# WATER FETCHING AID FOR RURAL WOMEN

PRODUCT DESIGN PROJECT II

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# Water Fetching Aid for Rural Women

PROJECT 2

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IDC
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# Declaration

I declare that this written document represents my ideas in my own words and where others' ideas or words have been included, I have adequately cited and referenced the original sources.

I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission.

I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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# Approval Sheet

The project titled 'Water fetching aid for rural women' by Sohini Guin, is approved for partial fulfilment of the requirement for the degree of 'Master of Design' in Industrial Design.

Guide:

Co-Guide:

Chairperson:

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*Sohini Guin*

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# Abstract

Access to potable water in villages is still a problem in India. It has to be fetched from long distances. This task is usually done by the women in the family. They go to fetch water from the well or a pump in the area. This constitutes approximately 50 litres of water per day for a family of 5 members. The most common method of fetching water is by carrying matkas/handas on the head. This form of head load causes a lot of strain on the neck and often is the cause of injuries and muscular spasms.

The following project aims at providing an aid to help in this load carrying task. Various methods of load carrying have been studied, complete motion and task analysis has been done to come up with a solution that reduces effort and is physiologically safe.

After coming up with various concepts and testing some of them, a product that distributes load around the trunk of the body has been decided as the final concept.

Fig 1.1 : Current Scenario of water fetching in villages

***Image source:*** *Fig 1.1: https://static-secure.guim.co.uk/sys-images/Guardian/Pix/pictures/2014/3/19/1395247105471/India-women-carrying-wate-014.jpg as on 19-08-2014*

# Introduction

## Current Scenario

Most villages in India do not have water supply in homes. Valuable time is spent by women in every household, fetching water for daily use. [1] Young girls, spend a lot of time helping in household work, a primary task amongst which is fetching water or taking care of younger siblings when the mother is out to bring water. This is valuable time that could be spent on education or to earn a living [2].

Every day, women and young girls go to the well or ground pump to fetch water for the house. They carry containers with them and then load them with water and bring them back as shown in Fig 1.1. Often, women carry their infants or children along since they cannot be left at home alone. This adds to the weight that the woman is already bearing. This may not be the scenario in case there are other family members or older children taking care of the infants.

The problem with this activity is that water is heavy [2]. Each woman carries approximately 15 to 20 litres of water per trip. This is done using matkas, handas or jerrycans. The most common mode of carrying the load is the head mode followed by the hip mode. Carrying load on the head even though the most common and traditional method of carrying water has adverse effects on the spine and neck. The terrain is usually hilly, with mud, bushes and stones. To walk over such terrain with a head load requires a lot of concentration as movement is restricted. Besides having to balance the vessels on the head; they have to make sure they walk safely without tripping over stones etc.

## Need of the project

Water is heavy. This load is harmful for women and causes a lot of discomfort. It also leads to problems such a spondylitis. Carrying such heavy loads from a young age may also lead to back problems and weaken the person. Pelvic problems may rise as the girl grows up leading to risky pregnancies [3].

There is also a lack of knowledge about what is good and what is not. Pregnant women who are advised not to carry weights, are often seen fetching water the same way they did even when they are in the advanced pregnancy stage. There is a need for intervening and allowing to carry load ergonomically and safely.

Socio-economic problems that exist in rural India also prevent such changes from taking effect. People do not want to spend on the woman in the family or try and improve her life. Due to low income, they cannot spend a lot on new products.

## Design process followed

| | |
|---|---|
| **August**<br>Finalizing the topic<br>Defining the need<br>Secondary Research | **October**<br>Concepts<br>Concept evaluation<br>Testing mockups<br>Finalizing concept |
| **September**<br>Field Study<br>Activity analysis<br>Ideation<br>Concept clusters | **November**<br>Prototyping<br>Field testing<br>Refinements |

