SMART ENVIRONMENTS PROJECT

DOCUMENTATION REPORT

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Chapter 0: Introduction

This project is carried out by team Khanjee. Ali Al-Kaabi is the team leader, Azizakhon Khodjakbarova is the innovator, Ferdy Sloot is the analyst, Ivo Hagenbeek is the driver, Jonathan Jacob is the explorer, Juul van Lier is the executive and Lucas Delfos is the completer.

This document describes the steps taken in this project. The goal of the project was to design a smart environment with the global theme *disasters*. In Chapter 1 of this document a list of 20 articles describing possible disasters is summarized. In Chapter 2 the list is narrowed down to 9 disasters. Chapter 3 is also a narrowed down list of 4 earlier described disasters to which 1 disaster was newly added. In Chapter 4 the motivated decision was made which possible disaster out of the 5 listed in Chapter 3 would be used for this project. This disaster is the problem to be solved in this project. In Chapter 5 the final research problem is defined, and some possible solutions are discussed and explored. In Chapter 6 the final decision was made regarding which solution would be worked out in the rest of the project. In Chapter 7 the methodology is described whereas in Chapter 8 the project results are described and discussed, which reaches to a substantiated project conclusion.

Several factors contributed to the choice of the project problem or research question. It started with the personal interest of the project team members on environmental topics. Secondly, the project team members agreed the problem was likely to be solvable with an in-depth solution. The main factor was the increasing importance of this problem. Because of global warming, natural disasters will get more and more common. Nowadays, most of our electronic devices are connected to each other, but safety precautions seem to be lacking in this field. Ultimately this problem was considered to be a perfect opportunity to turn the disaster alerts into a smart environment.

A standing device is proposed as a solution in this project. This standing device will function as an alarming device which warns potential nearby persons in both a most efficient and an informative way. It consists of a plastic base with several colour-coded LED’s which, when lit up, illuminate through a plastic cut-out with icons. It also contains a speaker and a charging device. This standing device is relatively cheap to build and will achieve the goal the Dutch government has set, namely, to introduce a new warning system after multiple failures or lacking solutions such as NL-Alert. In addition to solving the problem of the government it is also considered to provide an aesthetically pleasing way to improve safety for every household.

Chapter 1: Literature Review

https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1029/1998rg000054
Volcanic eruptions have a significant impact on climate change on many timescales. The study of the responses of climate to volcanic eruptions helps to better understand important processes that respond to both natural and anthropogenic forcing in the climate system. Volcanic effects had a large impact in interdecadal climate change of the Little Ice Age.

https://www.nepjol.info/index.php/ejms/article/view/32764
The Corona Virus Disease (COVID-19) is the novel disease of the respiratory system, causing the ongoing pandemic symptoms comparable to the flu. The most reliable diagnostic test to confirm COVID-19 is PCR (Polymerase Chain Reaction) which is a molecular-based test for the detection of SARS-CoV-2. Eradication of highly contagious SARS-CoV-2 Virus that causes COVID-19, requires individual attention and awareness throughout the entire world.

https://www.sciencedirect.com/science/article/pii/0012825268901542
Earthquake prediction research programs in a number of countries are reviewed together with achievements in various disciplines involved in earthquake prediction research, i.e., geodetic work, tide gauge observation, continuous observation of crustal movement, seismic activity and seismological method, seismic wave velocity, geotectonic work, geomagnetic and geoelectric work and laboratory work and its application in the field.

https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(98)07367-X/fulltext
There are an estimated 500 thousand to 2.5 million deaths of malaria each year, mostly in the poor countries. There are very cheap anti-malaria drugs (0.20 dollars per adult treatment) but there are high levels of resistance now in several countries, and the other multidrug-resistant treatments are ten times more expensive and thus too expensive for the poorest countries on earth. This is especially in Africa, where 90% of the malaria deaths occur.

https://pubmed.ncbi.nlm.nih.gov/28162117/
This is a literature study review that collected data of past disasters (“72 articles pertained to the Haiti earthquake, 38 to the Indian Ocean tsunami, and 14 to the Bam earthquake”) and uses this data to develop standardized performance measures for future disasters. The data collected consist of 5 main categories: 1. Personnel 2. Supplies and Equipment 3. Transportation 4. Timeliness and Efficiency 5. Interagency cooperation

https://pubmed.ncbi.nlm.nih.gov/30821339/
This is a review that aims to provide several key principles to follow after a mass disaster. This is essentially to reduce the number of deaths and injured, economical losses, social problems and environmental damage. This will mainly have to do with preparations before and effective medical response after the disasters.

