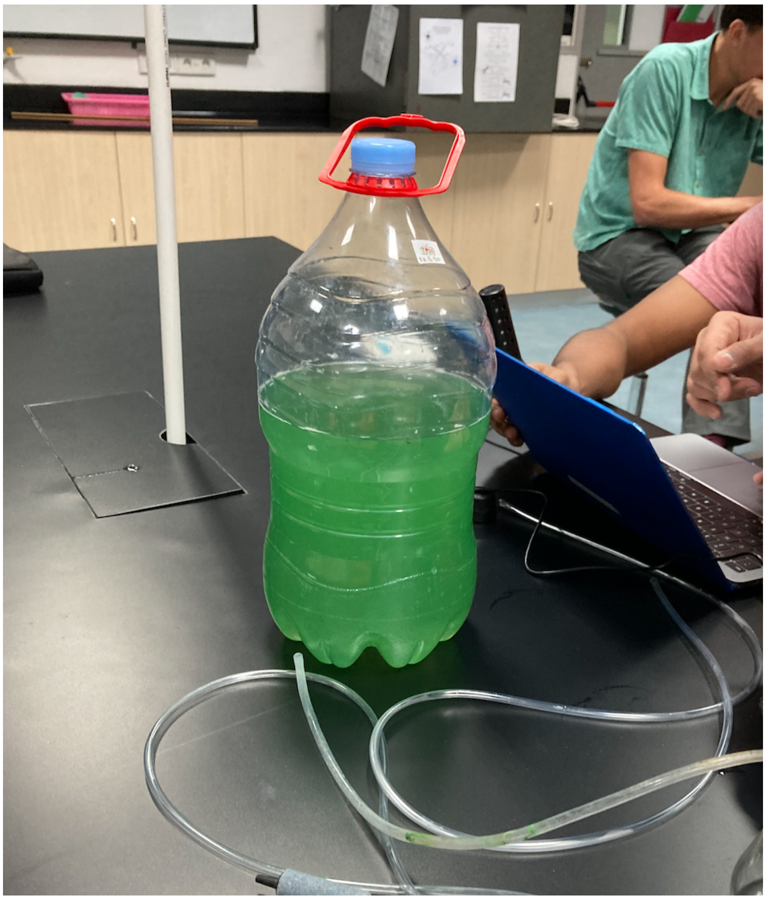

Figure 7: The algae solution from which we tested our air purification system

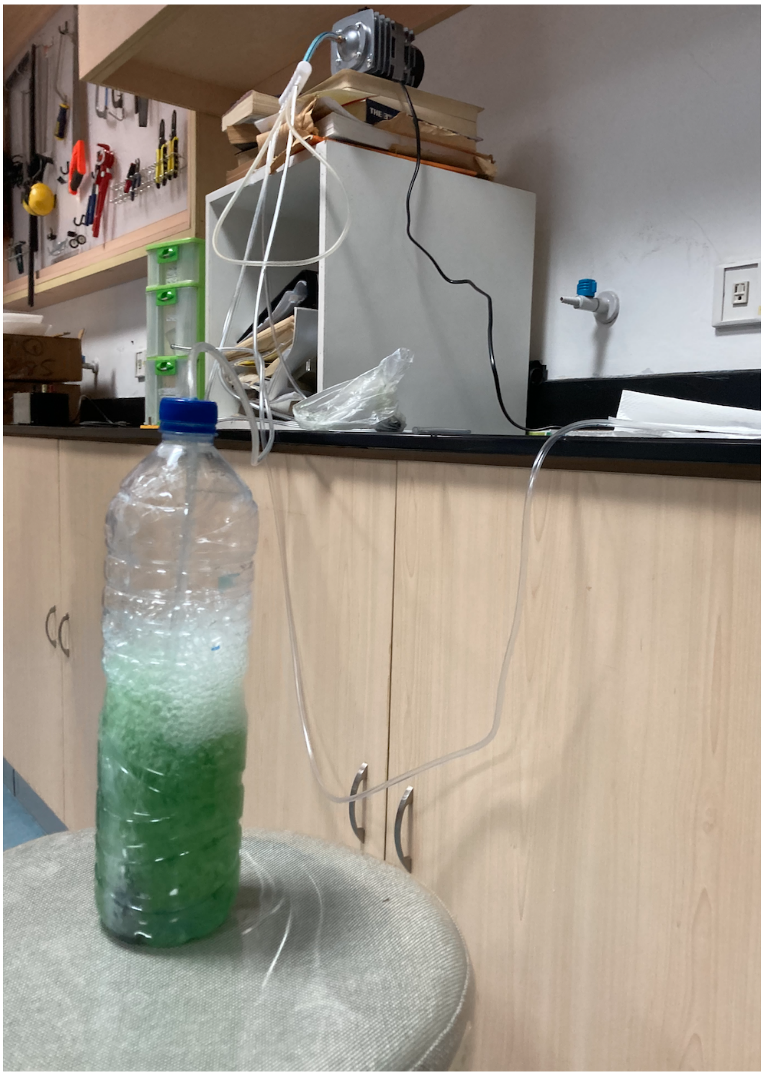

Figure 8: The testing in action. The air pump is situated above the box, which is piping air into the bottle of algae, distributed throughout the solution using an airstone. The air then flows out of the bottle, having been purified.

Throughout the entire testing process, we used a 25 Watt, high pressure, 12.5cm x 7cm x 7.8cm aerator. The aerator operated at 220-240 volts, a frequency of 50Hz, a pressure of 0.015Mpa, and an output of 20 to 45 L/min. It had six outlets, weighing 1.2kg, and is typically used for fish farms, aquariums, and ponds to increase oxygen levels in the water. We operated the aerator at medium speed because at high speeds, the oxidation occurs too quickly and the algae, which feeds off of CO_2, can be killed off if there is too much oxygen in its environment.

During the course of the project, we had several different bottles of algae, many of which ended up dying, as we made mistakes during the process of growth. As we cultivated culture after culture, we ended up improving after each iteration, and keeping the algae alive for a much longer period of time, to allow for testing. We also had better quality algae at the end of this period of trial and error, so it benefitted us to make mistakes and learn from them. We also had some issues with testing equipment during the testing process, so we consulted with Dr. Carter as well as doing our own tests to determine the issues with the equipment that we could alleviate, or modify the testing process to accommodate for these issues. An example of this was with the CO_2 sensor that was provided with the Logger Pro. We encountered issues with readings, which appeared to be unusually high, usually skyrocketing upwards after around 30 seconds, which we had to solve, since we intended to leave the purifier on for several minutes. Eventually, we realised that some of the sensors we were using were not calibrated correctly, and some of the readings we obtained were not erroneous, as we first believed, but normal for an enclosed room, which we did our testing in.

Reflections and Performance Assessment

Throughout the course of this project, we've learned a lot about air filtration. We've learned about growing and cultivating algae, as well as using it for more purposes in order to benefit our environment. We also learned about air purification, the importance of air filters and the many roles they play across different industries. We've researched the applications of air filters in different environments, and the efficacy of our multiple models. Most importantly, we discovered some elucidating things about the extent of air pollution in Jakarta and many other places, and ways in which we can help.

