



DELIVERABLE B

Context Study, Script, Deepenings,
Storyboard & Preliminary Sketches

"Designing a sustainable solution to hinder the transmission of

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Challenge in times of COVID-19"
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1. Context Study



Figure 1. Camp Moria 2017 versus 2020 (Nicolas Economou/NurPhotos, 2017; Dimitris Tosidis/EPA, 2020).

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1.2 Preliminary Research

1.2.1 Our challenge

During this project, we will focus on the question: “How can we design a physical, sustainable solution - a prototype technology - that hinders the transmission of COVID-19 in the Greek refugee camp Moria?”

The main goal of our design will be to minimise the transmission of COVID-19 in camp Moria. We have decided to focus on this camp because transmission prevention is incredibly tricky there. This is due to the fact that large groups of people live in cramped, unhygienic conditions (Welle & Schmitz, 2020). The reason that we chose camp Moria specifically is that it is the largest refugee camp in Europe (Welle & Schmitz, 2020).

In camp Moria, social distancing is virtually impossible. The Greek refugee camp is built to house a maximum capacity of 3000 people. However, the population in Camp Moria is much larger (BBC, 2020). This means that thousands of people share restrooms and showers with each other, and tents are very closely packed. It is also impossible to wash one’s hands regularly, because the queues are incredibly long. This is due to water shortages in the camps.

Although reducing the transmission of COVID-19 is our end-goal, we will also focus on sustainability when working on our design. The pandemic has resulted in a sudden surge in usage and production of plastics for PPE. Management of plastic waste was a problem before the outbreak, but the expected amount of waste due to COVID19 will

far exceed the available capacity for plastics and hazardous medical waste. This is illustrated in figure 2 (Klemeš et al., 2020)

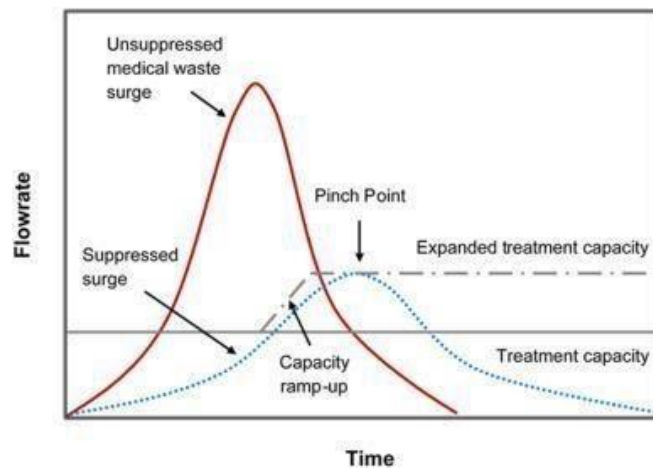


Figure 2 Expected amount of waste (Klemeš et al., 2020)

We use a model to define different aspects of sustainability. This model divides sustainability into three dimensions: environmental, social, and economic sustainability.

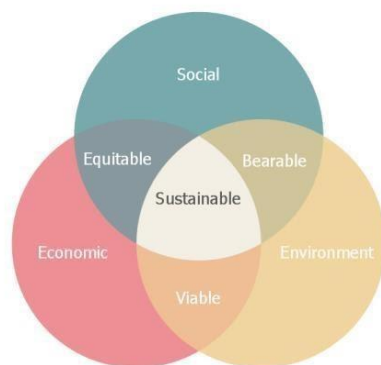


Figure 3 Sustainability diagram (sustainable development, n.d.)

This diagram describes how the three dimensions are connected. Sustainability can only be reached if all three dimensions are sufficient. Hence, when designing a solution, problems in all three dimensions must be addressed.

There is no set definition for social sustainability, although it is frequently used in literature (Lee & Young, 2019). Boyer et al. (2016) believe that the lack of definition is because social sustainability is context-specific. One of the descriptions given by McKenzie (2004) is: “Social Sustainability is a positive condition within communities and a process within communities that can achieve that condition.”

Several indicators describe those conditions according to McKenzie.

These indicators include:

- Equity
- Diversity
- Political participation, preferably on a local scale
- Cultural relations
- Community ownership and responsibility
- Mechanisms in case not all needs are met by the community. (This can be the case for subjects like education)

Thus, social sustainability is related to the general wellbeing and quality of a group or community. Besides the indicators given by McKenzie, this involves the extent to which individuals can meet their basic needs and have the capabilities they have. Upon that, it has to do with how positively individuals perceive the society they live in. Hence, we should ensure that our design has a positive impact on the wellbeing of refugees in camp Moria (Magee et al., 2012).

Economic sustainability is generally about creating a maximum profit, with resources that are as cheap and efficient as possible (Durant et al., 2015). It should be considered that the situation in camp Moria is similar to that of a developing country. This means that economic sustainability changes. In this case, when designing something sustainable for this specific stakeholder, the goal will be to reduce inequality, thus making sure the cost and benefits are in balance (Popovic et al., 2013). Therefore it is more important to design something that reduces inequality and can be bought by everyone than it is to attain maximum profits.

Environmental sustainability can be described as the use of resources, waste, and direct utilities (Durant et al., 2015). Additionally, producing a minimal amount of greenhouse gas emissions is part of environmental sustainability. In the context of camp Moria, these factors mean that the product should be assembled closeby, with local resources that generate a minimal amount of non-degradable waste.

The focus in Greek refugee camps is survival and protection, so sustainability is not high on the priority list of residents and authorities (Norwegian Geotechnical Institute & Eckbo, n.d.). The water that is provided in the camp is almost exclusively provided in disposable plastic bottles. These bottles are only used once, and the plastic waste it produces is not being recycled. This has an immense impact on the environment, as it leads to huge amounts of plastic waste (Norwegian Geotechnical Institute & Eckbo, n.d.).

Therefore, we must take environmental sustainability into account when we are designing our product. We intend to minimise plastic usage but will ensure to use more sustainable types of plastic when we do.

In short, our goal for the project is designing a product that will minimise COVID-19 transmission in Greek refugee camps. During the design progress, we will focus on environmental, social, and economic sustainability.

1.2.2 Required information and relevance

Our challenge essentially consists of two parts: minimising COVID-19 transmission and sustainability. Therefore, we need to gather a lot of background information about those two themes. In this section, the required information for both categories, as well as its relevance, will be summarised.

1.2.2.1 Minimizing COVID-19 transmission

To minimise COVID-19 transmission, we need to understand COVID-19 transmission. Therefore, we must do a lot of background research about how the virus can spread from person to person. To achieve this, we will study subjects such as virology and epidemiology. Jordan will work on this for his deepening, but we will make sure to all have a basic knowledge of these topics. If we understand transmission, we will be able to think about ways to reduce it.

Furthermore, we need to be very aware of the situation and organisational structure within camp Moria. The circumstances are vastly different than the ones we know and

are accustomed to. We need to consider that the options for specific infection prevention methods, such as social distancing, are minimal. Additionally, identifying the main issues with transmission prevention within these circumstances will equip us to find solutions for them

1.2.2.2 Sustainability

To create a sustainable design, we need to be aware of the factors that influence the sustainability of a product. To achieve this, we will investigate sustainable materials. Femke will focus on the chemistry of biodegradable plastics for her deepening since there is a chance that at least a part of the product will contain plastic. Additionally, we will investigate alternatives to plastics to ensure that we choose the most sustainable option. Furthermore, the material needs to be relatively cheap, so that the economic sustainability can be achieved.

The second component of an environmentally sustainable design is a sustainable production process. This means first waste that is difficult to dispose of must be limited. Additionally, the greenhouse gas footprint should be kept to a minimum. We will thus investigate alternative production methods and research on how companies have achieved carbon neutrality and have limited waste so that we can learn from their methods.

Lastly, we will look at the ways our product can be recycled. Our product may generate an amount of plastic waste. We will also explore waste disposal methods. Thereby, we ensure that our product will not add to the current excess of waste (Klemeš et al., 2020).

During this process, we will also research economic and social sustainability. Thus, we will be sure that our final product suits our stakeholders and their capabilities, and that the product can be produced cheap, so it stays accessible for our intended users.

1.2.3 Conceptual and theoretical elements

Several concepts and models have influenced the framing of our challenge. We have been introduced to the theories in the project lectures and through individual research. In this section, the most prominent theoretical elements and their influence on our challenge will be discussed.

1.2.3.1 Design ethics

During the design process, it is vital to consider the wanted and unwanted mediations of an artefact (Gonzalez Woge & Sivakumar, 2020a; Verbeek, 2006). We will therefore consider the unexpected or even undesired mediations that may come with our design and use these considerations to limit adverse mediation effects. Furthermore, our primary goal will be to design something that can be used for positive mediation.

1.2.3.2 Technological mediation

Technological mediation concerns the role of technology in the experiences and actions of individuals and groups. In practice, this means that people can use artefacts to connect with their environment. They can also use technology to a particular end. Often, the technology at hand influences the action an individual chooses to take (Gonzalez Woge & Sivakumar, 2020a; Verbeek, 2006).

Building on this concept, we will make sure that we are aware of the mediations that come with our design. We will aim to design something that actively influences the behaviour of individuals, in which our goal is to stimulate the use of transmission prevention methods.

1.2.3.3 Hard and soft impacts

Soft impacts are how our solution affects relationships between people and the norms and values of a society. Hard impacts relate to more functional aspects of our solution, such as how it will affect the environment or economy.

1.2.3.4 Capability approach

We have been introduced to capability centred design in one of the project lectures and the corresponding reading. A core concept within the capability approach is that every individual should have access to ten basic capabilities (Gonzalez Woge, Sivakumar, 2020b; Oosterlaken, 2012).

We will design for life and bodily health by decreasing the transmission of COVID-19 within the refugee camps. We will also create for other species, which means that we

will make our design as sustainable as possible. Furthermore, we are designing for senses, imagination and thought. Finally, we will design something that stimulates the control over one's material environment, meaning that we will try to increase the availability of PPE. We will have to make sure that we design an artefact that is not only good but also appropriate for our stakeholders and their capabilities (Gonzalez Woge, Sivakumar, 2020b; Oosterlaken, 2012). With every iteration, we will make sure to reflect on the potential soft and hard impacts and their moral implications with the knowledge we gain from existing solutions. This is essential to ensuring that the system or product we develop is sustainable in the context of its use. Therefore, in the following chapters there will be given more insight in these concepts and models and how they apply in the context of our challenge.

1.3 Urgency of our challenge

To say that refugees in camp Moria experience stress is a profound understatement. They must deal and cope with migration, war, oppression, forced detention, violence, and witness death and destruction. They suffer abuse from smugglers, criminals, and governments' (Papadimos et al. 2020). They are exposed to poverty, abuse from locals and fellows, to human trafficking, rape, malnutrition, and inhumane living conditions. Disease, insects, cold, uncontrolled amounts of waste, impure water, congestion, and increased sexual abuse have led to violence in camp Moria. Almost 13.000 people were left homeless after their camp was burnt down to ashes. There are frequent clashes, riots, and increased incidence of violence, where 72 people would share a toilet and 84 people - a shower (Pazzano 2020); during a global pandemic, where almost a million people lost their lives (WHO Coronavirus Disease (COVID-19) Dashboard).

The situation is so dire that children as young as ten years old are attempting suicide. (Katy Fallon and Peter Beaumont 2020).

The international public health community is concerned about childhood morbidity in the refugee camps of Greece. Kampouras was one of the first groups to investigate and report on the disease burden of camps among children. They divided the illnesses that occurred over the winter of 2016–2017 into infectious and non-infectious categories. Children less than the age of 12 years were usually presented with infectious causes (nearly 81%). The most common infections in younger patients included infections of the respiratory tract (67%) (Kampouras et al. 2019, pp. 6(3)). This report only shows the disastrous potential an outbreak of COVID-19 can have in camp Moria

By 2020, the total number of refugees who had travelled through the island, Lesbos - one of the biggest points of transition for refugees in the world, was close to one million, which is an enormous number for an island with a population of 90,000 people. In early 2020, it held about 20,000 people, whereas its facilities had been designed for fewer than 3,000 people (Jussi 2020).

This case illustrates how extremely vulnerable people are neglected in times of severe economic, social, and political challenges and distress, such as the COVID-19 pandemic (Jussi 2020).

Refugees in camp Moria are left unprotected against the life-endangering coronavirus; they do not have access to the necessary medical services provided by the state and other authorities. They do not have proper shelters. Thousands of them live in tents packed with four to ten people. They have minimal access to water and sanitation. They live in deplorable conditions and overcrowded places, so they cannot keep social distance; they do not have hand sanitizers, facemasks, or even the needed medicine to treat a simple cold.

An outbreak of COVID-19 in camp Moria can have devastating consequences and can result in a disproportionate amount of life loss and suffering.

It is for all these reasons that urgent and immediate action needs to be taken. Therefore, the design of a solution that prevents the transmission of COVID-19 in camp Moria is indispensable.

1.3.1 Existing initiatives

The WHO reports that “in a catastrophic fire that broke out on 8 September 2020, the Moria reception and identification centre for asylum seekers and refugees in Lesbos, Greece, was burned to the ground. The world turned its attention towards the Greek island as some 12 000 refugees and migrants were left without shelter, food, or access to health-care services. With 35 refugees and migrants having tested positive to COVID-19 a few days prior to the fire, the situation was particularly urgent, calling for immediate action and coordination” (Author not specified 2020).

The specialized agency of the United Nations responsible for international public health has coordinated great efforts in response to this humanitarian crisis. European organisational bodies and Greek authorities (Greek National Public Health Organization (EODY) taking the lead) have mobilised on the ground trying to maximise their impact. A tented living structure is already being established in efforts of providing refugees with a substitute for shelter (Author not specified 2020).

“A total of 22 team members, including medical doctors, nurses and paramedics of diverse specializations, have worked with local authorities and health professionals to triage, test, isolate and treat COVID-19 patients at the new site and to provide medical support to people in need. The WHO’s background work to make this happen ranged from customs clearance for shipments of medical supplies and equipment, organization of their transportation and storage, coordination of initial briefings on security and public health, and provision of Farsi and Arabic interpreters” (Author not specified 2020).

This clearly underlines the hard work the WHO is performing these days. However, there is no clear indication of the efforts to prevent the transmission of COVID-19 within the newly established living structure. This is a tremendous shortcoming and unfortunately, it is not unprecedented. Similar shortcomings could be observed in the camp before the ongoing tragedy.

The international community has the alarming tendency to handle the situation in Moria reactively. On a European level, intentions to restructure the system in order to improve the living conditions of asylum seekers seem to lose velocity, mainly due to friction forces between European and national law as precisely analysed by the University of Maastricht.

“The initial implementation design of the EU’s asylum policy fores[ees] that Member States would realise the Common European Asylum System (CEAS) largely through deploying their own resources. Initiatives [...] follow [...] emergency-driven trajectory of intra-EU solidarity, rather than structurally embedding solidarity and fair-sharing of protection responsibilities into the EU’s asylum policy. Until there is a permanent redesign of the CEAS, it will arguably be impossible to realise the legally binding principle of solidarity and to ensure human health and dignity, in the time of coronavirus and beyond” (Tsourdi 2020).

On Tuesday, 15 September 2020, Germany announced they would evacuate 408 families from Moria, rescuing in total 1,553 individuals (Noticas 2020). In the meantime, Greece reported the first person in Moria’s refugee camp to have fallen victim to SARS-CoV-2 (Koutantou 2020) - a 61-year-old male. Even though

Germany's action contributes to resolving this humanitarian crisis, other Member States seem to be very passive when it comes to their involvement in constraining the outbreak of COVID-19 in camp Moria.

However, this is not an insight that applies only to European bodies. In the undertaken research, the lack of initiatives with regards to hindering the transmission of COVID-19 in Moria and other refugee camps is alarming. International and non-governmental bodies focus on how to milden the consequences of the outbreak, instead of reducing its magnitude.

Hence, the real challenge is that initiatives do not address the cause of potential outbreaks – which is indeed the greatest shortcoming. This can result in disproportionate life loss and suffering.

It is important that this fact is not confused with improper action or inaction of the previously mentioned organisations. Many ongoing initiatives address the mental well-being of asylum seekers (Refugee Trauma Initiative 2020), the housing emergency situation on Aegean islands (European Commission Initiative 2020), the educational infrastructure for children from refugee families (Theirworld's in collaboration with Nationale Postcode Loterij and Education Cannot Wait 2020), the provision of medical supplies, treatment or nutrition (WHO, UNICEF, UNHCR 2020) or the provision of statistical data about COVID-19 in refugee camps (Greek Impact Initiative 2020).

1.3.2 Consulted resources

During this stage, different resources were used to gain an overview and better understand the identified challenge. Peer-reviewed literature, quality-journalism and social media posts were consulted to properly depict the situation on the ground.

Different databases with scientific papers created by many experts were taken into consideration, the reliability of quality journalism sources was examined, and social media posts from different sources were considered. A list with used references is provided at the end of this document.

One of the defining scientific elements of the framework of this design challenge will be the reconceptualization of sustainable development and its relationship to the capability approach (Lessmann and Rauschmayer 2012). We will use this model to relate the capabilities we design for to the different dimensions of sustainability of our solution.

In establishing this relationship, we will consider different relevant standard regulations and how specific requirements and functions respond to them according to the Value Sensitive Design recommendations by van de Poel (2013).

By considering these scientific frameworks, we will ensure that our design challenge solution is largely driven by the needs and capabilities of our stakeholders - securing standard quality following specific norms and scientific approaches towards sustainable product development and transgenerational justice (Lessmann and Rauschmayer 2012).

1.3.3 What do we want to research in the limited time you have?

As we only have a single semester to work on this project, it is imperative that we carefully prioritise what we research. Now that we have a more in-depth understanding of the social and technical aspects of our design challenge, we want to study how a disease spreads within the context of an overcrowded refugee camp. A deeper knowledge of the dynamics at play within the epidemiological situation in refugee camps in Greece would inform us on how we can reduce the transmission of Covid-19 most effectively.

We also know that it is essential that we reach out to people who are close to the problem. This could be refugees, local and national authorities, the European Union, or any other working forces who are closely linked to Covid-19 in Greek refugee camps.

Our current leads include:

- The Hellenic National Public Health Organization (EODY) who are in charge of surveillance and control of infectious diseases in Greece (European Centre for Disease Prevention and Control, 2020)
- Legal Centre of Lesbos
- Existing Initiatives on providing people in crisis situations with drinking water
- The World Health Organisation
- NGOs: Doctors without Borders, Caritas
- Local authorities of the asylum process department

We also want to conduct further research in the fields of economics, chemistry of polymers and product design and prototyping as these topics will help us to design a solution that is economically, socially, and environmentally sustainable.

1.4 Design Ethics and Technological Mediation

1.4.1 Technological Mediation

Design Ethics can be thought of as a set of ethical standards or considerations which concern “moral behavior and responsible choices in the practice of design” (Buchanan, 2020). Technological Mediation is a theory linked to Design Ethics which suggests that technologies alter the way in which humans act within their environment, as well as how they experience it. This theory suggests that technology plays an active role in what we do and how we do it, which is known as the existential dimension of a technology. Furthermore, it plays an active role in how we sense the world around us, which is known as the hermeneutic dimension of a technology (Ihde 1990; Verbeek 2005, 2011). The framework of technological mediation allows us to acknowledge and analyze this role.

We need to predict, as best we can, the changes in behaviour or experience brought on by our solution. This means we must have an in-depth understanding of the people who will use our technology and take a critical stance throughout the design phase on how our technology could negatively affect these stakeholders, especially when it comes to long-term use. The primary concern of our solution will be slowing the spread of coronavirus in refugee camps such as Moria Camp in Greece. However, we must understand that any technological fix may have unforeseen consequences. These consequences can affect the refugees directly (such as a PPE made from an irritating or slightly toxic material) or indirectly (such as a solution that is not economically

sustainable and results in further financial problems for the government or NGOs working locally).

According to Akrich (1992) and Latour (1992), designers inscribe instructions in the technologies they create, explicitly or implicitly. These inscriptions make up a “script”, which prescribes certain behaviours to an “actor” or those who interact with the technology. The user may follow some or all of these instructions, though not always in the way that the designer intended. These ideas are very useful in helping us think about how to best achieve our goal. For example, a face mask has a built in script, which tells the wearer not to cough or sneeze into their hands. This is the existential dimension of the technology. When a large proportion of the people we see in our daily lives are wearing masks, it may remind us of the presence of the virus (this could then indirectly affect our actions by making us more careful etc.). In this sense, masks change how we view the world. This is the hermeneutic dimension of the technology.

