# CALCAN

*Clean Ample Lightweight Can*

ME 110, Spring 2016
Introduction to Product Development
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# 1. CONTEXT

663 million people in the world lacking access to safe water[1] despite the various global efforts to tackle this problem. Lack of access to safe water is not limited to any particular region, and can strike anywhere even in developed countries. The 9.0 magnitude earthquake that struck the coast of Japan in 2011 rendered many temporarily short of water due to the destroyed water piping networks. Similarly, the Haiti earthquake led to many people being displaced and housed in emergency shelters.

More recently, the refugee crisis has gotten more media attention. Refugee camps often lack access to clean water due to the fact that they often form very abruptly and quickly leaving no time for building of piping infrastructure even if there are the resources to do so. Often, refugees try to settle near to any water source they may find[2] even though the water is not safe for drinking. Non-Governmental Organizations (NGOs) often spend plenty of money and effort to transport and treat water to drinkable standards at these refugee camps. However, despite all the efforts to bring clean water to the camps, the water often gets re-contaminated with dirt and fecal matter due to dirty hands and exposed buckets[3] during the transportation process from the collection point to their homes, increasing the risk of the outbreak of waterborne diseases. Often, women and children are tasked with carrying this water[1] which still ends up getting re-contaminated, putting all prior efforts to naught.

# 2. MISSION STATEMENT & VALUE PROPOSITION

## 2.1. Mission Statement

CalCan aims to improve the status of safe water transportation in the developing world by developing a personal container that is easy to clean, transport, and which prevents contamination. We aim to design a durable and sustainable container that can be widely adopted by NGOs for use in Zataari refugee camp and all similar areas facing the problem of water recontamination.

## 2.2. Value Proposition

CalCan is a safer, cheaper and more versatile container that allows users to transport water safely from the distribution point to their homes without fear of recontamination.

# 3. CUSTOMER AND USER NEEDS

## 3.1. Background Research: Pre-interview

Our background research was done in three main components – a literature review, informal interviews with known contacts who face problem of water access, and drawing upon our own experiences outside of class. Prior to conducting interviews, a literature review was done to investigate the context and current situation regarding water recontamination. Publicly available material online from the websites of Médecins Sans Frontières (MSF) and the United Nations High Commissioner for Refugees (UNHCR) confirmed that recontamination was a serious and widespread problem in refugee camps[5]. In particular, a survey conducted in Zaatari camp in Jordan by UNHCR showed that 24% of survey respondents experienced diarrhea due to exposed water during transportation[5]. While we researched on Zaatari Camp in Jordan, we also conducted informal interviews regarding water transportation with friends and family members as our team is composed of people from six different countries including China, India, Iran and Peru. Several members of the team also brought in material from previous classes and from engineering clubs on campus. Through this preliminary research, the strongest common point that resurfaces was the need for a personal device that protect the water from the environment and which could be easily transported even by children.

## 3.2. Collecting Raw Data: Experts

With the basic understanding of the problem, we then identified and interviewed three groups of experts – people who have worked in the area of water recontamination and transportation, people who have knowledge of Jordan and Zaatari camp because they have worked there or grew up in the region, and people who face a problem of water transportation in general. From the first group, we interviewed Syed Imran Ali, a post-doctoral researcher at the Blum Center for Developing Economies at University of California, Berkeley who has volunteered with MSF at refugee camps in Pakistan, Sukkur and Jordan to improve water and sanitation conditions. We also interviewed Mogboluwaga Ayo Olubunmi who was a faculty member of the industrial design engineering department of Delft University of Technology for his work on household water containers for use in refugee crises. Other interviewees in this category

include Caroline Delaire, and Alyssa Yu. From the second group, we interviewed several students currently in UC Berkeley who have been to or grew up near Jordan including Roy Zebian, Nour Coudsi, Khairuldeen Al Makhzoomi, Niveen Rizkhalla and . Lastly, family members and friends from India and China were interviewed to determine if there were any common needs regardless of location. These interviews are shown in **Appendix A**.

### 3.3. Interpretation of Raw Data

From the interviews conducted, key insights and user needs were generated using the same process of converting user statements into needs statements that was done in class. The common needs statements were grouped together and used to generate the top five main user needs for a personal water transportation device. These top five user needs are summarized below.

The product must:

i) Prevent entry of contaminants
ii) Be easy to clean must prevent contamination,
iii) Be physically easy to transport (for women and children)
iv) Have sufficient volume
v) Be easy to ship (by NGOs).

Both Syed and Mogboluwaga agreed in their interviews that current methods of transportation are either too exposed or too hard to clean, and emphasized the importance of keeping the water free from contaminants – an important feature that is glaringly missing from current buckets and jerry cans. They also brought to our attention the minimum water requirements of a typical refugee household, and emphasized that collecting less water could severely deteriorate hygiene conditions in a camp. This gave us the valuable point that the device must have ample water carrying capacity.

Other interviews including the interview with Alyssa highlighted that women and children are often tasked with the task of collecting water, of at least an hour a day and that this task is physically challenging. This brought up the necessity of making the device easy to transport from one location to another over long distances. The interviews with Khairuldeen and Niveen highlighted that there should be an easy to way keep the container clean even with a lack of water.

Finally, we note that our users and our customers are not the same. While the users of our product will be the refugees, our customers are the NGOs in charge of water in refugee camps including UNHCR and OXFAM. We thus leveraged on Syed's work with MSF to determine specific concerns of NGOs. This provided us with the valuable insight that NGOs are concerned with the cost of the product which is attributed largely to the transportation of the product to the camp. A product that is easy to ship will invariably cost less and will thus be more likely to be adopted by NGOs.

From this, we were then better able to create a persona – Leyla, a typical refugee girl in Zaatari camp who is tasked to collect water. The persona can be seen in **Appendix B**. Having a persona helped the team put the situation in context and was helpful when brainstorming for concepts shown in the next section, *Concept Generation.*

## 4. CONCEPT GENERATION

### 4.1. Identifying the Problem

In order to design a solution, we first had to be clear on what the problem was. With the literature review as well as the insights from our interviews, we found out that the main problems in transporting water in Zaatari camp are that the women and children have difficulty to carry and keep the water from the distribution tanks clean when bringing the water back to their houses. We thus focused our design on a device that could make carrying of water easy, while ensuring that the water stays clean in the transportation process.

### 4.2. Determining the Concepts

With the problem in mind, we further decomposed the main problem into components in order to determine the key functions of the device. We then generated our ideas based on these functions that the device must serve. Key functions include bringing water from a point to another, contaminant free, contaminant prevention, and being stackable. With these key functions in mind, we then each generated 10 ideas with every idea aiming to fulfil at least one of the key functions listed above. A sample of an idea generated is shown below in Figure 1. After we each shared our 10 ideas amongst the team, we then brainstormed and drew inspiration from each other's ideas. Using the SCAMPER method and morphological matrices, we then expanded upon our ideas by mixing and meshing ways to fulfil the functions to finally obtain another 10 ideas each for a total of 100 ideas. The full list of concepts generated can be seen in **Appendix C**.

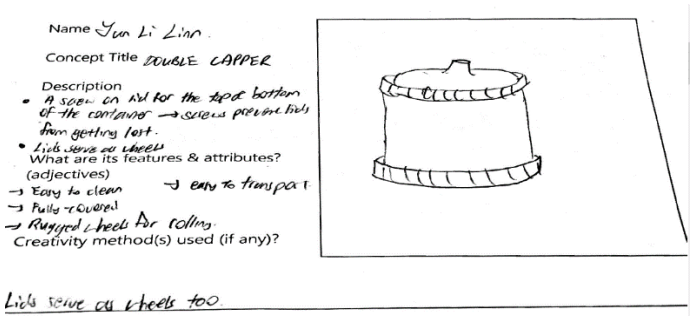


**Figure 1.** Sample sheet for concept generation process

### 4.3. Classifying and Consolidating Concepts

In this process, we invariable came up with multiple similar ideas as may be seen from the list in Appendix B. These concepts were then classified according to their main features:

i) Rollables
ii) Wearables
iii) Filters
iv) Collapsibles
v) Bladders
vi) Cleanables

Grouping the ideas together was done in a bid to consolidate the 140 ideas, as well as to serve as an informal form of voting for the features that could address the problem stated above. We noted that these concepts also generally targeted either one or more user need, indicating that we were on the right track.

### 4.4. Reflection on Possible Solutions

While we managed to successfully group our ideas, we note that none of the ideas alone could fully address all of our top five user needs. While rollables made transportation easier, it alone cannot solve the problem of keeping the container or the water clean. Similarly, a filter by itself may provide clean water, but it does not address the issue of physical exertion in carrying the water.

Furthermore, while it was not a need that surfaced, the team was constantly tying each idea back to the triple bottom line (TBL). With the TBL in mind, cost and manufacturing were a couple of issues that we anticipate having to consider more carefully when narrowing down our 140 ideas. Similarly, we were aware that while some ideas may seem radical, the cost of manufacturing and prototyping may render the idea unfeasible. Nonetheless, this concept generation process helped us consolidate our ideas, and gave us the inspiration for the final prototype.

## 5. CONCEPT SELECTION

The next logical step for the team was then to narrow down the concepts while trying to retain the best features and ideas. At the same time, we had to be open to new ideas which would randomly spring up. This proved to be the hardest process, which took several iterations, scoring matrices, and voting rounds.

### 5.1. Rating the Concepts I: User Needs Selection Matrix

We first took the approach of using a scoring matrix to score our ideas based on how well they could meet our top five user needs. At this point, metrics were avoided since the concepts were still not fully developed and assigning metrics would add complexity to the scoring process. Instead, metrics were added in a later stage as will be described slightly later. The ideas were then ranked from a score of one to five for each user need with the score assigned based on the idea's potential to achieve that user need. A score of one equates to a poor potential, while a score of five indicates great potential to fulfil the user need. This first scoring process was done for all 100 ideas and proved to be extremely useful in helping us narrow our ideas down to the top 3 ideas. The results from the scoring process can be found in **Appendix C**. A sample of the matrix is shown in Figure 2 below:

| IDEAS | Easy to Clean | Prevents Entry of Contaminants | Suffcient Volume | Easy to Carry | Easy to Roll | Collapsible (Storeability) | Total |
|---|---|---|---|---|---|---|---|
| Carry-On Bucket + Side Handles | 4 | 1 | 4 | 4 | 1 | 3 | 13 |
| Duffle Bag Container | 4 | 4 | 3 | 3 | 0 | 4 | 14 |
| Carton Container + Filter | 1 | 4 | 3 | 2 | 0 | 4 | 14 |
| Cubic Plastic Container + Filter + Outlet | 1 | 4 | 3 | 2 | 0 | 4 | 14 |
| Carry-On + Flat Container + Filter | 2 | 4 | 3 | 4 | 0 | 4 | 15 |
| Water Wheel + Modified Shape (Bladder) | 5 | 5 | 3 | 4 | 5 | 4 | 21 |
| Bucket + Folding Outlet (Easy Stacking) | 4 | 3 | 3 | 3 | 0 | 3 | 12 |
| Bucket + Outlet + Filter + Modified Shape | 4 | 3 | 3 | 3 | 0 | 3 | 12 |
| Bucket + Bottom Handles (Carry on Head) | 4 | 3 | 3 | 2 | 0 | 3 | 11 |
| Duffle Bag Container + Filter | 3 | 3 | 4 | 2 | 0 | 4 | 13 |
| Pressure Locker | 4 | 4 | 3 | 2 | 1 | 3 | 13 |
| Double Capper | 4 | 3 | 4 | 2 | 5 | 3 | 17 |

**Figure 2.** Sample from the first round of scoring matrix based on user needs (top scores were highlighted)

### 5.2. Iteration of Concept Generation

Inevitably, this first rough round of concept selection meant that several great ideas were cut out due to an arguable arbitrary scoring. We thus went through a second iteration whereby we brainstormed from these top three ideas to expand to a new set of top 20 ideas. This allowed for previously cut out ideas to resurface for a second chance of scoring, as well as gave us inspiration for new ideas. The new list of 20 ideas can be seen in **Appendix D**.