Fig 2.1: Head mode

Fig 2.2: Hip mode

Fig 2.3: Head and hip

Fig 2.4: Hip and hand

Fig 2.5: Shoulder mode

***Image source:*** *Fig 2.1 : https://mozes42.files.wordpress.com/2009/12/picture-009.jpg as on 19-08-2014*
*Fig 2.2: http://oregonstate.edu/terra/wp-content/uploads/2013/05/Woman-wWaterCan.jpg as on 19-08-2014*
*Fig 2.3: farm3.static.flickr.com/2428/3696799330_045d647110.jpg as on 19-08-2014*
*Fig 2.4: habitat.corp.ebay.com/wp-content/uploads/2014/04/well-3.jpg as on 19-08-2014*
*Fig 2.5: news.bahai.org/sites/news.bahai.org/files/imagecache/bwns_imagewidget/sites/news.bahai.org/files/images/bwns_4844-0.jpg as on 19-08-2014*

# Secondary Research

## Modes of carrying water

**Head mode**: The head mode as shown in Fig 2.1, is the most common method of carrying the load. It is convenient for horizontal roads since it maintains the C.G. at the centerline of the body. However, in hilly, uneven terrain, it is difficult to balance the load. This mode of carrying is harmful for the neck muscles and the back since the neck muscles are constantly constricted so that the weight can be balanced.

**Hip mode:** The hip mode of carrying load as shown in Fig 2.2, is usually coupled with the head. It involves the person resting the vessel on the hip bone and the shape of the vessel fits into the contour of the body.

**Head and hip:** It is quite common to see this mode of carrying water vessels. Women carry one matka on the head and one by their side with the support of their hip bone as shown in Fig 2.3. Since it is carried on only one side, it causes an imbalance. This imbalance causes a strain which occurs trying to counteract it.

**Hips and hand:** Women may also carry one big vessel on the hip and one smaller vessel in the hand by their other side as shown in Fig 2.4. They carry a smaller vessel in the hand because the swaying motion is more in the hand and that makes it difficult to carry a heavy vessel due to the changing C.G.

**Shoulder mode:** A matka can be supported on one side on the shoulder and held with both hands as depicted in Fig 2.5. This strains one side of the neck and can be difficult to carry.

# Containers currently being used

The containers currently being used by the villagers for fetching water are the following:

## Matkas:

The matka shown in Fig 2.6 is the most common container for carrying water. Its form aids filling, cleaning, and pouring out of the water. Since it is made of mud, it also keeps the water cool.

## Handas:

These are matkas which are made of out steel or copper as shown in Fig 2.7. The use of metal makes them more durable and also keeps the water clean.

## Jerry cans:

Jerrycan shown in Fig 2.8 is a cheaper alternative. Existing jerrycans with the mouth cut out, are used.

Fig 2.6 : Matka

Fig 2.7 : Handa

Fig 2.8 : Jerrycan

***Image source:*** *Fig 2.6:http://www.dsource.in/resource/kitchen-products/items-used-for-storage/matkas-ghadas/images/750/matkas-ghadas-5.jpg as on 19-08-2014*
*Fig 2.7: http://thumbs2.ebaystatic.com/d/l225/m/ml8iaziDpg-YQL0bBdljciw.jpg as on 19-08-2014*
*Fig 2.8: http://www.bio-bottle.com/wp-content/uploads/2013/07/PP5L3H1_520x520.jpg as on 19-08-2014*

Fig 2.9: Bhishti

Fig 2.10: Kanwar

***Image source:*** *Fig 2.9: http://travel.cnn.com/mumbai/life/bishtis-bombays-water-carriers-810115 as on 03-11-2014*
*Fig 2.10: http://biodataofdrvhp.blogspot.in/2012/09/queue-of-devotees.html as on 03-11-2014*

# Traditional methods of carrying water

## Bhishti:

Bhishti is a traditional Indian water carrier. It is carried on one shoulder as shown in Fig 2.9. The bags are skin bags and a group of people go around supplying water to others. The bhishti has a body hugging form which facilitates easy pouring out of water.

## Kanwar (Yoke):

The water carrying pole is known as Kanwar. 2 vessels are slinged from the end of the carrying pole as shown in Fig 2.10. There is a small notch made at the end of the rod so that the rope doesn't slip out. This is carried on one shoulder by men and women.

# Parallel Product Study

## Q Drum:

The Q drum shown in Fig 2.11 can be rolled on the ground and moved from the house to the well and back. It can hold upto 80 litres of water. The product costs approximately Rs. 4800.
It has the advantage of being able to hold a very large volume of water and the ease of rolling [5].