So how would script affect how we design our solution? If we wanted a face mask that prevents the user from touching their face, we would design the mask so that it can be adjusted to fit different sized heads comfortably, therefore reducing the wearer’s impulse to constantly adjust the mask while wearing it. If we wanted a mask that reminds people to be wary of spreading the virus, we could ensure that the masks are brightly coloured (of course the number of people wearing the masks would have a larger effect, but accessibility and implementation of our design will come later).

Our priority for the design, is that it slows the transmission of coronavirus in camp Moria in a way that is sustainable. It is important then, to define what we mean by sustainability. A technology will have soft and hard impacts (Verbeek, 2015). Softs impacts include how a technology affects the norms and values in a society. We want to understand the context of our design’s use, as well as the different cultures within the refugee population in camp Moria, in order to minimize any negative impacts of our design on culture (note that phenomena affected by soft impacts change more slowly than those affected by hard impacts). Hard impacts have a more quantifiable risk. They affect things like unemployment, health, and the environment. By taking a critical stance on the soft and hard impacts, we will make our design as sustainable as possible within the context of its use.

Here is a model describing the relationship between our stakeholders and and our design

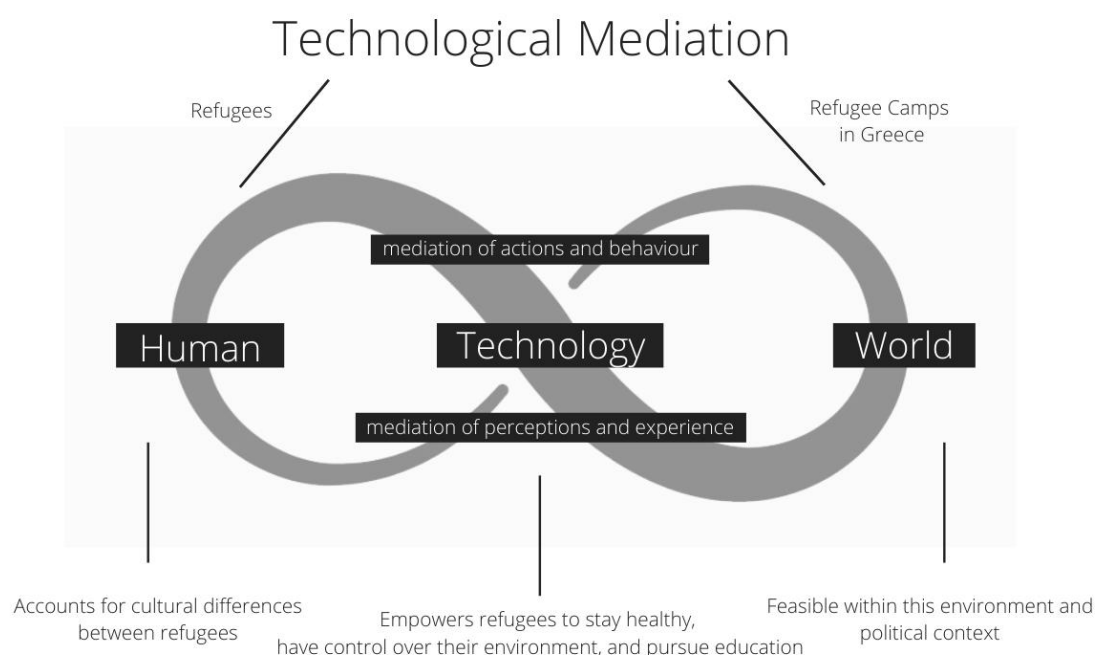


Figure 4. Technological mediation.

The point of this model is not to represent concrete causal relationships between the variables, but to acknowledge and visualize the dynamic flow across the variables. The lemniscate represents the intermediation of humans, technology and their environment. In other words, it shows two things:

- how humans affect the world using technologies (in this case tools that increase abilities like motor and cognitive functions)
- how the world affects humans through technologies which actively shape our perceptions and hence, shape what is considered to be “objective” (telescopes, infrared cameras etc.)

1.4.2 How will the interplay of these elements inform our design?

We must understand the cultural differences between refugees so that we can design inclusively and understand whether or not our design is appropriate in the context of its use (Oosterlaken, 2012).

We want our technology to facilitate the capabilities (Nussbaum, 2002) of refugees, without pushing our own priorities on them. In other words, our aim is to create external conditions that allow the refugees to keep themselves and others healthy, and to use their senses, imagination, and freethought to pursue education. We aim to do this in a way that does not decrease the already low level of financial control they have over their material environment.

It is also important that we understand the constraints of the specific environment in which our technology will be used. For example, asylum-seekers do not usually have the luxury of social distancing or owning smartphones, so designing a Covid-19 tracking app for use in refugee camps in Greece would be pointless. Also, Greece itself has large-scale financial problems. Without knowing this we would not be able to effectively find long-term funding for our solution.

1.5 Capability Sensitive Design

1.5.1 Stakeholders

In Camp Moria 2.0, there currently live around 8000 people (Oxfam, 2020). According to Infomigrants (2019) there are presently a total of 70 different nationalities living in Camp Moria. The latest site profile published by the United Nations Refugee Agency is from September 2018. Here it can be found that around one third of the population is from Afghanistan, about 20% is from Syria and 11% comes from Iraq. On the 9th of October 44% of the population in Camp Moria are male adults, 22% are female adults, and 34% are children (Oxfam, 2020)

Oxfam (2020) warns people about the inhumane living conditions in the new Camp Moria. According to them, food is only handed out once or twice a day, and there is a lack of running water, to use for both washing and drinking. During COVID-19, the World Health Organization's advice is: "wash your hands regularly, keep distance and self-isolate." All of these seem to be nearly impossible for refugees in camp Moria. People are sharing a water tap with up to 250 people (Oxfam, 2020a,). They usually do not have more than 3,5 square meters per person (International Refugee Committee, 2020), and live with up to 20 people in a single container or tent (Oxfam, 2020a, June 5). Furthermore, due to the lack of food and water, refugees must queue all day every day, making it impossible to keep 1.5-meter distance. This severely increases the chances of getting COVID-19 (International Rescue Committee, 2020). Therefore, a solution to reduce the queues in camp Moria need to be found.

1.5.2 Sustainability and capabilities

1.5.2.1 Sustainability

When tackling the challenge (“How can we design a physical solution - a prototype technology - that hinders the transmission of COVID-19 and is sustainable and available globally?”) there will be looked at a sustainable way to reduce the transmission. To describe sustainability, the sustainability diagram is used, as shown in chapter 1.2.1.1.

In the case of our stakeholders, the most relevant thing is social sustainability. Firstly, it will be made sure that the situation of the stakeholders is fully clear. This gives the opportunity to make the solution socially sustainable. More information about social sustainability and its concepts can be found in the deepening about stakeholders.

1.5.2.2 Capabilities

Capabilities are part of the Capability Approach, which is set up by Amartya Sen and Martha Nussbaum. Nussbaum (2007) describes the Capability Approach to measure human well-being and human development. This information can advise policy makers, instead of using GDP. A way to figure out how social sustainability can be improved, is to look at what capabilities have been lost. These capabilities will show problematic areas. To use the Capability Approach in such a way, Nussbaum created a list of ten capabilities. The most harmed capabilities in times of COVID-19 in the case of camp Moria are:

1. Life. Being able to live to the end of a human life of normal length; not dying prematurely, or before one’s life is so reduced as to be not worth living.

2. Bodily Health. Being able to have good health, including reproductive health; to be adequately nourished; to have adequate shelter.
3. Other Species. Being able to live with concern for and in relation to animals, plants, and the world of nature.
4. Control over One's Environment. Material. Being able to hold property (both land and movable goods) and having property rights on an equal basis with others.

According to Nussbaum (2007), the goal is to give every human on earth a minimum of those capabilities. From there, countries can start developing towards even better standards. For the refugee camps in Greece, these capabilities were already not being met, but now during COVID-19 the situation has gotten even worse. This has affected some capabilities.

Life and Bodily health

Firstly, and most importantly, is the harm towards the capabilities of "Life" and "Bodily health". The immensely high transmission rates and the lack of proper hospitals and health employees has caused the capabilities "Life" and "Bodily health" to be in danger. Since there live around 204 people per thousand square meters in camp Moria (International Rescue Committee, 2020), the hazard towards these capabilities grows even bigger. Not only do people die from the virus, they also suffer long-term, or in some cases even life-long, consequences of the virus. A modelling study done by Tucker Gilman et al. (2020) shows the consequences of a big outbreak in Camp Moria when no measures are taken, for both high and low transmission.

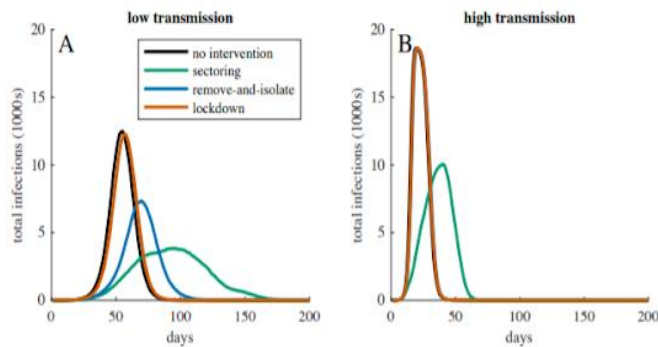


Figure 5: Total infections over time (Tucker Gilman et al., 2020).

With such a rapid spread it is even more difficult to isolate infected groups. Additionally, according to Jervelund et al. (2019), it was not possible to meet the medical needs of the refugees even before COVID-19. This means that if such a big outbreak occurs, it will be impossible to help all the refugees properly. Furthermore, due to the need to stand in queues for water, where it is relatively easy to get COVID-19, this capability is harmed. Lastly, once the virus starts spreading through the camps, all control will be lost and thus the capability of Life and Bodily Health is in big danger.

Other species

Even before COVID-19, refugee camps were harmful for the environment. Now it is getting even worse, due to COVID-19. To stop the transmission of COVID-19, equipment like bottles with soap or hand sanitizer and disinfecting wipes are handed out (UNICEF, 2020), all including plastics. Also, the water distribution system, where plastic water bottles are handed out to everyone, has a big environmental impact. With the current population it means that around 12 000 plastic bottles a day are handed out

(International Rescue Committee, 2018). It gets even worse when taking into account that these bottles take 450 years to biodegrade (WWF, 2018). Looking at Sustainable development, this threat towards the environment has an influence on environmental sustainability.

Control over one's environment (Material)

This capability is being especially harmed during times of COVID-19, due to the lack of medical supplies and protective equipment (International Rescue Committee, 2020). Besides that, due to the queues and lack of water (Oxfam, 2020) there is no possibility to have equal amounts of water for everyone. According to the International Rescue Committee (2018) refugees had to queue for four hours to get 1,5 liters of water in the old camp. Looking back at sustainable development, this means that in the field of economic sustainability something needs to change to decrease inequality.

Looking at the ways these capabilities are harmed and how COVID-19 can spread to the camp, it can be concluded that there needs to be found a way to ensure water distribution without queues. When such a solution is sustainable it will also contribute to the capability of other species since there will be fewer plastic bottles and there will be less need for single use PPE. This also positively influences the capability of control of one's environment since people have a more equal access to water and PPE is not as necessary as before.

1.5.3 Designing an appropriate technology

Designing something that accounts for human diversity is essential. If not, something great can be developed, but there might be a chance that the intended user is not able

to use it. This means it is important to think about the user and their context, otherwise it will never expand one's capabilities.

1.5.3,1 Defining an appropriate technology

Firstly, appropriateness does not have a single definition, it can be seen in many ways, mostly depending on its context. In the light of appropriate technology, synonyms used can be: "suitability, fitness, applicability and usefulness" according to Oosterlaken & Hoven (2012). To fully understand appropriateness and what it means for technology, there are several things to consider. All these things are summarised by Oosterlaken & Hoven (2012) in their book: "The Capability Approach, technology and design". This will be used as a guideline to design a solution during this project.

Human diversity

First, it is essential to take human diversity into account. According to Houkes and Vermaas (2010), aside from judging the material for a certain function of a technology, the plan of usage should also be considered. The plan of usage should account for the capacities and circumstances of the user. This leads to the insight that technology or a specific solution will never be appropriate for everyone, and it only gives opportunities to help a particular group.

Good-, poorness and (in)appropriateness

A technology can be good or poor. It can work well or not. This is something different than appropriateness. According to Franssen (2006, 2009) poor or good is relative to the expectations about the stakeholders and context. Those ideas exist of the properties of such a technology, and those are related to the assumed abilities. This is related to

their actual abilities. Here the difference between goodness and appropriateness can be made clear. Something can be good, meaning it is functioning well. This can be said regardless of whether the real abilities match the function of the technology or not. That does not really matter, because the technology can still be a good technology. When something is appropriate, the assumed abilities will match the real abilities. So, the user will be able to use the technology.

Balance of reasons

It can be that something is poor but appropriate or good but inappropriate. The best pick in this case depends on the definition of both poor and good and appropriate and inappropriate. This is dependent on human diversity. Something can also be useless for a certain goal; this can be the case due to the circumstances or capacities. This is something completely different than whether it is inappropriate or poor. When such a thing happens, something is extremely inappropriate.

Moral judgments

Lastly, moral judgments play a role as they might have implications with the safety of a certain technology. A safer technology would be considered as morally better. The same can be said about appropriateness; if something is appropriate for a bigger group of people, it can be argued that it is morally better. This only happens when this technology is important to people, so then people will not like it if they cannot use it.

The meaning of this is that, when looking at new technology for a specific stakeholder group, it is important to consider human diversity. Hence, the next step is to look at the capabilities and context of the user. Upon that, it should be considered whether the

technology is good/poor and/or (in)appropriate and how much this influences each other. For example, how poor is poor? Next to that, there also needs to be thought about whether a certain technology is not useless, because this gives a good argument for the intended users to not use it. The last important step is to argue about the moral side of appropriateness. All these concepts give a guideline when designing technology. Keeping an eye on them is extremely important to deliver the right solution. Without these concepts, essential things can be overlooked, which will end in a failed design.

1.6 Responsible Research & Innovation

1.6.1 Visual inspiration

The designs in figure 6 and 7 have inspired us when looking for a solution that fits our stakeholders

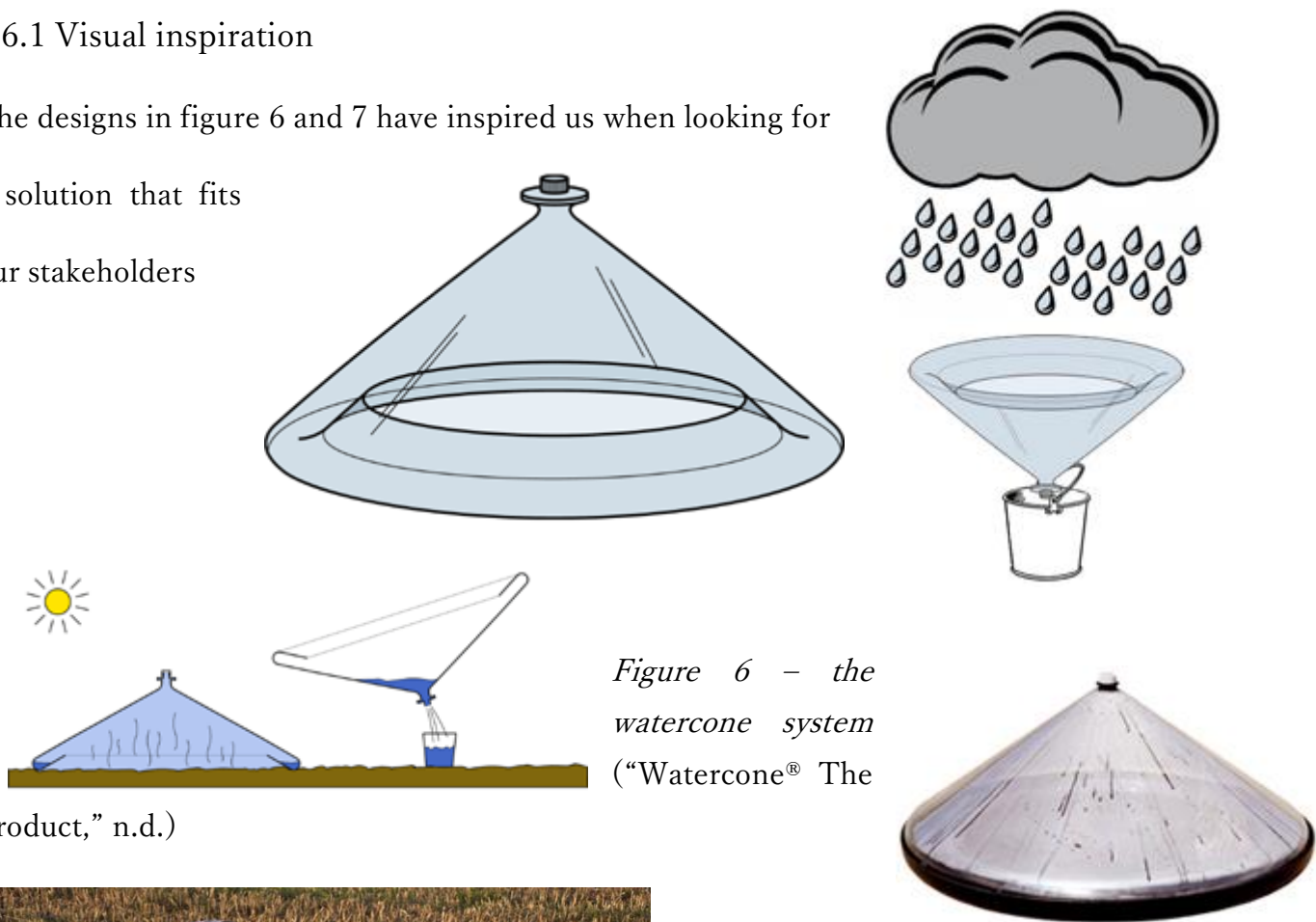


Figure 6 – the watercone system (“Watercone® The Product,” n.d.)



Figure 7 - eliodomestico (“Eliodomestico desalinates seawater into drinking-water running on solar power | DesignAgenda,” n.d.)

In these visuals, the solar power desalination systems are shown. These products turn sea water or brackish water into drinkable water, using nothing but the warmth of the sun.

1.6.2 Suitability

The Watercone system inspires us to create a solar powered distillation system that suits the needs of the refugees in camp Moria. In that way, the lines for water distribution can shorten, which will lower transmission rates. Furthermore, there will be more access to clean drinking water and water to wash their hands with, which improves their general living situation.

To make this solution as appropriate as possible, we have considered the following adaptations to the design:

- Making it square, so that it can be stored more easily
- Using cheap materials, in order to keep the product affordable
- Using biodegradable or recyclable plastics, to reach environmental sustainability

We combine the knowledge we have about our stakeholders with the inspiration we got from the Watercone system. Thus, we can create a sustainable solution that helps reduce COVID-19 transmission in camp Moria, as well as improving the overall quality of life of the refugees.

1.6.3 Principles and regulations

The niche that shapes our challenge is healthcare, related to COVID-19, in refugee camps. We want to shape and improve healthcare, related to COVID-19, by designing a prototype technology that hinders the transmission of COVID-19. This technology must reduce the queuing for drinking water.

Universal health is a human right, which shapes the niche that we are trying to innovate in. The WHO states that understanding health as a human right creates a legal obligation on states to ensure access to timely, acceptable, and affordable healthcare of appropriate quality, as well as to providing for the underlying determinants of health, such as safe and potable water, sanitation, food, housing, health-related information and education, and gender equality (WHO, 2017).

The standards used by the UNHCR, the UN refugee agency, are from the Sphere. “The Sphere Minimum Standards for Healthcare are a practical expression of the right to healthcare in humanitarian contexts. The standards are grounded in the beliefs, principles, duties, and rights declared in the Humanitarian Charter. These include the right to life with dignity, the right to protection and security, and the right to receive humanitarian assistance based on need.” (‘Sphere Handbook Health Standards’, 2019)

The list of SPHERE standards on health can be found Appendix A.

These are the SPHERE standards that the UNHCR claims relate to refugee camps (UNHCR, 2020). If these cannot be met, as can be seen in prior sections due to shortages in for example well trained medical staff, this will severely influence the capability of Life and Bodily Health.

Besides that, water is an important underlying determinant of health. According to the SPHERE standards (Sphere Association, 2018), everyone should have a water distribution point less than 500 meters away from their household, as well as less than 30 minutes waiting time. This is something that is not happening in Camp Moria. Therefore, these standards are not met and thus people do not have equal access to water.

Furthermore, refugees only get 1,5 litres of drinking water a day, while the SPHERE standards suggest a daily quantity of 2,5 to 3 litres. This means that the refugees do not have equal access to water compared to people that do not live in Camp Moria. Hence, the capability of control over one's environment is harmed.