### 5.3. Rating the Concepts II: Design Metrics Selection Matrix

With this iteration of the concept generation process, we were better able to visualize our ideas as this process forced us to more concretely describe our ideas to our teammates. More importantly, this made it a ripe time to assign metrics to each user need (if applicable) and perform another round of scoring. Using metrics allowed us to assign a physical unit (be it weight/length/time etc), to more concretely score our ideas. A same scale of one to five was used for scoring, but it was based on metrics instead. Keeping in mind the triple bottom line, cost was also added into the mix this time as our interview showed that cost is an important consideration by NGOs. The conversion from user needs to metrics is shown in Table 1 below, and a sample of the final scoring session is shown in Figure 3.

**Table 1.** Conversion of user needs to metrics

| User Need | Metric |
|---|---|
| Prevent entry of contaminants | Size of exposed opening (inches) |
| Easy to clean | - |
| Sufficient Volume | Capacity (L) |
| Easy to Carry | Empty Weight (Kg) |
| Collapsible | Shipping Volume ($in^3$) |

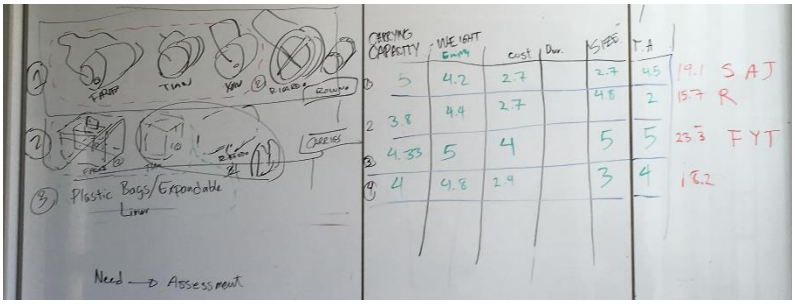


**Figure 3.** Sample of scoring based on metrics.

While the exact details and dimensions of the ideas was not set, going through this selection process brought us down to our top three features. Namely, the final design will have the features of:

i) Being rollable
ii) Have a cleanable of disposable internal membrane/bladder
iii) Being collapsible

Being rollable would address the user need of being easy to transport since rolling approximately 20kg of weight is invariably easier than carrying it on flat surface. Having an internal membrane would provide a layer to buffer against the environment, and the amorphous nature of the membrane would allow for easy sealing to prevent the entrance of

foreign matter. The flexible nature of this membrane would also allow for it to be easily removed for cleaning or replacement, thus addressing the user needs of preventing contamination and being easy to clean. Finally, being collapsible would reduce the space required to ship the product and hence lower its cost making it attractive to NGOs. With the membrane, containers would not have to be replaced as regularly due to degradation in cleanliness as the component to be replaced would be the membrane instead which is cheaper and easier to transport.
Note that even with the narrowing of ideas, the exact implementation and manufacturing was still left to be decided since the complexity of prototyping the idea was completely and deliberately left out of the picture in order not to hinder our creativity (this is addressed in *Prototyping and Testing* instead). The final design was also still left open to changes, with the only requirement being that they could incorporate these 3 features so as to allow for feedback from feedback sessions and following interviews. Nonetheless, a few rough initial Solidworks CAD models were generated and are shown below in Figure 4.

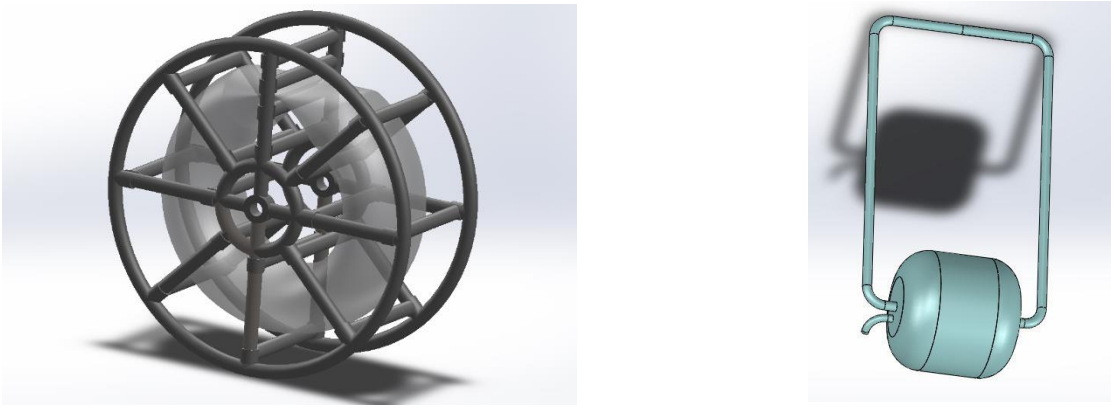

**Figure 4.** Two rough initial concept sketches

### Rating the Concepts III: Expert and General Feedback

With these final three top features and rough Solidworks sketches, we were able to consult our interviewees on their thoughts and feedback. Roy highlighted that the device must be easy to use and cannot be too complicated to assemble. This proved invaluable in helping in eliminate one of the rolling mechanisms we were toying with. Roy also highlighted the importance of being able to store sufficient volume of around 20-30L to meet the minimum needs. Niveen further brought up an important insight that many of the Syrian refugees come from places where the supply of water is abundant. They are hence not used to being in a dry place like Jordan, and that they could potentially not be as conscious in water-conserving techniques. We thus supplemented our top three features with the requirement that the final design must have a capacity of at least 30L. These interviews and feedback from people with knowledge of the area proved crucial in helping us with our final design, and was thus duly represented in our final design. Nonetheless, we note that even with these rounds of iteration, our final prototype still kept evolving based on the user feedbacks of our prototype, and our experiences while prototyping as will be described in the next section.

## 6. PROTOTYPING AND TESTING

Prototyping and testing was done in three main stages – low fidelity, mid-fidelity, and high fidelity. For all three stages, prototyping was done with the three main features (rollability, membrane, collapsible) in mind to ensure that the user needs are met. Between the stages, testing was done and the prototype was pitched to design experts as well as the general public through a LinkedIn critical review session as well as CalDay. The prototyping and testing stage was particularly helpful in helping us further develop and refine our concept as it helped us test how well our ideas could function, and allowed us to mimic the process of transporting water.

### 6.1. Low-Fidelity Prototype

To get our idea across quickly, we build a low-fidelity prototype using a 1:30 scale model. To allow rollability, two cylindrical food containers were cut and joint in the machine shop. The cylindrical shell allowed for smooth rolling as well as a cavity to store water. To illustrate the concept of a membrane, a crude but suitable idea was to use a latex condom due to its size and amorphous properties. An axle was designed and 3D printed, and a rope was attached to allow for pulling. A picture of our low-fidelity prototype is shown below in Figure 5.


**Figure 5.** low-fidelity prototype

From making this prototype, we were able to learn several lessons. Firstly, our initial guess that latex would be a strong enough material proved to be wrong. While its stretchable properties made it a good candidate for material, it would easily tear when stretched. From our testing, the latex membrane would often not last longer than several trials. Secondly, we were able to bring this to the LinkedIn review session and CalDay where visitors gave their inputs on the product. Several users highlighted that a good feature would be if the prototype could demonstrate the mechanism for being collapsible, and that if there is an option to pull it using a rope or a more rigid material. We found these feedbacks useful so they were duly noted and incorporated into our final prototype. With the low-fidelity prototype done, we confirmed that our design was capable of meeting some user needs, but it needed to be demonstrated in the full scale with improvements to the membrane and attachment mechanism.

### 6.2. Mid-Fidelity Prototype

Next we aimed to demonstrate our prototype in larger scale as close to the full scale as possible in order to do more extensive testing on whether the membrane and the container can support the weight of a larger volume of water. A picture of this larger prototype and its CAD design is shown below in Figure 6.

**Figure 6.** CAD rendering and a picture of the mid-fidelity prototype

At about the same period, we were introduced to the concept of designing for the environment and the Cradle to Grave concept. Through workshops in class, we were inspired to construct our product from materials that were either readily available, or from "waste". The main idea here was leveraging upon the concept that "one man's waste is another man's treasure". One such example is by using the large five galleon water cans used so commonly in developed countries as our main material base. By doing so, our product would not only be born from "waste", but would also have a large enough storage volume. To continue with the membrane feature to keep the water clean, a large trash bag was used. A hole was cut at one of the ends to allow for the membrane to be inserted and filled with water, and a clip is used to seal the bag shut. Again, new axles were designed and 3D printed, while two large water containers from Berkeley Institute of Design (BID) was cut and joint using duct tape in the machine shop.
With this mid-level prototype, we were able to realistically test the forces exerted on the can by a 20L volume of water. We were also able to test what kind of membrane would be strong enough to handle the pressure of the water. Finally, we were also able to test the design and strength of our rope-axle system. This product was rolled over various terrain including concrete, gravel and grass. In all our tests, we are pleased to report that the materials held up. However, we

also noted that the material of the trash bag was relatively fragile. While it was able to hold water overnight, we are not confident that it will last long. In a bid to reduce trash generated, we decided to proceed with a stronger material. Hence, testing of the mid-level prototype helped us reveal flaws in the membrane, but confirmed that the material of the containers used were decently strong.

### 6.3. High-Fidelity Prototype

Finally, we built our high-fidelity prototype with the intention of improving all the previous features of the mid-fidelity prototype, as well to incorporate the method of joining the two halves of the can together. A picture of the prototype and the improved bladder is shown below in Figure 7.

**Figure 7.** Picture of the improved prototype, prototype collapsed, and bladder

Firstly, rubber strips were sourced, cut and wrapped around the can to allow for less wear to the can itself. This would allow us to replace the rubber strips instead of the can when the material wears down. Due to its elastic properties, the rubber can simply be stretched and fit around the perimeter of the cylinder. Secondly instead of using a thin membrane, a thicker material in the form of low density polyethylene is now used and is our new bladder to be placed within the can. Thirdly, we incorporated the option of allowing the device to be pulled by rope and by a rigid PVC handle. Finally, a series of opposite matching threads was inserted at the edge of each half to allow for the two to be joint together in a sturdier manner to improve upon the taped system used in the mid-fidelity prototype. A picture of the two halves disjointed can be seen in the middle picture of Figure 7.