When we began the project, one of our first major ideas was to go to one of our school teachers, Dr. Robin Carter, and consult with him throughout the course of the project. We met with him several times, both online and in person, and discussed a variety of different things, most relating to the stage of the project we were working on. In our first few meetings with Dr. Carter, we brought up the ideas that we brainstormed and discussed with him the feasibility and usefulness of each idea, later settling on air purification. Later, we approached him with a model for an air purifier, requesting feedback and further suggestions. Once we had our materials, we requested time in the school laboratory to run our experiments, testing the effectiveness and efficacy of the air purification system that we had developed. We then discussed these results with Dr. Carter, interpreting how well the purifier was working and seeing if we could make improvements along the way. Throughout the project, we coordinated with Dr. Carter, and also made use of the school's materials and facilities in order to advance our progress and improve our product.

We could improve on time management with the project. During some weeks, the project stagnated, as other commitments or unavoidable circumstances disallowed us from doing as much work as we hoped to. As such, improving on time management would allow us to maximise our working periods, work more efficiently, and consequently expedite the process of bringing our ideas to fruition.

As for specifics about our use of time, we met with each other on a regular basis, setting goals to achieve before future meetings and making plans for each step of the project. For example, in the first few meetings we began with briefing each other on progress we had made in our initial research and making research deadlines for future meetings. Through setting clear and achievable goals for each other we were able to expedite the process and get started on the project much faster than we expected. We additionally set personal goals for each researcher in order to increase efficiency at which the project was completed at. For example, one researcher's goal may have been to research the Air Quality in Jakarta which would have a similar deadline as another researcher's goal of researching algae purification properties.