Lastly, the SPHERE standards (Sphere Association, 2018) strive for environmental sustainability with regards to one's household. Here one of the key indicators is that at least 70% of the solid waste onsite should be reused, repurposed, or recycled. This is definitely something that is not done with, for example, the plastic bottles in camp Moria. Therefore, camp Moria is currently hurting the environment, and thus the capability of other species cannot be met.

The low living standards at the refugee camps are an issue that needs to be addressed. Therefore, the information available on this capability, together with the standards, should provide guidelines for different policy makers, such as the Greek Government and the European Union, on how and what to do. If these standards can be met by their effort, the quality of life will be raised, and the minimum capabilities will be met. We should also do everything that lies in our power to better these living standards. To

design a prototype technology that hinders the transmission of COVID-19 is a good first step to stabilize the situation in camp Moria, so we can work on improving the overall living conditions the camp in the future.

2. Script



Figure 8. Mom walks with child on Lesbos, Greece (Connelley, 2020).

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2.1.1 Introduction

In the following sections, we would like to define the script of our design and elaborate on our conscious decisions why the script will take the particular form provided in the next paragraphs.

It is important to remember that, while the wellbeing of our main stakeholders has been our primary focus in all of our design choices, it is impossible to predict with perfect accuracy how our product will affect them and their environment. Technology plays a central mediating role in the relationship between people and their environment. For this reason, it is essential that we not only focus on intended interactions but take a critical stance on what the unintended interactions may be. In the upcoming sections, we will give an overview of the design process we have gone through over the past few weeks. Additionally, we provide the requirements, functions and norms that have guided us and will continue to guide us in our design. But firstly, we will make an attempt to see through the eyes of our stakeholders to understand their needs better. Therefore, an empathy map has been made, this can be found under chapter 3.2.5.4.

It also important to have the current product explained before introducing functions and requirements. The proposed solution for which we designed our script is a solar still that distils seawater. This design and its components can be found under chapter 5.

2.1.2 Requirements

Inspired by the capabilities mentioned in our context study, these are the requirements our product has to fulfil:

2.1.2.1 Life & Bodily Health

1. The product shall enable users to wash their hands with purified water when they do not have direct access to running water (reducing the transmission of COVID-19 below the value of $R = 1$ within Camp Moria)
2. The product shall reduce the time refugees spend waiting in lines by 50% or more
3. The product shall reduce the salt level of seawater to levels stipulated by GDWQ guidelines
4. The product shall reduce bacterial pathogens, viral pathogens and cysts to levels stipulated by GDWQ guidelines

2.1.2.2 Other Species

5. At least 80% of the product shall be biodegradable.
6. The production process shall be at least 80% greenhouse gas neutral
7. 100% of the plastic that is used during the manufacturing process shall be recycled
8. The product can be packaged with less than 20% wasted space so it can be transported in bulk
9. The product shall fit to all standard plastic bottle sizes without leakage
10. Our product shall account for cultural and individual differences (language, ethnicity, country of origin, etc.) and shall allow every user to navigate the product.

2.1.2.3 Control over one's Environment

11. The product shall be affordable to be manufactured in bulk, purchase, clean and repair
12. The product can be packaged with less than 20% of wasted space so it can be transported in bulk
13. The product shall purify 1000 litres of water to GDWQ standards before the storage tank B needs to be rinsed.

2.1.2.4 Definitions

Term	Definition
R	Transmission ability rate of a disease from a person to others
Group-based education	Students go to a specific location with the purpose of receiving education in a group setting
Affordable	This depends on the specific product architecture and cannot be fully defined right now. Once that is clear affordability will be specified as the capital cost and the operating cost per liter.
GDWQ standards	Specified below in the norm subsection
GDWQ guidelines	Specified below in the norm subsection

Table 1. Definitions.

2.1.3 Functions

Based on the previously formulated requirements, our list of functions states that our product will:

1. Admit seawater to storage tank A.
2. Contain seawater in storage tank A without leakage.
3. Evaporate seawater with solar energy.
4. Contain water vapour in storage tank A without leakage.
5. Transport water vapour into storage tank B through heat flow and pressure difference.

6. Retain impurities such as pathogens, sand and crystallised salts in storage tank A.
7. Condense water vapour in storage tank B.
8. Contain distilled water in storage tank B without leakage.
9. Stop environmental contaminants such as sand, leaves and other debris from entering storage tank B.
10. Uncover/Remove storage tank B when necessary.

2.1.4 Intended Interactions

As previously stated, the main outcome of our product will be to allow refugees to avoid queuing for clean water by providing them with personal water purifying devices. This would make it easier for refugees to stay socially distanced as much as possible while also receiving the resources they need. This goal will be facilitated by functions (1) to (10).

Our product will also allow the refugees to rinse storage tanks A and B themselves when necessary. This interaction will be facilitated by function (1) and (10).

Refugees should not need any prior training or expertise to be able to do this without damaging both storage tanks.

The use case diagram in figure 9 visualises the intended interactions that our product will have with the user and the environment.

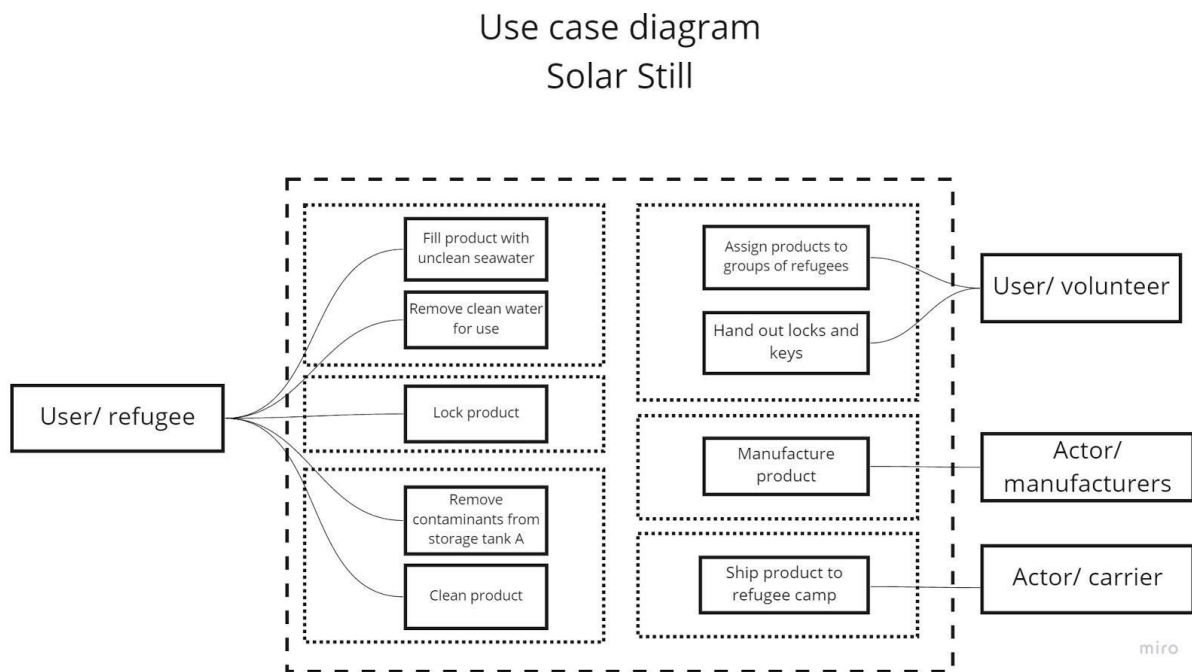


Figure 9. Use Case Diagram

2.1.5 Unintended Interactions

After considering all intended interactions, we have to account for another type of interactions which can indeed influence how well our product considers the stakeholder's capabilities - unintended interactions. People do not always use a product in the way it is supposed to be used. For instance, this can happen when there is a lack of knowledge on how to use the product. Sometimes, external factors are not considered when designers develop a product. These circumstances could cause an incorrect use of it and put the user at risk.

It is impossible for a team of designers to be aware of all unintended interactions. However, the most important pitfalls can be recognised upfront after an analysis of the potential use of the product, e.g. with a use-case-diagram. These pitfalls can, for example, be solved in the final design - minimising the exposure of the user to a possibly dangerous use. The most important unintended interactions we identified are:

- Refugees can put themselves into unsafe situations attempting to collect seawater
- Refugees can use our product incorrectly (for example by not rinsing storage tanks A and B) and consume unclean water or use it to wash their hands.
- Refugees may queue to use the product, which may cause another source for transmission of communicable diseases (far less queuing than is currently happening however).

2.1.7 Norms

After we define our functional requirements, functions, intended and unintended interactions, it will be important to ensure certain minimum standards of our design.

Hence, we will work within the framework of different policies, regulations and codes.

Our solution involves the provision of access to drinking water to our stakeholder.

Therefore, we considered the guidelines for drinking-water quality, in their 4th edition, incorporating the first amendum from the World's Health Organisation to be of great relevance (WHO, 2017). In response to this, one of our requirements has to ensure users' access to drinking water that meets the GDWQ quality standards.

The challenge we want to address considering these guidelines is, as previously mentioned, that in providing our stakeholders with the resource drinking water, we will considerably reduce queues for perhaps the most important and rare resource in Moria. Consequently, we will combat one of the largest sources of COVID-19 transmission in the camp. Currently, our stakeholder is lining up to eight hours for resources where hundreds of people are present and social distancing is everything, but possible (Harlan, 2020).

Sphere Minimum Standards (2018) will guide us too in securing minimal standards for our stakeholder. The Sphere Minimum Standards aim at securing a life in dignity for every human being and especially for those living under extreme conditions and crisis situations.

We will focus on the chapters Water Supply, Sanitation, and Hygiene Promotion (WASH), particularly targeting the following standards (Sphere Association, 2018):

- Hygiene promotion standard 1.1, “[p]eople are aware of key public health risks related to water, sanitation and hygiene, and can adopt individual, household and community measures to reduce them.” Our product’s functional requirements and design functions will indeed fulfil this standard because our product shall help our stakeholders reduce a public health risk, namely the spread of COVID-19.
- Water supply standard 2.1: Access and water quantity, “[p]eople have equitable and affordable access to a sufficient quantity of safe water to meet their drinking and domestic needs.” Our product aims to ensure the access of our stakeholders to drinking water by desalinating and disinfecting seawater. Thus, it will provide our stakeholders with a sufficient amount of water on a daily basis.
- Water supply standard 2.2: Water quality, “[w]ater is palatable and of sufficient quality for drinking and cooking, and for personal and domestic hygiene, without causing a risk to health. Our functional requirements want to ensure a minimum standard of creating clean drinking water, so by fulfilling this requirement we we will meet this standard
- Solid waste management standard 5.1, “[s]olid waste is safely contained to avoid pollution of the natural, living, learning, working and communal environments.”
 - Our solution has to be biodegradable for at least 80% of its components and all plastic components of the product shall be recyclable. Hence, we will create an environment free from solid waste (regarding our solution).

- Solid waste management standard 5.2, “[p]eople can safely collect and potentially treat solid waste in their households.”
 - This is a standard we will meet too, since we set an ergonomic requirement of our product to be free of pain and that it shall be easy to use. Combined with our requirement of the product to be recyclable, we will indeed account for this standard.
- Standard 6: WASH in healthcare settings, “[a]ll healthcare settings maintain minimum WASH infection prevention and control standards, including in disease outbreaks.” Specifically, during outbreaks we shall ,”increase water quantities [...] according to disease type, risk and needs.” Additionally, we shall account for, ”provid[ing] handwashing stations in each zone.”
 - We shall include the following key points in considering this standard:
 - *Number of handwashing stations*
 - Minimum: one station for every ten inpatients
 - *Drinking water quality at point of delivery*
 - Minimum: 0.5–1mg/l FRC
 - *Quantity of safe water available*
 - Minimum: 5 litres per outpatient per day

Our solution has to be affordable and should be easy to navigate by any of our stakeholders. Therefore, by being affordable, our product will meet the standard above in terms of the quantity of the product the stakeholders will have at their disposal.

In our research, we also realised that it is challenging to find and set universal standards for creating a sustainable solution which will avoid Moria of adding more waste to the thousands of tons of plastic around the entire camp zone (Squires, 2017). Therefore, we created the following requirements which our solution shall fulfill, according to Lessmann's model (2013) of sustainable development based on the capability approach:

- At least 80% of the waste from our solution shall be biodegradable.
- The production process shall be at least 80% greenhouse gas neutral
- All plastic that is used during the manufacturing process shall be recycled.
- The product can be packaged with less than 10% of wasted space so it can be transported in bulk.

(The final ideation of this part has to address engineering regulation standards for the particular design solution).

2.1.8 Conceptual connections of theoretical framework

After discussing capabilities, requirements and functions, it will be useful to relate the elements of the theoretical framework of this project to showcase the scientific line of reasoning of the product design.

Figure 10 and 11 conceptually connects the types of impacts our product has on the stakeholder's environment. Specifically, we identified that the soft and hard impacts of it are linked to specific aspects of sustainability relevant to our design (see fig. 2 and 3). On the other hand, the sustainable development aspects as a goal of our product can be bridged to the capability approach model. We will base these relationships on the theoretical framework developed by Lessmann et al. (2013).

From this step on, the necessary policies and regulations identified in the previous paragraphs (summarised under the term 'norms') will be defining for our solution and how it will meet its technical requirements and goals for sustainability. Using the Value Sensitive Design recommendations by van de Poel (2013), we can clearly link the capabilities we design for to the functional requirements of the product. Lastly, inspired by these requirements, we derive the functions of our product.

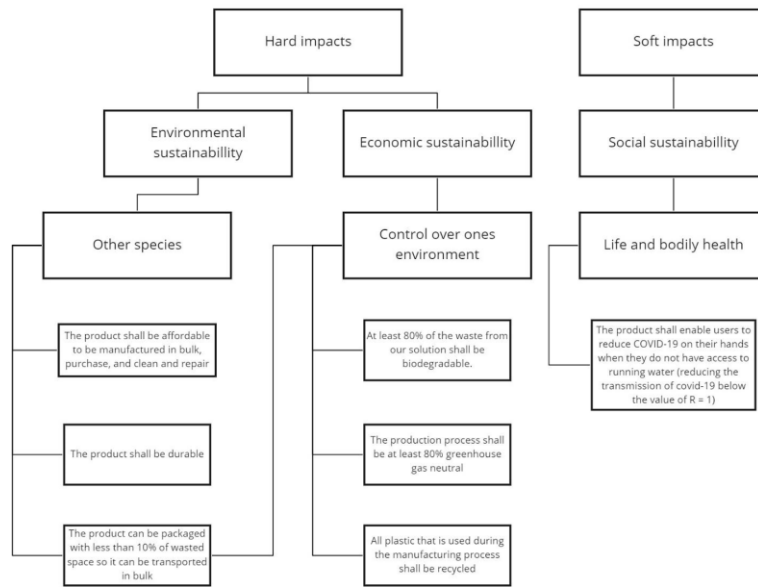


Figure 10. Visualisation of different theoretical frameworks combined.

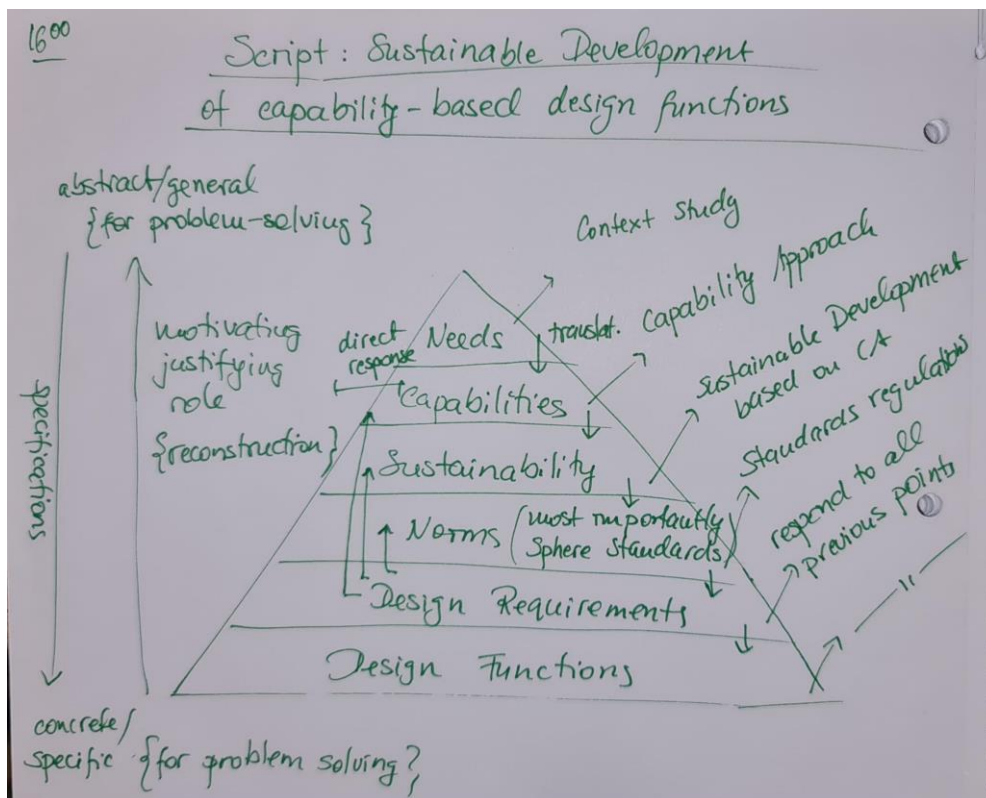


Figure 11. Visualisation of different theoretical frameworks combined 2.0

3. Deepenings



Figure 12. Ikigai (Dayman, 2020)

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3.2 Deepening table

In this deepening table all the deepening are listed, including the planned format. Next to that, there is very short indicated why the deepening matters to the person and why it is important for the challenge. More elaboration on the deepening can be found in the next chapters.

Team Member	Deepening and Format	Why does it matter to you?	Why is it important for the design challenge?
Femke Zijderveld	The Chemistry of Biodegradable Plastics <i>Text Essay</i>	Learning if chemistry is something Femke would like to pursue in the future.	Environmental sustainability
Freek Vercammen	Product Design <i>Portfolio of research and drawings</i>	Freek dreams of becoming an inventor or creator, to attain this goal product design is essential.	Product designing
Iordan Nikolov	Virology and epidemiology of COVID-19 <i>Digital Story</i>	Iordan wants to explore the relationship between his interest in the field of astrobiology and epidemiology.	Transmission
Isaac O'Sullivan	Economics <i>Text Essay</i>	Isaac would like to learn to look at design problems from a new perspective.	Economic Sustainability
Kayla Veldkamp	Stakeholders <i>Text Essay</i>	Learning if Humanities and Social Sciences is something Kayla would like to pursue in the future.	Social Sustainability

Table 2. Deepening table.

3.2.1 Deepening Femke Zijderveld – The Chemistry of Biodegradable Plastics

3.2.1.1 Introduction

For my deepening, I will focus on the chemistry of biodegradable plastics. In order to become an expert on this, I will at least research the following themes:

- The chemical structure of different biodegradable and ‘normal’ plastics
- The chemical process of polymer (plastic) degradation
- Factors affecting biodegradation
- The production process of biodegradable plastics

My deepening will be conducted in written form, accompanied by diagrams to visualise information when needed. The topic I have chosen is quite theoretical. Therefore, the document must contain a lot of information and explanations. I believe that my gained knowledge can be communicated most effectively by writing it down in such a manner that it can be easily understood, while still including the relevant information. Hence, my aim will be to create a document that contains the information I have gathered in a written format.

3.2.1.3 Intended Learning Outcomes

As stated previously, I will research the chemistry of biodegradable plastics. By diving into this topic, I want to become more knowledgeable about several sub-themes. These themes include chemical structures, chemical processes of polymer degradation and biodegradable plastic production, and the factors that affect biodegradation. Combining the knowledge, I will have gained about these themes, I will be competent in the subject polymer chemistry and processes as a whole.

While working on my deepening, I want to reach the following Intended Learning Outcomes:

- Re-activate and expand my knowledge about polymer reactions and apply this knowledge in the context of biodegradable plastics.
- Become more comfortable with block diagrams and production process chemistry
- Become aware of the factors that affect biodegradation

3.2.1.3 Relevance

Personal relevance

I have always been interested in natural sciences, including chemistry. During ATLAS, I want to explore whether I would like to pursue chemistry, physics, or a combination of the two for a master's degree and as a career. In order to do this, I need to get a clear understanding of the way it is taught at a university level and how it can be applied in the professional world.