## 7. DESIGNING FOR THE ENVIRONMENT

CalCan looks to affect change in communities faced with widespread resource-scarcity--not just in water. For this reason, we take ‘design for environment’ very seriously. CalCan is dedicated to pushing the bounds of NGO-sponsored innovation, while minimizing the ecological impact of water transportation systems. We look to do this in the following ways:

From our prototyping phase through the eventual dissemination of shippable products, CalCan has and will continue to use recycled materials. Most importantly, the ‘outer shell’ of our product will be made from bio-friendly plastics or recycled materials.

To help the environment, CalCan is focused on minimizing the consumption of energy, natural resources, and manufacturing materials by making a durable solution to water transporting devices. The inner bladder/bag inside the outer shell is provided to maximize the lifespan of the shell since it is not required for the customer to get a new outer shell if the container has small cracks. Hence, each container will have a longer lifespan.

‘Green Manufacturing’ is not just a process, but a value of CalCan. This means that we are minimizing the impact of our final product--by making it as environmentally-friendly as possible--and the entire network and system of manufacturing that precedes it.

# 8. TECHNICAL FEASIBILITY

**Figure 8.** Final Production Design

optimizing both the end user experience as well as the manufacturing process were key components of our design process. We wanted to make sure the product was durable as well as easy to physically manage. In addition, we wanted to ensure the design allowed for streamlined and efficient manufacturing, both with respect to process costs and materials.

User performance dynamics centered on the mechanical properties of the materials involved as well as comparisons made to existing products. A primary concern was how the water inside the container wound affect rolling dynamics. Turbulence, a changing of center of mass, and the resultant fluctuation in momentum were deemed to be potentially serious problems while rolling. It was determined that using multiple bladders would mitigate these effects by limiting the range of motion for fluid volumes within each compartment. There was also the added benefit of lowering the full weight of the container the user would have to lift and more to the water outlet. The shape of the shell was also designed in a manner that would minimize stress causing moments on the device’s primary connection points. Testing conducted with the prototype showed that the plastics used in the prototype showed more than enough structural strength to resist both the outward water pressure as well as the forces exerted on the device while rolling.

From a manufacturing perspective, the need to use pre-existing products in prototype construction allowed us to confirm that all components could be manufactured, given the limited modifications made. In addition, the production final design, in Figure 8, incorporates various material and process cost saving measures. The final device design uses identical left and right shell components, to cut down on unique manufacturing processes and dies. The design also allows for multiple plastics and plastic forming technologies to be applied, including plastic casting and blow molding, that are low complexity, using limited production steps and resources. All components lack subcomponents, and can be shipped without need for factory assembly, cutting down on labor costs as well. Finally, the parts count was kept intentionally low, with a total number of unique parts limited to 6.

# 9. BUSINESS ANALYSIS

## 9.1. Business Plan

It’s essential to have an adequate business plan and financials in order to sustain, and grow our idea for years to come. A typical investor always cares about what’s in it for them. Their main goal is to leverage their money in order to make more money. Hence, in order for them to invest in our water transportation idea it’s essential for us to have a business plan that can position us differently from the competition. Our business plan was broken up into 4 sections as outlined below:

## 9.2. Why Us?

In today’s rapidly evolving marketplace CalCan merge's enterprise and social welfare. CalCan addresses a massive, world-wide market in which our product can make real positive impact and create a world of shared responsibilities. By combining our team’s technical experience and the additional bandwidth of connections provided by investors will allow us to make a big splash in water transportation.

## 9.3. Typical investor

1. NGO's- Clinton Global Initiative, Acumen Fund, BRAC, Ashoka
2. Corporate Companies- Microsoft, Salesforce Foundation, Coke, & Target

**Matching Gift Strategy:** Elevate the capability of your donor's contributions. One donation is always welcome. Two donations for the work of acquiring one seems too good to be true. It's not! Matching gifts give nonprofits that exact opportunity. Companies big, small, and everything in between, match gifts.

## Reward Strategy

Tax-Deductible: 501(C) 3 Incorporated. Not a single penny taxable.
Growth Prospects: 10-15% return in the long-run. Comparable to S&P 500 returns.

## 9.4. Conclusion of Business Plan

We believe that by having a detailed business plan will boost inventor confidence, differentiate us from the competition, and help position us to raise the necessary capital in order for our idea to become a reality.

## 9.5. Business Financials

An important aspect of business is the financials. The following data below showcases the required estimates of the cost, followed by a NPV analysis that showcases the growth trajectory and profit margins.

## 9.6. Bottom Up Estimates

Compare the price points with that of the industry average. For example, our competitors are hypo rollers, and Wello wheel. They are charging $50 to $100 per product. Our product aims to provide a highly competitive cost point.

## 9.7. Estimated Cost of Producing:

- Membrane: $1 (Alibaba.com)
- Container: $3 - Fixed Cost (Mold): ~$10,000, Variable Cost (Materials) (Alibaba.com)
- Connection parts: $2 (Home Depot)
- Holding cost rate (inventory costs): 20% (Wello Water)
- Shipping cost rate: 20% (Alibaba.com)
- Total unit cost (excluding mold cost): ($6) * (1.4) = $8.40

## 9.8. Bottoms-up Market Quantitation

- Average Selling Price (ASP): $30
- Target first year revenue (R): $1,500,000/year
- Customers (C) required to reach revenue target

  C = R/ASP = 50,000 customers/year

J72 fx 20%

**NPV PROFITABILITY ANALYSIS (New Product)**

**Company:** CalCan
**Members:** In, Ankita, Riccardo, Josh, Tien
Analysis Date: 42487

| | | | Sales Price |
|---|---|---|---|
| **End-User Price** | $ 30 | Gross Margin | |
| Reseller 2 (if any) Price | | 0% | $ - |
| Reseller 1 (if any) Price | | 0% | $ - |
| Company Sales Price (to reseller) | | 0% | $ 30 |
| **Company Target Cost** | $ 30 | (or less) | |

**Note: For all input numbers, show a separate sheet describing how you determined these numbers.**

| **Calendar Year** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **TOTAL** |
|---|---|---|---|---|---|---|---|---|
| **Expected Volumes** | 50,000 | 65,000 | 100,000 | 150,000 | 200,000 | 250,000 | - | 815,000 |
| **Company Actual Sales Price** | $ 30 | $ 25 | $ 22 | $ 20 | $ 18 | $ 15 | - | |
| | | | | | | | | |
| **FIXED COSTS** | | | | | | | | |
| **(describe costs on separate page)** | **0** | **1** | **2** | **3** | **4** | **5** | **6** | **TOTAL** |
| - Product Development | $ 18,000 | $ 11,500 | $ 7,700 | $ 4,350 | $ 600 | $ - | $ - | $ 42,150 |
| - Machines & Equipment | $ 8,000 | $ 6,000 | $ - | $ - | $ - | $ - | $ - | $ 14,000 |
| - Mfg Start-up | $ 2,400 | $ - | $ - | $ - | $ - | $ - | $ - | $ 2,400 |
| - Tools/Molds (inj. molding, casting, etc.) | $ 10,000 | $ 10,000 | $ 10,000 | $ 10,000 | $ 10,000 | $ 10,000 | $ 10,000 | $ 70,000 |
| - Testing (UL, FDA, CE, etc.) | $ 2,600 | $ - | $ - | $ - | $ - | $ - | $ - | $ 2,600 |
| - Misc 1 | $ 1,000 | $ - | $ - | $ - | $ - | $ - | $ - | $ 1,000 |
| - Misc 2 | $ - | $ - | $ - | $ - | $ - | $ - | $ - | $ - |

**Figure 10:** NPV Analysis

| VARIABLE COSTS / unit (describe costs on separate page) | | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|
| - Material | | $ 8.40 | $ 8.40 | $ 8.40 | $ 8.40 | $ 8.40 | $ 8.40 | $ - |
| - Labor | | $ 2.50 | $ 2.50 | $ 2.50 | $ 2.50 | $ 2.50 | $ 2.50 | $ - |
| - *Overhead %* | | | | | | | | |
| Material OH | 10% | | | | | | | |
| Labor OH | 10% | | | | | | | |
| Total Overhead Cost | | $ 1.09 | $ 1.09 | $ 1.09 | $ 1.09 | $ 1.09 | $ 1.09 | $ - |
| - Shipping | | $ 0.25 | $ - | $ - | $ - | $ - | $ - | $ - |
| - Misc | | $ - | $ - | $ - | $ - | $ - | $ - | $ - |
| PRODUCT'S VARIABLE COSTS / unit | | $ 12.24 | $ 11.99 | $ 11.99 | $ 11.99 | $ 11.99 | $ 11.99 | $ - |

| ANALYSIS | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|---|
| Unit Contribution Margin (Price - Variable Cost) | $ 17.76 | $ 13.01 | $ 10.01 | $ 8.01 | $ 6.01 | $ 3.01 | $ - |
| Gross Profit Margin | 145% | 109% | 83% | 67% | 50% | 25% | #DIV/0! |
| Revenues (Price * Volume) | $ 1,500,000 | $ 1,625,000 | $ 2,200,000 | $ 3,000,000 | $ 3,600,000 | $ 3,750,000 | $ - |
| Total Variable Costs (Volume * Var Cost/unit) | $ 612,000 | $ 779,350 | $ 1,199,000 | $ 1,798,500 | $ 2,398,000 | $ 2,997,500 | $ - |
| Gross Profit (Rev - Tot Var Costs) | $ 888,000 | $ 845,650 | $ 1,001,000 | $ 1,201,500 | $ 1,202,000 | $ 752,500 | $ - |
| Fixed Costs | $ 42,000 | $ 27,500 | $ 17,700 | $ 14,350 | $ 10,600 | $ 10,000 | $ 10,000 |
| Pretax Income (Loss)=Gross Profit-Fixed | $ 846,000 | $ 818,150 | $ 983,300 | $ 1,187,150 | $ 1,191,400 | $ 742,500 | $ (10,000) |

**Figure 11:** NPV Analysis

### 9.9. Conclusion:

The NPV analysis proves that our product is a very scalable idea with investment returns that are on par with any other investment idea. Our expected volume sales are 50,000 with an average cost of $8.40 is a very reasonable estimate considering that Zaatari camp has close to 80,000 residents and entire refugee camp population worldwide is close to 5 million. To add on even developing rural areas can be a potential market that we can venture which would boost our market size to close to 3 billion.

Considering our low price point of $30 we are positioned to make money and are looking at long-term profit of 15-20% profit. This return is comparable to any other investment and with a multitude of tax benefits would only incentivize NGO's and corporates to invest in our non-profit. Even my existing out of our company the investor would only have to pay 15% in taxes compared to other investment where the minimum tax rate is 30%. In all our transportation device is a profitable venture with low costs, and a high profit margin making it a winning investment for all parties involved.