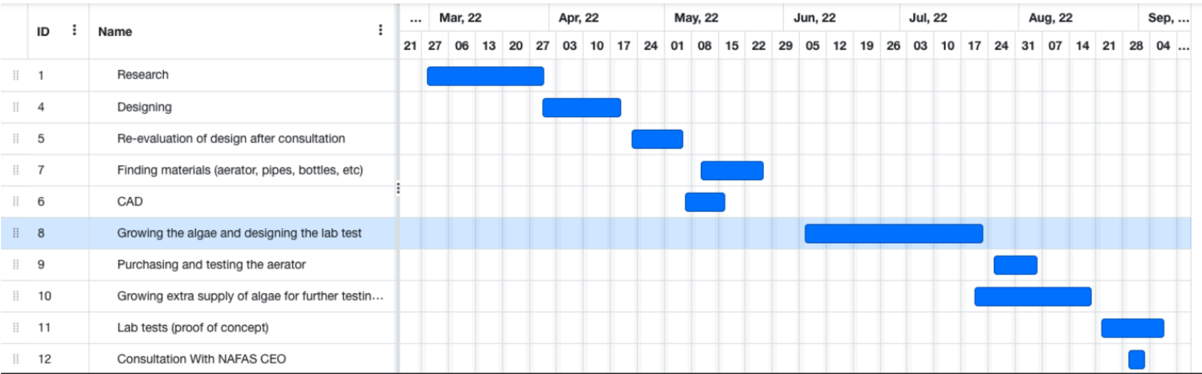

Figure 9: Timeline (updated as we continued on the project)

Session No.	Person(s) working	Start Date (DD/MM/YY)	Time Start (HH/MM/SS*)	End Date	Time End	Objective / Tasks Done	Goals for next session*	Session Total (Hours)	Running Total	Amit Total	Haider Total	Nikhil Total	Shayan Total
1	All	16/02/2022	11:56:00	16/02/2022	12:16:42	Meeting with Dr. Carter	Define the parameters of the investigation Do further research on	0.35	0.35	0.35	0.35	0.35	0.35
2	All	19/02/2022	18:40:00	19/02/2022	19:06:18	Planning Meeting	Goals are cost efficiency, specific measuements, and the beginning of the research process	0.44	0.78	0.78	0.78	0.78	0.78
3	Nikhil	25/02/2022	18:00:00	25/02/2022	19:00:00	Initial Research + Completion of Abstract	-	1.00	1.78	0.78	0.78	1.78	0.78
4	All	26/02/2022	18:38:00	26/02/2022	19:07:15	More research	Research all our indiviual components	0.49	2.27	1.27	1.27	2.27	1.27
5	All	10/02/2022	18:00:00	10/02/2022	20:00:00	Deciding project	-	2.00	4.27	3.27	3.27	4.27	3.27
6	Shayan	26/02/2022	20:30:00	26/02/2022	21:12:00	Researching everything about algae	Do more research	0.70	4.97	3.27	3.27	4.27	3.97
7	Amit	27/02/2022	21:00:00	27/02/2022	21:30:00	Research air filter components		0.50	5.47	3.77	3.27	4.27	3.97
8	Amit	28/02/2022	16:00:00	28/02/2022	16:30:00			0.50	5.97	4.27	3.27	4.27	3.97
9	Amit	28/02/2022	18:00:00	28/02/2022	19:00:00			1.00	6.97	5.27	3.27	4.27	3.97
10	Nikhil	02/03/2022	09:30:00	02/03/2022	10:30:00	Part A research	Start collecting data	1.00	7.97	5.27	3.27	5.27	3.97
11	All	06/03/2022	18:41:00	06/03/2022	19:04:00	Regular Meeting	Finish data collection by April 2nd	0.38	8.35	5.65	3.65	5.65	4.35
12	Nikhil	14/03/2022	16:20:00	14/03/2022	17:00:00	Research	Figure out if algae really can absorb PM2.5 and PM10 particles	0.67	9.02	5.65	3.65	6.32	4.35
13	Shayan	15/03/2022	18:13:00	15/03/2022	19:07:00	Algae Properties Research	Do more research!	0.90	9.92	5.65	3.65	6.32	5.25
14	Shayan	16/03/2022	18:10:00	16/03/2022	18:56:00	Continuing algae research	try and finish my segment by the next session	0.77	10.69	5.65	3.65	6.32	6.02
	Shayan	19/03/2022	18:02:07	19/03/2022	18:58:00	More Algae Propety Research	Do more research!	0.93	11.62	5.65	3.65	6.32	6.95
15	All	20/03/2022	18:33:14	20/03/2022	18:41:40	Regular Meeting	Meet with Dr. Carter for authorisation to start testing	0.14	11.76	5.79	3.79	6.46	7.09
16	Haider, Nikhil, Shayan	25/03/2022	11:50:00	25/03/2022	12:05:00	Meeting with Dr. Carter	Set baselines for all our tests	0.25	12.01	5.79	4.04	6.71	7.34
17	All	24/04/2022	19:00:00	24/04/2022	19:47:25	Regular Meeting	Set baselines for all our tests (N, A) Start designing prototypes (S, H)	0.79	12.80	6.59	4.84	7.50	8.13