During the first semester, I will be following two physics modules. However, chemistry is not covered as an ATLAS subject during the first semester. This is why I have chosen to focus on a theme that involves a lot of chemistry for my deepening. Doing this deepening will help me explore my own interests further. It will help me gain clarity on whether chemistry is something I would actually like to pursue. Furthermore, it will prepare me for any future electives in this scientific field and prepare me for a possible master's degree in chemistry.

Relevance to the team's design challenge

For our design challenge, we will focus on COVID-19 infection prevention in the Greek refugee camp Moria. One of our main aims is to develop a sustainable product or solution.

As mentioned, we want to create a product that aids in supplying refugees with clean water to wash their hands with. In order to create this product in an affordable way, we

will likely have to include plastics in our design. To prevent our product from becoming unsustainable, we must ensure that a majority of the used plastics is produced in a sustainable manner, as well as being easily degradable.

This deepening will allow us to find sustainable materials for our final product and think about ways to dispose of used products so that the environmental impact is limited. Additionally, it will help us become aware of the impact our product may have on the environment.

3.2.1.3 Evidence

Structures of plastics

Plastics are defined as long chain polymeric molecules that are manmade. Plastics are currently widely used, because of their favourable chemical properties, such as their strength, low mass, and water resistance. Furthermore, plastics are very stable and durable (Shah, Hasan, Hameed, & Ahmed, 2008).

Some of the most used plastics are polyethylene (PE), polyvinyl chloride (PVC), polypropylene (PP), polystyrene (PS), polyethylene terephthalate (PET), and polyurethane (PU).

(Shah et al., 2008) The chemical structures of these polymers are shown in figure 13.

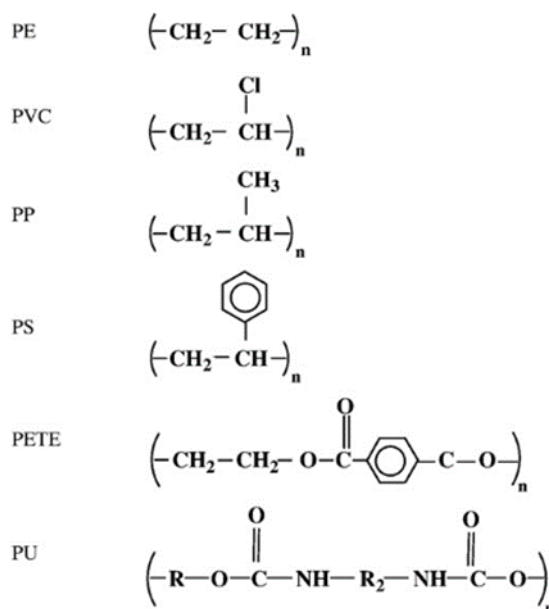


Figure 13. Polymer structures of widely used plastics (Shah et al., 2008)

Biodegradable plastics and bioplastics

Biodegradable plastics are designed to become susceptible to microbial attack. This makes them degradable in environments that are microbially active. Biodegradable plastics have the chemical name polyesters because they are a chain of esters. They are usually also polyhydroxalkanoates. The

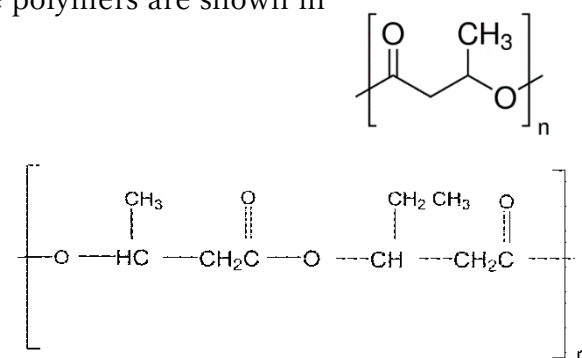


Figure 14. Chemical structure of poly-3-hydroxybutyrate and poly-3-hydroxybutyrate-co-3-hydroxyvalerate ("Poly[(R)-3-hydroxybutyric acid] natural origin / 29435-48-1 / Sigma-Aldrich," n.d.; Rivera-Briso & Serrano-Aroca, 2018)

most important ones that have been developed successfully are poly-3-hydroxybutyrate (PHB) and poly-3-hydroxybutyrate-co-3-hydroxyvalerate (BHBV). (Shah et al., 2008)

The chemical structure of both polyesters is shown in the figure 14.

Bioplastics, also called biopolymers, are obtained from the growth of microorganisms or plants that have been genetically engineered in such a way that they produce the desired polymers. It is likely that such polymers will replace currently used plastics at least in some of the fields (Shah et al., 2008).

Currently, none of the introduced biodegradable plastics are efficiently biodegradable in landfills. Hence, they have not yet gained widespread use. In the future, bioplastics will become relatively cheaper to produce, assuming that oil prices will continue to rise. (Shah et al., 2008)

Production of plastics

The plastics we use today can be made from both inorganic and organic raw materials. The basic materials needed for the production are extracted from oil, coal, and natural gas. (Shah et al., 2008)

Environmental impact of plastics

Commercial polymers have dramatically increased in production. During all stages of the production process, plastic waste is released. Additionally, every plastic product is a waste after consumption. Unfortunately, most commodity plastics lack biodegradability, meaning that they are very persistent in our environment. Hence,

plastic materials that are not properly disposed of, are a significant source of environmental pollution. If the situation remains unchanged, the world will have to deal with an enormous environmental accumulation and pollution problem, which would take centuries to solve (Shah et al., 2008).

Degradation of plastics

Polymer degradation includes any processes that induce changes in polymer properties caused by bond scission and chemical transformation through chemical, physical, or biological reactions. There are three types of degradation: photodegradation, thermal degradation and biological degradation (Shah et al., 2008).

Photodegradation

Photodegradation happens through the absorption of high-energy radiation in the ultraviolet part of the spectrum. This activates electrons to be more reactive, which leads to different forms of degradation, such as oxidation and cleavage. Polymers tend to be sensitive to photodegradation when they absorb the harmful part of the tropospheric solar radiation, which includes wavelengths between 295 and 2500 nm (Shah et al., 2008).

In photodegradation, UV-light and high-energy radiation are the main active agents. The initiation of the reaction (getting the reaction started) is slow, but propagation (the actual reaction) is quite fast. This process is environmentally friendly, as long as

UV-light is used. Unfortunately, photodegradation is currently still quite costly. Hence, it is not widely used as a waste disposal method at the moment. (Shah et al., 2008)

Thermal degradation

Thermal degradation of polymers happens as a result of overheating. When temperatures are high, molecular scission can occur, which means that the components of the chain backbone begin to separate. The separate components then start reacting with one another, which causes physical and optical property shifts in the material.

For thermal degradation, only heat and oxygen are required. The process is very quick and inexpensive. However, the negative environmental impacts are considered to be too large. For this reason, thermal degradation is deemed an unacceptable method of degradation.

Biodegradation

The breakdown of organic substances by living organisms, such as bacteria and fungi, is called biodegradation. In wild nature, plastics are biodegraded aerobically. They are biodegraded anaerobically in sediments and landfills. In composts and soil, the biodegradation is a combination of aerobic and anaerobic processes.

Process of biodegradation

The degradation of polymers usually takes several steps, which are all carried out by different organisms:

1. Breaking down the polymer chain into its constituent monomers
2. Using the monomers for biological processes, during which simpler waste compounds are excreted as by-products.
3. Using the excreted waste compounds from the previous step.

The specific microorganisms responsible for the degradation vary depending on the soil conditions and the properties of the plastic. (Shah et al., 2008) In the following section, these steps will be explored in more detail.

Depolymerization is the breakdown of a polymer into smaller monomers. Several physical and biological forces can lead to the initial breakdown of a polymer. Possible physical forces include temperature changes and phase changes. These forces can lead to the cracking of the polymeric materials or cause other mechanical damage. Examples of biological forces are the growing of fungi and depolymerization by microbial enzymes. (Shah et al., 2008)

The most important reaction for the initiation of environmental degradation of synthetic polymers, is abiotic hydrolysis (Shah et al., 2008). This is the breakdown of one larger molecule into multiple smaller molecules, with water acting as the active agent.

Extracellular depolymerases play an important part in the depolymerization process. Exoenzymes from microorganisms break down the complex polymers, creating smaller molecular chains. (Shah et al., 2008)

The smaller particles are small enough to pass the semi-permeable outer bacterial membranes, which essentially means that they enter the bacteria. They can then be used as a source of carbon and energy. (Shah et al., 2008)

Biodegradation of natural plastics

Polyhydroxyalkanoates (PHAs) may be degraded under nutrient rich conditions by microorganisms that produce and store PHAs when nutrients are limited. Bacteria must have evolved extracellular hydrolases that can convert the polymers into hydroxyl acid monomers that can diffuse through the bacterial cell wall. (Shah et al., 2008)

Once the monomers are within the cell, they are metabolized through β -oxidation and the tricarboxylic acid cycle. Under aerobic conditions, carbon dioxide and water are produced. When the conditions are anaerobic, methane is also produced. No harmful by-products have been found to be generated during PHA degradation. The amount of CO₂ that is produced during this process has been experimentally found to be in control. (Shah et al., 2008)

In the biological degradation of PHAs, at least two categories of enzymes are actively involved: extracellular and intracellular depolymerases.

Various microorganisms have extracellular PHB depolymerases, which play an important role in PHB metabolism. The enzymes contain a substrate-binding domain, which plays a role in binding to the solid PHB. Furthermore, there is a catalytic domain, which is composed of a catalytic triad (Ser-His-Asp). This domain acts as a catalyst, lowering the energy that is required for the reaction. The two domains are connected by a linker region. (Shah et al., 2008)

PHB depolymerases share several biochemical properties:

- Relatively small molecular weight
- Do not bind to anion exchangers
- Strong affinity to hydrophobic materials
- Optimum pH between 7.5-9.8
- Inhibited by serine esterase inhibitors.

Most PHA degrading bacteria produce only one type of PHA depolymerase. However, there are some exceptions to this. For example, the PHA-degrading bacteria *P. lemoignei* produces at least seven different PHA-depolymerases (Shah et al., 2008).

Factors influencing biodegradation

The process of biodegradation depends on different factors. First of all, polymer characteristics such as its molecular weight, the type of functional groups, and its mobility play a role. Furthermore, the types of organisms carrying out the degradation and the nature of the pre-treatment need to be considered. (Shah et al., 2008)

Molecular weight

In order for microbial attack to occur, bacteria require the substrate to be assimilated through the cellular membrane. This happens most smoothly when a molecule has high solubility. Larger and heavier molecules are less soluble. Hence, polymers with a higher molecular weight are generally less degradable by microorganisms.

Organism characteristics

The degradation ability of the microorganisms that carry out the depolymerization process is very important for biodegradation. Polymers are generally too large to pass through the bacterial membrane. Hence, the organism must have produced extracellular enzymes that are capable to break the large chains down into smaller monomers.

3.2.2 Deepening Freek Vercammen – Product Design

3.2.2.1 Introduction

My deepening is about desalination methods. It will consist of a description of the different methods of desalination, a comparison between the methods, explains how the principles of the methods work, and do a benchmarking analysis to learn from the processes and smart ideas that already exist. Furthermore, my deepening will describe the way we thought about our design choices and show the red line of the story from ideas to reality.

My deepening will consist of an explanation, comparison, and benchmarking analysis in written form, then there will be design and prototype visualisation. This way of showing the different parts of my deepening ensures that I document the way of arriving at a prototype technology in the right order, through the right methods. Therefore my deepening will start from scratch defining the methods and processes to explain my reasoning for the design choices made in the design exploration phase of the semester project, after that, I will dive more in-depth into the methods, what are the pros and cons, the physical restrictions, and the differences between the two.

After that I will go even more in-depth into one of the methods, how can the design harness the methods to desalinate seawater more efficiently, reliably, and by using the minimum amount of resources in production and shipping. This will include some brainstorming to come up with my own solutions, doing research in efficiency and vaporisation of water of solar stills, and benchmarking analysis of the limited number of products that exist.

When most of the technical details are all clear, and I know the details of the factors that influence the design of the product I will explore the design and form of the product to put all of that knowledge into one product. Making sure our prototype technology is appropriate.

3.2.2.2 Intended Learning Outcomes

I want to learn how to do a benchmarking analysis, make design sketches involving cut-outs to show the inside workings of a project, and learn how to take into account resources for shipping and manufacturing processes. Furthermore, I want to learn how to decrease ambiguity by having visuals accompany the text, and just more practice for soft skills, like researching, writing, and structuring a document.

- Learn how to sketch functional cut out design drawings.
- Learn how to do a proper benchmarking analysis.
- Learn to take material resources and shipping situation into account when designing a prototype technology.

The above-mentioned goals are my final intended learning outcomes.

3.2.2.3 Relevance

In the middle of my ikigai, there is a dream to become an inventor or creator. Product design and understanding the mechanical processes is one of the most important things for an inventor. It is a process that is essential if you want to solve problems by inventing physical products. The ability to understand the situation to be able to make things happen is a really important step in the process of making something. Understanding

the process on a small mechanical level helps develop a general understanding of the product design. Designing through functionality is my style of designing, that is why I chose desalination processes as my deepening. The design part of problem-solving is the direction that I want to head into later in my career and in atlas. That is why I have a design visualisation component into my deepening. First getting a better understanding of the process of what you are designing for, then designing the product makes for a more thoughtful design.

I want to be an inventor; somebody who comes up with concepts and can design products to solve complex problems. Solving a problem (even though it is stated as a challenge) by designing a physical product (invention) is what this challenge is about. Only now the teams are pushed in the direction of problems related to COVID-19, the problem is just more specific. The general methods of design still apply. I will grow in experience by taking that part of the design challenge upon myself. Practice makes perfect.

3.2.2.4 Evidence

The desalination processes

Problem to solve

The problem is that refugees have to stand in line to get drink water, or water to use for washing their hands. These queues are a high risk for the transmission of COVID-19. It is clear that a lack of drinking water is the direct cause of the queues. When

investigating the stakeholders' geological surroundings, it becomes apparent that a specific natural resource is available, however not in the appropriate form; the refugee camp is close to the sea, there is an abundance of seawater. That is where our prototype technology comes in. By increasing water autonomy by providing personal (or per tent) seawater filtration or distillation systems we can lower the transmission rate in the refugee camp, by reducing the need for queuing.

What is desalination?

Desalination is defined as the process of removing salt and other contaminants from water for human consumption (Mallinson, 2016). Contaminated saltwater is desalinated to produce water that is suitable for human consumption and washing hands. During desalinating water, the desired clean water is separated from the concentrate of the contaminated saltwater. This highly concentrated by-product is called brine. The process of desalination is one of the only sources of water produce that is not dependent on rainfall (Fischetti, 2007; Mallinson, 2016). Making this method of producing water particularly effective and reliable in areas with warm and dry climates with access to seawater.

One of the issues associated with water desalination is the energy to cost ratio (Mallinson, 2016). This issue is remarkably explained by Professor Lienhard from MIT, an expert in the field of desalination, in the following example:

“For example, a well-designed thermodynamic power cycle might run at a 60% exergetic efficiency, while a well-designed desalination system typical reaches 20-30% exergetic efficiency at best, and often much less. But many of the potential solutions

for improving energy efficiency, such as enlarging a surface area for heat exchange, also increase the total cost of the system. Suddenly you have got an energy-efficient device that is not at all cost effective. The issues of cost are particularly challenging in impoverished areas such as parts of India, where the need is dire but the ability to pay is low.” (Mallinson, 2016)

Getting the optimum desalination system is a hard process that involves a great deal of research, refining and fine-tuning. Understanding the exact mechanical process is a mandatory piece of research to be taken into account when optimizing a desalination system. The following section will cover the overview of the processes involved.

The different methods of desalination

When it comes to desalination, the overall quality of the water is determined by the total dissolved solids (Oram, 2020). However, the TDS is not a good indicator for water quality, what is effectively measured is the amount of minerals dissolved in the fluid, not the water quality or if the water is within the regulations of safe consumption. A TDS reader measures the conductivity of the water, thus the amount of dissolved metals in ionized form (team, 2020).

For distillation, the total dissolved solids in the liquid do not matter (as long as the dissolved solids do not have the same boiling temperature), for membrane filtrations however this is different. The more TDS the more energy is needed to separate the permeate (the clean water) from the brine. When choosing the appropriate desalination method this needs to be taken into account.

One of the dissolved solids in seawater that limits the use of types of membranes, is salt. When salt is dissolved in water it is broken apart in a positive and negative ion, these very small, charged particles are difficult to filter out. The amount of total dissolved solids and charged particles in the water therefore are the requirements for the desalination method. The only method of membrane filtration, which filters out dissolved salt particles is reverse osmosis filtration.

There are numerous methods of desalination. These methods are grouped into two groups: distillation and membrane filtration. There are numerous sub-methods of these umbrella methods. In this deepening, I will be discussing the ones most appropriate to the situation of our stakeholder.

Distillation

The process of distillation is a way of separating a liquid of the solids and liquids dissolved in it. A heating source separates the two components through a difference in melting point. The desired liquid substance will evaporate and is then cooled down and caught in a liquid state, the residue of all the dissolved solids and liquid remains. For the method of distillation, this is the brine.

The method of distillation requires a liquid to be vaporised, utilizing an external heat source or a high-pressure vacuum chamber. This method demands a great deal of energy. As an inspiration for desalination methods the natural processes of evaporation and cloud forming could be utilized, it becomes apparent that there is an abundance of natural energy waiting to be harnessed. The sun is a free, reliable, and powerful source

of energy. There is one method of distillation which uses the heat of the sun, namely solar thermal powered desalination.

Solar thermal-desalination methods make use of solar radiation primarily in the infrared (IR) range to power the desalination of salt water to freshwater. (Reif & Alhalabi, 2015). The specific method within solar thermal-desalination I will be focussing on uses the thermal energy of the sun to evaporate water, then the pure water is cooled down on a cold surface, and stored in a container for later usage.

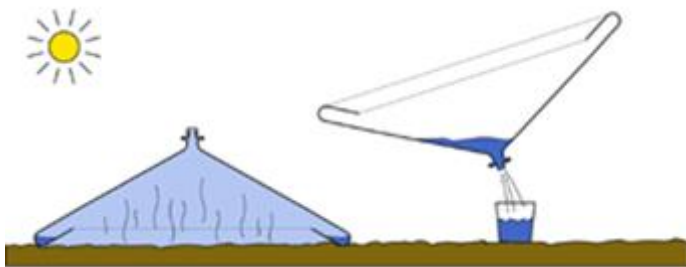


Figure 15. An example is the water cone. as depicted in the figure above. (NAIB, 2007)

Membrane filtrations

Membrane filtration is a separating method, this method is characterized by the ability to separate molecules of different sizes and characteristics. Membrane filtrations use a semi-permeable membrane that lets through molecules of certain sizes while it blocks others. The water stream on one side of the membrane is passed through the membrane and through that the water is separated into the permeate and retentate. The separating force is created by having a pressure difference. Membrane technology is relatively cheap, in energy usage and in production costs, however, this is highly dependent on the solids dissolved in the water. (Laval, 2020)

The semi-permeable membrane consists of a thin barrier. The pores of such a membrane are extremely small and pressure is required to force the liquid through them. In some of the specific membrane filtrations, like reverse osmosis and ultra-filtration, the pores in the membranes used for nanofiltration and reverse osmosis are so small that they cannot be seen even with a scanning electron microscope (Laval, 2020).

There is only one membrane filtration that can filter dissolved salts out of seawater: reverse osmosis. Therefore, I will mainly look at reverse osmosis, as a membrane filtration method.

Reverse osmosis

The principles of osmosis make this filtration system work. Osmosis is a way of diffusion. If there is a membrane or barrier where fluid can move through, but the dissolved solids in that liquid cannot. The liquid will move through the membrane and make the concentration of the dissolved solids the same on both sides (water, 2020)

For example, if the liquid would be water and the dissolved solid would be salt, and on the right side of the membrane, there would be normal drinking water, left there would be salty water. Then the following would happen: the water at the drinking water side would pass through the semi-permeable membrane and move to the saltwater side until the salt concentration of the liquid on both sides of the membrane is the same. This means that the water level of the saltwater side will rise, so there will be more (less salty) water and less fresh drinking water.

The idea of reverse osmosis is to not let this equilibrium balance out. By adding a lot of pressure to the saltwater the side the opposite of osmosis is going to happen. The concentration difference will get bigger and bigger. In the case of the water and salt example, by providing pressure the saltwater will be more concentrated creating fresh drinking water. (water, 2020)

This is the process of operation of a reverse osmosis filter.

Physical design requirements

What are the boundaries of a sun-powered distillation unit?

A large surface area for the sun to heat up is required, furthermore, it needs to be cheap, moveable and consist of the least amount of parts possible. It also needs to retain its filtering rate for a longer period of time (for example clear plastic will slowly become opaquer and block sunlight).