## Wello water wheel:

The Wello waterwheel as shown in Fig 2.12 can also be rolled on the ground. Its capacity is about 60 litres and the cost has been brought down to Rs. 1800 [2].

## Problems with the products:

- Difficult to clean
- Psychological rejection of rolling drinking water on the ground
- Difficult to roll over rough terrain
- Cannot be used directly, needs to be transferred into smaller vessels for use in the kitchen.
- Most houses have a few steps at the entrance of the house, the drum cannot roll into the house.
- Lastly, the Q drum carries 80 litres of water. This is very heavy for a single person to maneuver.

Fig 2.11: Q drum

Fig 2.12: Wello water wheel

***Image source:*** *Fig 2.11: http://www.arthaplatform.com/news/286/can-indias-women/ as on 19-08-2014*
*Fig 2.12: http://www.theguardian.com/global-development/poverty-matters/2013/dec/29/waterwheel-burden-women-water-container as on 19-08-2014*

Fig 2.13: $H_2O$ packs

Fig 2.14: Load carrier for labour

***Image source:*** *Fig 2.13: http://dzinetrip.com/wp-content/uploads/2013/11/water-carrying-backpacks-pack-h2o-02.jpg as on 03-11-2014*
*Fig 2.14: http://www.carryology.com/insights/carry-culture/load-carrier-for-labour/ as on 20-08-2014*

## $H_2O$ water packs:

$H_2O$ water packs shown in Fig 2.13 are canvas bags which have waterproof material on the inside and is used to carry water. It can have a capacity of 20 litres of water. It can be hooked onto the wall, and a tap can be used to use water from this bag. The bag costs approximately Rs. 1500.The bag is useful since it is just one container and has a tap for usage [7].

### Disadvantages:

- The bag has a capacity of 20 litres of water which is carried entirely on the bag. Such a large load cannot be carried safely on the back without any other support.

## Load carrier for labour:

The load carrier shown in Fig 2.14 is a structure made by bending bamboo. It can be locally manufactured, and foam or thermocol can be used to make the padding for the shoulders. Steel screws and connectors are used for the different parts. The product can be used in different orientations. It is an easy procedure to change the orientation by adjusting a few attachments. It can be used to carry load over the head, on the back or like a small trolley [8].

### Disadvantages :

- Since it is a rigid structure, once worn, it is difficult to bend or move freely if there is any load over the head.
- It cannot be used to carry water as any vessel with water cannot be secured and hence may fall.
- Everytime making adjustments to change orientation may be a hassle.
- The castor wheels would not work in muddy or rocky terrain.

# Physiological problems

## Loading on the head:

Load carried on the head is carried downward the spine due to gravitational pull. X-ray imaging have proved that head loading straightens the cervical curvature to relieve the associated muscles and ligaments which in turn produces enormous pressure on the vertebrae. The impact of head load on the spine is shown in Fig 2.15.

Head loading over long periods of time can cause adverse effects on the spine. Strength of the associated muscles and ligaments reduces due to fatigue.

Users may develop cervical spondilytis due to long periods of head loading. Neck pain and fatigue are common complaints of such users [4}

Several studies about the various modes of load carrying have been done. These are usually conducted based on experiments such as heart rate, pulmonary ventilation, oxygen consumption. Carrying load distributed around the trunk of the body is considered to be easier than carrying load on the head or on the front side of the body only. Studies also show that carrying large loads on the hip under the arm is considered to have a very high energy expenditure. [6]