## 10. LESSONS LEARNT

### 10.1. Research

During the user research phase, we spoke to secondary users who have been to Zaatari or other refugee camps. We also interviewed people who have lived in rural areas where access to water has been a challenge. Throughout the process for interviewing and analyzing the interviews, we learned that the interviews that were conducts in person or where recorded were more useful as we could relate to the users better than those conducted through emails or phone calls. For further development of this product, we would like to interview our primary users by visiting the camp.

Regarding getting feedback on the prototype, we got good feedback from visitors at Cal Day and the LinkedIn tradeshow. However, to develop more features on our product, we will test the entire process of collecting and transporting water on women and kids of various ages to make sure that our product is ideal for all sets of users.

Finally, we are assuming that NGOs will support us in distributing and using this product, and we should contact some NGOs that work in Jordan to get more feedback.

### 10.2. Approach

The product development process is not a rigid formula. Designers needs to jump from one part of the design process to another or go through the process of researching, ideating, and prototyping again. After defining the design specifications from the user needs, we have used the divergent-convergent design process to generate, score, and select our final prototype. We have been through the design process twice to get the product we have. We anticipate that as we research more about the people in Zaatari and visit the place, we will learn more about our users and will have to go through the design process to modify our solution again.

### 10.3. Prototype

Currently we have some rapid prototypes of our concepts based on the limited budget we had. We also have estimated from manufacturers in China on building our concept. In the future, with more funding, we will test various prototypes (manufactured product vs the one made from reusable parts) so see which one best fits the needs of our users and customers, and is environmentally friendly at the same time.

# 11. WORKS CITED

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# 12. APPENDICES

**12.1. Appendix A – Interviews**
**12.2. Appendix B – Persona: Meet Leyla**
**12.3. Appendix C – List and Scoring of Concepts Generated**
**12.4. Appendix D – New List of Concepts Generated**

# APPENDIX A – Interviews

**1.**

**Date: 02/10/2016**

**Location: Berkeley, California**

**Interviewer: Ricardo Fort**

**Interviewee: Chris Jones**

**Interviewee Background:** concerning Camelback water storage system

RF: Hi Chris. This interview is to ask you a few questions concerning your thoughts and experiences using a Camelback or Camelback-like water pack.

Chris: Sounds good.

RF: Here's my first question. When and why do you use a Camelback?

Chris: Okay. Why do I use it?

RF: Yeah. Why, or when, or where.

Chris: I use it because it allows me to bring water in all sorts of circumstances. I can bring water when mountain biking, or hiking. Going anywhere, really. Going outdoors; anywhere. Also, you can use it to carry extra stuff, like snacks and supplies, in the surrounding pouch. It also can kinda protect your back, like if you fall on it. It supports your back. Oh, I also use it for ROTC. For activities and running.

RF: How long do you usually use it for?

Chris: Couple hours usually. Two, maybe more sometimes.

RF: Can you give me a walkthrough of what it's like to use it, kind of like a step by step?

Chris: Okay, well, if I'm not lazy I'll open it up and make sure to rinse it and air-dry it.

RF: Why?

Chris: I don't want weird stuff in it. If it's been awhile I'll make sure to run some water through it. Also gotta make sure to get air out of the bladder. It's a bit of a process. Once you get through that though you're good. Stock up on some snacks, put it on, and you're good to go.

RF: Is there anything you like or dislike about it?

Chris: Well, that whole drying process, like I said, is annoying. The bladder is hard to keep open. They do sell products to help keep them open while drying.

RF: Why is drying important?

Chris: Well, you don't want anything to grow in there. Bacteria. Gross stuff.

RF: Are there any design elements of it that you like?

Chris: Yeah, with some units, the drinking tube is insulated, with like mesh. Also, some have a bite guard. I like those.

RF: Why?

Chris: Helps counter dust and dirt.

RF: Is dust and dirt a problem?

Chris: Yeah, it turns like mud. Sometimes if it gets in there it makes it tough to close the system.

RF: What if dirt gets in the bladder?

Chris: Dirt isn't gonna get all the way in there, but yeah if it gets in the tube it's a pain.

RF: How do you clean it?

Chris: Hot water and soap.

RF: How about the bladder? Do you clean that?

Chris: Yeah.

RF: Why?

Chris: Like I said before, you don't want things growing in there. You clean it the same way as you clean the tube, with hot water and soap. Some companies sell cleaning tabs. I think they have bleach or something.

RF: Are there any positives or negatives about the cleaning process? Anything that stands out?

Chris: Yeah, it's tough to get in there. Camelback has like a threaded cap opening that can be a pain. There's another company, Hydrapak makes bags with a better opening. They're bigger and easier to get into. It's like a lip that folds over and then a sliding lock that seals it. It's way wider and more convenient.

RF: Do you think that is a feature you would look for if you were shopping for one?

Chris: Yeah, definitely. Oh, something I like is when the tube has a 90 degree bend. It seems like a small thing, but its way easier to use when the tube has a bend. If it's just straight, it's kinda weird to use. You gotta twist your wrist around. Also, the tube could get kinked.

RF: So you like the 90 degree bend because it's easier and more comfortable to use?

Chris: Yeah.

RF: Are there any other features you might look for when shopping? Any features that might stand out, or make you choose one over the other?

Chris: I mean, there are things, like if it was flatter, and wider. Sometimes they kinda bulge out and feel awkward, especially if they slosh around a bunch. It can feel like it's affecting you center of gravity. Some have, like, internal baffles that help to control the movement.

RF: Are there any design improvements you would make, if you had the chance?

Chris: Well, again, it'd be nice if they were flatter and less awkward. Maybe shaped in a way to better distribute the water, like a vest maybe, although that might be more work to take off. Still, maybe it would depend on what you're using it for.

RF: Well, thanks Chris. That was all really good information.  I appreciate it.

Chris: Yeah, no sweat.

**2.**

**Date: 02/16/2016**

**Location: Andhra Pradesh, India (via Skype)**

**Interviewer: Sujay Choudary Yantrapragada**

**Interviewee: Nitin Gaddipati**

**Interviewee Background:** CMU (Master Student)

S: How closely do you resonate with the Indian culture?

N: I go to India every year, and grew up in India for the first 13 years of my life. I am well aware of the Indian culture, values, and traditions. As a matter of fact, I make it a point to celebrate every Indian cultural festive here in America, and raise awareness among my friends about Indian values, culture, and traditions. I have plans to move to back to India, after I am done with my education.

S: How closely did you monitor the water transportation system in India?

N: I come from a family of farmers and go back to visit my village every year. Over the years, I have seen my village progress slowly and become a interconnected with the rest of the world. However, the one thing that has stayed constant is the water transportation system. For example, fiber optics was a recent phenomenon in India that only started at the turn of the new millennium. As India, became more industrialized one would assume that infrastructure would improve the water transportation system. However, the Indian government built great new cities neglecting the rural areas.

S: So how does regular human being get hold of water in your village?

N: Water infrastructure is there for people who have houses and can afford it. However, the middle class, to poor people that live in subsidized housing and huts have to resort to going to the nearby canal or river getting water.

S: How do they get water?

N: They usually have a steel can, or bucket and fill it up. Every member of the family usually come with a bucket or can and fills up the bucket.

S: Can you describe the bucket/can more? The material of it?

N: My grandmother told me that from 60's-90's plastic cans were usually the mode of transportation. They were not very reliable at all. However, from the turn of the century more and more people from what I observed are using a steel can and we all know that steel cans last much longer.

S: How do they carry the water?

N: The mode of transportation is to carry it on the sides, or on top of the head. It is a very physically tasking job.

S: Is the water covered?

N: No the water is not covered. One of the biggest problems is that the water is extremely dirty and by transporting it without a lid it gets exposed to harsh chemicals and dirt from hands of others. You should realize that the main purpose of the canals is to feed the farms so that they would have year round water supply.

S: How long does the water last?

N: According to my grandmother, who grew up with getting water from the canals and rivers told me that the water usually last about a week. This is considering the fact that the water is used only for drinking. Majority of the population that relies on such water takes a showers on the banks of the canal or river.

S: What some other ways to get water in the villages?

N: Some of villages have common taps now, which reaches more people with a better quality of water. However, this is just in the beginning phase in India, and will take more time to make this universally applicable.

S: Do you see a feasible solution to this problem?

N: Well this is a very complex problem to tackle. For example, drip irrigation played a huge role in helping solve the problems for millions for farmers. I think the solution to this problem stems from the farmers. Farmers in India get uninterrupted water supple thru canals which are then fed into their systems through drip irrigation. The local farmers need to do a better job of helping build the local infrastructure. Or a more temporary solution would be a better device which eases their mode of transportation.

**3.**

**Date: 02/20/2016**

**Location: Berkeley, CA**

**Interviewer: Yun Li Linn**

**Interviewee: Syed Imran Ali**

**Interviewee Background:** Post-Doctoral Researcher at Blum Center for Developing Economies at UC Berkeley

1) Can you list some of the methods/devices that you have seen being used in refugee camps to transport water to and from the tap stands back to their households? And where were they used?

- Oxfam Bucket
- Regular buckets
- Jerry cans
- Janky buckets of all shapes and sizes
- Anything available that does not leak too much water

2) Is there any contamination that occurs during this journey of transport, what do you think is the main cause of contamination? (i.e. dirty hands etc.)

- Dirty hands
- Dirt inside container (already existing – containers are often dirty to begin with)
- Material falling from outside the containers
- Introduction of dirty cups/utensils when drawing water for drinking.

3) In your opinion, what are some of the advantages and disadvantages in the methods described in 1)?

- Often different aims are contradictory
- Eg. Being easy to clean means a large opening is required which in turn allows debris and dirty hands to enter
- Some buckets are easy to stack and hence easy to transport by the NGOs
- Some are old buckets with weak handles
- Buckets are often regular buckets – handles were not designed for carrying over long periods of time – calluses.
- Lids to buckets often go missing

4) From your experiences, what do you think can be improved on the existing devices?
The holy grail for water container in the field would have the following features:

- durable
- cheap
- stackable (easy to transport)
- easy to clean (wide enough open access to clean inside)
- closed to outside contamination
- sufficient volume (15-20 L)
- easy to carry/transport (most of the time, women have to carry over long distances -- over time can lead to chronic musculoskeletal conditions and a huge time/labour burden for women)
- Some of these are contradictory so you get an idea of why design the perfect device is so difficult!

5) Assuming that cost/weight etc are not constrained, what features would you like to have on a new device? What would that solve?
Same as 4)

**4.**

**Date: 02/16/2016**

**Location: Berkeley, California**

**Interviewer: Ricardo Fort**

**Interviewee: Steven Bosiljevac**

**Interviewee Background:** Captain, National Health Service, Professional Engineer (Environmental), PhD.

Ricardo Fort: Hello Steven. Thank you for speaking with me today. Do you mind if we start off with me asking you a bit about your past experience?

Steven Bosiljevac: I have over 30 years combined experience working with the National Health Service and the Peace Corps.

RF: Has any of your experience touched on clean water access in Aid or development environments?

SB: Yes, I've worked with Engineers Without Borders on a groundwater arsenic remediation project in Peru for 5 years. I was a water and sanitation technical trainer for the Peace Corps in Nepal. I have vast experience with water projects working with the National Health Service, as well as the working with the Indian Health Service.