The device should still work in colder time periods, and when it is cloudy. (an example of a solution could be a water storage tank, for periods of time when the filter does not (fully) work)

What are the boundaries of the reverse osmosis filtration system?

The pressure needs to be in the range of 55 to 75 bar to have a working reverse osmosis filter (Schrotter, Rapenne, Leparc, Remize, & Casas, 2010). The higher the pressure the higher the permeate to brine volume ratio will be and the more concentrated brine solution will be produced.

There is a need for a power source (human work is also a power source)

How to get the water container portable?

The device needs to be small enough to be carried by an adult person (for example QuenchSea(Indiegogo, 2020)), other military solutions are made to fit on humpies and in helicopters, and then a small generator is the power source. In the refugee there being a lack of resources, means a generator is not suitable, but human power or solar power might be the way.

Filter size

The filter can be made small, it needs to be a combination of multiple filters, like ultra-filtration, activated carbon, sediment, and reverse osmosis. Sometimes a UV lamp is included to sterilize the drinking water by destroying the bacteria and viruses. (a combination of the above-mentioned filters needs to be fit in one system unless the desalination device uses the method of distilling). (Berkey, 2020)

These boundaries have driven our solution into the direction of solar thermal desalination. Because it is the least high-tech solution, the easiest and most efficient and more sustainable and appropriate solution.

3.2.3 Deepening Jordan Nikolov – Virology and Epidemiology of COVID-19

3.2.3.1 Introduction

Within our design challenge project, I will focus on the epidemiological characteristics of COVID-19 in overcrowded queue settings. Given the fact that our main stakeholder spends hours of lining up for resources like water and food supplies in the camp Moria (Harlan, 2020), my deepening can prove to be essential to determine a feasible solution. In my deepening, I want to explore what implications the long queues in Moria have regarding the transmission of COVID-19 and how to combat the spread of the disease with proper epidemiological measures. To gain a good understanding of these fields, I will research the following topics:

- Epidemiology of COVID-19
- Existing Mechanisms for the Prevention of Viral Diseases in Queue Settings - Focus on COVID-19
- Modelling of Hindering the Transmission of Viral Diseases in Queue Settings - Focus on COVID-19
- Design Visualisation of Epidemiological Data

This is a specialisation in epidemiology. For this project, I would like to present my findings in an essay with visuals supporting the data of this deepening. The topic of epidemiology is quite complicated, and it deals with tremendous amounts of advanced calculations. Therefore, it is essential to find ways to make the epidemiological insights of this paper accessible to the broad audience.

An essay will allow me to elaborate on definitions and findings based on calculations and discuss their relevance to a potential solution to the challenge we identified. I will also be able to include visual representations of the epidemiological situation in Moria in an essay which will make the gained information even more understandable - turning it into knowledge.

Additionally, an essay will give me the chance to attach an appendix with all detailed calculations done to support the findings of the epidemiological situation of our main stakeholder, so even experts can critically evaluate the results of this deepening. The main scope of the format of this deepening will be to create a comprehensive and transparent document that can be assessed by experts and understood by non-experts.

3.2.3.2 Intended Learning Outcomes

In this deepening, I would like to explore the epidemiological characteristics of COVID-19.

A crucial finding of my research will be to address the question, “how to efficiently prevent the spread of COVID-19 in the refugee camp, Moria - using epidemiology-based insights.”

I want to acquire the knowledge needed to understand the mechanisms of transmission of communicable diseases like SARS-CoV-2 in queues and how to model a reduction of an outbreak in this particular setting.

The outcome of my deepening has to highlight the relevance of our solution and answer the question whether it is going to contribute to one of the main pillars of our design

challenge - the significant prevention/reduction of the scale of a potential outbreak with the virus.

Below, you will find three intended learning outcomes I formulated for the purposes mentioned above:

1. Outline the epidemiologic characteristics of COVID-19 and clearly link your research to the design challenge.
2. Learn how to mathematically model the transmission of any disease under idealised conditions and develop appropriate measures to minimise the paths of transmission of a pathogen to infect susceptible persons. Apply your general findings to a potential epidemic with COVID-19 in the Greek refugee camp, Moria.

Note: Mind to critically evaluate which model(s) might be useful for this purpose and argue why you have chosen a specific model over others.

3. Visualise your findings, so that every non-expert can easily follow the line of reasoning as well as your results. Discuss the implications and limitations of the used model(s) and how they relate to the design challenge.

3.2.3.3 Relevance

In this section, I would like to elaborate on the main reason why epidemiology is a relevant deepening for me.

I enjoy, and I am very passionate about problems related to physical and mathematical modelling. Therefore, I would love to work in a domain that includes a lot of questions from mathematics and physics. I want to be able to make contributions to the global pool of useful findings in the realm of knowledge and application of the mathematical and physical sciences. Thus, I need a robust skillset when working on advanced mathematical or physical phenomena.

Mathematical modelling and epidemiology are more closely related to each other as one would think in the first place.

Epidemiology has to do a lot with mathematical modelling of complex systems - using diverse differential equations and statistical analysis methods to help determine the significance of specific factors and how they can damage public health. Mathematical modelling also helps predict how specific measures could counteract 'bad' health behaviours or the spread of disease and secure higher health standards in public.

Hence, my deepening in epidemiology will be tremendously useful for me - academically too. I not only enjoy complex mathematical modelling but also I plan on developing strong skills in this domain for my future career. Epidemiology will, thereafter, be a very significant deepening which will help me develop strong modelling abilities in the hard sciences - in a challenging and context-related setting.

Relevance to the project

Epidemiology is going to be crucial in understanding the transmission of COVID-19 in queues and how mechanisms can be developed to minimise potential outbreaks in this specific setting. It will further give us insight into what solutions may be plausible and successful while trying to prevent the spread of the disease. We want to design a solution that reduces the rate of infection with SARS-CoV-2 in extremely over-crowded locations where people have drastically limited options to protect themselves. Epidemiology is an integral part of comprehending the virus' interactions and transmission paths. Insights from epidemiology will be imperative, for instance, for creating a physical solution to the problem of hindering the transmission of COVID-19. So, this domain is of extreme value to the challenge we face.

3.2.3.4 Evidence

Introduction to epidemiology and link to our design challenge solution

Epidemiology is a scientific discipline which sets the foundation for public health regulations, standards and legislative decision-making. Its methods analyse the cause of health problems, health outcomes or diseases in populations. The central patient of epidemiologic research is the community itself, where all individuals belonging to a population are examined as a collective unit (Centers for Disease Control and Prevention 2016).

Based on multiple disciplines (medicine, mathematics, biology, sociology), epidemiology not only strives to explain potential causes for diseases or other public-health-related issues. But it also supervises current developments (rate of incidence, distribution). Epidemiological findings advise policymakers how to control the spread of disease or other factors putting the public health at risk. This discipline also evaluates

the effects of implemented policies on public health (Centers for Disease Control and Prevention 2012).

Hence, this medical domain is imperative to understand better our design challenge and what feasible solutions might be to tackle the transmission of COVID-19 in Moria actively. In our context study, we identified a potential primary source of infections with the novel coronavirus - queues. Refugees on Lesbos line up for up to eight hours for resources like water or food supplies (Harlan 2020). It makes sense to analyse the transmission of this betacoronavirus (genus of the virus) and how possible transmission paths of it can be reduced by specific measures based on mathematical epidemiology generally and in queues.

Novel Coronavirus, COVID-19, and its epidemiological characteristics

SARS-CoV-2 belongs to the family of coronaviruses. Coronaviruses are enveloped RNA-viruses, see figure 16, that build viral structures with a diameter of 80 to 140 nm (Kaniyala Melanthota et al. 2020). These structures consist of RNA-molecules (with a positive polarity) of about 30.000 bases - the hugest genom of all RNA-viruses (Robert Koch Institute 2020).

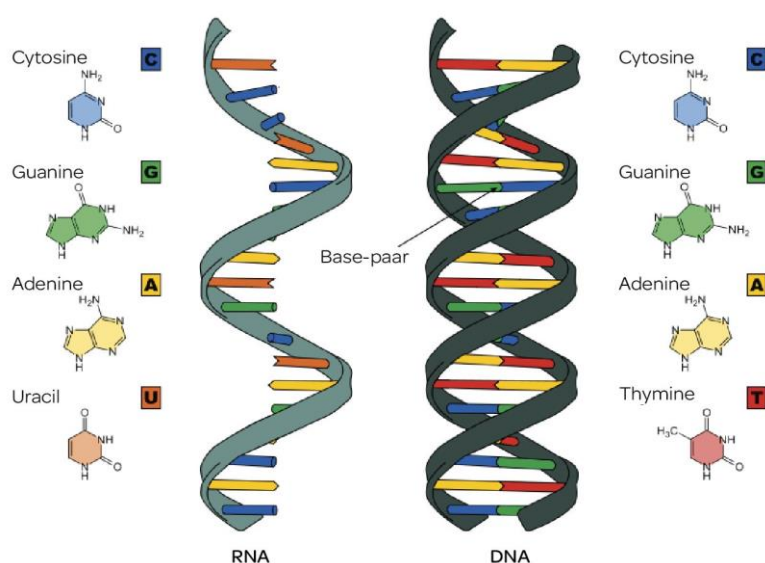


Figure 16, Comparison of RNA to DNA

The outbreak of the novel coronavirus disease (COVID-19) has quickly become an emergency of primary international concern - turning into a pandemic where over a million people have lost their lives. The virus was initially detected in the Chinese province, Hubei, a couple of weeks before the end of 2019. The infection with SARS-CoV-2 causes clusters of severe respiratory illnesses comparable to other severe acute respiratory syndrome coronaviruses, e.g. SARS-CoV or MERS-CoV (Zhai et al., 2020).

There are several transmission paths identified that could infect a susceptible individual with human-to-human transmission being the most prominent path of infection (Zhai et al. 2020).

In a study regarding the transmission of the disease, Zhang et al. (2020) found that *“airborne transmission route is highly virulent and dominant for the spread of COVID-19.”* This means that contamination occurs via droplets, contaminated hands or surfaces. The incubation periods of the virus extend from 2 to 14 days (Zhai et al. 2020).

The Dutch National Institute for Public Health and the Environment (2020) also reports some cases of animal-to-human transmission with minks being a secondary source of infection. The institute emphasises that some pets have been identified as carriers of the virus, but there is no evidence that pets have infected humans.

In a meta-analysis (including 45 different studies from January to August 2020), conducted by Ahammed (2020), results have shown that the basic reproduction number of the virus approaches a global average of 2.69 (margin of confidence: 0.95). According to the Federal Institute for Disease Control and Prevention of Germany (2020), the basic reproduction number of a disease describes how many people an individual can infect on average. For comparison, the novel pandemic influenza virus from 2009 had a reproduction number of 1.1 to 1.5 (Cowling 2011) - SARS-CoV-2 is seemingly highly infectious.

Note: To prevent an endemic (an outbreak restricted to a small local area), epidemic (an outbreak restricted to broader regions, even multiple countries) or a pandemic (global outbreak), the basic reproduction number of a communicable disease has to be less than one (Ahammed 2020).

An imperative epidemiological characteristic of any disease is its rate of mortality - the average percentage of fatal outcomes concerning the entire infected population. In Ahammed's meta-analysis (2020), the average fatality rate of COVID-19 is estimated to be 2.67% globally - despite social distancing and other measures of prevention. This might seem a small number. Indeed, in the next sessions, we will show that this is not the case - under the characteristics of COVID-19, it is expected that almost every individual on the planet will contract the disease sooner or later (provided the basic reproduction number does not reach values below one - a goal that can be attained by successfully vaccinating all susceptible population).

According to the platform Population Reference Bureau (2020), there are 7.8 billion people on the planet. Suppose we made a very rough estimate that everyone contracted the disease. Then, the fatal outcomes may approach the devastating number of 200 million casualties - based on the current global case fatality rate.

Understandably, national governments have put a lot of effort in developing appropriate measures that can keep infection rates as low as possible (OECD 2020).

3.2.4. Deepening Isaac O 'Sullivan - Economics

“Economics is the art to meet unlimited needs with scarce resources”
– Laurence J. Peter

3.2.4.1 Introduction

For my deepening I will focus on economics. In particular, I aim to deepen my understanding of the following themes:

- The Economics of a Refugee Crisis
- Frugal Innovation & Effective Fundraising
- Shortage Economies & Queuing

My aim is to develop a deeper understanding of the economic effects of a refugee crisis, both short term and long term and within different cultural and environmental contexts. By examining case studies in Uganda, I will learn how refugee crises can be dealt with in a way that minimises loss in standard of living for migrants and decreases their long-term dependence on humanitarian aid. I will also study queuing theory and queuing systems used by economies and organisations both currently and throughout history in hopes that this will inspire our solution and help us in our efforts to shorten queues for clean water in Camp Moria. Additionally, I am going to study the principles of frugal innovation and find ways to make our design cheaper to purchase and use.

I will present my research findings in the form of a text essay. I believe that this format is necessary as it will provide the degree of control that I need to portray what will likely be a relatively large body of information in a structured and coherent way. I plan to use various case studies to explore concepts of macroeconomics, queuing theory, and design. I believe that discussing these context studies with the required level of care and detail would prove difficult if I were to do this with, for example, a presentation or poster.

3.2.4.2 Intended Learning Outcomes

In order to guide my research and operationalise the achievement of my goals, I have defined the following intended learning outcomes:

1. Comprehend and discuss the economic factors related to a refugee crisis.
2. Exhibit an understanding of the six principles of frugal innovation and be able to discuss which of these will influence our design and why.
3. Be able to explain the principles of queuing theory and discuss the use of queues in various modern and historical contexts.

3.2.4.3 Relevance

The reason I chose ATLAS over any other engineering course is so that I could apply myself to a wide range of subjects. For me, economics has always been a topic of consistent peripheral interest. Reflecting on my Ikigai, I see a pattern in the things I love to do. I love gaining new perspectives on perceived problems. Having studied Engineering and Applied Maths in secondary school I believe I have begun to look at global issues from an Engineer's perspective. It is interesting to me how an engineer and an economist can look at the same problem and draw completely different conclusions about how it should be tackled. In my exploration of what I think the world needs, I have written that the world needs to view money as a tool for good and not as a merit system or something to hoard. I think this is why I am so interested in deepening my knowledge of Economics. It is a subject that can be used to maximise what can be done with the resources we have. I am excited by this opportunity to take a deep dive into economics, especially as I will do so with a particular objective in mind: how will this help our design solution?

It is easy for us to be idealistic in our design. We could spend the remainder of our semester prototyping a technology that is highly effective, aesthetically beautiful, and absolutely useless in the context of Camp Moria. The reason? Budget. Even if our project is not going to progress past the development phase, it would be a waste of time to design a solution that is not - at least in theory - economically viable. To achieve a design that is viable long term, we must understand the economic situations and priorities of the refugees, as well as that of policymakers. We must also know how to

fundraise effectively. I believe that, through my study of economics, I will help to optimise what is achievable with our design.

Through my study of frugal innovation, I will find ways to optimise the price-performance ratio of our design. This will also help to ensure that our design is sufficiently low-tech to be employed in the context of Camp Moria. Our product must not only be affordable to purchase, but also easy and affordable to operate and maintain long term. By studying queuing systems employed in the USSR as well as those employed in banks and retail outlets, I can advise my team in how we can most effectively shorten queues for clean water in Camp Moria, which we hope will hinder the spread of COVID-19. This is the main intended outcome of our solution.

3.2.4.4 Evidence

Shortage Economies & Queuing: *Queuing theory*

In mathematics, queuing theory is the study of the formation, function and congestion of queues. It was invented by a Danish Engineer named Agner Krarup Erlang who wanted to find the minimum number of phone lines that would allow ninety-nine percent of calls in Copenhagen to be connected immediately (Mann, 2018).

According to queuing theory, the most fair queuing system is one long, serpentine line, where queuers at the front of the line proceed to the next available server, as opposed to a system where there is a separate queue leading to each server. However it has been proven that most customers prefer the second option as it means they have a chance to cheat the system and get lucky by picking a faster queue. The first option has been used

by banks for decades, however retailers adopted this system relatively recently, perhaps because they feared a long line would deter customers (Barbaro, 2007). In the case of food and water queues in Camp Moria during the COVID-19 pandemic, neither of these systems are ideal. They both involve people standing in physical queues, which makes it difficult to remain socially distanced and therefore contributes to the spread of the virus.

In a single server queuing model, the capacity utilisation or the extent to which the productive capacity of the system is being used, is a percentage given by the equation $C = (\lambda/\mu)100$ where λ is the mean number of people joining the queue per unit time and μ is the number of people being served per unit time (Mahadevan, 2020, pp. 1–3). If λ becomes greater than μ , the system is over capacity and the queue will get longer indefinitely. There are two ways that this can be reconciled. One way is to increase the service rate and hence, decrease waiting time. Another way is to switch to a Multiple Server Model. The equation for this is $C = (\lambda/n\mu)100$ where n is the number of servers or points of access to the product or service (Mahadevan, 2020, pp. 1–3). In theory, the number of servers can be increased indefinitely to cope with the demand for the product or service. This is the model that inspires the design of our product. In order to decrease waiting time in queues and hence slow the spread of COVID-19 in Camp Moria, we will increase the number of points of access to potable water.

Queuing is one of the most common reasons for customer dissatisfaction in banks (Queuing Management System in Banks, 2018). Therefore, it's no surprise that banks pour so much of their resources into the development and integration of efficient

queuing systems. Banks use ATMs as they increase both the service rate and the number of servers and hence, decrease capacity utilization. However, ATMs are limited in the number of services they can provide. Other popular queuing systems used by banks involve self-service kiosks which issue customers with numbered tickets denoting the place of the customer in a virtual queue and some even allow for the customer to join the virtual queue with their phone, saving the need to wait at the bank entirely (Queuing Management System in Banks, 2018). In times of COVID-19, these online queuing systems have also been utilised in other areas of the tertiary sector such as bars and restaurants. Nowadays most banks also allow customers to access services completely online. However, the range of services available to customers online is limited depending on the regulations of each bank (Queuing Management System in Banks, 2018).

Shortage Economies & Queuing: *Case study: USSR*

In the USSR prices and production quotas were not regulated by the capitalist principle of supply and demand. Instead, the government decided which goods would be produced and in what numbers. This led to extreme shortages of goods and sometimes even an overabundance of products that people simply didn't need (Birman, 1988)

The USSR is an interesting case which could inspire solutions to the queuing problems in Camp Moria. Like Moria, but on a much larger scale, the USSR was a centrally planned economy in which there was no competition between private companies to drive up product quality. This regime strived for equality, so a "first come, first serve" model for the distribution of products made sense. However, this led to a system

governed by social Darwinist principles, where those who were willing and capable to wait in line the longest would have their pick of the best quality products (Tšernov, 2018). Similar patterns can be observed in Moria, where refugees will often begin the three hour wait for breakfast at 3 a.m (BBC News, 2018, 00:00-13:51).

Law enforcement in the USSR in the late 30s and early 40s dealt with overcrowded queues by charging fines to people who queued outside of stores (Tšernov, 2018). This was a quick fix which failed to address the root causes of the queuing problem. In most Soviet retailers, multiple queues were organised. There would be one queue for each type of product, such as meat or fruit, followed by a general queue which led to the cashier. However, queuing was often so disorganized and time-consuming that customers would be forced to police themselves by writing numbers on their hands and hence, avoiding physical queues (WDEF News 12, 2017, 00:00–04:29). This is similar to the virtual queues we see today.

The Economics of a Refugee Crisis: *Case Study: Uganda*

If more countries followed the example set by initiatives in Uganda which allow refugees to work, there is evidence that this would decrease refugees' reliance on humanitarian aid (The Economist, 2016).

In Uganda, refugees are welcomed into the labour market. They are allowed to vote, and even to start their own businesses. In nearby countries, such as Kenya, refugees are forced to pay considerable sums for short term work permits. In contrast to this,

refugees in Uganda are given almost complete freedom of movement, employment rights, and equal access to healthcare and education (The Economist, 2016).

Uganda's low unemployment rate relative to its neighboring countries may be a part of the reason why this system is largely accepted among voters (The Economist, 2016). It is likely that policies which give refugees employment rights are less popular in countries which have a high unemployment rate relative to surrounding countries. Greece's unemployment rate is the eighth highest in the EU (15.5% as of April 2020) (Eurostat, 2020). This is just one of the reasons why similar strategies may be difficult to implement in Greece. Another is that Greece's economy is far less reliant on agriculture than Uganda's. Agriculture accounted for 71.9% of Uganda's GDP in 2017 (Wikipedia contributors, 2020), whereas it accounted for only 3.65% of Greece's GDP in 2019 (Statista, 2020). All refugees who arrive in Uganda are given land to cultivate or lease as they wish. An equivalent financial stimulus would need to be provided in Greece to avoid refugees becoming reliant on long-term humanitarian aid, ideally in conjunction with equal access to education.