https://journals.ametsoc.org/bams/article/97/5/767/69885
Tornado disasters are responsible for both hazard risk and up following physical and social issues. This investigation looks into exposure, which is a valuable part and driver of vulnerability, and its correlation with tornado risk in the U.S. This research shows how each of these dynamic variables have developed individually and interacted as a whole to produce differences in hazard impact and/or disaster potential at national, regional, and local scales.

https://www.sciencedirect.com/science/article/pii/S1877705812012647
Flood impact is one of the most significant disasters in the world. More than half of the global flood damages occur in Asia. Causes of floods are mostly due to environmental factors such as heavy rainfall, high floods and/or high tides, and human factors such as aggravation of drainage channels or blocking of channels, improper land use, deforestation in headwater regions, etc. This paper describes plan, policy, concepts and operation on integrated urban flood disaster and how to manage potential risks.

https://www.sciencedirect.com/science/article/pii/S0959378016303806
With the help of empirical data from the response to a major wildfire in Sweden, we examine how individuals select collaboration partners during the formation of the collaborative crisis response network. We show that patterns of individuals and task interdependency influence the way a collaborative network is formed.

https://www.economist.com/briefing/2018/04/14/america-has-let-down-its-puerto-rican-citizens
Puerto Rico was completely devastated during Hurricane Maria in 2017. This disaster and the people in need that it had left behind, triggered a new discussion about the country's relation with the U.S. Many argue that Puerto Rico did not receive the same emergency response as other parts of America even though it is destined to.

https://www.wfp.org/publications/how-disasters-drive-hunger
80% of hungry people live in disaster-prone areas. When a disaster strikes a community, the impacts go way beyond a lost home. The destruction of crops leaves a famine, which renders the population malnourished and helpless for a potentially new disaster.

https://www.businessinsider.nl/insects-dying-off-sign-of-6th-mass-extinction-2019-2?international=true&r=US
In the U.S. 40% of all honeybee colonies perished from 2018 to 2019. The reasons for that are for example the climate change, pesticides, urbanization or farming. This will have a huge impact on our world as the total mass of all insects is also declining by 2.5% per year. All these signs consequently show us that we are heading towards a sixth mass extinction.

https://link.springer.com/content/pdf/10.1007/3-540-28079-0.pdf The Chernobyl disaster was caused by a nuclear accident that occurred on Saturday 26 April 1986. This book looks at the impact of the disaster on the world. It looks at the impact on terrestrial ecosystems and aquatic systems, health consequences, the taken countermeasures, effect on wildlife and social and economic effects.

https://www.sciencedirect.com/science/article/pii/S0169534704002666
Southeast Asia has the highest relative rate of deforestation of any major tropical region and could lose three quarters of its original forests by 2100 and up to 42% of its biodiversity. In this article they look at the state of the current forest.

https://journals.sagepub.com/doi/pdf/10.1080/03064220008536696
The Jewish holocaust took place in WW II. Historian David Irving claims that the 'holocaust industry' sciences its critics by a combination of blackmailing and intellectual terrorism. He seems to have some arguments on his side.

https://acp.copernicus.org/articles/20/3009/2020/
Overall, the climatic implications of regional aerosol emissions are poorly understood. In this article, the mean and extreme temperature response is investigated. The most important emission that is investigated is sulfur dioxide, while assessing the statistical significance of mean and extreme temperatures.

https://besjournals.onlinelibrary.wiley.com/doi/full/10.1111/j.1365-2656.2006.01122.x
This article says that locust plagues can be a huge problem. One of the most key finding was that the higher quality the vegetation in an area is the more locusts the wildlife will attract. That means that whenever there is an improvement being done on the quality of the plants, the locust's population in that area will increase as well, resulting in a locust plague that was worse than before.
Problem: Whenever vegetation quality is improved, the risk of a locust plague is also increased

The Association of Typhoon Intensity Increase with ... - MDPIwww.mdpi.com › pdf
Aggressive climate harm and financial loss can be caused by typhoon events. Identifying the rise of typhoon experiences can provide useful information for avoiding and minimizing disasters. The strong difference between the abrupt growth in mass information and the absence of a system for intelligence appreciation emerges in the era of big data. In the area of threat control, there is an immediate need to facilitate the transition of information systems into expertise services. A 7.2 magnitude earthquake affected Typhoon Haiyan, Bohol island, impacting 3 million residents in Bohol and Cebu, killing more than 200 people. Many people were already getting assistance and staying in emergency centers when they were struck by a second storm, Typhoon Haiyan.