RF: From your experience, could you tell me what some of the primary issue faced by users dependent on a tap stand or centralized water hauling situation face, and what someone working in these environments might want to take into account?

SB: The are numerous issues and concerns. First off, water is heavy. Extremely heavy, and its generally carried by women and children. It's a sad truth that in these circumstances it is often the most physically capable that won't contribute to tasks that may be considered menial. Also, contamination. Source water is often contaminated, and if it isn't, it is often contaminated during hauling, or by improper storage. In circumstances of limited water supplies, people have been known to hoard their water, and it doesn't take long for that water to go bad. Also, there are other risks. People are often attacked or robbed on the way to water collection points, because would be attackers know the paths they will have to use.

RF: Are there any specific problems you see with current water transportation devices.

SB: Yeah, like I said before, they can be easily contaminated, either by people putting their hands in the water, or by debris falling in. It is also physically difficult to carry water in that manner. Certain populations have learned how to carry water on their heads, but those are just a fraction of all water hauling populations. It should be noted, too, that water hauling can be a cultural thing. You find it in certain parts of the world, say, Southeast Asia and Africa, but not so much in, say, South and Central America, where point of use water systems are more common.

RF: that's good to know. Are there any characteristics someone might want to take into account if they were designing a new type of water hauling system?

SB: Yes. Having a small opening or closing cap would help reduce contamination during transport. Also, the material must be resistant to cleaning agents like chlorine or bleach. Also, as far as volume is concerned, there must be a balance. It must not carry too much water so that it's not too heavy, but it also should carry enough water to minimize trips and potential trip hazards, like attack or theft. Something to look at might also be how water is stored. When all water is stored in one place, it creates an ideal environment for the spread of pathogens.

RF: Are there any organizations you might recommend to find out more about these types of environments, and maybe even if there are organizations that specialize in working with refugee camps.

SB: There are numerous organizations. To find out about refugee camps, you should really look into the Sphere Project charter for humanitarian response. Groups to look at might be the USAID Office of Foreign Disaster Assistance. Also the United Nations and the Red Cross.

RF: Thank you for all the information and for your time Steven!

**5.**

**Date: 02/23/2016**

**Location: Berkeley, CA**

**Interviewer: Ankita Joshi**

**Interviewee: Alyssa Yu**

**Interviewee Background: Worked on a water purification project in El Salvador**

- water testing of the ground water that the people used for everything
- pumped for 6 hours a day.
- Water not treated
- Bacterial contamination
- water from one pump shared by Adjacent communities.
- 300 homes 1000 people
- water transportation
    - pumped from the ground water well to distribution tank
    - that pushed the water directly to the taps of the houses
    - water wasnt flowing 24 hours a day
    - fill a tank with water.
        - tanks not covered
        - stored outdoors
    - water used for drinking and cooling
    - recent policy to chlorinate the water
        - not enough to use it for everything
- Water contamination
- iron and mg
  Adds taste and odor to the water (people dont drink water at all).
  bacterial concern. water is not treated at all
- Alternate sources of water
    - no alternate source of water
    - a lot of kindney problems for people because they no not drink water.
- This pump supplied the 7 communities
- right across the street is a water treatment plant
    - distributed to the city
- each family had their own
- Water trucks come in
    - distribute “clean” water
    - only the edge communities get the water from the trucks
    - they do not come on schedule
    - government
    - peace corp trucks
- They had it out in the open.
- The faucets are open too
- the same water for everything
    - same buckets for every work that they do
- Varied a lot

        - some homes had running water
        - no one could figure out how it was distributed
        - relatively these homes are a lot more sophisticated
- Water bottles around with you
    - she carried a bottled water
    - tap water only to clean their fruits
        - that leads them to get sick
- Showers arent running
    - use buckets outdoors
    - they hand wash clothes
- People are just used to getting sick there. THey do not go to the doctor
    - people know that clean water is important. they are used to living without it.
- They view making money more than getting clean water.
    - they rather not deal with water
    - if it is inconvenient
        - no one is at home to get water when it comes
        - chlorinating their water
            - some do not have the time to go and get the packs from teh city
            - bottled water is expensive.

whoever is home gets the water

- access to water is a concern. but the cleanliness is a bigger issue
    - air is bad
    - they burn their trash
    - many mosquitoes
    - natural bacterial exposure
    - same as water leaving water here
    - no paved floors
    - stray dogs. effect is minimal. Tanks are pretty tall

**6.**

**Date: 02/24/2016**

**Location: Berkeley, California**

**Interviewer: Ankita Joshi**

**Interviewee: Caroline**

**Interviewee Background:** PhD Student in Environmental Engineering at UC Berkeley. Focus on water and sanitation in developing countries.

C: it would be interesting to me, many people have bikes. Married women do not ride bikes. Young girls and men do. They carry water in bikes. Women will not ride bikes. Bikes are convenient. If a solution includes bikes. Then it would be nice. The main transportation is a bike. A small cart or a platform. Something simple that they already use. It goes everywhere.

A: if women the people carrying, then will men do it?

C: she has other stuff to do

A: what about the men?

C: Muslin west bengal. Men were not opposed to fetching water. If it on the way they will do it. There is no taboo. Changes based on location. If it is going to me on motorcycle or bike, it will have to be in a closed container.

A: How are people carrying water currently

C: buckets. A public tap and they will fill their buckets or water for the wells, they had purchased water came in huge water bottles. Like the ones over the water fountains.

A: Relation between people who purchased water vs ones who got from the tap

C: purchase water: socio-economic water. People started realizing that well water will make them sick. It has iron. The water looks orange. They will say that they have gas. People who had higher risk perception purchased water.

A: far wells?

C: people have them in their backyard. Fetch water from public tap, that would be 1 or 2 km away. Safer source is far away. Anyone uses well water for cooking and everything. Some will only buy drinking water. Only drinking water is carried. Hopefully the purchased water is not contaminated. They give the water bottles back to the water guy who will clean it and take care of it.

A: what are the charges for this service?

C: Chargers for the service are? 20 liter jar is like 20 - 30 rupees. Also, two types of people transport water. The home people. Other than that there is water business. This will be someone like a kid with a cart who will carry these jars. Carrying all these jars for that kid is more difficult.

A: what are some other vehicles used by the water business people? Other vehicles are: rickshaws and trucks, cycle rickshaws.

A: weather effects on this

C: people complain about lack of drains in the villages. I was not there at that time. Then the cycle rickshaw cannot take it there with them.

C: water is kept elevated.

A: how people's behavior changes based on water

C: metallic water will use one glass to drink water without touching it. People in India just usually do that. It is a cultural thing.

A: Recreational stuff
C: these places there are many ponds. So people will go there. People will not waste this water. They have purchased it.

C: people who drink directly from it. And other people will filter it by a ceramic pot filled with sand a gravel to filter water. Or a pipe and cloth filter. They will make their own filters. Some people purchase filters.
Bought filters are about 10, 000 - 50, 000 rs.

C: Two type of people design for: the water business people or individual people

A: where do the business people get water from

C: They get their water from a guy from the village who had a treatment plant in his home. Or people legally or illegally get water from pipes in urban areas.

A: profit these people make?

C: They are portrayed as "bad people" media. They are not making that much money. Business of water is a low margin business. Now there is less emphasis on calling them names. They do provide water. Support these water vendors so that you can lower the price. Water is just not free.

**7.**

**Date: 02/24/2016**

**Location: Shenzhen, China**

**Interviewer: Tian Cheng**

**Interviewee: Mei Li**

**Interviewee Background:** mother of the interviewer. She has water transportation experience when she was a teenager.

Tian: Do you know anybody has experience in using any tools to transport water?

Mei Li: I have. I used bucket to transport water for my family when I was young.

T: What was the water source you got water from?

M: We got water from well. Normally, one village shared one well in the past.

T: How far was the well from your house? Was the road easy to walk?

M: Less than 1 km, and since the well was in the village, the road is flat and easy to walk.

T: what kind of bucket you used for water transportation? How was it look like? What is the material of it?

M: Just normal bucket with a lifting handle on it. At first, we used wood bucket, and later the metal bucket was getting popular. Now, if people still want to get water from well, they usually use plastic bucket.

T: Why did your family choose wood bucket at the beginning? What is the disadvantage of it?
M: Since the wood bucket is cheap, each family can make their own bucket, and also, there was no one selling metal bucket at that time. However, wood bucket is relatively easy to leak, and if it falls on the ground, it breaks into pieces easily.

T: Then you change the wood bucket to metal bucket, why, and any disadvantage of it?

M: Metal bucket is not easy to break, and it is thinner than wood bucket. However, metal bucket is more expensive than a wood bucket, and it is easy to rust when the coating falls off.

T: Did you used any plastic bucket for water transportation when you lived in the village?

M: No, plastic bucket got popular in 1990s, I already go to work in the city at that time. But I used plastic bucket in the house, just for cleaning mop, or saving water sometimes. Plastic bucket is cheap, and light.

T: Like you mentioned before, there are people living in the village still gets water from well. I have seen that the water could transport to the house by pipe in the village, isn't it?

M: Yes, now people living in the village can easily get water from tap. However, some villagers might want to save money, so they will get water from the well, because it is free.

T: And they use plastic bucket now, right?

M: Yes

T: Talking about the water transportation experience, after you took the water to home, how did you preserve the water?

M: I normally transport water couple times in the morning, and pour them into a big crock pot. The crock pot has a wood lid in order to prevent the pollution. Every time we needed water, we would get it from the crock pot.

T: What is the disadvantage of using bucket as a tool for water transportation?

M: Using bucket to carry water is energy and time consuming, or you could say it is inefficiency. If the water is for drinking, the bucket needs to be cleaned often, because it is exposed in air. Also, If the road is rough, the water spill out easily from the bucket.

**8.**

**Date: 02/24/2016**

**Location: Guilin, China**

**Interviewer: Tian Cheng**

**Interviewee: Shaolong Li**

**Interviewee Background:** cousin of the interview, does stone mining for living in China.

Tian: Hi, I heard from my parents that you are doing stone mining in Guangxi Province (China), and the water transportation system is not developed there. Could you tell me about how do you get water every day?

Shaolong Li: We normally get water from the hill, because there is spring water on the hill. The ways of transporting might be different depends on the mining sites.

T: Could you give me some examples?

S: For the mining site close to the hill, we built a little pool on the hill in order to save the spring water there, and the water could be transported through the pipe to our site.

T: What is the advantage and disadvantage for this method of transporting water?

S: The advantage is it saves time and energy; you don't have to go up hill every time to get water. The disadvantage is it took times to build the pool and design the pipeline. The road on the hill is kind of rough. If the road is flat we would use hard pipe like PVC pipe, because it is strong and easy to repair. But sometimes the road is rough and hard to construct the hard pipe, then we will use soft pipe like PVC hose in that area.

T: What about the mining site far away from the hill that has spring water?

S: We drive up to the spring water source. Then we use many jelly cans to contain water and put the cans on the truck and drive them to our sites.