3.2.5 Deepening Kayla Veldkamp - Stakeholders

3.2.5.1 Introduction

This deepening will provide you with a look into the social side of our challenge to shine a light on social sustainability and thus complete the dimensions of sustainability. Here the stakeholders play a major role, it is all them in relation to our solution. Therefore, to gain an in depth understanding of our stakeholders, their context and their engagement with the solution, by questions asking to portray a stakeholder analysis, as well as asking questions on social sustainability, quality of life, and engagement.

Stakeholder analysis.

Who are our stakeholders, and what is their current situation?

Social Sustainability.

What is social sustainability? How is social sustainability related to sustainability? What does social sustainability mean in our context (camp Moria)?

Quality of Life.

How does COVID-19 influence the capabilities of the stakeholders in the refugee camps in Greece and how does this influence the quality of life? How is queueing influencing quality of life?

How can our solution influence the quality of life?

Engagement.

How do you make sure stakeholders are engaged with the product? How can policymaking influence the engagement? And how can stakeholders influence policymaking? How can education influence engagement and correct use of our solution?

Currently I am planning to write a text essay because with all the information I will gather it will never all fit on a poster. When answering all these questions in the deepening, we will know what their problems are, which of those have the most influence on them, how our solution can make their lives better, how we can make sure they have something to say about the product, how the government can help us implement the product and how we make sure people will use it (properly). This deepening will create social sustainability and make sure our product will be a success for the people.

To me, the best way to portray this deepening is as an essay, so the influence of a certain product can be, as much as possible, objectively discussed without too many ethical problems. Upon that, it will give the space to illustrate and discuss all the information in depth. Also, the skills I will acquire when doing this deepening can be portrayed best in an essay. Here I can show how I learned to analyse the situations and use this skill to predict the influence of our solution as well as creating a way to let our stakeholder engage with the product.

3.2.5.2 Intended Learning Outcomes

There are a lot of things I want to learn when creating this deepening. In relevance to the personal development plan as well as just a more general goal for myself I want to firstly figure out if this domain, the more social side, suits me. Besides that, I want to learn how I can combine both social and technological influences and, in this way, create an appropriate solution. To find this “perfect” solution a thorough understanding of the stakeholders is needed, something very much needed, but often forgotten. Therefore, I would also like to learn how to analyse stakeholders. Upon that, I want to learn about social sustainability, because this is something which you will not notice when it is there, and only when it is not there you become aware of it. We did not notice this until COVID-19 started, and because this is so relevant, I would like to learn more about it. Lastly, I am very interested in (the effect of) policy making and I think this might be interesting for my future, so I want to learn more about this. This all considered my Intended Learning Outcomes are the following:

1. Analyse the stakeholders and their context.
2. Analyse social sustainability, create a definition and asses it with regards to our solution.
3. Analyse engagement and create a plan to maximise engagement.

3.2.5.3 Relevance

The Ikigai covers four main questions that should be asked. These questions are the following:

1. What do I love?
2. What am I good at?
3. What can I be paid for?
4. What does the world need?

During my research on the meaning of an Ikigai and while deciding if the Ikigai is something I would like to follow or dive into more profound, I realised something. I was reading about the translation of Ikigai and how that can mean two things. Firstly, it can be something that explains why life is worth living. Secondly, it can be something that makes someone's life worth living. Eckhart Tolle describes this as being and doing. Being is an inside factor; it is a feeling from inside, for example, a happy feeling. Doing is the outside factor; it is something that gives purpose; it can be a family or a job, for example. It still is a challenging subject to figure out with the little life-experience I have. Being and doing are depending on each other to align, but it is also important that they never connect. It is crucial to keep the two separate. It should not be about comparing yourself in your doing to create a being. Being needs to give someone an example to go out and discover doing. If not, people tend to overthrow themselves with, for example, work and get the best at this to reach happiness and thus a being. This, to me, is a different concept, because nowadays both being and doing are so connected, it makes it hard for me to split them up. Tolle suggests that to find both, you first need

to find small present things that are in your life right now, instead of striving for the stars right away. This is the concept I have the most difficulty with; I tend to focus too much on the future, on reaching my maximum potential, most of the times compared to others. Instead of focusing on the present time and looking at how I can build from the building blocks I have now. This leads me to that I feel like an Ikigai should mostly about the process, instead of the end goal. This why I believe my Ikigai is still unknown and can be unknown for long. There is also no problem with finding it to me, the finding of the Ikigai can lead to purpose, but it can also give building blocks to reach a new Ikigai later in life.

Before answering the questions regarding the Ikigai and why this specific deepening is important, I felt like I need to be able to fully understand the process of the Ikigai in order to fill it in and provide reasoning. Firstly, what do I love? I love being able to discover, help, to learn new things and hear more stories every day. My doing in terms of things I love are nature, animals, and people. Secondly, what am I good at? I am good at listening, at working hard and at finding solutions. Thirdly, what can I be paid for? I can be paid for my research skills and my quick understanding and overview. Lastly, what does the world need? The world needs people that care about others, especially those who have nothing because, in times of COVID-19, most people and nations are busy saving themselves first and then start caring about others.

Why does it matter to me?

So, why does it give me purpose, or even why may it be an alignment of my being and doing for now?

Firstly, I want to figure out whether my passion might be laying within the field of social sciences and humanities, to figure this out, my deepening is the perfect opportunity. Also, caring about stakeholders gives purpose to me, because I feel like they are the ones left out in this whole story. Nations first care about their own inhabitants, but what is happening then to the people that officially are living nowhere? What is happening to those people put away in camps? Why is the life of those people so inhumane? I care about people, so I want to help them. I can do this, because of the things I am good at, especially in the field of stakeholders, I am good at finding out what their problems are. I can come up with a solution and propose this to the team. Besides that, I could get paid or valued in the team for my research skills and overview. This will contribute to the team in a way that I know what is going on and can easily connect everything to the stakeholders. It matters to me because this is a way I can help in showing the importance of the stakeholders. Lastly, the world needs people to care about others, and I feel like this is the perfect opportunity for me to do this.

This deepening is meaningful and important, considering the design challenge because the stakeholders are the ones that need to use the product in the end. If they will not use the product or not use it the intended way, our solution clearly did not work for the specific problem. A stakeholder analysis is very important; it will specify our stakeholders, their context, their capabilities and the difficulties they face in times of COVID-19.

When diving into social sustainability it is firstly very important to obtain a proper understanding of the actual definition of social sustainability and the way we define this. Since there are no set definitions in literature for social sustainability, defining this will be covered in the deepening. Upon that the social sustainability within the camp will be investigated to get a more complete stakeholder analysis. Also, Quality of Life will something that will be researched within this deepening, since this is one of the most important factors of social sustainability that is impacted in times of COVID-19. So, in this deepening there will be research on how COVID-19 influenced the capabilities and, in that way, influenced that quality of life. Next to that, queueing is a big part of the lives of our stakeholders, so it is important to understand how this influences their quality of life. When this is known, it can partly provide the answer on how our solution influences the quality of life. Together with the stakeholder analysis, these answers will determine if our product is appropriate and socially sustainable. Lastly this deepening will investigate the engagement, to make sure our stakeholders will engage, and engage in a way that they are meant to, with our solution. There will be research in this deepening on how engagement can be stimulated and assured, for example through policy making.

This is created from my ikigai, however it will not only contribute to the project, it will also help my attain my intended learning outcomes, both through the project as directly from through my deepening. When attaining this intended learning outcomes, as well as when writing this deepening, it will affect my own and set semester goals.

3.2.5.4 Evidence

Parts of my deepening are already deeply integrated into specific parts of this and earlier milestones and deliverables. Some of those parts were afterwards iterated. Some of those parts are only for example 80% of the parts that is in my deepening and other parts are fully there. Also the context study I did on stakeholders and the capability approach are the framework for this deepening, thus needs to be understood that those things are deeply connected and interlinked. Also parts here are based on the knowledge provided there. Lastly it is important to notice that this deepening is still in construction. This will happen in different phases. Firstly I will make sure I have some basic knowledge on everything. This is something I did prior, however this was more casual non document research in order to provide important information to my team. After that I did very thorough research on our stakeholder, their context and their capabilities. My next step will be to complete the full stakeholder analysis and work on the still unknown parts of the social sustainability. Lastly I will look deeper into engagement.

Stakeholder analysis.

Who are our stakeholders, and what is their current situation?

Our main stakeholders are defined as the refugees in Camp Moria, Greece. To get a thorough understanding on them, their living situation and the people that influence their living conditions the stakeholder analysis will take place in different phases. First a stakeholder map is analysed to get an overview of the influence and impact of the different stakeholders. After this a ecosystem assessment and a motivational analysis will be used to gain a better understanding of the influence and impact. Lastly an empathy map will be used to analyse the situation of our main stakeholders, the refugees.

Stakeholder map

The refugees in Camp Moria are the main stakeholders, however there are a lot of other parties involved that have a high or a low influence on the situation in the camp as well as parties that are interested or not in impacting the camp to change things positively. Therefore, the stakeholder map is used to get a visual representation of this.

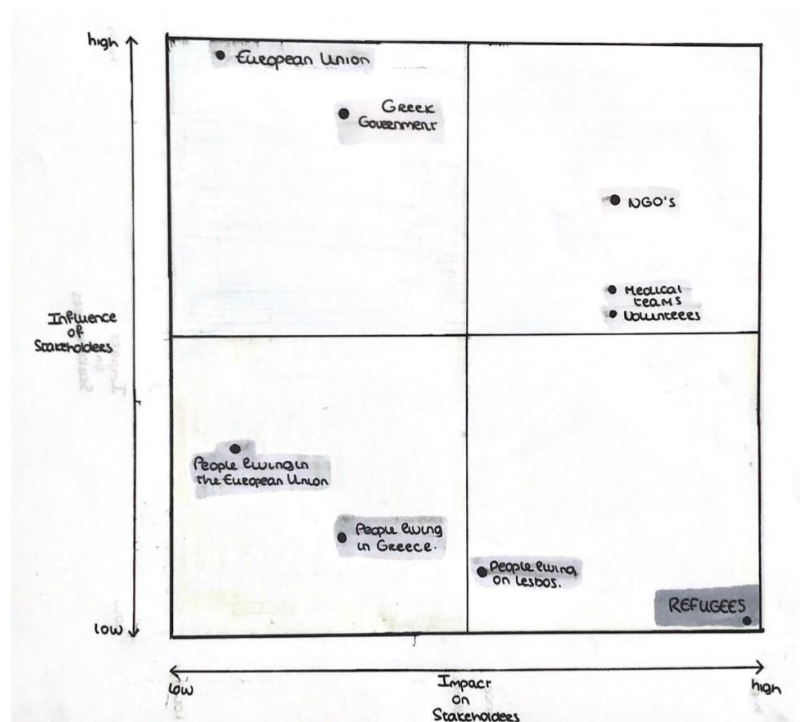


Figure 17. Stakeholder mapping

The main stakeholders, the refugees can be found all the way down in the far-right corner. This clearly represents the situation the refugees are in, they have no power, and thus influence. Since their living situations are inhumane, especially in times of COVID-19. They are the ones that want to see things change the most. More information about the main stakeholders can be found in chapter 1.5.1. Of the context study. Besides that, their context and urgency are clearly portrayed in chapter 1.3.

Other people that are severely influenced by the situation going on in Camp Moria are the people living on Lesbos. Due to all the refugees that came to the camp, the tourist halved in 2016, and barely any cruise ships come to the port of Lesbos (Higginbottom, 2020). This has an enormous impact on the local economy. Upon that the tension between the locals and refugees is big (Cossé, 2020). This means they want to see an impact. However, Moria being such a small population, with only 1000 inhabitants (Zander, 2020), they do not have any resources, and thus barely any influence, to change the situation.

The people in Greece are also impacted by the refugees in Camp Moria. Over the last months a lot of people have been replaced to the mainland following the fire that entirely destroyed Moria (Infomigrants, 2020b). Gonzalez-Barrera and Connor (2018) found in their research that 74% of the Greek population feels like refugees are negatively impacting their country, because they steal away the jobs as well as benefits. Therefore, they want to see a solution with a high impact. Since the Greek population is with 10.7 million people (Data Commons, 2020), they do have a slightly bigger

influence on what is happening with the refugees, since they can for example vote for different parties that have different plans with the refugee camps.

Also, the people living in the European Union have a saying on what is happening with the refugees stuck in the camps. According to Poushter (2016) 50% of the respondents in 10 EU countries stated that they are also afraid that refugees will take their jobs as well as their things like social benefits. Upon that 59% is worried that the replacement of refugees to European Union countries will lead to more terrorism. Yet, there have also been large groups protesting and signing petitions to take refugees in after the fire that destroyed Moria (Infomigrants, 2020a). The European Public wants to help people if (they believe) it will not lead to negative consequences for them. So, they want to make sure a certain impact takes place. The entire population of the European Union, with 445 million inhabitants (Eurostat, 2020), do have a way bigger influence than the Greek population.

The party with the most influence is the European Union. They have both the methods and the ability to say what happens with the refugees. However, they are usually very influenced by their own political agendas. They want to keep most of the people and thus, member states happy and that is by not letting the refugees further in Europe. This means they are not likely to make sure Camp Moria will be impacted positively.

Upon that, the Greek Government is playing a major role in this refugee crisis. They are the ones that receive and divide the money; thus, they have a lot of influence. Besides that they can make laws, just like they did last summer, where the new government stopped the asylum process for one month, then started it again but

changed it fully around, to make it even more inhumane (Oxfam International, 2020b). According to Oxfam International (2020b) this is done to discourage refugees to come to Greece, also now the borders with Turkey are open again. Therefore, they are more interested to see things change than the European Union if it does not negatively impact Greece.

Next, the NGO's operating in Camp Moria would like to see things change, for the sake of the refugees as well as their volunteers and medical teams (Human Rights Watch, 2020b). They do have an influence since they have the resources to arrange more volunteers and medical teams. However, they might be restricted by regulations from both the European Union and the Greek Government.

Lastly the volunteers and medical teams want to see things change. With the already limited number of medical professionals, according to Human Rights Watch (2020b) and the shortages in PPE (International Rescue Committee, 2020a). They can barely help the refugees. These shortages in combination with the extreme queueing bring the volunteers and medical teams in danger every day, which might lead of them not being able to do their work anymore. Therefore, they want to see things change. However, they do not have the influence to actually change things.

Stakeholder ecosystem assessment

In the prior part all the stakeholders as well as our main stakeholder have been defined. Already in some of the parts it was made clear how different stakeholders are influencing each other. To get a clear overview of the stakeholders and how they are influencing the main stakeholder and each other, a stakeholder ecosystem assessment will be used. The lines will predict for a positive, negative, or neutral influence and how big this influence actually is. This information can guide in the process of decision making.

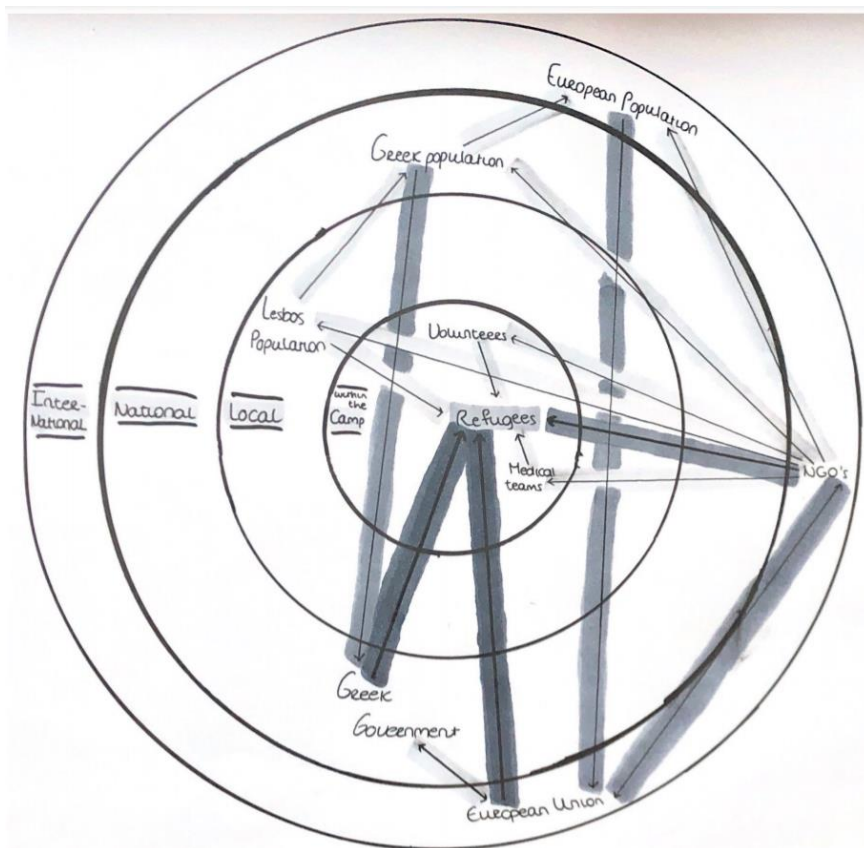


Figure 18.
Stakeholder ecosystem assessment

In the stakeholder mapping the following list of stakeholders was established:

1. European Union
2. NGO's
3. European population
4. Greek Government
5. Greek population
6. Lesbos population
7. Volunteers
8. Medical teams
9. Refugees

In the case of this sociogram/stakeholder ecosystem/ people & connections map the refugees are the target audience. That is why they are placed in the middle. Around there the other stakeholders are placed in their different contexts; in Camp Moria, local, national, and international.

The European Union is with their decisions directly influencing the life of the refugees (Deutsche Welle, 2020). Due to their resources their influence is also relatively big. The European Union is influenced by the European population because they protest, sign petitions and vote for political parties, as can be seen in Germany after the fire in Moria. (Infomigrants, 2020a). Since the Greek population, and thus Lesbos population, are part of the European population they slightly influence the European population. The European Union and the European, Greek and Lesbos population are influenced by NGO's. The NGO's are the ones calling for action and raising awareness,

and in this way, they can influence the agenda of the European Union as well as the opinion of their population. Like they for example did with a petition to improve the treatment of refugees, that is presented to the European Union and signed by over 165 000 people. (Infomigrants, 2020a)

The NGO's are also influencing the refugees themselves directly by for example investing in an education centre, like the Dutch Postcode Lottery did (Theirworld, 2020). Besides that, they also influence the refugees through volunteers and medical teams, by for example recruiting more volunteers and medical teams (Stichting Bootvluchteling, n.d.). These volunteers and medical teams do have an influence on the NGO's as well because they see what is needed from the ground.

The next party directly influencing the refugees is the Greek Government, since they are the ones dividing the money over camps and making asylum regulations (Oxfam, 2020). Besides that, the Greek Government also influences the opinion of the European Union, not as strong as the European Union does the other way around, since it is 26 versus one, but the Greek Government still has a vote. Yet, the Greek Government is not able to speak too loudly, since the European Union is investing million in them protecting the European Border (Souli, 2020).

The Greek Government is also influenced by their own population. The Greek inhabitants are the ones voting for parties. Besides that, the population of Lesbos is part of the Greek population and therefore influencing the opinion of the Greek Government indirectly. Yet, the Greek Government cannot speak too loud because the European Union helped Greece during the economic crisis. And therefore, Greece has

an unimaginably big debt and here the European Union can profit from, just as Rachman (2016) from the Financial Times predicted.

Besides that, the population of Lesbos is also influencing the refugees directly, since they for example create their own regulations and police forces when they feel like the governmental bodies are not doing their job properly. They did this for example after the fire to prevent the refugees from coming into the towns of Moria and Mytilene (BBC, 2020).

Stakeholder motivation

In the prior part all the stakeholders as well as our main stakeholder have been defined. In the Stakeholder mapping both the impact and influence of the stakeholders was made clear. Now it is time to dive deeper into the impact of each stakeholder since they all are motivated for the situation to change or not change. Therefore, a stakeholder motivation analysis will be conducted in this section to get a better overview of all the motives.

Underneath there are different solutions stated. These are all solutions to fight the transmission of COVID-19 and includes are current solution. For every solution, the stakeholder then will be split up into four different categories. These are anti, neutral, facilitate and active involvement. These categories will explain the different reactions towards a solution. After this, the reaction will be shortly explained. It is important to understand that an organisation, group of people or whatsoever can be against a solution, but also be the ones that must facilitate it. This can be for example the case when a hierarchically higher party obliges them to do so. Therefore, it was important to first understand the hierarchy and the different connections.

