RefuHeat

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Problem Statement

How might we provide an affordable, sustainable, and electrically efficient heating system for refugee shelters and tents in Zaatari Refugee Camp in Jordan during cold winter months?

Problem

We are tackling the lack of heating accommodations for harsh winter weather in refugee shelters and tents. In particular, we are focusing on Zaatari Refugee Camp in Jordan in order to improve the overall quality of life of the inhabiting refugees.

Significance

The problem of inadequate heating is caused by the fact that Middle Eastern winters can be very cold. For example, some areas of Lebanon fell to five degrees Fahrenheit and saw nearly twenty inches of snow in the winter of 2014-2015 (UNHCR, 2015). Unsuccessful attempts have been made to solve this problem and heat refugee shelters. First, however, it is crucial to understand the significance of this problem and its impact on the lives of refugees.

Poorly heated houses have been shown to have a significant impact on peoples' health and quality of life. Cold housing has been linked to poor health conditions such as asthma as well as an increased amount of needed medical care (Evans, Hyndman, Stewart-Brown, Smith, & Petersen, 2000). Failing to address refugees' need for heating will therefore simply push the cost forward to healthcare expenses. Additionally, cold housing has been linked to issues with mental health. In a study of mothers in New Zealand, researchers found a significant link between cold housing and depression in the subjects after accounting for all other variables (Butler, Williams, Tukuitonga, & Paterson, 2003). It is important to remember that the populations researched in these studies live in the United Kingdom and New Zealand, both secure and highly developed countries. Refugees may be even more vulnerable to the effects of the cold due to the physical and mental hardships that many of them already face. Finally, we must consider simple human dignity. Although morality is subjective, everyone has to agree that society is failing when people's living conditions are wholly insufficient. By failing to adequately heat refugees' shelters, society incurs a great cost of human health and happiness.

Solving this problem, however, would serve to greatly improve society. For one, there is the intangible yet extremely important value of human life and happiness saved by providing refugees with adequate living conditions. Even if refugees were completely unable to contribute to society and providing them with better heating resulted in a net loss of resources, we would be compelled as a society to solve this problem because human lives are inherently valuable. What's more, the notion that refugees are unable to contribute to society could not be further from the truth. Leaving aside the untapped potential present in many uneducated refugees, many Syrian refugees are already educated. Even highly skilled professionals such as doctors and bankers are among them, as Syria has become a dangerous place to live no matter what socioeconomic class you belong to (McHugh, 2015). As such, at least some of the cost society must pay to provide heating to refugees will be recouped in the value that refugees contribute back to society. In short, the problem of inadequate heating in refugee shelters must be solved for the benefit of both the refugees affected by it and society at large.

Stakeholders

There are several stakeholders within this problem space. The refugees themselves are the largest group affected. According to a recent United Nations High Commissioner for Refugees report, 66% of refugees do not think that their housing structures are adequate for winter conditions. In addition, 73% of refugees in the camps and 53% of the refugees out of the camps do not consider their housing unit suitable for the climate. When families within the camps were asked to name their top three non-food needs for the winter, 81% said that they needed heaters (Zaatari Refugee Camp Winter Response, 2016). The high percentage of the refugees who consider their housing unit unsuitable for the climate, especially those within the camps, is significant, given that many refugee camps are located in regions with harsh winter conditions and they are the ones trying to keep warm. The refugees will be the stakeholders most impacted as they will be the ones using the product.

Other stakeholders are non-governmental organizations that are currently working within the camps, namely United Nations High Commissioner for Refugees (UNHCR). NGOs have been trying to meet the need of heat in the winter, but have run into funding problems (Refugees endure worsening conditions as Syria's conflict enters 5th year, 2015). In Zaatari, the present NGOs are the UNHCR, the Norwegian Refugee Council (NRC), and United Nations Office for Project Services (UNOPS) (Syrian Regional Refugee Response, 2016). These stakeholders will be influenced by our product because they will have to fund our solution and implement it in the camps. They will also heavily influence our solution since they control the camps and will regulate us with certain standards..