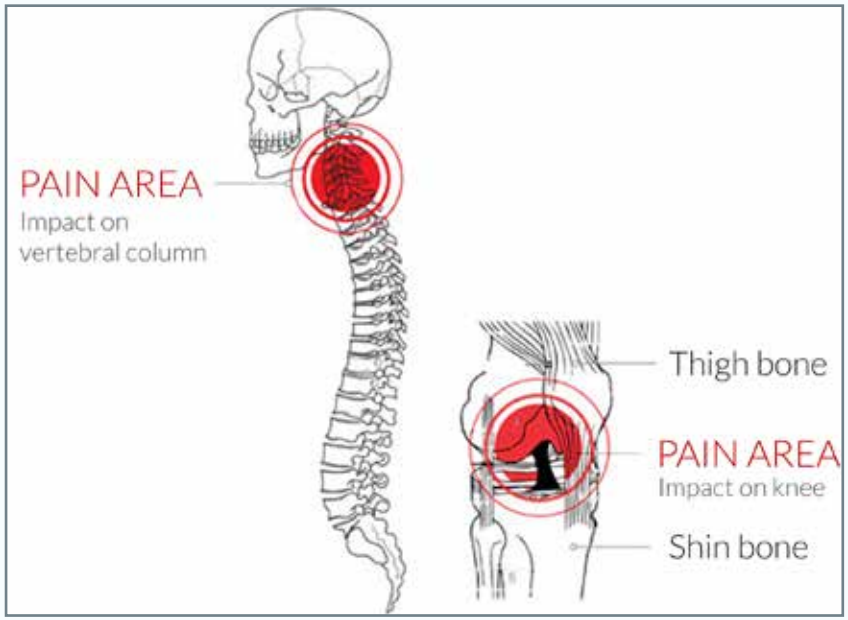



Fig 2.15: Impact of head load

***Image source:*** *Fig 2.15: http://www.tuvie.com/special-needs-by-pranali-linge/ as on 03-10-2014*

# System level approaches

## Direct supply in homes

While this would be the best solution to end all water woes, the goverrntment has not been able to reach a point where pipelines can be put in every village. Every village comes with its own water source and its terrain. It is difficult to provide direct supply in the current scenario.

## Water supply via pumps

Pumps can be installed at every well, and at common junctions in the village where people can be appointed to provide water. This would reduce the distance travelled by the women to collect water. However, installing pumps and pipelines have a large initial investment which the villagers may not be willing to do. The investment would have to be in a community setup. Villagers may not have so much money at one time. Even if they do, they may not be willing to make community level investments. This system also involves villagers in the management of the scheme. Such involvement in the management would instill a sense of ownership among the users.. Although this may be true, it may not be the most efficient solution in all cases and in the long run, as users have to spend considerable time in management activities in addition to their regular occupation [10]. Also, it increases dependency on other people which makes it slightly less acceptable to them. Also the water supply from wells and hand pumps may not be constant. Often in the summer season, people need to go to different wells to fetch water.

## Person going door to door to supply water

This happens in some villages, where a person has a cart with a  huge tank. He gets some money for supplying water from door to door. While this can work in many villages, the people do not want to spend on water daily, Also, there is another person brought into the equation who brings them the water. This increases dependency and uncertainty.

# Primary Research

## Field Study

For the field study, Bharatiya Agro Industries Foundation (BAIF), Jawhar was contacted. BAIF's Mission is to create opportunities of gainful self-employment for the rural families, especially disadvantaged sections, ensuring sustainable livelihood, enriched environment, improved quality of life and good human values. This is being achieved through development research, effective use of local resources, extension of appropriate technologies and upgradation of skills and capabilities with community participation. BAIF is a non-political, secular and professionally managed organization [11].

Village visited : Dengachimat, Maharashtra (Route: Fig 3.1)
The members of the BAIF office, Jawhar were very forthcoming in introducing the villages, the people and the overall scenario of the area. Dengachimat is a village where there are several load carrying issues such as water fetching, wood fetching and transporting harvesting produce.Thus, Dengachimat was finalized as the pilot village for research and validation.

Dengachimat is primarily a paddy producing village. The people of this village live in small clusters of houses. The farmers in this village practice subsistence farming. They also produce some fruits and vegetables like onion, cabbage and chikoo. Some of them sell these fruits in the market. For a lot of their farming work, the villagers need to employ labour. They people also work as labourers themselves when it's off season. For this work, they get approximately
Rs. 100 per day.