Figure 10: Partial screenshot of our hours logged. We updated this after every research session, meeting, testing session, or any engagement relating to the project whatsoever.

As we began developing the purifier, we realised there were ethical implications to growing algae as it is a living organism and must be treated well. Hence, we contacted local algae growers in Jakarta, specifically for spirulina, as well as consulted our school's Natural Science department and our supervisor Dr.Carter to figure out all the logistics and everything we need to do to keep the algae healthy and alive. We were able to use this detailed plan and grew the algae based on these instructions from our consultations:

- Clean the culture media tools before use with 70% alcohol and wipe with a tissue.
- TOOLS REQUIRED:
    - 15-50 watt power lamp: Round / long LED fluorescent lamp
    - Aeration pump which functions to create air bubbles that create oxygen in the water
    - Air stones to attach to the aeration pump's piping. This will allow for better airflow.
    - For the container, you can use new mineral water bottles, aquariums, jars, buckets, gallons and others. The size depends on your needs. It just needs to be clean.
    - Use sterile bottled mineral water (Nestle, Ades, Aqua)
    - Use the provided nutrient packet, or add your own nutrients.
- After installing the hose, turn on the aerator, add the air stones to the piping and drop the air stones into the algae contained. The purpose of the air stones is to circulate oxygen in the purifier in addition to the air being pumped in by the aerator. Bring the bottle close to the light. The distance should be 5cm between the bottles and the light. The light should be on for 24 hours a day. The air from the aerator should be of medium speed. Not too fast, not too slow.
- The culture, in 5-7 days, will look solid in colour and cannot be penetrated by light.

We decided on our project after drawing from many different sources. We took inspiration from some of the issues that were present where we lived and prominently discussed in the media, like air pollution, water pollution, etc. We decided on a select few issues to tackle, then built our project around these issues, keeping in mind the scale, scope, and purpose of our project. When faced with a problem, whether it be in the testing process or the designing process, we figured out ways to work around them and produce a satisfactory product.

Our use of recycled materials and cheaper air pumps was a conscious choice as our ultimate goal is to distribute these filters to areas where air pollution is at its worst in Jakarta, and therefore we had to be creative with the design, wasting no expense on a container or a large mechanical filtration system; the very use of algae as our filtration agent is our way of working around cost but also providing an effective air purifier to the community.

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Appendix

Table 1: 5 minutes before running the purifier	
Minutes	**Carbon Dioxide (± 1 ppm)**
0	886
1	879
2	872
3	881
4	883
5	885

Table 2: Purifier on	
Minutes	**Carbon Dioxide (± 1 ppm)**
0	885
1	884
2	867
3	875
4	875
5	869
6	872
7	864
8	864

9	866
10	863
11	851
12	859
13	854
14	853
15	849
16	844
17	844
18	842
19	838
20	833
21	831
22	829
23	825
24	823
25	819
26	817
27	813
28	815
29	809
30	806

Table 3: 10 minutes after turning off the purifier	
Minutes	**Carbon Dioxide (± 1 ppm)**
1	806
2	824
3	856
4	880
5	879
6	872
7	870
8	873
9	868
10	870