Stakeholders also include the host countries of the camps. Most host countries like to think of the refugee camps as temporary, even though it is becoming more and more apparent camps can remain for more than ten years. Therefore, anything that might make a home seem more permanent, like a heating system, may not be looked upon in the most favorable light. Additionally, while the host countries will not be impacted, they will influence if our solution will even allowed entry.

Manufacturers, the people who produce our product, are also stakeholders for this project. If they can make a profit, they will be happy. They can also look good in the eye of the public because they are helping out refugees on the other side of the world. This stakeholder can influence our solution by putting constraints on what can be manufactured.

Context and Existing Solutions

Winters get extremely cold in the Middle East. In 2014, the winter was particularly harsh, and many refugee camps were hit with several snow storms between November and January. In Lebanon’s Bekaa valley, temperatures dropped to five degrees Fahrenheit (Winter of 2015-16: Tens of thousands of refugees and migrants in Europe and millions displaced in the Syria region face a winter in the cold, 2015). Additionally, most of the tents used as housing structures for the region are geared toward the searing hot temperatures common in the summer, so they are made out of polyester or cotton blended fibers (UNHCR Family Tent For Hot Climate, 2014). Therefore, these are not suitable for protection against brutal winters.

World Vision Jordan’s winter project WARM Plus has tried to alleviate the effect of the cold weather by distributing clothes to the refugee children. They give out a jacket, one pair of shoes, and five socks per child between the ages of 6 and 16 for up to two children per family

(Ata, 2016). Unfortunately, many families have more than two children. The project also gives each family one gas cylinder and 40 Jordanian Dinars, which is about 56 USD, to fill the gas cylinder each month (Ata, 2016).

The UNHCR has also elected to try to give winter supplies to refugees in an attempt to keep them warm over the winter. They give out plastic tarpaulins, tent liners, polystyrene foam boards, insulated floor mats, or other forms of shelter insulation to the refugees. They also give out heating fuel, stoves, or heaters (Winter of 2015-16: Tens of thousands of refugees and migrants in Europe and millions displaced in the Syria region face a winter in the cold, 2015). Unfortunately, the UNHCR does not have the funding to adequately supply every family.

Staying warm is a vital part of being healthy and happy, and currently, NGOs lack the resources and funding to provide this for the refugees. We want to meet this basic need so that they can focus on other things, like education, employment, and family.

Why is it still a problem?

Refugees endure worsening conditions as Syria's conflict enters its fifth year. By the end of 2014, only 54% of the funding needed to assist refugees outside Syria had been raised. Inside Syria, humanitarian organizations received even less. A study from November 2015 - February 2016 stated that 81% of refugee families reported heaters as primary non-food need and 66% reported their shelters not suitable for winter conditions (Zaatari Refugee Camp Winter Response, 2016). In general, makeshift supplies such as sleeping bags, raincoats, socks, clothes, and footwear do little to solve the underlying problem. High thermal blankets and plastic tarpaulins are more successful advances, but are also not any more cost effective. (Winter of 2015-16: Tens of thousands of refugees and migrants in Europe and millions displaced in the Syria region face a winter in the cold, 2015). For example, when IKEA provided thousands of flat-pack shelters to refugees in Syria, they made living conditions slightly more comfortable but did not meet sufficient standards to provide proper heating during the brutal winters (Dunn, 2015).

Proposed Work

Goal

We have decided to focus on a technological solution to the problem. Rather than developing policy or finding a way to make the current system more effective, we feel that this problem can be best solved by creating a new heating device that is affordable and energy-efficient. The intended impact of this solution is to reduce the number of refugees who feel that their shelters are inadequately heated and improve their quality of life.