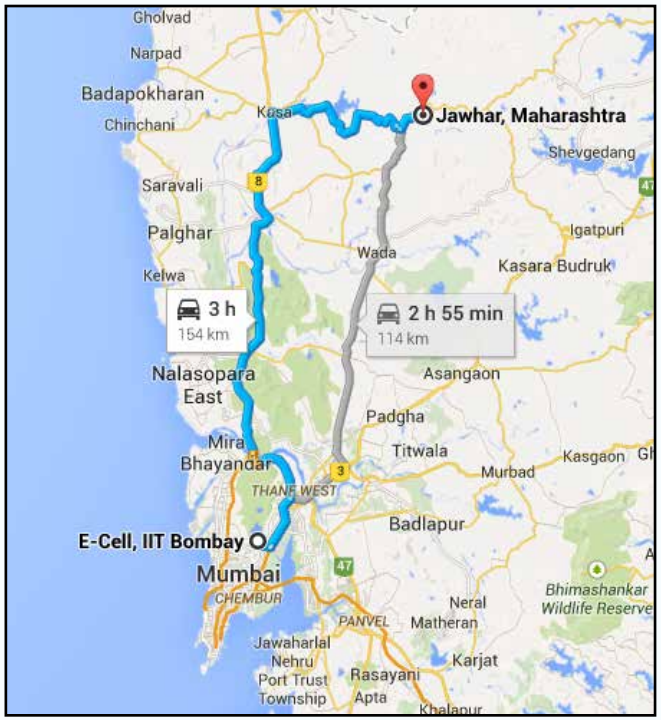



Fig 3.1: Jawhar, Maharashtra

***Image source:*** *Fig 3.1: https://www.google.co.in/maps/dir as seen on 28-08-2014*

Fig 3.2: Field Study

## User Interviews & Analysis

During the field visit, the activity of water fetching was observed as shown in Fig 3.2, and experienced.

### User 1: (Fig 3.4)

- Demographics : Woman, 45-50 years old
- Family : 6; husband,wife, 1 daughter, 2 sons and 1 daughter in law.
- Occupation : Subsistence farming, temporary labour work
- No. of trips made : 3 in the morning, 1 in the evening
- Amount of water carried per trip: 15 litres
- Total time : 1 hour
- Discomfort or pain : temporary soreness in the back and neck but nothing much. Says she is used to it and so it does not matter

### User 2: (Fig 3.3)

- Demographics : Woman, 30 years old
- Family : 3; husband and 1 child, over 8 months pregnant
- Occupation : Helps in farming, also goes to college herself
- No. of trips made: 2 in the morning, 1 in the evening
- Amount of water carried per trip: 15 litres
- Pain: Strain in the back and neck muscles

### User 3: (Fig 3.4)

- Woman, 45 years old, Injured(due to wood fetching)
- Family: Has two children
- One goes to school but helps at home, the other lives in boarding school
- Occupation: Farming, goes to fetch wood as well as water.
- No. of trips made: 2 in the morning, 1 in the evening
- Amount of water carried per trip: 10 litres
- Pain: A lot of pain in the neck and back. Due to wood fetching, there is pain in the knees as well.

## User 4 :

- Demographics: Male, 45 years old
- Income : Rs. 100-200 per day for labour. Variable income.
- Farming – Rice farming, grows onions, cabbage, some fruits like chikoo.
- Other activities: Goes for fetching wood with his wife.
- Pain: Considers it very painful and tiring. Shoulders, back, neck, knees hurt after water and wood fetching.
- Says it is time consuming and also dangerous to go into the forest for bringing firewood.

## Self as user:

I tried the entire activity of water fetching(Fig 3.6). As a new user, I found it extremely difficult to lift up the filled matka and put it on the head. There was immediate discomfort in the neck muscles and back. A colleague also tried the activity(Fig 3.5) and had similar feedback.

Balancing and walking over the stones and uneven terrain required a lot of effort and concentration. The water kept moving which kept moving the head back and forth. This put further strain on the neck muscles.

Fig 3.3: User no. 2

Fig 3.4: User no. 1 and 3

Fig 3.5: Colleague as user

Fig 3.6: Self as user

## Inferences :

- The most common mode of fetching water is using a steel handa and the mode of carrying it is the head mode.
- They travel approximately 1 – 1.6 kms with the water one way.
- The average amount of potable water that a family needs is 45 litres of water for a family of 5.
- This is fetched by the woman in about 3 trips to the wellover the span of the day.
- The water is stored in the same vessel in the kitchen as it is fetched in
- The terrain is generally rough, is slightly hilly and has stones and rocks all along. It also gets a little muddy and soft during the monsoons. The path to walk on, is generally narrow.
- The head mode of carrying matkas causes physiological problems.

