Deepening: Economics

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"Economics is the art to meet unlimited needs with scarce resources"

- Laurence J. Peter

In this essay I will be discussing some of the economic factors related to the design and implementation of my Semester 1 Project team's product - Solar Still. The aim of this product is to reduce the length of queues for clean bottled water in Camp Moria, Greece by providing the refugees who live there with clean water that can be accessed at any time. By doing so we believe we can slow the spread of COVID-19 in the camp, while also reducing its high levels of plastic waste. In creating this design, it would be easy for us to be idealistic. We could have spent our semester prototyping a technology that was highly effective, aesthetically beautiful and entirely 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 can make a difference in Moria long term, we must understand the economic situations and priorities of the refugees, as well as that of policy-makers. In this essay I will discuss a selection of interesting case studies relevant to our project as well as some more theoretical aspects such as the frugal innovation design approach and economic sustainability. I believe that, through my study of economics, I will help to optimise what is achievable with our design.

The Economics of a Refugee Crisis

Case study: Greek Refugee Crisis

When you look at the development of Greece's refugee crisis since 2015, a rather depressing story unfolds. This is a story involving millions of euros in mismanaged funds, sporadic public support and possible conflicts of interest at the highest level. Measured in cost per beneficiary, the Greek refugee crisis is the most expensive humanitarian crisis in history (Howden & Fotiadis, 2017).

In 2017, European funding alone provided Greece with enough money to allocate €7,000 to every single refugee inside its borders (Leape & Brown, 2018). This could potentially have provided every refugee in Greece with a shared apartment, food and other necessities. Since 2015, the European Commission has promised Greece €613.5 million in long-term funding to manage migration if they can develop an adequate spending strategy (European Commission, 2019). So far only €198.9 million has been paid, although the difference between these figures may partially be accounted for by spending not being reported. On top of this, officials have stated that up to 70% of the funds that did make it to Greece by 2017 were misspent (Leape & Brown, 2018; Howden & Fotiadis, 2017).

An example of mismanaged funds can be seen by looking at the total humanitarian aid granted to Greece to deal with the refugee crisis between 2015 and 2017. The total amount given to Greece from all sources in this period is estimated to be €663.5 million (Howden & Fotiadis, 2017), this was intended to be used to help 1.03 million people which would have worked out at approximately €615 per refugee. However, the majority of these funds were spent on 57,000 people, meaning the cost per refugee was closer to €11,114.

To add to the problem, official numbers of refugees in Greece are often inaccurate. Caterers at the camp in Oreokastro say they still receive enough funding to feed the 604 refugees who supposedly live there, despite a headcount by a foreign diplomat revealing only 135 (Howden &

Fotiadis, 2017). In February of 2017, the UNHCR admitted that their count was 13,000 refugees short of what the Greek government claimed was inside the borders (Howden & Fotiadis, 2017). Another example of mismanagement, which was quite clear to anybody living in the original Camp Moria, could be seen in the empty housing units where funds did not fully cover installation costs (Leape & Brown, 2018).

In 2015, a Syrian toddler named Alan Kurdi washed up on a Turkish beach after drowning while trying to reach Europe with his family. A picture of the toddler's body was posted online and published in newspapers around the world. The surge of public donations caused by this harrowing image was enough to crash the International Rescue Committee's website (Howden & Fotiadis, 2017). However, there are those who doubt that this short, intense burst of public and NGO support for the Greek refugee crisis had a net positive effect. When Alan Kurdi's picture went viral, the massive influx of money and NGOs in Greece, led to smaller organizations losing workers to larger, higher-paying ones (Howden & Fotiadis, 2017). Lora Papa, the head of one of these smaller, underfunded organizations, concluded that "sometimes money can do more harm than good". She believes the influx of money after 2015 turned refugees into "commodities" and drove larger NGOs to dump resources into Greece for the sake of showing a presence (Howden & Fotiadis, 2017). On top of this there are often tensions between local and international staff working in the refugee camps. One possible cause for this may be the fact that international UNHCR staff are paid on average three times as much as local staff (Howden & Fotiadis, 2017).

These are far from being the only scenarios in which money is a barrier to the betterment of the lives of refugees. It has also been argued that there is a serious conflict of interest between the UNHCR and the European Union. UN staff have claimed that the UNHCR often cannot voice concerns for violations of refugee rights in the EU because the European Commission is their second biggest financial contributor worldwide (Howden & Fotiadis, 2017).

It is fair to say that organisational issues played a major role in how the conditions in facilities such as Camp Moria became as bad as they are, although it has been argued that the lack of planning is a strategy in and of itself. If the people reaching Greece's shores send word back home about how awful the conditions are, perhaps fewer refugees will arrive.

Case study: Refugees in 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)(European Commission, 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, 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.