Objectives

Our first objective is to create a working prototype of only a solar heater and fan which are capable of heating a room, as this is the first step to creating a device which is capable of heating a refugee shelter efficiently. Unless this step is accomplished, further progress on the design will not be possible. First, we need to determine through experimentation the optimal

material for our heating element. Once this has been found, we need to construct the frame and pipes to transfer hot air into a tent. Next, we need to create a system that pumps air into the tent by using a fan. Finally, we need to find a way to store solar energy so that we can use it during the night. While this may take the form of solar panels connected to a battery (the battery will be the storage element) we will need to explore many types of renewable energy to accomplish this. The success of this prototype will be proven when the device is able to make a heat differentiable. This will be shown by the prototype being able to raise the temperature of a small living space by a significant amount. However, doing this may prove to be difficult, as we might encounter complications with finding an affordable material that effectively absorbs the sun's heat, creating a substantial amount of heat, and heating the shelters at night. We would fail this objective if the prototype was unable to create a significant change in the temperatures of the shelters. If our prototype did fail in this, we could work to improve tent insulation. The addition of more effective insulation can made by attaching tarps or lightweight screens to the tent entrances and custom mats around the base of the tent. This extra insulation would help trap warm air. The combination of this insulation and the improved heating device would bring us closer to the objective of efficiently heating shelters.

Our next objective is to partner with organizations working in Zaatari in order to be able to implement our solution within the refugee camp and receive funding. Without contacts in the camps, we will not be able to transport our design or distribute it to the refugee families. Organizations within the camps will be the most likely ones to offer us funding as they are already trying to improve the lives of refugees. Without this funding, we will not be able to buy the resources needed to build prototypes or create our final solution. We will also not be able to provide the refugees the resources to recreate the solution themselves. The first step in doing this is to make contacts in relevant organizations. Then, we need to pitch a prototype of our solution to them and agree to work with them. During the rest of the time that we are working on our solution, we will need to keep in contact with the organizations so we can certify that we are building to their standards. We will also use their feedback to improve our solution and discuss implementation details. This way we can tailor our solution to the specific needs of the refugees and organizations. Some problems that we anticipate running into are that the organizations may place design constraints on our project that are difficult to conform to. Also, they may reveal that they dislike part of our solution and we will have to start over in areas that we had been working on for a long time.

Another objective is to ensure that our solution follows camp rules and regulations so that it will be allowed inside Zaatari. To do this, we will contact NGOs, most probably the UNHCR, in order to figure out what the specific rules are. We will continue to remain in contact with them and certify that every prototype abides by these rules. This will ensure that NGOs will allow our product inside Zaatari. However, we may have difficulty designing within these rules as they may have restrictions on the materials used and other such things.

Our final objective is to implement our solution in Zaatari and research if the percentage of inadequate shelters has decreased. This will allow us to judge the ultimate success or failure of our project. To do this, we will have partnered with NGOs with presences in Zaatari and provided them with the final product to their standards. We will then wait for winter to come and evaluate the performance of the device. Finally, we will gather advice from refugees on possible improvements. We will need to assess quantitatively how the refugees benefit from our solution. For example, we will evaluate the difference in the proportion of refugees who feel they are able

to heat their homes more effectively. We anticipate that some refugees may not embrace the solution as they may see it as cheap or want something more modern. They also may not understand how it works, be unable to set it up properly, or be unable to maintain it. There is also the possibility of theft.

Project Team

The team will be composed of seven students that will fill the following roles.

Design Expert:

The team will need a design expert to help create the individual components of the project. They should be efficient, detail oriented, and familiar with the design of the product. Their role will be to understand the components of the device and how they work together and in different environments. They should be able to make models of the devices using computer-aided design. It is necessary to have a design engineer in order to insure that the product functions well and is suitably made for refugee camps.

Thermodynamics Expert:

The team needs a thermodynamics expert to use their knowledge of heat transfer to optimize the energy consumed and heat released from the solution. They will need to be well-informed, inventive, and creative. Their role will be to figure out how the product will move warm air into the refugees' shelters, how temperature is affected, and how heat is controlled.. This person is needed to ensure that the device is effective in meeting the heating needs of refugees.