http://www.bom.gov.au/cyclone/tropical-cyclone-knowledge-centre/understanding/tc-info/
Tropical cyclones are systems of low pressure developing over warm tropical waters. When the sea-surface temperature is over 26.5 ° C, they usually shape. For several days, even weeks, tropical cyclones will persist and can take fairly irregular routes. Once it passes over land or over colder waters, a cyclone can dissipate. Tropical cyclones are harmful since they can bring strong waves, intense flood precipitation and destructive storm surges that can lead low-lying coastal areas to flood.

https://scied.ucar.edu/learning-zone/storms/hurricanes

Citizens brace when a powerful hurricane heads for the coast - boarding homes, loading the car, and evacuating. For people in hurricane-prone countries, these storms may mean tragedy. Of all weather systems, they are the most effective. They are also big hurricanes, with the average hurricane spanning over 340 miles. Powerful waves and wind batter coastal towns as a hurricane hits shore. In a brief period of time, hurricanes can cause a large amount of flooding, which will cause rivers to overflow their banks and flood areas that are both close to the coast and farther inland. Usually, though, most coastal hurricane destruction is flooding caused by storm surge and precipitation. The temporary increase in sea level that occurs when waves of the hurricane drive water to the shore is a storm surge.

Chapter 2: Identification of General Problems and Challenges

In this chapter, a selection has been made of the disasters described by the literature in Chapter 1. The disasters have been translated into general problems and challenges based on perceived incidence, social relevance and impact. The outcome of this has been designated as potentially relevant research areas.

List of general problems and challenges:

1. Problem: Increasing tornado impact is driven by growing built-environment exposure.
2. Problem: Flood problems/events increase with climate change, population increase and limited funds.
3. Problem: The complexity of selecting partners and tasks during the creation of a collaborative crisis response network.
4. Problem: Prevent rather than respond. Humans don’t think ahead and therefore have to deal with unwanted consequences.
5. Problem: Vicious circle. Hunger as a result of a disaster renders the population unable to prepare for a new disaster.
6. Problem: Hard to impact the slow nature of evolution.
7. Problem: Lack of understanding of the repercussions of our emission.
8. Problem: Whenever vegetation quality is improved, the risk of a locust plague is also increased.
9. Problem: Preventing / reducing resistance to drugs to reduce costs for poor countries.

Chapter 3: Identification of Relevant Problems

In this chapter, 5 new problems are identified that are considered to be relevant, urgent and interesting by the project team and that have not been addressed effectively.

1. Problem: Accuracy of public warnings of tornadoes, flash floods, large hail and damaging thunderstorm wind. (So false alarms and on the other hand unpredicted disasters) CiteSeerX — The moral problem (psu.edu)
2. Problem: Vicious circle. Hunger as a result of a disaster renders the population unable to prepare for a new disaster.https://www.wfp.org/publications/how-disasters-drive-hunger
3. Problem: Whenever vegetation quality is improved, the risk of a locust plague is also increased. https://besjournals.onlinelibrary.wiley.com/doi/full/10.1111/j.1365-2656.2006.01122.x
4. Problem: Prevent rather than respond. Humans don't think ahead and therefore have to deal with unwanted consequences https://www.economist.com/briefing/2018/04/14/america-has-let-down-its-puerto-rican-citizens
5. Problem: Lack of understanding of the repercussions of our emission. https://acp.copernicus.org/articles/20/3009/2020/

Chapter 4: Problem Selection and Motivation

The problem found to be most relevant, urgent and interesting to try to effectively address in this project is the following:

“Accuracy of public warnings of tornadoes, flash floods, large hail and damaging thunderstorm wind. (So false alarms and on the other hand unpredicted disasters)”

Mankind has been collecting data like weather reports, geothermal changes or atmospheric sampling for a long time. It is not only a way to understand what is happening on the planet, but also a possibility to ‘take a look into the future’ in order to try to influence, change or at least anticipate it in order to avoid injury and damage if possible.

From the data collected over all these years, conclusions can be drawn this can possibly save lives. The overall temperature on the planet for example has risen each year. If this trend continues and mankind does not adjust its behavior, the effect will become increasingly damaging.