Stakeholder Motivation	Anti	Neutral	(Should) Facilitate	Active Involvement
Keep the Refugees in Moria (lockdown)	* European Population * Greek population * Volunteers * NGO's * Medical teams	* European Union * Greek Government	* European Union * Greek Government * NGO's	* Volunteers * Medical teams Refugees
Relocate in Greece	Greek population Greek Government	* European Union * European population * Lesbos population * NGO's * Volunteers * Medical teams	* European Union * Greek Government	- Refugees
Relocate in Europe	European Union Greek Government	* European population * Greek population * Lesbos population * NGO's * Volunteers * Medical teams	* European Union * Greek Government	- Refugees
One solution: More Water + Less queuing	-	Everyone if: - Less money - Less time consuming	* European Union * Greek Government * NGO's	Not/ barely Needed Refugees

Table 3. Stakeholder motivation.

Keep the refugees in Moria

This is part of the strategy the governmental bodies are currently following. For example, the Greek Government insisted on a lockdown for the camp, just to keep COVID-19 within there (Medicines Sans Frontieres, 2020). The NGO's, volunteers and medical teams are against this (Medicines Sans Frontieres, 2020) since it will negatively impact the mental health of the refugees. The European and Greek population do not seem to agree with this solution (Infomigrants, 2020). However, the European Union gave Greece 130 million euros to build another closed camp on Samos. To make a lockdown work in Moria, the European Union, the Greek Government and NGO's should facilitate the camp with more police assistance to keep the refugees inside (Deutsche Welle, 2020). This solution also needs even more active involvement

from the volunteers and medical teams to keep life in the camp going. However, in other Greek camps the government is making it very difficult for the NGO's and thus the volunteers and medical teams to work (Deutsche Welle, 2020). This trend might follow in Moria as well.

Relocate in Greece

This is something the Greek population and thus the Greek government will be against because they are afraid it negatively impacts them by the refugees taking away their jobs and social benefits. Besides that, they see a risk of terroristic attacks increasing (Gonzalez-Barrera and Connor, 2018). Also normally costs of relocation covered by relocation country (OECD,2017). This would mean that most of the costs in this case would be covered by Greece, which would be very expensive. The European Union will be neutral if they refugees do not come to the rest of Europe and if will not have to cover the costs. The European population will be neutral about this decision because it does not negatively impact them. Also, the NGO's, volunteers and medical teams are neutral towards this solution, if the situation the refugees are in now gets better and they can help more people. Also, the locals on Lesbos will be neutral, since there will be less refugees on Lesbos, however this will probably not be enough to get the economy back to where it was. The ones that should facilitate this are the European Union and the Greek Government, however as seen before they rather over refugee's money to go back than invest that in the asylum process (BBC, 2020)

Relocate in Europe

This is something the European population says they are fine with, according to their protests (Rankin, 2020). However, the European Union seems to be against this since they have not undertaken any action according Medicines Sans Frontieres (2020). Next to the European population, also the Greek population tried to raise awareness for the situation and asked for refugees to be relocated (Infomigrants, 2020). Just as the European Union the Greek Government is against this idea. During the beginning of this year refugees were even offered to get money to go back home (BBC, 2020). Also, with their 2016 deal with Turkey they agreed on making sure refugees could not get further into Europe (Amnesty International, 2020). Because Turkey was hosting around 3.6 million Syrian refugees, according to Amnesty International, the Syrian population in camp Moria was relatively small. However, Turkey is now putting pressure on the European Union by not playing border police anymore. Therefore, a lot of Syrian refugees arrived over the summer and more can be expected. Due to the new refugees coming in, the fire that left a lot of refugees homeless and the fact that the inhumane living situations came to the public eye, which then led to protests as mentioned before, can no longer leave the European Union ignorant. However, with member states not happy to take a lot of refugees, it is easier for the European Union to leave them in Greece or even better in Moria. So, they do not really want to see things change. Neutral in this decision are the NGO's, volunteers, and medical teams, they just want to get a better situation for the refugees as well as a safer working situation for themselves. If the refugees will be relocated mostly, this will make the locals happy and that might decrease the risk of volunteers and medical teams getting

harmful to locals (Speed, 2020). The ones facilitating this should be the European Union and the Greek Government.

Our solution: more water/less queueing

All parties will be neutral about this solution if it will not cost more money and be more time consuming. That is why our solution must be cheaper in long term situations to increase the governmental motivation to change their way of working around and in that way get governmental funding. Also, our new solution should not be more time consuming for volunteers, so that they can spend more time on helping in other ways. What makes this solution hard is the facilitating phase, since a lot of players are involved. The European Union, together with the Greek Government and the NGO's need to find money and resources to make it happen. However, once it is installed there is barely any active involvement needed in using the product.

Empathy map

To get the most in depth understanding of our main stakeholders possible, there will be made use of an empathy map. The empathy map is a way of conducting a stakeholder analysis by describing the situation of stakeholders. By capturing the user persona, it can help bring across knowledge to other team members, who might be less involved in the research regarding stakeholders. Upon that it creates an easy understanding for non-team members. Lastly it can provide guidance in the decision-making process, since it is easier to distinguish what is important and what not. It specifically helped us as a team to discover the things we were still unaware of and create an understanding of how we can make a meaningful impact.

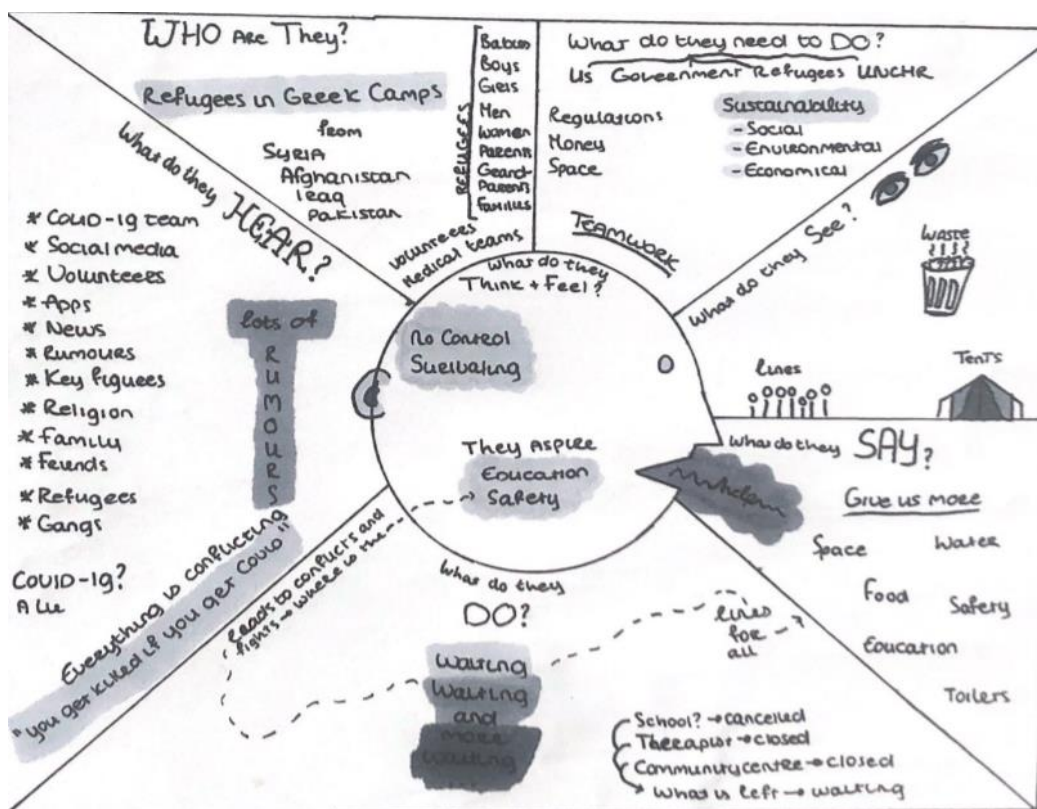


Figure 19. Empathy mapping

Within the empathy map, several questions are answered, these include:

- Who are they?
- What do they need to do?
- What do they think and feel?
- What do they do?
- What do they say?
- What do they hear?
- What do they see?
- Who are they?

Who are they?

This question is important to illustrate the background of the stakeholders. In our case their ethnicity, age groups and gender. Here we figured that our stakeholder group, the refugees in Greek camps, is diverse (Fallon & Beaumont, 2020). More information on the diversity of our main stakeholders can be found in the context study under chapter 1.5.1. This means that our solution should not in any way exclude the most represented age groups.

What do they need to do?

The second question aims to address what the stakeholders themselves can do. We decided to incorporate some important other groups as well, since they have a major influence on the freedom of our main stakeholders. All these groups can be found above in the stakeholder mapping and sociogram. We also saw that these groups of people, including us, can together change something that will benefit everyone. And maybe in

this way reach sustainability. For this, several things are needed, such as money, other resources, and proper regulations. Regulations might influence the freedom of our stakeholders, which might impact the appropriateness of our design.

What do they think and feel?

This question is important to understand the motivation of our stakeholders. It is very relevant to have a deeper understanding of one's motivations since our stakeholders must have a motivation to use the final product. If they are not motivated to use a product or service, they will never adopt it into their lifestyle. Refugees mostly seek freedom basic needs (Emmanouilidou, 2020) and if possible, aspire education (Theirworld, 2020). The basic needs come in various forms and contain both physiological and safety needs, from a shelter above their heads, to no conflicts and enough water and nutrition, all things that do not always apply to a life in a Greek refugee camp. This pattern can be seen as well in Maslow's hierarchy of needs. Here the most important needs are physiological needs, like water, food, and sleep. Next, safety and a stable environment are needed. After this, psychological needs need to be met. And lastly self-fulfilment, for example through education is important (Maslow, 1954).

What do they do?

This question will guide us through the daily life of our stakeholders. The answer illustrates the situation our stakeholders have to go through every day. This was very important for our decision making when designing a solution, since we became aware that queuing (Human Right, 2020a) is the most important daily activity. In times of

COVID-19, this is a controversial thing to do. This realisation led us to the conclusion that we wanted to design something that can reduce the queuing and thus the spread of COVID-19. Also, in times of COVID-19 education centres, also used for many other activities have been closed, or are just open for a very small amount of people (Theirworld, 2020). This leaves no other activity than waiting.

What do they say?

The fifth question also provides a deeper understanding of what the stakeholders need from their point of view, instead of from a more general perspective. It is important to consider both, since the problems of the stakeholders might be caused by situations, they are unaware of. This can also happen the other way around. We identified the need for safety, water, food, sanitary and education (Human Right Watch, 2020a). These needs are mentioned by both refugees and external parties like NGO's. As stated before, refugees also really want freedom, however this is something noted less by external parties. Interesting is that they queue for nearly all of these needs. This is why we made the decision to combine the reduction of queuing and the need for water. Hence, we can come up with something that is important to the stakeholders themselves, while also having an influence on the bigger picture.

What do they hear?

The sixth question is there to help us understand stage how to implement a solution in later stages. We need to get an understanding of where the information comes from and how the refugees are influenced. According to Refugees International (2020) the very restricted access to reliable sources makes it hard for volunteers to help.

Misinformation, lack of communication, language and cultural barriers and distrust in governmental bodies make rumours easily spread. Also, the information is coming from many different people.

What do they see?

This question is important to understand the viewpoint of refugees and how they could see a change in their world when our design is implemented. Because if they do not perceive a change in the world by using a product, they will be less motivated to adopt it. In order to give them a product that actually makes a difference, it is important to understand the world of a refugee as well as their perspective at this moment, while also having an idea of how their world would change if a certain product is implemented. Found is that they usually just see queues everywhere, with fights between ethnic groups breaking out regularly (Donadio, 2019). Besides that, they camp has been dealing with uncontrollable amounts of rubbish over the past years (Stubley, 2018). This led to waste laying around everywhere in and around the tents. Since there is nothing known about a waste collection system in the new camp, history will likely repeat itself.

This stakeholder map provides us with a clear situation on what there can be done to better the situation of the refugees in times of COVID-19. Due to the power of both the European Union and the Greek Government the refugees cannot go anywhere. Therefore, a solution needs to be found to lower the transmission of COVID-19 within the camp, so the refugees can live a little bit safer. This will also create a better working space for the volunteers and medical teams and give the local population a bit more rest. $M^{djdd} m^2$

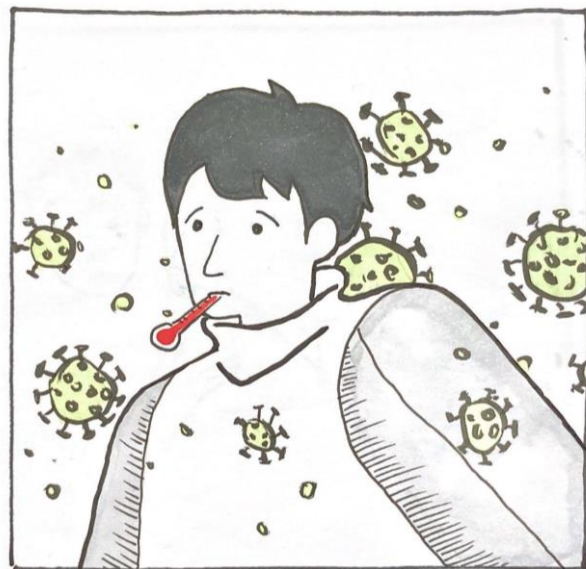
4. Storyboard



Figure 20. Illustration of the European refugee crisis (The Hope Project, n.d.).



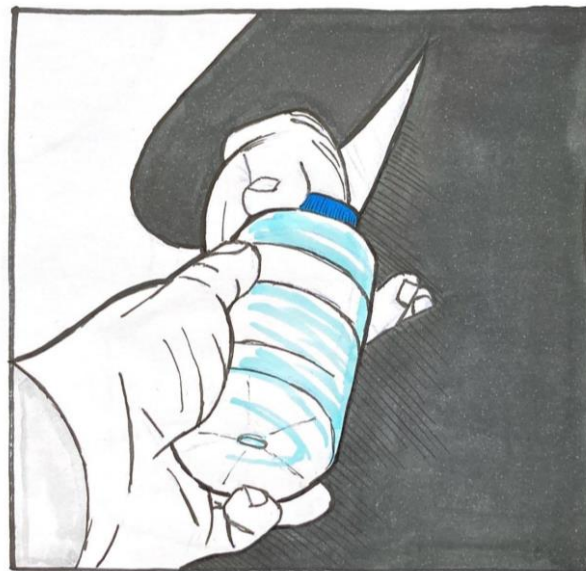
This is Camp Moria on the island of Lesbos in Greece. Conditions here are said to be among the worst of any refugee camp on earth.



The healthcare needs of refugees were not adequately provided for, even before coronavirus began to spread within the camp.



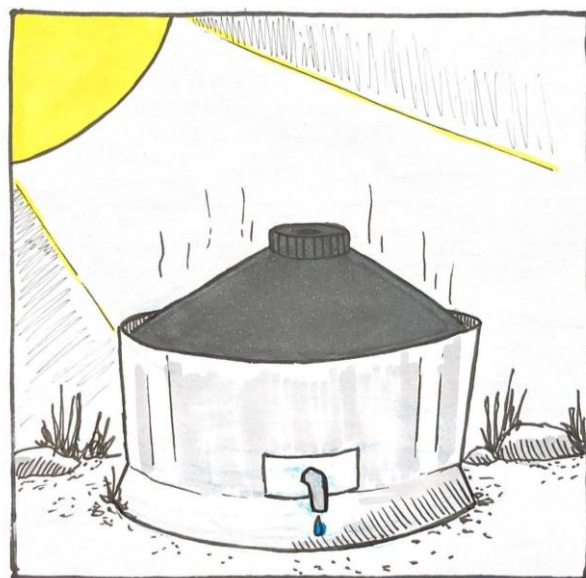
The conditions in the camp make social distancing impossible. Refugees must queue for hours every day to receive fresh bottled water. These queues are long and overcrowded, and there is often not enough water for everyone.



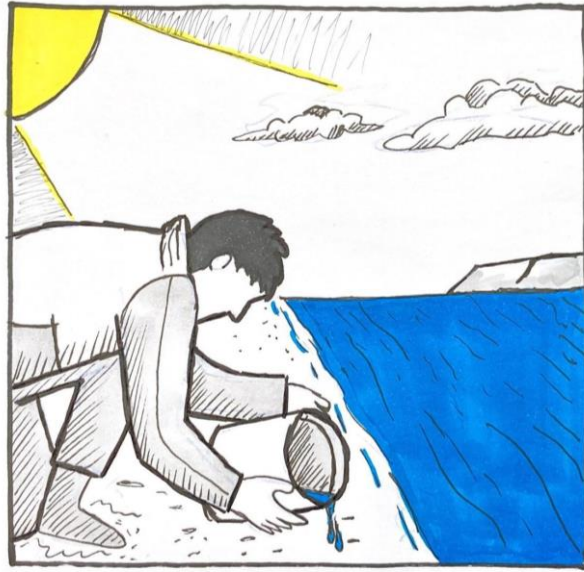
However, the refugees have no other choice. They need clean water to drink and to wash their hands with.



On top of this, the camp lacks a proper system for disposing of the plastic water bottles that are used. The piles of plastic waste surrounding the camp grow every day.



Our solution arrives in the camp. It is a solar powered water desalination and purification device. If regularly filled with unclean sea water and left out in the sun, each device will provide the refugees with 5 litres of potable water every day.



The extra potable water provided by these devices allows refugees to queue for bottled water less frequently, making the queues less crowded.



The shorter queues and the increased access to clean water for hand-washing eventually slow the spread of COVID-19 on the island. This provides the refugees with a better standard of living.

5. Preliminary Sketches

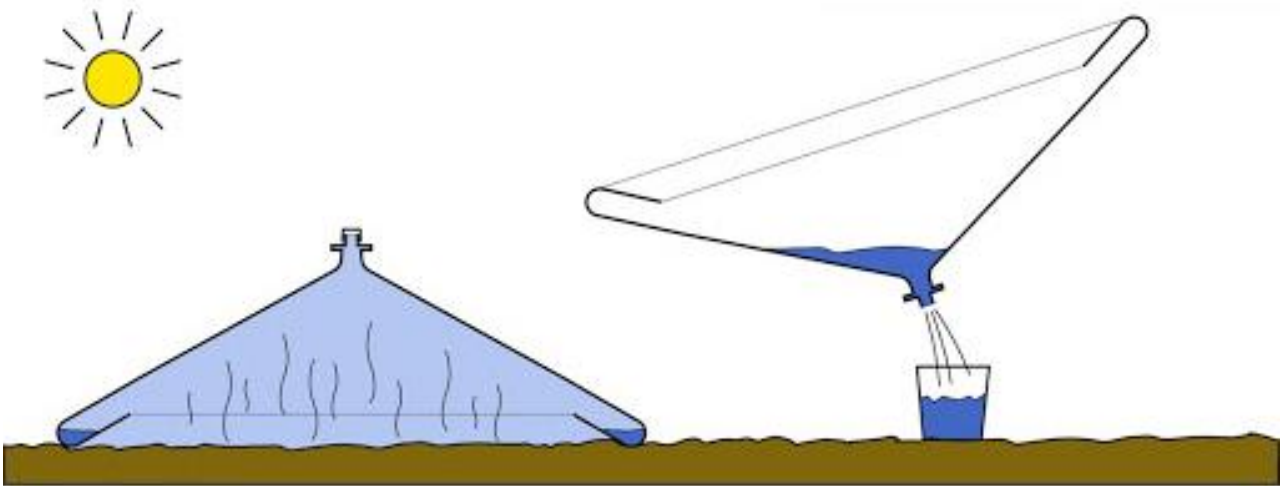
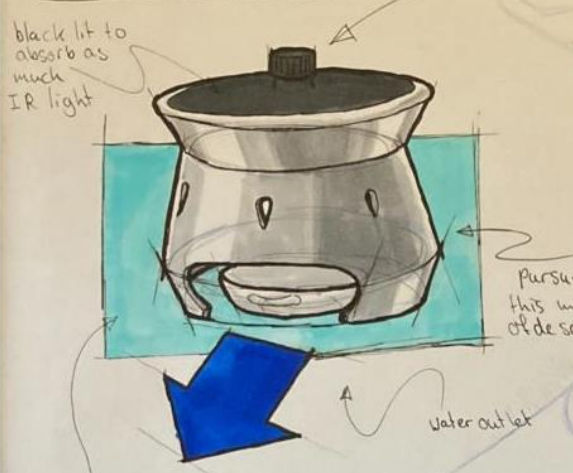
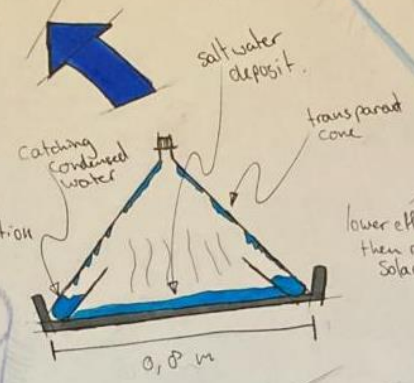


Figure 21. Watercone Sketch (NAIB, 2007).