Electrical Expert:

The team needs an electrical engineer to successfully integrate the solar panels, bulbs and fans into the heating device. They should be efficient and knowledgeable. They will understand how much energy the device will use and how we can to optimize this number. This team member will ensure that the product's electrical components are incorporated in a safe and effective manner.

Materials Expert:

A materials experts will research the components needed for the product. They will be familiar with different materials that effectively store and transfer heat and solar energy. They are needed to ensure that the product is designed with materials that do not hinder its effectiveness.

Testing Expert:

The testing expert is needed to design tests that evaluate the performance and limits of the product, while also simulating refugee camps. Their role will be to find what improvements need to be done to the product's design in order to ensure that it is sturdy and functions properly in different environments and stressors.

Spokesperson:

The team will need a spokesperson. This person should be a good communicator, persuasive, and passionate about the project. Their role will be to act as the main connection for the team and NGOs, professors, and other experts. They are needed to ensure that the team stays connected to partners and resources needed for the project's success.

Secretary:

A team secretary is needed to ensure that the team works effectively. They should be well organized and responsible. Their role will be to record the group's progress, organize meetings, and keep track of the team's funds, contacts, and social and legal relationships. They are needed in order to verify that the team stays organized and in a stable position as it moves forward.

In regards to faculty mentors, the team wants to work closely with Dr. Vicki Birchfield, Dr. Wayne Li, and Dr. Shannon Yee. Dr. Birchfield, an international affairs professor, has offered to help us stay informed on refugees and possibly test prototypes in Europe. Dr. Li is an architecture professor, involved in humanitarian design, and advises startups. He has given the team valuable information and will be a very helpful resource as we move forward. Dr. Yee is an expert in heat transfer, combustion, and energy systems. He is also familiar with mechanical topics. The team plans to consult him about how to create a device that can transfer heat, store solar energy, and function in varying conditions. The team plans to use the insights gained from these individuals in order to design a well made heating device.

Timeline

During Summer 2016, we will be putting our solution on pause as most team members will not be able to work on it.

In Fall 2016, we will resume by researching ways to optimize our solution, such as producing more heat and reducing energy consumed. To do this, we will be consulting experts on energy and conducting experiments. After using different materials and methods to optimize our solution, we will select the best method with availability and affordability of materials in mind.

In Spring 2017, we will make prototypes of our solution and use them to present our idea to various organizations, such as the UNHCR, in hopes of partnering with them. Our goal for this semester will be to create a functioning prototype that impresses the UNHCR enough for them to partner with us.

In Fall 2017, we will continue creating prototypes in order to try to reduce the price of the overall product and utilize materials readily available in Zaatari. We will also be building according to specifications restrictions placed on us by the UNHCR.

In Spring 2018, we will be finishing our solution, making sure it is up to the UNHCR's standards and completes our own objectives. We will also be testing the solution in the United States to make sure that we have found all possible shortcomings.

In Fall 2018, we will put finishing touches on our solution and make any adjustments if applicable. We will also prepare to go to Zaatari in order to implement our solution in person and observe the results over winter break.

During Winter Break 2018-2019, we will travel to Zaatari with our final solution.

Budget

There are four main portions to the device: the heating element, the nighttime hood, the heat transfer element, and the wiring involved. The heating element will most likely be made with items that the refugees have, such as aluminum cans. These will be perforated and painted black so that they retain heat and can transfer it through the heat transfer element. This will be encased in a hardwood casing, due to the fact that wood is easily available and a great insulator. These may have to be purchased and will be approximately $20. This wood casing will be lined with styrofoam to increase the amount of heat retention.