There is substantial progress in the accuracy of public forecasts of tornadoes, flash flooding, massive hail and destructive thunderstorms, considering the developments in atmospheric science since the twentieth century. But even with all the gathered data and the most precise sensors the warning precision will never be 100%. This means there are cases where a disaster is predicted but does not occur (a ‘false alarm’) and disasters happening that were not foreseen (a ‘surprise’). For example, the falsely issued tsunami warning of September 2019 in Hawaii.

The project team decided to use this problem because of the following factors:

- Personal interest. This problem stands out when compared to the other problems. This problem doesn’t focus on the prevention or fixing of a disaster, but rather the accuracy of predicting one. This provides new options and opportunities for this assignment compared to others. The creative thinking of the project team will be tested in a different manner as well.
- Increasing importance of the problem. Because of global warming, there will be an increase in the amount of natural disasters such as flooding and hurricanes. Because of this increase more accurate warnings are needed. When given a warning, there are measures that need to be taken which give the inhabitants of the region a lot of stress and likely panic and chaos.

A ‘false alarm’ results in actions and measures taken for nothing. If this happens repeatedly, the faith in and value of the report may diminish with a higher risk for damage and injury during future events as a result.

- The project team sees opportunities to counter this issue with the help of a Smart Environment. In addition to the possibility of predicting upcoming atmospheric events with the use of old data, the change of certain values can be tracked with precise sensors. This enables the project team to establish a rapid warning system for possible upcoming disasters like tornadoes or floods.

Chapter 5: Potential Solutions

After a progress meeting with the teachers, it became clear that the old problem was too complicated for this project to work on. Therefore, the problem has been changed to match the intended level of the assignment and narrow down the field on which the problem applies.

The original defined problem was: “Accuracy of public warnings of tornadoes, flash floods, large hail and damaging thunderstorm wind.”

The new defined problem is: “Inefficient way of notifying people about (natural) disasters”.

In this chapter, the assignment requires to define five ways to give a technical interpretation to answer the research problem. In the following list, five technical interpretations with relevant context are described.

1. Emergency Alerts via SMS are already used in the NL. This solution can address everybody with a smartphone. The ease of SMS alerts gets overshadowed by the simple fact that a notification on a phone can easily be missed. Having an application that might even be preinstalled on the phone could have the functionality to make a specific sound or light signal, to notify the owner of a disaster. This could solve the problem of an emergency alert being overlooked/overheard. This feature could be implemented in smartphones, smart watches or even TVs with a device-specific operating system.

2. All people living in the Netherlands know about the global siren warning system that is activated every first Monday of the month at noon. This system emits a loud noise that will warn people in the vicinity of it to alert them of the existence of a great threat. However, what if this system was replaced with a warning system that uses words instead of sounds? People would know what kind of disaster would occur, where it is and if it’s an actual threat. The system works essentially the same as the current one. When the government gets notice of a local or national threat, they would be able to warn everyone that might get involved with the threat. It would be able to accurately describe what is happening and where.

3. A separate cheap accessory made just for notifying people about disasters. These cheap accessories can be mass produced to reduce the price. Every citizen could receive one for free and get advice on how to wear it and when to use it. One possible accessory could be a bracelet. This bracelet would have some LED-lights under the screen and several icons (tornado, earthquake, etc.) that light up to explain the corresponding situation and a small speaker to repeatedly read a message to inform about the problem. Also, a number could be added to describe the severity of the disaster. Next to this every household, shop, public building, etc. could receive one or more (depending on the size of the household)

standing devices to place in their house. This device works the same as the accessory however makes a louder sound and has a bigger screen. For such a signaling system to function properly, it must be accessible to everyone. This means that no barrier in the form of costs may be raised for citizens. The relatively small costs that have to be invested to implement this solution should not be a problem for the government.

4. People are often distracted by TVs and therefore don't take notice of their surroundings. Therefore, it is advisable to have an emergency alert system like many TV stations have already. The broadcaster switches all possible channels to one emergency channel that everybody gets to see (TVs could also automatically turn on with that signal). This process could also be automated by displaying emergency related information and instructions instead of for example having the need for a news anchor to be present.

5. It is conceivable that comparable technology can be used via a subcutaneous chip. The chip will actually work quite simply. A mini microchip is injected some seeable place on the body, let's say it will be implemented in the wrist. Then when an incoming disaster is reported. A signal is sent to the chip via radio waves. According to the possible severity and danger level of the disaster the chip will vibrate in different ways. A LED can also be added to further specify the danger level of the incoming disaster. For example, a small storm is headed your way. Nothing too serious, staying inside is enough to prevent the storm from doing you any harm. In this case the chip will vibrate short and smooth, with the LED having a green color. This way the person knows that it is nothing especially dangerous, but it might be good to check the phone for further information. When a very dangerous and potentially lethal disaster is speculated or reported, the chip will react more heavily. It will vibrate wildly with an urgently red blinking LED. In this way we can implement multiple levels of seriousness. Giving the person with the chip the possibility to react immediately to an incoming danger.