T: What is the volume of the jelly can? Why do you choose jelly can?

S: I guess the volume is 50 Liters for the jelly can. Jelly can is easy to take in water and has good sealing.

T: How do you preserve the water?

S: Once we get back to our site, we will pour water into a huge plastic bucket. We get the water from the plastic bucket whenever we want.

T: How do you clean the jelly can? I think it is hard to clean.

S: We barely clean the jelly can, because we just use them to take in water. Every time we get back to our mining site, we pour the water out from the jelly can immediately, and then put back the cap of it. I don't think the jelly can would easily get dirty inside.

**9.**

**Date: 02/27/2016**

**Location: Berkeley, California**

**Interviewer: Yun Li Linn**

**Interviewee: Mogboluwaga Ayo Olubumni**

**Interviewee Background:** Masters in Industrial Engineering from Delft University of Technology, Netherlands

Y: How important was the "cleanability" of the product generated? i.e. If the product can be cleaned on the inside, they could perhaps last longer and thus lead to lower costs?

M: This is a very dicey one because there is a thin line between "cleanability" and how easy it is to contaminate the water stored in the container. So you have an oxfam bucket that is easy to clean (and transport by the way, which is also very important) but the argument against the bucket is, it is easy to contaminated the water stored, thereby risking an epidemic outbreak. on the other hand, the jerry can is not easy to clean, but its less likely to contaminate water stored in it (you can't dip containers in it.)

Y: Was there any particular emergency scenario or refugee camp that the designs proposed were tailored to? Especially in terms of cultural needs.

M: No. No specific emergency scenario.

Y: Is there any one particular user need that you would rank as the top priority?

M: The top priority is, the container must be able to store water safely without the risk of contamination.

Y: In your design and focus group discussions, did the possibility of screw-on lids come up? And if they did, were there any stark disadvantages of it?

M: The lids can easily be misplaced. When that happens, it renders the container useless and also increases the risk of water contamination and an epidemic outbreak.

Y: Were there any opportunities to conduct interviews with a direct user (displaced person), on top of the interviews with the experts? Do you think having a direct interview with a user can add more insights?

M: No, there wasn't any direct interview with displaced persons. At the time of my research, there was no funds available for that.

However, I think it is very important to understand the context of use and have the opportunity of empathizing with the end user (depending on who you want to consider as end user. During my research, I found out, although the displaced person uses the product, he/she doesn't have the purchasing power therefore it all comes down to what the emergency relieve organization deem fit. On the other hand, if relief organizations are convinced that the water container will be useful for displaced people, they might buy into it and purchase it)
I think having a direct interview with the end user will give more insight (but them Im thinking, why not just observe the user in his or her natural habitat… then you can now ask questions to understand reasons behind a particular behavior)

**10.**

**Date: 02/28/2016**

**Location: Berkeley, California**

**Interviewer: Faraz Ghahani**

**Interviewee: Khairuldeen Al Makhzoomi**

**Interviewee Background:** Political science and near eastern studies at UCB, Comes from Jordan.

Q: Do you have any information about water resources and water transportation in refugee camps?

A: Jordan is the 3rd poorest country when it comes to water resources and the population of Syrian refugees is 620,000 people. They consume about 2.3% of the water in Jordan. Jordan is facing very difficult problems to managing water specially for the refugee camps.

- Al Zaatari is one of the three major camps in Jordan
- Different tents responsible for different needs like water, medicals, ...
- The main source of water is water delivery by water trucks
- People believe that water from water trucks is not clean
- The main source of water in the camps are very large water tanks
- Filling water tanks and delivery services are very expensive

Q: You lived in Jordan for 8 years. How did you get water to your house in Jordan?

A: Water delivery was every Tuesday through pipelines and each apartment has its own tank to keep the water until the next delivery (next week).

- For refugees, no water for hygiene purposes
- Clean and drinkable water is very expensive
- Jordan is a country living on crisis, no natural resources, no oil, no gas

Q: The main source of water in the camps are tank/water trucks. How do families transport water from the tank/water truck to their tents?

A: Al Zaatari has 2-3 big tanks for each site. Some tanks are made from steel and some made from plastic. Most of the tanks that I have seen were made from plastic.

- Each family has small bucets
- In Al Zaatari, each person has 35lit/day

Q: Assume we have clean water in the tanks, what's a good way to transport it to the tents?

- Pipeline would be a permanent project which is expensive and not efficient
- Buckets
- Adding filter on faucets would help all camps with less funding
- Refugees use carts to transport buckets

Q: Any suggestions?

- The best thing is to maintain clean water access to refugees especially in Jordan
- I suggest filter on tanks or buckets
- Probably filter on faucet is more efficient

**11.**

**Date: 02/29/2016**

**Location: Berkeley, California**

**Interviewer: Faraz Ghahani**

**Interviewee: Nour Coudsi**

**Interviewee Background:** Studying Media & Journalism in the University of California, Berkeley. Teaching English in a camp in Lebanon at the border of Syria and Lebanon.

Q: What was your experience about refugee camps and water problems in Lebanan?

- Teaching English in a camp in Lebanon at the border of Syria and Lebanon
- I have been to Turkey camps too. They have small houses, no tents. no major water problems in Turkey
- 500 families in Lebanon. Using Nestle gallons for drinking water and pipeline water for other purposes

Q: You wrote an article about the refugee camps. Do you have anything to share about water problems in your article?

- Title: Between the Devil & the Deep Blue Sea
- Turkey has better situation compared to Lebanon
- No water or hygiene purposes
- All of the students were sad since they did not have the basic hygiene conditions
- Having drinkable water is "luxury" and so expensive in camps in Lebanon

Q: How do the refugees get drinking water?

- Pipelines are not drinkable
- Usually by 11am, there's no water in pipelines
- Drinking water by Nestle gallons
- Nestle truck delivers water every morning
- Usually very long lines to get water
- First come first serve

Q: Any suggestions to improve water transportation?

- Document refugees to know exact population: better information to determine the distribution of water
- Plastic pipes to deliver water to tanks would be better but needs funding

**12.**

**Date: 03/07/2016**

**Location: Berkeley, California**

**Interviewer: Faraz Ghahani**

**Interviewee: Ahmad Ahmadian**

**Interviewee Background:** Economy at the University of California, Berkeley. Ahmadian have been to Zaatari for a research project.

Q: What is the main source if water in Zaatari camp?

A: Since Jordan is a dry land, it does not have many water resources like rivers. The main source of water in Zaatari camp is water trucks which deliver water everyday (not 100% sure about the frequency).

Q: Is there a limit for water delivery per person/family?

A: I heard form the family I was interviewing that it's 35 liters per person everyday.

Q: How is the quality of water?

A: The quality was very poor and it still tastes bad after boiling.

Q: What is the process of water transportation from the source to homes?

A: They used to use buckets or any containers they could get their hands on. Then they walked back to the tents/homes. I guess it was a 20-30 minutes walk to the nearest water tank. They were planning to add more tanks but I don't know the status of the process.

Q: Assume we have clean water in the tanks, what's a good way to transport water to the tents?

- Buckets and containers (short-time)
- Pipeline and tap-stands (long-time)

But since the water is already contaminated, I assume, it's best to help them with water filtration. Like finding a way to make the water clean at the source.

Q: Any suggestions?

A: I suggest cleaning the water at the source, since it would be more affordable and easier to maintain. However, to prevent contamination is very important. It would be useful to find a solution to help the families to make the best out of all 35 liters since the water get contaminated sometimes during the transportation.

**13.**

**Date: 03/30/2016**

**Location: Berkeley, California**

**Interviewer: Faraz Ghahani**

**Interviewee: Roy**

**Interviewee Background:** Chemical Engineer. Works on a moving recreational center to give therapy to refugees, mainly sports and theatre.

Lebanon: Abundance of water

Where are you thinking of getting the water from?
T- assuming that there is a water source in the area. The main problem is the recontamination after the water is collected.

Focusing on the camp is easier

- Better cooperation when dealing with the camp
- They need more water in Jordan
- Dealing with the government is difficult

What other organizations are working there?

- Lebanon: UNHCR
- Jordan: There are many refugee camps

Prevent using something that is alcohol based for cleaning

Waste and theft is not an issue.

Easy to use

- Something children can do
- People are already in a very stressful environment
- Mostly the people are going to go and get the water are mothers and children

Plastics leach in heat and that dissolves in water. This could be an issue in Jordan. So whatever contains the water is insulated.

- How often they have to change the plastic? Is that going to be affordable?

Cleaning or disposable?

- You need more data to answer that question
- How much grey water is available?
- Is there soap?
- A returning and recycling service which created jobs in the area?

**14.**

**Date: 04/22/2016**

**Location: Bhubaneswar, Odisha, India (Skype)**

**Interviewer: Sujay Choudary Yantrapragada**

**Interviewee: Prasanna Gandhi**

**Interviewee Background:** Co-Founder Gram Vikas

**Interviewee's company Background:** Gram Vikas is an Indian non-governmental organization based in Orissa, and founded in 1979. It uses common concerns for water and sanitation to unite and empower rural communities, including adivasi communities.

S: What is the current mechanism of carrying water?

P: Open-buckets is the current form of mechanism that majority of the rural population in India uses.

S: How do they get hold of these buckets?

P: Usually, the government distributes the buckets in the local area for a subsidized price. Even free in some areas depending on the socio-economic factors.

S: How much water can they carry in the buckets?

P: Plastic bucket can carry up to 5liters of water.

S: How much water is usually required per day/per human?

P: The household use close to 25L of water per day. That is not taking into account the amount of water they need to make food, clean, and shower. It should be noted that showering and cleaning happens at the nearby canal.

S: What is the major problem with regards to water transportation?

P: The biggest problem in rural areas in India has to do with re-contamination of water. The water is already not that clean to begin with, and in the process of carrying the water back to their homes the water gets even more dirty.

S: What are some other secondary problems?

P: Women and kids are subject to physical exertion as they are carrying the water back and forth multiple times in order to satisfy their daily needs.

S: What is the biggest problem in your local area?

P: Access to clean water is the biggest problem in rural villages in India. India has enough water to feed its people, but the biggest problem is making sure that the water is clean. Majority of the water is readily accessible and lack of infrastructure plays an integral part in majority of the rural population not having access to such clean water.

S: How is Gram Vikas tackling this situation?

P: We do not provide a water transportation solution. Instead, in a partnership effort with local government and engineers we setting up a small water refinement center in the local village in order to make sure that water is clean.

S: How has the response been?

P: They are extremely happy that the water they are getting is healthy for them. We are satisfied with our efforts knowing that we are providing people with clean water, which can have help lead them a better life.

S: Do you know of any NGO's/Companies that are focusing on water transportation?

P: Yes, we do. The biggest advantage of having a water transportation is that India is such a big place that multiple areas require safe water transportation. For example, WelloWater is primarily focused on small rural villages in one state. India has room for multiple water transportation devices to thrive. I suggest you come up with a device that can lessen the physical burden on the human being during the transport process.

S: What are your thoughts on our idea/prototype?