The nighttime hood will be created with translucent black polypropylene. Polypropylene is a derivation of plastic that has a greater ability to retain heat. While this is more expensive than cheap plastic, it is less expensive than polycarbonate and serves as a good mid-tier construction material in order to retain heat from the heat lamps. It is predicted that this will cost around $20. Two heat lamps, most likely in the form of halogen bulbs, will be encased within the hood and shine through a convex lens in order to refract the light to make sure it hits every portion of the heating element. Halogen bulbs are ideal because they are cheap, energy efficient, and have a high energy to heat transfer rate. Ideally, solar panels will be used to power the bulbs, but price may restrict that. The bulbs require 60 watts to power, and a 100 watts solar panel is around $125. Two halogen bulbs will cost under $10.

The heat transfer element will include a long PVC pipe that will run underneath the tent or the shelters in order to direct the hot air into the homes. A fan wheel will be placed at the point of connection with the heating element so that the air can be propelled through the pipe. The fan wheel will require 40W of energy to power, and Zaatari gets eleven hours of electricity a day, so powering the fan wheel will not be an issue. The PVC pipe and the fan wheel total should come around to $28-38, depending on the size of the fan wheel and the power. The panels, bulbs, and fan wheel will require electrical wiring as well.

These materials will be assembled in the Invention Studio. A meterstick will be used to measure the casing, styrofoam, surface area, etc. A wood cutter will be used to size the casing materials, including the styrofoam. A soldering iron will be used to connect the panels and the bulbs to the hood, and a high powered water jet may be used to cut and size the sheet of polypropylene. A can perforator will be necessary to make holes in the aluminum cans, although this can be done with simple tools such as scissors as well. A heating system to bend plastic will be used to shape the hood. Screws, bolts, and screwdrivers may be necessary to assemble the panels and the bulbs as well.

All in all, with these materials, the project will cost around $218 to make, but further research may prove to not require a solar panel which would greatly reduce the cost. Long term costs of the device would be greatly decreased by utilizing materials available including a chain link fence, corrugated metal, wood, metal tent poles, cinder block, thin plastics, canvas, tires, cartons and buckets, plastic crates, and string. We will develop our design with these resources in mind.

Equipment

We plan on using the Invention Studio for much of our work and will not be requiring individual pieces of equipment costing greater than $1000.

Services

The simpler our device is the more effective it will be. Refugees inside the camp need to have the skills to repair and possibly build these heating devices. There is a wide variety of education levels and past professions in the camp, however we cannot not count on the availability of specific skill sets. Therefore we do not anticipate needing any services, the resources at Georgia Tech should be more than sufficient.

Travel

An opportunity for travel to a refugee camp in the Middle East would be ideal, and hopefully take place Summer or Fall 2017. For two students traveling for one week such a trip would cost $3100 total. The expense breakdown is as follows: $2000 for airfare, $455 for a hotel room for one week, $199 for food, $147 for a rental car, $300 for incidentals. All prices are estimated based on a trip to Amman, Jordan. The benefit of this trip would be to physically expose us to our problem space and give us an opportunity to talk to users face-to-face. We would no longer have to make highly educated guesses about our problem space. More pragmatically, we will be visiting the International Rescue Committee's Atlanta headquarters often, as they are currently our primary connection to Zaatari. The headquarters are outside the city and an Uber ride costs approximately $40 each way. We would need to make these trips in order to talk to IRC employees and former refugees. We also hope to attend a conference in the near future pertaining to refugee housing or heating in order to network and get new ideas. As of yet, we have not found an opportunity to do so.

Expected Outcomes and Future Directions

When this project is over, we hope to improve the quality of life for refugees in Zaatari by providing them with an affordable, sustainable, and electrically-efficient way to heat their homes. During Year 2, we will create our solution and partner with an organization for funding and implementing our project overseas. After Year 2, we will use our connection with the organization to implement the solution in Zaatari. As the solution is successful, we will branch out and start implementing the project in other refugee camps, particularly in those which are also governed by our partnering organization. Some of these organizations that we could partner with include the Norwegian Refugee Council, the United Nations High Commissioner for Refugees, and the United Nations Office for Project Services as they are three organizations that work directly on shelters in Zaatari (Syrian Regional Refugee Response, 2016).

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