Chapter 6: Solution Selection

The solution that has been chosen to be the center of the project is solution number three:

“A separate cheap accessory/standing device made just for notifying people about disasters.”

The following arguments have resulted in this solution to be chosen over the remaining ones:

- Solution one, emergency alerts via SMS, can have a lot of issues regarding connectivity - for example in border regions - or in app bugs. SMS might however be a better solution to some people as well (it is already in use, f.e. NL-Alert). The noticeability of an app on a phone wouldn’t be that high for people that don’t use their phone that much and using airplane mode will block the phone from receiving the signal at all.
- Solution two, a global siren with spoken text, isn’t really a smart environment solution and can’t be demonstrated. Also, it might be costly to make and certainly to maintain, considering different languages would have to be included.
- Solution four, the emergency alert via TV, isn’t exactly a smart environment solution, and is not a “mobile” solution either. This idea would only work if people were always in the vicinity of a tv, which is not the case. Also, getting permission to access the televisions of everyone in the Netherlands and securing their data would be more than complicated if not impossible.
- Solution five, imposing a subcutaneous chip, is considered to be unethical in the present era and can’t be used by a lot of religious people. The support for invasive ‘biohacking’ methods is overall very limited in our current society. This is also evident from research into payment solutions solving fraud. Costs are not in advance seen as the biggest objection when the comparison is made with the contraceptive Implanon®. This is a subcutaneous contraceptive which is implanted through a needle in the upper arm.

The preferred solution three with a separate cheap accessory or device can be utilized in such a way that it will have no privacy issues at all. The device will only be able to receive and display data and not collect or send any. Also, it would be possible to use it together with the already existing NL-Alert. The standing device will be able to emit a loud noise when needed, so that people who are sleeping or not paying attention will also notice what is going on.

The project team calculated that one standing device would cost around 3 euro to manufacture for the government, please see step 7 for components and explanation on how it can be funded. There are around 8 million households in The Netherlands so the maximum costs would be around 23 million euros to give every household one device. This will have a higher success rate then NL-alert, apps or websites have because of the simple fact that those solutions won’t work when a device is on airplane mode or turned off, and that it gives more information and attracts more attention than an NL-Alert. The standing device does not

have to be turned off at any given time because it only sends out a disturbing signal in cases of serious necessity and urgency.

Chapter 7: Methodology

Our final product (basic plan) will be a standing device for in-home use that is able to sense different events/signals like CO-level, temperature + humidity and smoke detection. It will alert the owner about the hazard visually and audio-visually. A different signal will result in a different warning. These warnings will be displayed via LED's, with one row giving color codes. In this layer there will be icons like a fire symbol, gas symbol etc. illuminated by the particular LED.

Our ambitious plan included the device's connectivity to weather stations and emergency alert systems like NL-Alert. This would include the capability to warn for more disasters like tornadoes, landslides, or floods. For those we will engrave some additional icons.

In the Netherlands for example it would work like this: The Netherlands are divided into areas/municipalities. Each area or municipality will get a corresponding code ID. When a disaster warning is being received by the device it will know whether its municipality is affected. There will also be a speaker/buzzer in the device which plays the corresponding alarm and message loudly.

So, in short what happens is if, for example, an earthquake is about to occur in Enschede signals will be transmitted. The standing devices in this area will receive the signal and check if the alarm is relevant for it. This will be the case and thus the Orange LED beneath the Earthquake symbol will turn on brightly and the speaker/buzzer will start an alarm.

The project must be realized with methods available to the project team and sufficiently accessible for the level in this phase of the study. Subsequently, the project must be delineated in connection with the limited time available for this project. For this reason, Arduino was chosen. Sufficient information about Arduino is available online to determine which components Arduino can work with. This concerns for example, sensors. Based on online orientation, the project team has arrived at the following materials needed for the project:

Materials needed:

- Sensors: MQ7 (CO), DHT22 (temperature, humidity), MQ2 (gas/particle detection)
- LED's
- Wires
- Plastic case with engraved layer
- Speaker/buzzer

- 9V Battery

The technical design was established by taking stock of the competences of the members of the project team. The distribution of the modules is determined as follows:

Modules

The project is composed of 5 modules. These will be listed below together with a short explanation and who will be responsible for these modules.