## Activity Analysis

Fig 3.7: Activity Analysis

## Activity Analysis

An activity analysis of the whole water fetching process was done as shown in Fig 3.7

1. Pick up the matkas from the kitchen.
2. Hold one matka by the hip, one in the hand, and a smaller one in the other hand.
3. She takes a jerrycan attached to a rope, a sieve and a towel.
4. The jerrycan rope is looped around one hand or arm and the sieve is put inside it. The towel is hung on the shoulder.
5. Walk out of the house
6. Walk towards the well barefoot with a few other women from the neighbourhood
7. On reaching the well, they place one matka on the ground.
8. Then use the free hand to place the other items on the ground
9. Take the jerry can, loop the rope around the hand
10. Throw the jerry can into the well and jerk it a little
11. Once the jerry can submerges, pull it up rapidly
12. Pour water into the matkas and wash them
13. Place the sieve over the matka mouth
14. Throw the jerrycan into the well, jerk it
15. Pull it up rapidly.
16. Often, women are seen to climb onto the well wall.
17. They then do the task of pulling up the jerry can. It helps them pull it up more easily as they get more space to move their arms.
18. They then hold the jerry can by the base and rim and pour out the water into the matka
19. The sieve removed any unwanted particles like stones or leaves.
20. They repeat the above steps till the matka is full.
21. They then go on to transfer the sieve onto another matka and repeat the process.
22. After filling, they empty the jerrycan and put the sieve inside it.
23. Then they roll the towel around one hand
24. They place this looped towel on their head and keep it steady.
25. They take the matkas one by one and place them on the well wall.
26. This makes it easier for them to transfer the handa onto their head
27. Then, they cautiously place the biggest matka over their head first.
28. Once it is stable, they lift up the next size and place it over the top of the bigger matka.
29. Some women place a third matka over their head as well.
30. Others carry the smallest matka in one hand.
31. The jerrycan and sieve are carried in the other hand or looped around the arm.
32. The hand without the matka is often used by the women to support the matkas on the head.
33. Or they place the hand beind their head at the base of the matka since they feel strain on the shoulders and neck.
34. Once they reach their homes, someone helps them take off the matka from the head. It is then carried by the waist to the kitchen and placed on the kitchen platform.

# Inferences from Field Study

After doing the activity analysis, the following steps of the activity analysis seem to be problematic. After identifying the steps, they were broken down to understand the underlying problem.

## No. of items to carry:

Each woman carries too many containers and loose items. Hands are constantly engaged. She carries the big handa on her head. Due to the uneven terrain she has to often try and hold it with one hand to balance it. A jerrycan, two small handas and a sieve are carried in the other hand. She also hangs a towel on her shoulder. Carrying so many things engages her hands, and restricts movement.

## Neck and back strain:

The women carry approximately 15 litres of water on their head. Along with this, some women may carry another 5 litres of water in their hand. So much weight on the head keeps the neck muscles in a constricted state at all times. This leads to spondilytis issues at a later stage.
The weight being carried on the head also leads to back pain and strain in the pelvic region. Young girls often do the task of fetching water from a very young age. They are seen to carry the handa on their hips. These kind of load carrying activities from such a young age may lead to problems with pregnancies later [3].

## Time consuming :

Often, the families are big, and the women must go to fetch water several times throughout the day, Thus, they involve the young girls in the family to help in the task of water fetching. This often leads to the girls not going to school. Women in villages often complain about lack of time to earn a livelihood or to have a chance at education.

## Pregnant women :

Pregnant women are advised to not carry heavy loads through the tenure of their pregnancy. However, it is seen that pregnant women also carry such heavy loads throughout their pregnancy. They must not be allowed to carry such heavy loads. However, due to lack of education or medical advice, they are practicing this.