P: It's very simple but gets the job done. Don't worry about it being similar to other products, because there is always room to scale and expand the product into different regions of the world. Focus on the specific needs and make sure your product address those needs.

**15.**

**Date: 04/25/2016**

**Location: Berkeley, California/Denver Colorado (Via Skype)**

**Interviewer: Ricardo Fort**

**Interviewee: Joshua Knight**

**Interviewee Background:** Professional Engineer (Environmental), PhD.

Ricardo Fort: Hello Joshua. Thank you for speaking with me today. Do you mind if we start off with me asking you a bit about your past experience?

Joshua Knight: I have 15 Years of professional environmental engineering experience includes: water and wastewater treatment, project management, site assessment and remediation, and environmental compliance.

RF: Is there any experience of yours that's stands out as pertinent to water collection and contamination issues in Aid or development environments?

JK: Working with Engineers Without Borders, I've overseen assessment, design, construction, maintenance & evaluation and closeout of over 120 community driven participatory development projects in 34 countries, directly benefiting over 53,000 people. With regards to sanitation, I've provided technical oversight and training for construction and maintenance and closeout of composting toilets, latrines, lagoons and wastewater treatment plants.

RF: That's quite a bit of experience. Have you ever worked with or done research concerning tap stand, or any other type of centralized water collection set up where people have to haul their water home?

JK: Yes, I have had some experience.

RF: Could you tell me what some of the primary problems people face in with these environments.

JK: There are multiple problems. Contaminated water is a huge one. Safety. People have to often walk great distances, maybe even miles.

RF: Are there any problems with the devices that are currently most often used. Would you say buckets and Jerri cans are pretty prevalent?

JK: Yeah, those two, definitely. They're cheap and readily available.

RF: Are there any major problems you see with those types of devices?

JK: Yeah, they can be difficult to carry. They're tough to clean. You can try to mix water and chlorine or some other agent, but its really tough to get any gunk out. Also, the environment is perfect for the growth of coliforms.

RF: You mentioned carrying problems?

JK: Yeah, when full they can get real heavy, something like 20 kilos each. I can't imagine anyone taking more than one or two for any long distance.

RF: Is there anything else you can think of concerning contamination?

JK: Yeah, if the container is plastic, it can be permanently fouled if it has been preciously used to carry anything chemical or toxic. You really should never use a container for drinking water that has also been used for, say gasoline…but people often do. The poor will pick up anything they can find and use, even after others throw them away.

RF: If someone were to design an alternative, are there any things you think should be stressed in the design.

JK: Well, the existing products are so cheap, so if you have something that's substantially more expensive, some people just won't use it, or be able to afford it.

RF: What about designing for distribution? Are there any things that should be taken into account that might make this more desirable to Aid/development agencies?

JK: That's a great question, especially since those agencies might subsidize some of the cost.

RF: We'd been looking at making a poduct similar to a rolling barrel, like a Hippo roller, but with some modifications. One would be that breaks down to cut down on shipping. We also thought we could address some of the cleaning and fouling issues by using removable bladders inside to hold the water.

JK: That's a great idea. It's also nice that the outside container doesn't have to be water tight. Hey listen, I've got to go, but feel free to ask me more questions at any time in the future.

RF: Okay. Thanks Joshua!

**16.**

**Date: 04/29/2016**

**Location: Berkeley, California**

**Interviewer: Whole team**

**Interviewee: Niveen**

**Interviewee Background:** Psychology and English lit. Social work from undergrad to grad school. Her current research in Jordan.

- Research about adults in the host communities.
    - Most of the refugees are not residing in camps. But they are in host communities.
    - These communities are in urban areas. They are not detention centers.
    - People in Jordan, they need someone to sponsor them and guarantee that they will take care of them. Then refugees can pay and get out of the camps.
    - People who do not have people to sponsor them and have money, they pay people to smuggle them out of the camp.
    - People who do not have money or hosts, live in camps. The largest camp has 8000 people. There are about 5 camps here.
    - Cybercity is ethnically Syrian
- Water from Syria goes to Jordan. Some of it is going to Israel.
- "Golan" - common area between Jordan and Syria.
- UNHCR has to approve your visit to the camp. And then Jordan has to approve it (office of interior affairs).
    - Israeli people cannot enter the camp
    - Because they revealed the truths about the camps.
- Jordan conditions:
    - Water:
        - The main source of water is no longer from Syria.
        - They are working with isreal to get water from the Dead Sea. egypt also comes in the picture here.
        - Millions of dollars are invested here.
        - Jordanian authorities are outsourcing infrastructure work to other countries. (including sanitation and water)
        - Jordan is sending a lot of people to go outside, learn, and come back. But they do not come back.
        - Jordan is very poor and has secondary refugees (Palestine, to syria, to jordan).
        - Little Jordanians and there are more refugees. And the Jordanians want to leave.

        - There is a lot of traffic and poverty and stress.
- Politics gets in the way of everything in the middle east
    - Very dry country and very less water.
    - They need water.
    - People do not shower everyday.
    - They have huge gallons of water and they use that for cleaning
    - Tuesdays and Thursdays, a trunk with huge tank of water will arrive and give it to people
    - There is not much plumbing there. Nowhere in the middle east is there cold and hot water. You have to use a heater and wait for the water to get heated.
    - No water in the toilet flush.
    - Water infrastructure is shitty.
    - Situations in the camps
        - Syrians had a lot of water but now in the camps they have no water
        - They are not used to the high price of water.
        - They do not know how to consume less water.
        - Zatari camp, there was a "rule" that water should be distributed twice a day and take care of all the sanitary needs (in the morning), and then come again the evening.
        - They have plastic containers which are not clean.
        - Syrians have built kitchen in the camps for them to be able to cook.
        - They will drag the containers of water from the distribution point to their homes and the kitchen.
        - Instead of twice a day, the truck comes only once a day.
        - Foundations, NGOs, and Jordan companies pay for this water.
        - Sometimes the trucks come in with no water although it was paid for.
        - People sit in this tank to leave the camp.
        - This water truck is not good for water transportation because it can transport people as well.

## Creating a Persona

Student Name: Ankita Joshi + Cal Can Team

**The backstory:** About 80000 people stay in the Za'atari camp. Most of these people are second refugees who have moved from Palestine to Syria to Jordan. The population is very dense and people are poor. They are used to living with a lot of water, but in Jordan there is no enough water for refugees and also the usual public. The country is very dry and people in camps live in dry and dusty areas.

**Current Situation:** Leyla (10 yrs) is living in crowded, dusty, dirty, & low resource areas. The family pays a lot for water and they cannot afford that. They do not shower every day. They do not have water for basic sanitary needs. They trucks with water come twice a week. Sometimes and they come empty.
Lyela and her mother carry water from the trucks to their homes in pots and buckets. These containers are usually not clean.

**Beliefs about change:**
"Water will come today"
"Minimize the use of water for unneeded things"
"Better water infrastructure is needed"

**Key Insights:**
- Family needs to be able to afford water. Make water or water transport device affordable so that people or NGOs can purchase more of them
- Make sure that the water transportation device is easily clean-able and that people do not have to "waste" more water as they clean containers.
- There needs to be cheaper and efficient ways of transporting water from the source to the people to their homes.

**Capacities and resources:**
-NGOs providing water
-Refugees have the capacity to "carry" and store water
-Refugees are willing to work hard with anything that they do
-Refugees are well educated

**Goals:**
The goal for the refugees is having access to clean water and minimize wasting water.

**Issues and Challenges:**
Cleaning the containers because the area is dusty and they do not have access to much water
Carrying this water back home without getting it dirty. The camps are huge and the truck comes to the center of the camp. The child has to carry this in his/her has back to the tent.
Child and her family should be able to carry water over rough surfaces.
The water should remain clean in the entire way that it is carried.
No contaminants should enter the water as it is carried over dirt and in the wind.

**Workarounds:**
Currently, the child uses plastic bottles that are not covered. He will run home and make multiple trips to make sure the water is clean. He will drink the water directly from the truck so that it is clean (but usually this water is not clean either because the trucks are dirty with people travelling in it)

**Devices and Technologies:**
Currently, the kid and her family has access to the following technologies: tanks, containers, plastic bottles, trucks, some pipes and water storage tanks. Maybe, some method of transportation like a bicycle. There is a common kitchen with a stove to heat water if needed.