1. Programming (Ferdy, Ivo)
   Designing a program that can send the right input, which the prototype will be able to receive. Making the right Arduino setup. Doing research about what kind of transmitters and signals are necessary in order to have a proper functioning device etc.

2. Documentation (Ferdy, Lucas)
   Documenting process, writing this document, and keeping it up to date.

3. Presentation of the project (Ali, Jonathan)
   Presenting and putting the final project together. Making a fitting environment for the project (e.g. a corner of a living room as a showcase).

4. Design (Juul, Lucas)
   Designing the prototype with fusion or another program. 3D prints necessary parts.

5. Communication (Jonathan)
   Responsible for planning and communication with teachers.

The owners of the modules concerned have determined a partial design based on their own expertise. Subsequently, the project team met online to share, discuss and optimize the partial designs.

After this, the project plan was shared in an early design phase with the course supervisor who gave advice. The advice was used to improve the project plan. For example, extra sensors have been added, the documentation has been adjusted and the minimum requirements for the end product have been determined.

Subsequently, the module owners incorporated the advice in adjustments to their own partial design. The partial designs have been made and combined into a prototype of the end product.

The prototype has been tested by the project team and found to be working. A demo film has been made of the working design for the demo market. A further explanation was also given at the demo market in the form of a presentation.

The research for the project has been conducted on online sources. Various technical and informative sites were approached, such as Arduino forums, the National Budget 2020, scientific articles on natural disasters and hazard perception mentioned in chapter 1.

Chapter 8: Results and Conclusion

Results

After receiving the equipment ordered, we started testing the sensors. The graph of the testing result can be seen in Figure 1. The output of the different sensors can be seen when using the serial plotter. Given values are in order with the environment tested in. Now we have verified that all sensors work like they are expected to.

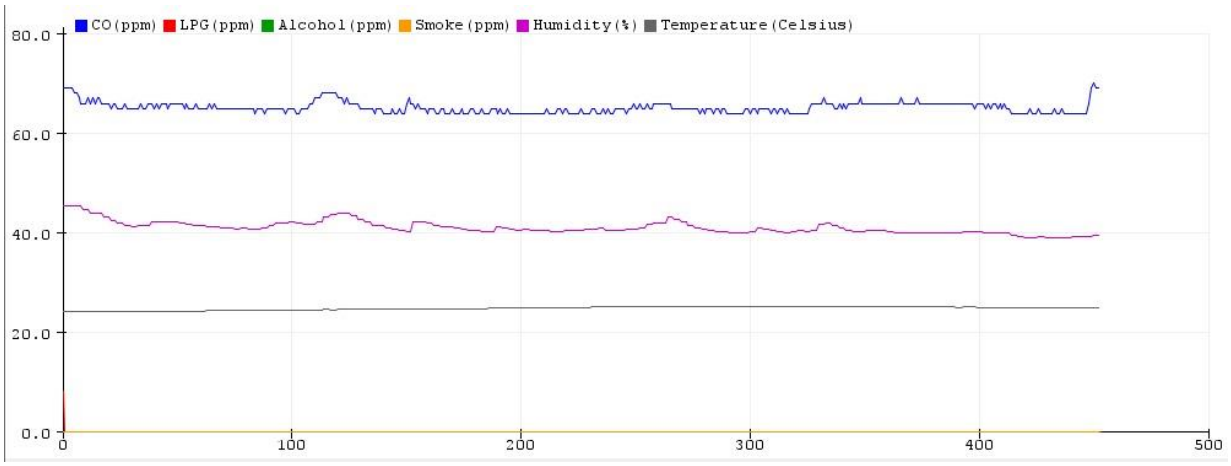

Figure 1: Graph of the sensor outputs

After assembling all the sensors on the Arduino, the setup is as shown in Figure 2.

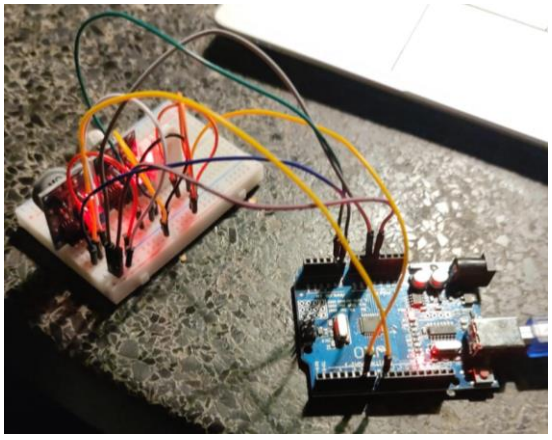

Figure 2: The Arduino with sensors

The fritzing schematic for the final product can be seen in Figure 3.