## Durability :

The steel handa that is currently being used in the villages for fetching and storing water has to be changed every 3 years. This is due to the fact that the handas crack or have dents which make them difficult to use. They are also quite heavy themselves and add to the load of the water.

# Project Brief

## Design Objective

To reduce the effort and minimize the difficulties associated with fetching water by rural women.

## Design Brief

1. Should allow 45 litres of water to be carried in 3 trips.
2. Should reduce the effort required to fetch equal amount of water.
3. Can be carried ergonomically by one woman
4. Should allow easy loading and unloading of water
5. Should store water in a hygienic manner
6. Should minimize wastage of water on commute
7. Minimize changing CG of water while walking
8. Should be usable over different terrains of different villages.
9. Should allow easy pouring/transfer of water.
10. Weight of the proposed design should be lesser than the weight of the existing handas.
11. Easy to clean and maintain

# Conceptualization

## Analogies for ideation

To start ideation, the various modes of carrying the load, their pros and cons, the impact on the various parts of the body were studied. Analogies were developed to aid in the ideation process. These analogies were related to load carrying, water fetching, and usage of other sources of water or any kind of load bearing activity. The features of each of these analogies were explored. Various ideas were developed by mapping these features onto a product which could be used for water fetching by village women. A diverse range of ideas were looked at.

### Vendors:

Vendors are seen to sling load on both sides across their shoulders as shown in Fig 5.1. This balances the load across their shoulders.

### Porters:

Porters carry bags and suitcases in the head mode as shown in Fig 5.2. They load up all the luggage on their head and then walk with it.

### Army vest:

The soldiers carry 35 kgs of weight on their back and are trained to run with it without sustaining any injuries. They also wear vests for training as shown in Fig 5.3, which distribute the load around the trunk of the body.

Fig 5.1: Vendor

Fig 5.2: Porter

Fig 5.3: Army vest

Fig 5.4: Bicycle trailer

***Image source:*** *Fig 5.1: http://www.rontravel.com/Web_Photos_Happy_Cannibal/Y_Vietnam/Vietnam_Hanoi_Vendor_Carry.jpg as on 20-08-2014*
*Fig 5.2: http://www.thehindu.com/multimedia/dynamic/01543/08_MP_PORTER_1543979g.jpg as on 03-11-2014*
*Fig 5.3: http://www.midwayusa.com/product/232297/blackhawk-lrak-machine-gunner-load-carrying-vest-nylon-olive-drab as on 20-08-2014*
*Fig 5.4: http://www.kinetics-online.co.uk/tag/load-carrying/ as on 20-08-2014*

Fig 5.5: Trolleys

Fig 5.6: Sled

Fig 5.7: Haversack

Fig 5.8: Suitcases

Fig 5.9: Skates

***Image source:*** *Fig 5.5: http://img1.targetimg1.com/wcsstore/TargetSAS//img/p/52/31/523173.jp as on 20-08-2014*
*Fig 5.6: https://www.antiqueandartexchange.com/sites/default/files/styles/uc_product_full/public/sled.png?itok=GS0oe8et as on 03-11-2014*
*Fig 5.7: http://ecx.images-amazon.com/images/I/41GefkJHeUL._SL500_AA300_.jpg as on 03-11-2014*
*Fig 5.8: http://gearjunkie.com/images/5247.jpg as on 20-08-2014*
*Fig 5.9: http://sydneyderbyskates.com/shop/images/sds/vanilla_skate_v2.jpg as on 20-08-2014*

## Bicycle trailer:

Bicycles may have a trailer connected to the back or to the front of the bicycle for keeping things or often to carry a baby as shown in Fig 5.4. This is a a method to carry trekking goods, shopping items etc. on wheel.

## Trolleys:

Various kinds of trolleys exist in the market. They range from airport trolleys to shopping carts as shown in Fig 5.5. They are loaded with the goods and then manoeuvered around on wheels.

## Sled:

A sled like the one in Fig 5.6 can be pulled over snow and does not have wheels

## Haversack:

Haversacks like the one shown in Fig 5.7 used for trekking can carry a large weight and are designed to be carried on the back, close to the body. People walk large distances in rough terrain carrying haversacks.