**Strong Ties with:**
Neighbors, NGOs, and family that might be outside the camps.

**Weak Ties with:**
Corporations, security guards of the camp, government officials.

# APPENDIX C – List and Scoring of Concepts Generated

| IDEAS | Easy to Clean | Prevents Entry of Contaminants | Suffcient Volume | Easy to Carry | Easy to Roll | Storeability | Total | Cost | Total2 |
|---|---|---|---|---|---|---|---|---|---|
| Water Wheel + Modified Shape (Bladder) | 5 | 5 | 3 | 4 | 5 | 4 | 26 | 2 | 28 |
| Hydra Wheel (Collapsible rolling frame and bladder) | 5 | 5 | 4 | 3 | 5 | 4 | 26 | 2 | 28 |
| WaterRoller with a faucet | 3 | 4 | 4 | 4 | 5 | 4 | 24 | 3 | 27 |
| WaterRoller (wheel with handles) | 3 | 4 | 4 | 4 | 5 | 3 | 23 | 3 | 26 |
| Cart 1 | 4 | 2 | 5 | 1 | 5 | 4 | 21 | 5 | 26 |
| Cheap-o hydration pack (Self explanatory) | 4 | 5 | 2 | 5 | 0 | 5 | 21 | 5 | 26 |
| Water Wheel | 4 | 3 | 5 | 1 | 5 | 3 | 21 | 3 | 24 |
| Double Capper | 4 | 3 | 4 | 2 | 5 | 3 | 21 | 2 | 23 |
| Modular Tower with Home Dispenser | 4 | 3 | 4 | 4 | 2 | 4 | 21 | 3 | 24 |
| Water Vest (Vest shaped water bladder) | 4 | 5 | 2 | 5 | 0 | 5 | 21 | 4 | 25 |
| WaterRoller with a stand | 3 | 4 | 4 | 2 | 5 | 3 | 21 | 2 | 23 |
| Jelly Can ( with plastic bag) | 5 | 5 | 3 | 4 | 0 | 4 | 21 | 4 | 25 |
| Zip Bag (Plastic bag with zip) | 5 | 4 | 2 | 5 | 0 | 5 | 21 | 4 | 25 |
| Screw-On Filter | 5 | 5 | 4 | 3 | 0 | 4 | 21 | | 21 |
| Magnetic Dispenser | 3 | 3 | 4 | 4 | 3 | 3 | 20 | 2 | 22 |
| Hygiene Promotion at Home | 4 | 4 | 3 | 3 | 3 | 3 | 20 | 4 | 24 |
| Bottle Backpack/bag | 5 | 2 | 4 | 5 | 0 | 4 | 20 | 4 | 24 |
| Hydra Crate (Collapsible box frame and bladder) | 5 | 5 | 2 | 3 | 0 | 5 | 20 | 2 | 22 |
| Off-Road Transport x Screw-On Filter | 4 | 4 | 4 | 0 | 5 | 3 | 20 | | 20 |
| Backpack x Screw-On Filter | 4 | 4 | 4 | 4 | 0 | 4 | 20 | | 20 |
| Sphere Transport x Screw-On Filter | 4 | 4 | 4 | 0 | 5 | 3 | 20 | | 20 |
| Two-Person Push Rig x Screw-On Filter | 4 | 4 | 5 | 0 | 5 | 2 | 20 | | 20 |
| WaterRoller + Faucet x Screw-On Filter | 4 | 4 | 4 | 0 | 4 | 4 | 20 | | 20 |
| Self-cleaning rocks | 4 | 3 | 3 | 3 | 3 | 3 | 19 | 4 | 23 |
| Tub Scrubber | 4 | 3 | 3 | 3 | 3 | 3 | 19 | 3 | 22 |
| Magnetic Cap | 3 | 4 | 3 | 3 | 3 | 3 | 19 | 3 | 22 |
| Screw Cap-Hose replaceable module | 4 | 4 | 3 | 3 | 2 | 3 | 19 | 4 | 23 |
| Clean Cup Storage | 3 | 4 | 3 | 3 | 3 | 3 | 19 | 3 | 22 |
| Water Tube (Telescoping water tube) | 4 | 5 | 3 | 4 | 0 | 3 | 19 | 3 | 22 |
| luggage Can X plastic bag | 3 | 5 | 2 | 1 | 5 | 3 | 19 | 1 | 20 |
| jelly can II X wheel | 1 | 4 | 2 | 3 | 5 | 4 | 19 | 3 | 22 |
| Water-Cart x Screw-On Filter | 4 | 4 | 5 | 0 | 5 | 1 | 19 | | 19 |
| [illegible] | | | | | | | | | |
| Bucket + Faucet + Filter II | 4 | 1 | 4 | 3 | 0 | 3 | 15 | 1 | 16 |
| Bucket + Bottom Handles (Carry on Head) | 4 | 3 | 3 | 2 | 0 | 3 | 15 | 3 | 18 |
| Can Plastic (3 gallon plastic can with handle) | 4 | 4 | 3 | 2 | 0 | 2 | 15 | 4 | 19 |
| Large Jelly Can (with wheel) X plastic bag | 3 | 3 | 5 | 1 | 0 | 3 | 15 | 4 | 19 |
| Luggage Can X screw cap | 3 | 2 | 3 | 3 | 0 | 4 | 15 | 2 | 17 |
| Zip bag X screw cap bucket | 2 | 4 | 2 | 4 | 0 | 3 | 15 | 3 | 18 |
| Water Scooter | 3 | 3 | 3 | 3 | 0 | 3 | 15 | | 15 |
| Carton Container | 1 | 4 | 3 | 2 | 0 | 4 | 14 | 4 | 18 |
| Carton Container + Filter | 1 | 4 | 3 | 2 | 0 | 4 | 14 | 2 | 16 |
| Cubic Plastic Container + Filter + Outlet | 1 | 4 | 3 | 2 | 0 | 4 | 14 | 2 | 16 |
| Helmet Attachable | 3 | 2 | 2 | 3 | 2 | 2 | 14 | 2 | 16 |
| Hand Pump | 2 | 3 | 3 | 3 | 2 | 1 | 14 | 2 | 16 |
| Clean Jug (Translucent jug with dye indicating dissolvable chlorine layer on inner surface) | 2 | 5 | 2 | 3 | 0 | 2 | 14 | | 14 |
| Water Fliter (fliteration at source) | 2 | 5 | 3 | 1 | 0 | 3 | 14 | 3 | 17 |
| Bucket+Faucet | 3 | 3 | 4 | 1 | 0 | 3 | 14 | 3 | 17 |
| Well Water (plastic can with ropes to get water from wells) | 3 | 3 | 3 | 2 | 0 | 1 | 12 | 1 | 13 |
| Jelly Can II (can open it like a laptop) | 1 | 2 | 2 | 3 | 0 | 4 | 12 | 3 | 15 |
| Pressure Dispenser | 2 | 2 | 3 | 2 | 1 | 1 | 11 | 2 | 13 |
| Shoulder Stick (scope to carry mutiple water cans) | 1 | 0 | 3 | 5 | 0 | 2 | 11 | 2 | 13 |
| Scooter Basket | 0 | 0 | 0 | 0 | 5 | 5 | 10 | 4 | 14 |
| Water Bike Basket | 0 | 0 | 0 | 0 | 5 | 5 | 10 | 4 | 14 |
| Bottle Bicycle Clamp | 0 | 0 | 0 | 0 | 5 | 4 | 9 | 0 | 9 |
| Decontaminate Tablet | 0 | 0 | 0 | 0 | 0 | 5 | 5 | | 5 |
| Sliding Tube | | | | | | | 0 | | 0 |
| "Lens" Changer | | | | | | | 0 | | 0 |
| WaterRoller + Faucet x Off-Road Transport | 3 | 3 | 5 | 0 | 5 | 3 | 19 | | 19 |
| Duffle Bag Container | 4 | 4 | 3 | 3 | 0 | 4 | 18 | 1 | 19 |
| Magnetic Brush | 5 | 4 | 0 | 4 | 0 | 4 | 17 | 2 | 19 |
| Bottle Basket | 3 | 3 | 3 | 3 | 3 | 3 | 18 | 3 | 21 |
| Water Bottle Tote | 3 | 5 | 3 | 4 | 0 | 3 | 18 | 4 | 22 |
| Head Cushion (ease of transportation) | 4 | 2 | 3 | 5 | 0 | 4 | 18 | 3 | 21 |
| Drip Irrigation | 5 | 5 | 4 | 0 | 0 | 4 | 18 | 5 | 23 |
| Jelly can with filter X wheel | 1 | 4 | 2 | 3 | 5 | 3 | 18 | 3 | 21 |
| Off-Road Transport | 3 | 3 | 5 | 0 | 5 | 2 | 18 | | 18 |
| Backpack | 3 | 3 | 4 | 4 | 0 | 4 | 18 | | 18 |
| Two-Person Push Rig | 3 | 3 | 5 | 0 | 5 | 2 | 18 | | 18 |
| Bucket + Faucet x Screw-On Filter | 3 | 3 | 4 | 3 | 0 | 5 | 18 | | 18 |
| WaterRoller (wheel with handles) x Off-Road Transport | 3 | 3 | 4 | 0 | 5 | 3 | 18 | | 18 |
| Two-Person Push Rig x Off-Road Transport | 3 | 3 | 5 | 0 | 5 | 2 | 18 | | 18 |
| Plastic Box + Faucet | 4 | 1 | 4 | 3 | 2 | 3 | 17 | 3 | 20 |
| Carry-On Bucket + Side Handles | 4 | 1 | 4 | 4 | 1 | 3 | 17 | 2 | 19 |
| Carry-On + Flat Container + Filter | 2 | 4 | 3 | 4 | 0 | 4 | 17 | 3 | 20 |
| Pressure Locker | 4 | 4 | 3 | 2 | 1 | 3 | 17 | 3 | 20 |
| Bernoulli's Extraction | 2 | 4 | 3 | 2 | 2 | 4 | 17 | 4 | 21 |
| Water Wheel (Rigid rollable water backpack) | 1 | 5 | 2 | 3 | 5 | 1 | 17 | 4 | 21 |
| Jelly Can ( with replacable filter) | 1 | 5 | 2 | 4 | 0 | 5 | 17 | 3 | 20 |
| Water-Cart | 3 | 3 | 5 | 0 | 5 | 1 | 17 | | 17 |
| Sphere Transport | 3 | 3 | 3 | 0 | 5 | 3 | 17 | | 17 |
| Foldable Transport | 4 | 3 | 3 | 3 | 0 | 4 | 17 | | 17 |
| Bucket + Folding Outlet (Easy Stacking) | 4 | 3 | 3 | 3 | 0 | 3 | 16 | 3 | 19 |
| Bucket + Outlet + Filter + Modified Shape | 4 | 3 | 3 | 3 | 0 | 3 | 16 | 3 | 19 |
| Duffle Bag Container + Filter | 3 | 3 | 4 | 2 | 0 | 4 | 16 | 2 | 18 |
| Banana Barrel | 3 | 4 | 3 | 3 | 1 | 2 | 16 | 3 | 19 |
| Zip Bag X wheel | 2 | 4 | 2 | 4 | 0 | 4 | 16 | 3 | 19 |
| Rickshaw Rig | 3 | 3 | 5 | 3 | 0 | 2 | 16 | | 16 |
| Bucket + Faucet | 4 | 1 | 4 | 3 | 0 | 3 | 15 | 4 | 19 |
| Bucket + Faucet + Filter I | 4 | 1 | 4 | 3 | 0 | 3 | 15 | 1 | 16 |

# APPENDIX D – New List of Concepts Generated

| IDEAS | Easy to Clean | Size of Exposed Opening | Capacity | Empty Weight | Collapsibility | Cost | Total2 |
|---|---|---|---|---|---|---|---|
| Water Wheel + Modified Shape (Bladder) | 5 | 5 | 3 | 4 | 4 | 2 | 23 |
| Hydra Wheel (Collapsible rolling frame and bladder) | 5 | 5 | 4 | 3 | 4 | 2 | 23 |
| Large Jelly Can (with wheel and plastic bag) | 5 | 4 | 5 | 1 | 4 | 1 | 20 |
| Drip Irrigation | 5 | 5 | 4 | 0 | 4 | 5 | 23 |
| Jelly can with filter X wheel | 1 | 4 | 2 | 3 | 3 | 3 | 16 |
| WaterRoller (wheel with handles) | 3 | 4 | 4 | 4 | 3 | 3 | 21 |
| Carton Cart | 4 | 2 | 5 | 1 | 4 | 3 | 19 |
| Cheap-o hydration pack Safety Vest | 4 | 5 | 2 | 5 | 5 | 2 | 23 |
| Double Capper | 4 | 3 | 4 | 2 | 3 | 2 | 18 |
| Modular Tower with Home Dispenser | 4 | 3 | 4 | 4 | 4 | 3 | 22 |
| Water Vest (Vest shaped water bladder) | 4 | 5 | 2 | 5 | 5 | 4 | 25 |
| Zip Bag (Plastic bag with zip) | 5 | 4 | 2 | 5 | 5 | 4 | 25 |
| Water Tube (Telescoping water tube) | 4 | 5 | 3 | 4 | 3 | 3 | 22 |
| Water Bottle Tote | 3 | 5 | 3 | 4 | 3 | 4 | 22 |
| Head Cushion (ease of transportation) | 4 | 2 | 3 | 5 | 4 | 3 | 21 |
| Duffle Bag Container | 4 | 4 | 3 | 3 | 4 | 4 | 22 |
| Two-Person Push Rig | 3 | 3 | 5 | 0 | 2 | 2 | 15 |
| Sphere Transport | 3 | 3 | 3 | 0 | 3 | 5 | 17 |
| Foldable Transport | 4 | 3 | 3 | 3 | 4 | 3 | 20 |
| Banana Barrel | 3 | 4 | 3 | 3 | 2 | 3 | 18 |