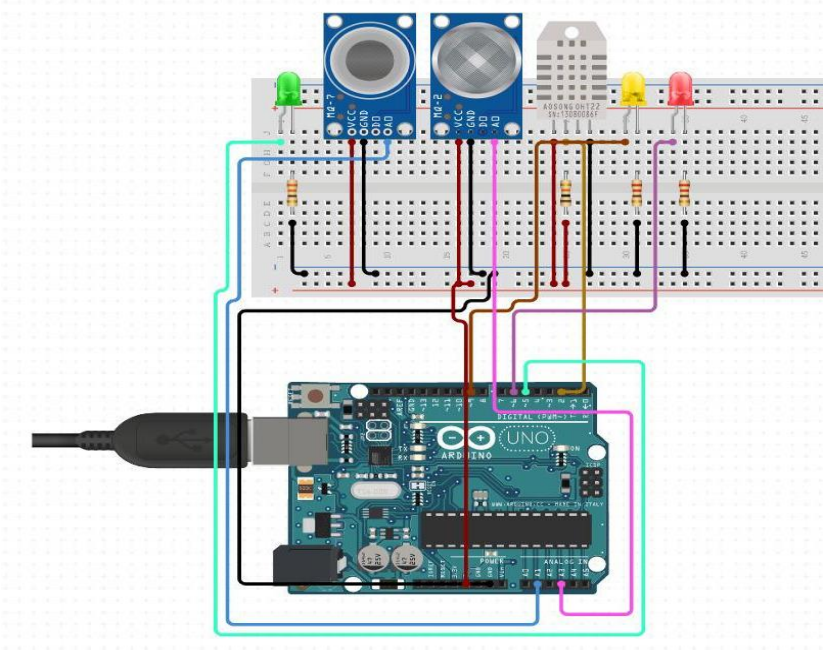

Figure 3: Final SAM fritzing scheme

Assembly will happen within a cube that was specially designed for fitting all the required parts. For the design process we started out with some ideational sketches as seen in Figure 4.

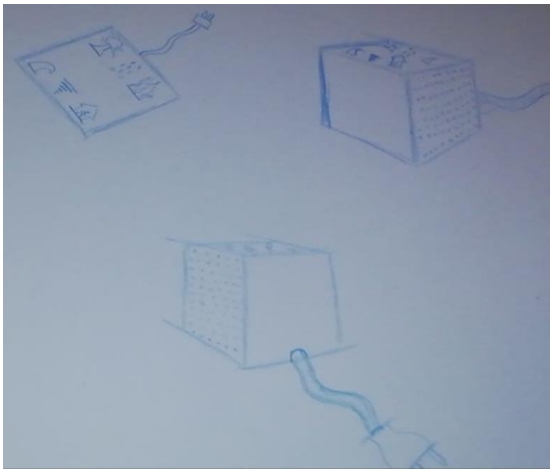

Figure 4: Design ideation

After we decided on a final design, we made a 3D model of it in Autodesk Fusion 360, and had it 3D printed in the SmartXp (Figure 5).

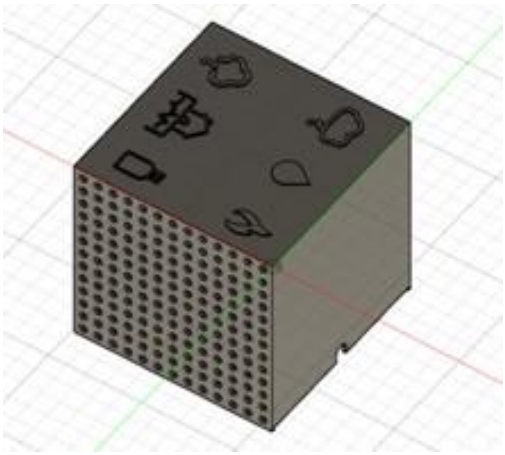

Figure 5: Device's events triggered

After receiving the first print from the SmartXP, we found out that the top part of the cube was not fitting, and the material was too thick so the LEDS wouldn't shine through as visible in Figure 6.