Frugal Innovation & Economic Sustainability

The Principles of Frugal Innovation and how they Influenced our Design

Frugal innovation is based on the concept of “jugaad”, which is a colloquial term used in multiple Indian languages and roughly translates to “hack”. It refers to ingenious, low-cost solutions achieved with few resources, through lateral thinking and creativity. This design approach, pioneered by the global South, stands in stark contrast to the expensive research and development, taking place in the labs of richer countries in the East and West. However, frugal innovation is not by definition low tech, it can also use high tech to make systems more cost-effective and accessible (Radjou, 2017). In its essence, this approach is about taking something that is abundant and turning it into something that is scarce. In the case of Solar Still, we have taken seawater and solar energy and created a low tech device which converts them into potable water.

Critics of frugal innovation believe that the idea’s rise to fame represents an over-intellectualisation of an approach that is by no means better, simply because it uses less. They raise the question of why giant corporations consider risking their greatest contribution to society, innovation, by cutting their own budgets. Media Lab Asia, a collaboration between MIT Media Lab and the Indian Ministry of Communications worked for ten years on developing low cost technologies for poor regions in India, only for the projects to eventually be taken over by large corporations like Apple and Google (Joseph, 2018). However, the benefits of low cost innovation strategies are hard to ignore when technologies such as a $25 incubator are born out of competitions hosted by non-profits. The “Embrace Infant Warmer” was created by a team of students at Extreme Affordability. It is an electricity-free incubator which can keep a newborn baby’s body at exactly the correct temperature for four hours before needing to be recharged by submerging in boiling water. This low tech solution was created to combat infant mortality in developing countries and later won $125,000 in prize funding (Extreme, n.d.).

The main principles of frugal innovation are cost-effectiveness, a concentration on core functions, and optimal performance. These principles were at the forefront of our minds from the very conception of Solar Still. In order for our product to be affordable for NGOs working in Camp Moria, we had to keep the cost of raw materials, fabrication and shipping as low as possible. We also had to ensure that the product was durable and easy to maintain, so that operating costs did not nullify the effort we put into keeping the capital cost low. We ensured our design would be cost-effective in a few different ways, some of which I will discuss in this section.

Firstly, we ensured that our solution was sufficiently low tech. This meant no expensive electronic components. It also meant no extravagant costs associated with the skilled workers needed to assemble a more complex product. This makes our solution cheaper long-term, decreasing operating costs for our stakeholders in the camp by making the product easy to maintain and repair.

Secondly, we chose materials that were relatively cheap to manufacture and almost entirely biodegradable. We also intend that our product will decrease the amount of plastic waste produced in Camp Moria by allowing refugees to reuse plastic bottles for storing the clean water from our device. These two elements show that our project is forwarding the policies of the European Union in terms of sustainable development. Our hope is that the project would be deemed eligible for direct financial support from the EU through schemes such as the European Fund for Sustainable Development, which was estimated to generate €44 billion in investments by this year "to help create jobs and economic opportunities, address the socio-economic causes of migration, and contribute to the achievement of the UN sustainable development goals" (European Parliament, 2019).

Thirdly, we specially designed the product's shape to allow for larger components to be stacked easily during manufacturing and shipping. This would increase manufacturing efficiency and allow for larger quantities of our product to be shipped in fewer containers, improving both the ecological and economic sustainability of our solution.

We also concentrated on the core function of our product and strived to make a design that could perform this function optimally. The core function of our design is to remove dissolved solids and dangerous pathogens from seawater. This is achieved by a process of distillation. Our design is optimised to distil seawater as effectively as possible, and accordingly we have not put our resources towards enabling any secondary functions that are not absolutely essential to this process. An example of an essential secondary function that our design does provide is storing the clean water after it has been condensed.

Desalination has become an increasingly popular method of procuring clean water. Climate change will bring on more erratic weather patterns with periods of intense rainfall and intense drought. This makes the supply of water unstable, while demand increases with a rapidly growing world population (Mallinson, 2016). According to MIT's Professor Lienhard, "desalination can help to provide resilience in the water supply and help to meet some of the base demand" (Mallinson, 2016).

Creating an effective desalination device is about finding the balance between energy efficiency and cost efficiency. The right balance should be inspired by the context in which the device will be used. With our device, the energy source - the sun - is free. In this case it becomes a balance between time efficiency and cost efficiency. How can we maximise the amount of infrared radiation absorbed by our device per unit time? Certain solutions, such as increasing the surface area of our design, lead to higher costs, which is why it is essential to find a good compromise between the two ideals.