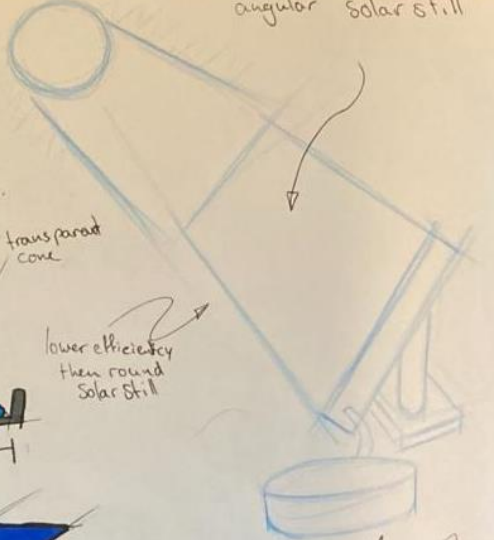
solar still exploration



collecting water from the WATER CONE



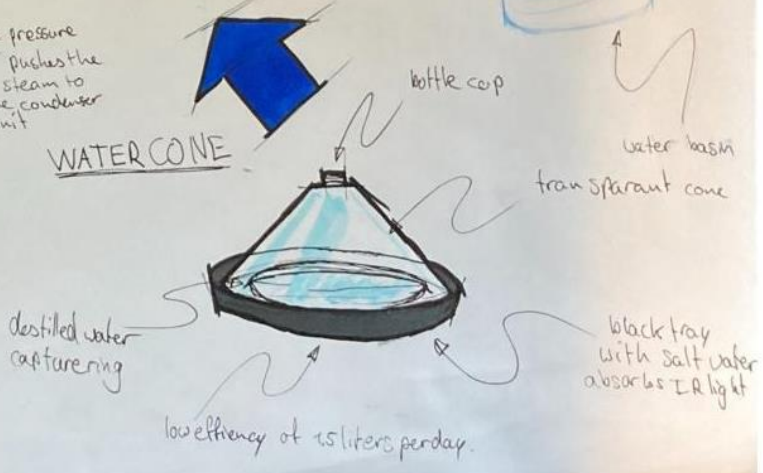
angular solar still



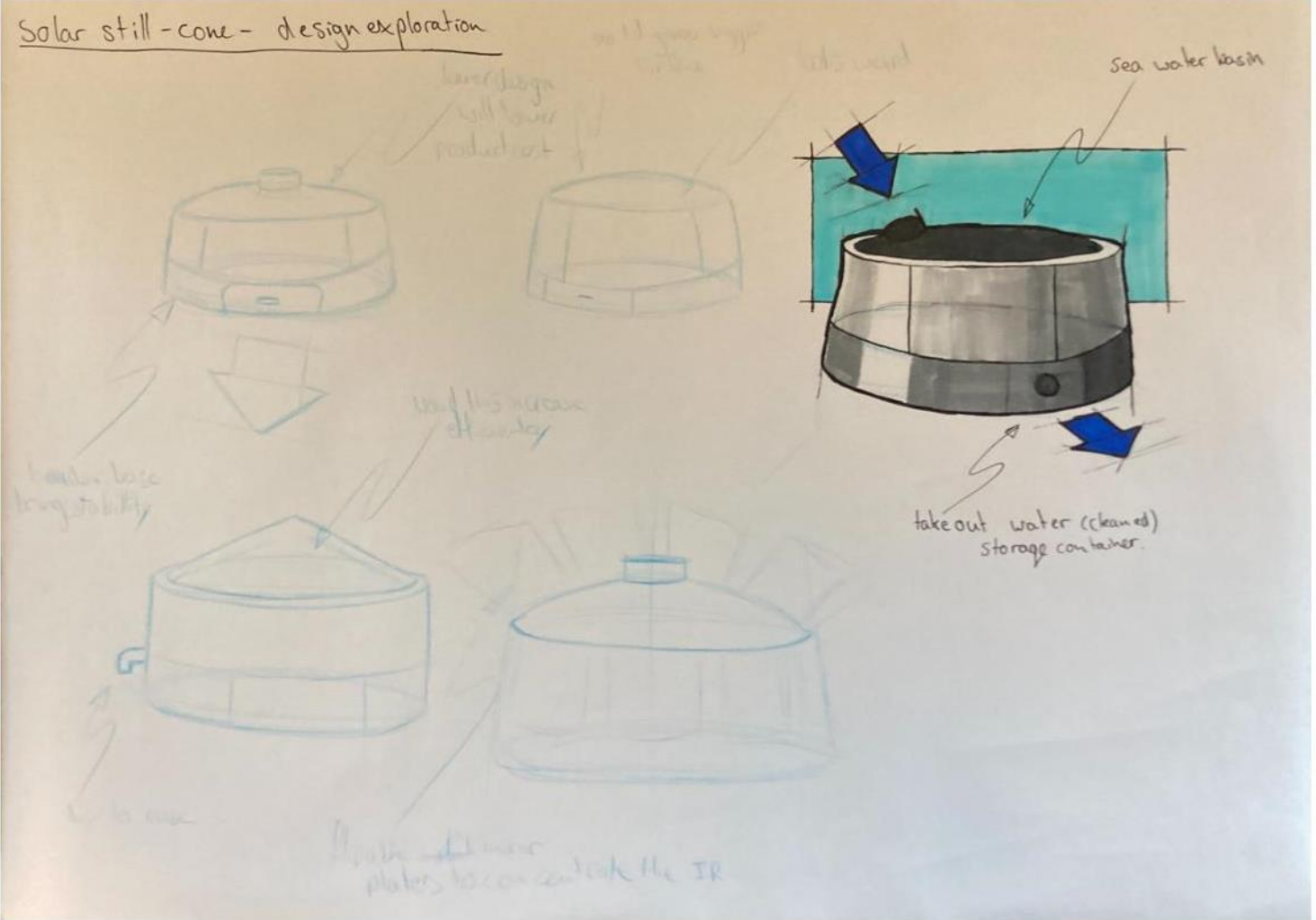
Elidomestico solar still



WATER CONE



Solar still - cone - design exploration



exploded view drawing

Solar still design

- focus on optimum performance and functionality
- visual through function
- a locking system might be added to ensure everyone has their own water.

can be taken out of the main body to remove salt and sand remnants in the sea water tank



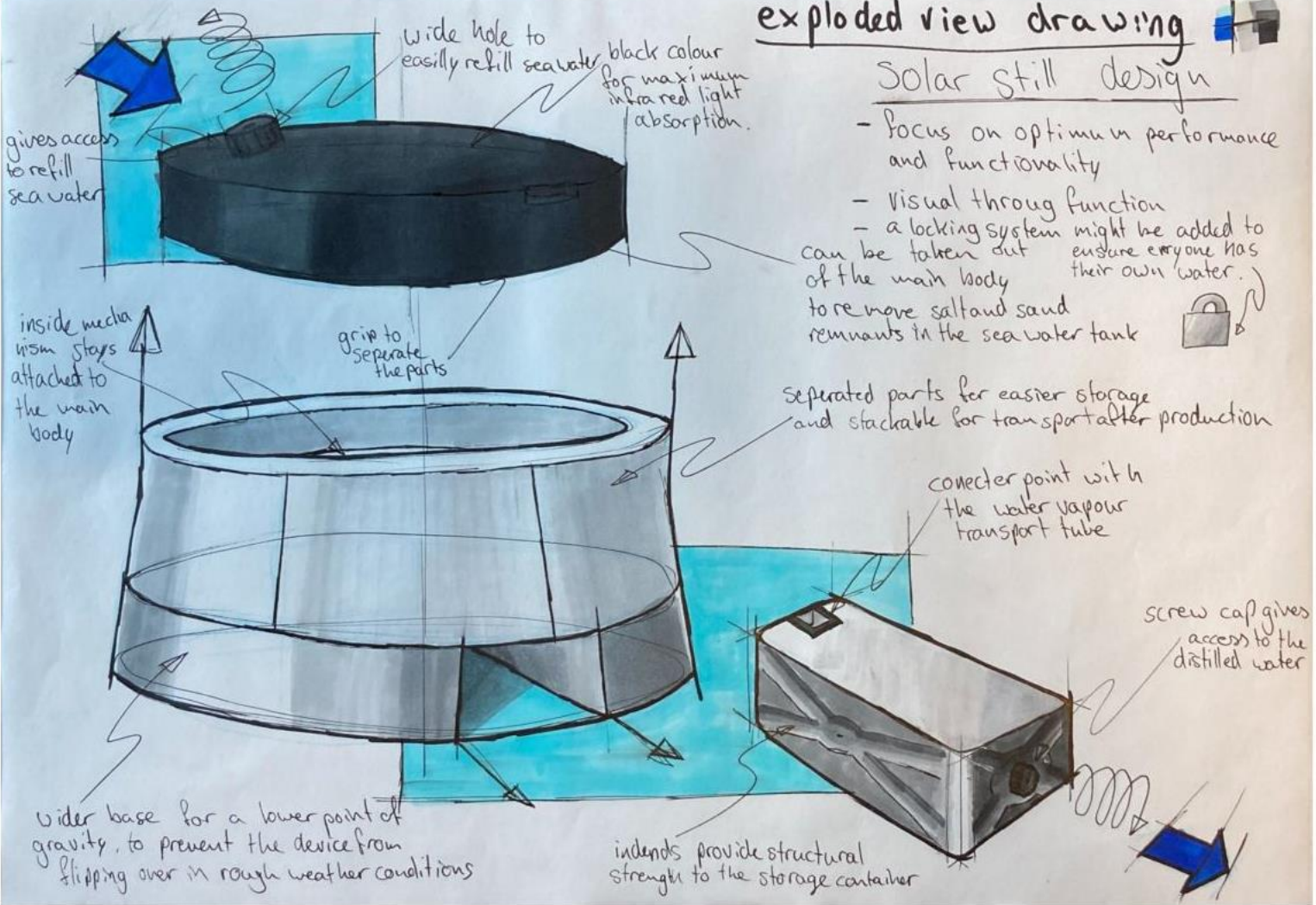
separated parts for easier storage and stackable for transport after production

connector point with the water vapour transport tube

screw cap gives access to the distilled water

intends provide structural strength to the storage container

Wider base for a lower point of gravity, to prevent the device from flipping over in rough weather conditions



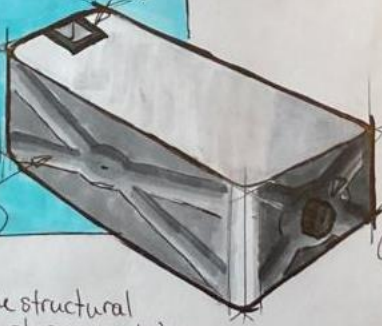
gives access to refill sea water

wide hole to easily refill sea water

black colour for maximum infra red light absorption.

inside mechanism stays attached to the main body

grip to separate the parts



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7.1 Appendix A

- Health service delivery. People have access to integrated quality healthcare that is safe, effective, and patient-centered.
- Healthcare workforce. People have access to healthcare workers with adequate skills at all levels of healthcare.
- Essential medicines and medical devices. People have access to essential medicines and medical devices that are safe, effective and of assured quality.
- Health financing. People have access to free priority healthcare for the duration of the crisis.
- Health information management. Healthcare is guided by evidence through the collection, analysis and use of relevant public health data.
- Prevention. People have access to healthcare and information to prevent communicable diseases.
- Surveillance, outbreak detection and early response. Surveillance and reporting systems provide early outbreak detection and early response.
- Diagnosis and case management. People have access to effective diagnosis and treatment for infectious diseases that contribute most significantly to morbidity and mortality.
- Outbreak preparedness and response. Outbreaks are adequately prepared for and controlled in a timely and effective manner.

7.2 Appendix B

Transmission of COVID-19 { SIR-Model } ①

S: Susceptible

I: Infectives

R: Removed (recovered, deceased)

Assumptions:

a) epidemic is short-term, population remains constant

b) (way disease is transmitted)

Rate of increase of I is proportional to the the contact of I to S, this rate is constant

c) constant rates (death, birth)

$$\textcircled{1} \frac{dS}{dt} = -rIS$$

rate of contact/transmission

$$\textcircled{3} \frac{dR}{dt} = aI$$

$$\textcircled{2} \frac{dI}{dt} = rIS - aI$$

rate death/birth
recovery/death

Initial Conditions:

$$S = S_0, I = I_0, \text{ At the beginning } I = 0 \Rightarrow \frac{dR}{dt} = 0 \Rightarrow R = 0$$

$$\text{From a)} \Rightarrow \left(\frac{dS}{dt} + \frac{dI}{dt} + \frac{dR}{dt} \right) = 0 \text{ always}$$

Q. 1. Will the disease spread?

If I grows, then there is an epidemic

$$\text{From } \frac{dS}{dt} = -rIS \Rightarrow S \leq S_0$$

$$\Rightarrow \frac{dI}{dt} < I \left(rS_0 - a \right) \rightarrow \text{If positive} \rightarrow \text{epidemic}$$

\Rightarrow If $\left[s_0 > \frac{a}{r} \right]$, then epidemic

(2)

Next step: $q = \frac{r}{a} :=$ contact ratio
 fraction of pop. that comes into contact with one inf.
 { contact of susceptibles to infected people

$\Rightarrow s_0 > \frac{1}{q}$

From $s_0 > \frac{a}{r} \Rightarrow \left(\frac{s_0 r}{a} \right) > 1$

R_0 { basic reproductive number
 ↓ represents number of secondary infections caused by an initial primary infection
 { 1, 5-2 : influenza
 3-4 : COVID-19

What is max. number of I?

$$\frac{dI}{ds} = \frac{dI/dt}{ds/dt} = \frac{rIs - aI}{-rIs} = -1 + \frac{a}{rs}$$

$$= -1 + \frac{1}{qs}$$

Solve separable equation:

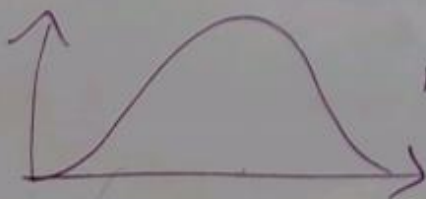
$$\int \frac{dI}{ds} = \int \left(-1 + \frac{1}{qs} \right) ds \Leftrightarrow dI = -ds + \frac{1}{q} \cdot \frac{1}{s} ds$$

$$\Rightarrow I = -\int ds + \frac{1}{q} \int \frac{1}{s} ds = -s + \frac{1}{q} \ln(s) \quad I_{max} \left(\frac{1}{q} \right)$$

$$\Rightarrow I \left(\frac{s}{s_0} \right) = -s + \frac{1}{q} \ln(s) + C \quad I_{max} = I_0 + s_0 - s + \frac{1}{q} \ln \left(\frac{s}{s_0} \right)$$

$$\Rightarrow \left(I + s - \frac{1}{q} \ln(s) = I_0 + s_0 - \frac{1}{q} \ln(s_0) \right) \quad \text{initial conditions}$$

From $\frac{dI}{ds} = -1 + \frac{a}{rs} = 0$ for $s = \frac{1}{q}$ MAX. Value



if q big
 Bad news

③ How many at the end?

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$$R + I + S = I_0 + S_0$$

$$~~R_0 = S_0 + I + S~~$$

→ This question can only be answered if $\lim_{s \rightarrow \infty} I(s)$

$$\lim_{s \rightarrow \infty} I(s) = I_0 + S_0 - S_\infty + \rho \ln \frac{S_\infty}{S_0} = 0$$

$$\Rightarrow I_0 + S_0 - S_\infty + \rho \ln \frac{S_\infty}{S_0} = 0$$

Under properties of Taylor expansion

$$\Rightarrow I_0 + S_0 - S_\infty + \rho \ln \frac{S_\infty}{S_0} \approx \frac{1}{2} S_0 - S_\infty + \rho \ln \frac{S_\infty}{S_0}$$

↓ for small $I_0 \sim S_0$

$$= \cancel{2I_0 + S_0} = S_0 - S_\infty + \rho \ln \left(\frac{S_0 - (S_0 - S_\infty)}{S_0} \right)$$

$$= S_0 - S_\infty + \rho \ln \left(1 - \frac{(S_0 - S_\infty)}{S_0} \right)$$

If $S_0 - p$ is small compared to $\rho \Rightarrow S_0 - S_\infty$ small compared to S_0

$$\text{From } \ln \left(1 - \left(\frac{S_0 - S_\infty}{S_0} \right) \right) = - \left(\frac{S_0 - S_\infty}{S_0} \right) - \frac{1}{2} \left(\frac{S_0 - S_\infty}{S_0} \right)^2 + \dots$$

$$\Rightarrow 0 = S_0 - S_\infty - \rho \left(\frac{S_0 - S_\infty}{S_0} \right) - \frac{\rho}{2} \left(\frac{S_0 - S_\infty}{S_0} \right)^2$$

$$0 = S_0 - S_\infty + \frac{S_\infty \rho - S_0 \rho}{S_0} - \frac{\rho}{2} \frac{S_0^2 - 2S_0 S_\infty + S_\infty^2}{S_0^2}$$

$$0 = S_0 - S_\infty + \frac{2S_\infty S_0 \rho - 2S_0^2 \rho - \rho S_0^2 + 2S_0 S_\infty \rho - \rho S_\infty^2}{2S_0^2}$$

$$0 = (S_0 - S_\infty) \left(1 - \frac{\rho}{S_0} - \frac{\rho}{2S_0^2} (S_0 - S_\infty) \right) \quad \hookrightarrow$$

Solve for $S_0 - S_\infty$ [difference in susceptibles beginning to end is equivalent to the number of people who ultimately contract the disease]

$$\Rightarrow 0 = 1 - \frac{\rho}{S_0} - \frac{\rho}{2S_0^2} (S_0 - S_\infty)$$

$$\frac{\rho}{S_0} + \frac{\rho}{2S_0^2} - 1 = \frac{\rho}{2S_0^2} (S_0 - S_\infty)$$

$$\frac{2S_0^2}{\rho} \cdot \frac{\rho}{S_0} - \frac{\rho}{2S_0^2} = S_0 - S_\infty$$

$$\Leftrightarrow 2S_0 - \frac{\rho}{2S_0^2} = S_0 - S_\infty$$

$$\Leftrightarrow 2S_0 \left(1 - \frac{\rho}{2S_0^2} \right) = S_0 - S_\infty \Rightarrow \boxed{S_0 - S_\infty = 2S_0 \left(\frac{S_0}{\rho} - 1 \right) = \frac{a}{r}}$$

Now let's find $\frac{dR}{dt} :=$ rate of removals | $N :=$ total number

$$\frac{dR}{dt} = aI = a(N - R - S)$$

$$\text{Use } \frac{dS}{dR} = \frac{dS/dt}{dR/dt} = \frac{-rSI}{aI} = -\frac{S}{\rho} = \frac{a}{r}$$

$$\Rightarrow \frac{dS}{dR} = -\frac{S}{\rho} \Rightarrow \int \frac{dS}{S} = \int -\frac{1}{\rho} dR$$

$$\ln(s) = -\frac{1}{p}R + C, e^{(\cdot)}$$

5

$$S(R) = e^{-\frac{1}{p}R + C} = e^{-\frac{1}{p}R} B$$

$$S(0) = e^{-\frac{1}{p} \cdot 0} B = S_0 \Rightarrow B = S_0$$

$$\Rightarrow S(R) = S_0 e^{-R/p} \rightarrow \text{The more removed, the less susceptibles}$$

$$\Rightarrow \frac{dR}{dt} = a(N - R - S_0 e^{-R/p}) \quad \left\{ \begin{array}{l} \text{Assumption} \\ -R/p : \text{small} \\ \text{hence, applicable only for} \\ \text{small population} \end{array} \right.$$

Then use TE:

$$e^{-R/p} = 1 - \frac{R}{p} + \frac{1}{2} \left(\frac{R}{p} \right)^2 + \dots$$

$$\Rightarrow \frac{dR}{dt} = a \left(N - R - S_0 \left(1 - \frac{R}{p} + \frac{1}{2} \left(\frac{R}{p} \right)^2 \right) \right)$$

$$= a \left(N - S_0 + \left(\frac{S_0}{p} - 1 \right) R - \frac{S_0}{2} \left(\frac{R}{p} \right)^2 \right)$$

Solve for $R(t)$!