Figure 6: First 3D print

Figure 7: Final prototype with working sensors and LEDs

The second print had a perfect fit for the Arduino, the additional components and the top fitted as well. The new material strength furthermore improved the visibility of the Icons. The final result of the prototype can be seen in Figure 7.

Costs

As shown above, assembly is quite simple and consists of cheap parts. This means that it will be very cheap for the Dutch government to make. The costs are estimated to be as low as 3 euros to mass produce without taxes. This means that if every household in The Netherlands, approximately 8 million according to the CBS[1], receives one. This will cost the Dutch government a total of 24 million euros, which is relatively low in comparison to the budget of the Ministry of Justice and Security where the Dutch ministry is responsible for. This budget is as high as €13.376.219.000, of which €32.402.000 is “still undivided”, all according to the State Budget of this ministry[2].
Another solution considered is to include the total cost in health insurance. A one-time payment will be done of 3 euro’s, which would also ensure new future households as every adult in the Netherlands is obligated to have health insurance. Unfortunately, under the current Health Act this seems not to be an option since the health insurance coverage is limited to diagnosis and cure or care in the treatment of illness.
An alternative could be to organize this via municipalities, because it can be regarded as a municipal facility, belonging to regional security facilities.
Something that should also be considered is that prevention is always better than treating, especially in cases of human health and safety. This means that not only the probability of saving lives in these disasters increases, but also less money is spent on treating the effects of these disasters and dangers.

Conclusion

For most of us this was a very exploratory project. We learned that a project will only take shape when a lot of effort and work is put into the said project. There are many aspects that you need to keep in mind that we have not thought about beforehand. For example, how will you get people to buy the product, why is this product better than similar products that already exist etc. Also, during the project you experience limitations which you must work around, like the corona measures and time management.

After going through the whole process of developing a product, we know scalability is an especially important aspect to keep in mind. It is quite easy to become too invested in certain ideas or lose track of the main goal. We quickly saw that some of the ideas we had and wanted to implement were just too complicated and would go beyond the scope of our project.

We are quite satisfied with the final prototype as it has a sleek design and every sensor worked. We decided to call it S.A.M. (Super Aware Machine). However, there are still a few drawbacks. For example, SAM requires outside information to trigger disaster warnings, as it

[1] https://www.cbs.nl/nl-nl/cijfers/detail/71486NED

[2] (Ministerie van justitie en veiligheid, 2020)

cannot detect them itself, it also cannot be battery driven yet because it would not last as long as we had hoped.

To summarize, S.A.M. (Super Aware Machine) is a standing device which you can put in your home. It notifies you about in-home dangers (like dangerous carbon-monoxide levels, smoke, gasses etc.) and potentially out-of-home dangers. This is especially handy when people need to be notified about wildfires, tsunamis, storms etc. this device provides a quick way to indicate a disaster a dangerous situation in home. With the goal to keep people safe.

Chapter 9: Discussion

What went wrong?

In retrospect, we can tell that it is important to delineate a project. You can work with less difficulty if the team works together simultaneously, this makes the work more manageable overall. This insight follows from the belated adaptation of the research question described in chapter five. An exact problem definition is necessary in order to be able to carry out a proper literature search.
It is difficult to come to a joint action plan with different people with different preferences, workstyles, and opinions. There was also some concern and frequent debate whether the project was going in the right direction (dynamic goal).

Another mistake we made is that we've set our overall expectations too high. We started off wanting to implement all sorts of features, for example, when the device detects a danger, further information would be sent to your phone so it would directly be clear what a person should do. Multiple features such as this one failed to be implement in the final prototype and could receive further attention in a follow-up project.

Commonly asked questions

"How are people going to subscribe to getting the data from the government?"
They aren't because they don't have to. SAM is designed for an easy set up. This means that once you receive the product, the only thing the user has to do is plug it into an outlet. This means that SAM will be connected to government messages via SMS. So, a small SIM card will be used to establish this connection.

"How is this different than using your phone? (NL Alert)"
There are a few problems with NL-alert. One being the setup takes too long and people can't be bothered to set it up. This is exactly why we wanted to make the setup of SAM as easy as possible. The next big problem is that sometimes people don't want to be disturbed (in the night for example) and they put their phone on airplane mode. This also means that NL-alert cannot warn the user. SAM does not have an airplane mode and only warns you when there is a highly hazardous situation going on.

"How will the production of SAM be funded?"
The idea is that SAM will be produced on a large scale, which will make production cheaper. These low costs are further enhanced since the components we are using are really cheap. Refer to Chapter 8 for the actual numbers.