Economic Sustainability

Economic, ecological and social sustainability are the three elements which, if achieved simultaneously, contribute to sustainable development as defined by Duran, Gogan, Artene and Duran (2015). Economic sustainability refers to the pursuit of economic growth while avoiding adverse effects on the other two factors, such as environmental or cultural impacts. Usually this

refers to the maximisation of profits with scarce resources (Popovic, Kraslawski, & Avramenko, 2013). However, the extreme shortages in Camp Moria make its economy comparable to that of a developing country. For this reason, the priority should be balancing costs and benefits in a way that reduces inequality for those living in the camp (Technology Exchange Lab, n.d.). We plan to reduce inequality in Camp Moria by manufacturing and distributing our product in a way that makes it affordable for NGOs. The organisations can then purchase in large enough quantities that every refugee can feasibly be given equal access to the clean water that is provided by the Solar Stills.

When estimating the costs associated with manufacturing and purchasing our product, a good place to start is by looking at the price of similar products on the market. Eliodomestico, another variation of the solar still, costs approximately $50 or €41 at time of writing. However this product is made from clay which, while being cheaper than plastic as a raw material, is usually more expensive for manufacturing large quantities of a product. The final cost of the Solar Still would depend on many factors. These include:

- The biomass which is used to create the polylactic acid base for our polymer blend
- The number of units produced (we estimate to need about 3,000 units in order to provide 6,000 refugees with 2.5 litres of water per day)
- Distance between the factory and the camp
- The means of transport from the factory to the camp
- The exact injection moulding technique used
- The time taken to assemble the product and the number of the steps involved

Without this information any approximation of the cost of our product would lack sufficient evidence, although in all likelihood the figure will be less than €40 given the cost of other products on the market. If our product cost, for example, €25, the production of 3,000 units would represent an investment of €75,000 from an NGO or group of NGOs. However, support in

the form of grants or subsidies from the European Commission could significantly decrease this figure.

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, 2014).

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, 2015). 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 $C = (\lambda/\mu n)100$ where n is the number of servers or points of access to the product or service (Mahadevan, 2015). 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 (Mais, 2018). Therefore, it's no surprise that these institutions pour so much of their resources into the development and integration of efficient queuing systems. (It's great that banks invest so much money into this research as it means my team and I don't have to.) 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 (Mais, 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 (Mais, 2018).

Case study: Soviet Queuing systems

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, n.d.). 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).

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, n.d.). 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). This is similar to the virtual queues we see today.

Having researched various queuing systems, the challenge is to design a system which allows refugees to access the water provided by our design without unnecessarily risking exposure to COVID-19. By far the most effective solution would be to get rid of all queues for water in the camp. While this is not entirely possible, we can avoid refugees needing to queue to use our product. To do this, all refugees need to be able to freely access the Solar Stills at any time of the day or night, which is possible as long they do not have concerns for the safety of their water reserves. One way to do this is by having one device allocated per group of refugees, for example one device per small tent. However, keeping the devices inside the camp would likely cause issues due to the physically cramped conditions and the fact that the product is literally designed to have the maximum surface area (within certain conditions). For this reason the Solar Stills would need to be kept at a centralised location near the camp. To implement our product in this way, we have designed it so that the storage tank in each unit can be locked with a key. The devices will be numbered and volunteers will allocate each one to a group of refugees who will

be given one or more sets of keys with which they can access their water reserve. Another set will be given to the volunteers, in case keys get lost.

Conclusion

Exploring the economic implications of the solution we have designed and the financial factors surrounding its conception and employment has given me a clear perspective on what this product could really achieve. In order to guide my research and operationalise the attainment of my goals, I defined the following intended learning outcomes (ILOs):

- Comprehend and discuss the economic factors related to a refugee crisis.

- Exhibit an understanding of the principles of frugal innovation and be able to discuss which of these will influence our design and why.

- Be able to explain the principles of queuing theory and discuss the use of queues in various modern and historical contexts.

I believe that my analysis of case studies in Greece and Uganda is evidence for the achievement of the first ILO. If given the time, I would have liked to analyse more case studies in order to recognise patterns in how governing bodies manage immigration. It would be especially interesting to research immigration patterns from the past and see how refugees have been treated in various historical contexts.

I have thoroughly enjoyed studying frugal innovation and economic sustainability. My only regret with regards to the second ILO is that I did not finish the research earlier in the semester in order to more concretely implement my findings. If I had, for example, spent more time focusing on practical elements of our solution, I may have been able to make a better estimation of the price of our product in time for the submission of our final portfolio. Nonetheless, I believe that I

have exhibited an understanding of frugal innovation and discussed numerous specific instances in which its principles have influenced our design choices.

Exploring the field of queuing theory and its historical relevance has been another engaging project which I believe captures the interdisciplinary approach of the ATLAS programme. In this essay I have explained the main concepts behind queuing theory and discussed its implementations in the modern tertiary sector as well as in a historical context by means of the USSR case study.

I am convinced that, from its conception, our product has had true potential to improve the lives of thousands of people. What we can learn from the field of economics is fundamental in realising this potential.

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