## Suitcases:

A suitcase as shown in Fig 5.8 carries approximately 15- 20 kgs of weight in it depending on its size. Different brands and sizes have different capacities depending on material usage.

## Skates:

Skates shown in Fig 5.9 are an indirect analogy to the activity of load carrying. However, it is interesting to include them in the list. They run on wheels and carry the weight of the human being on them.

# Mind Map

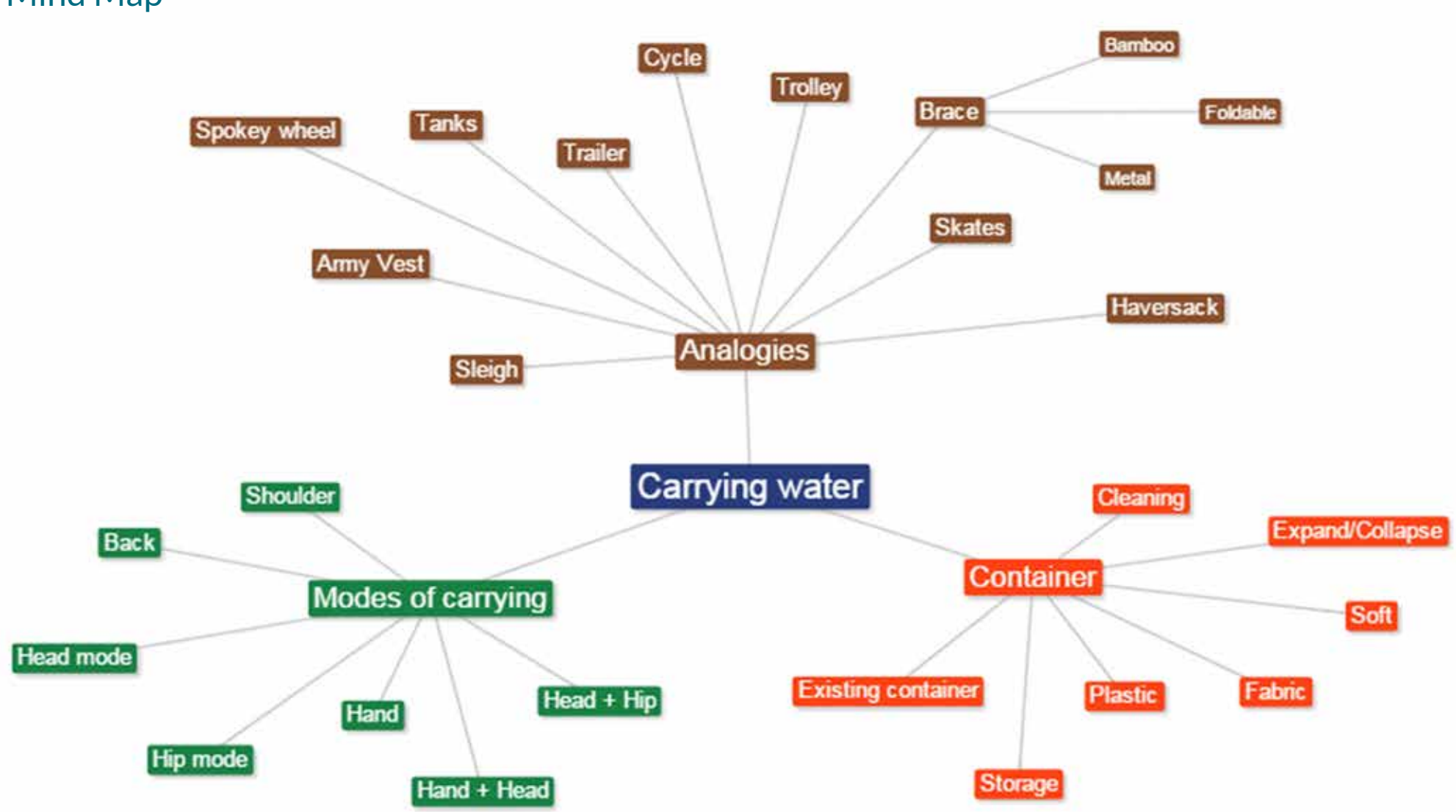



Fig 5.10: Mind map

# Ideation

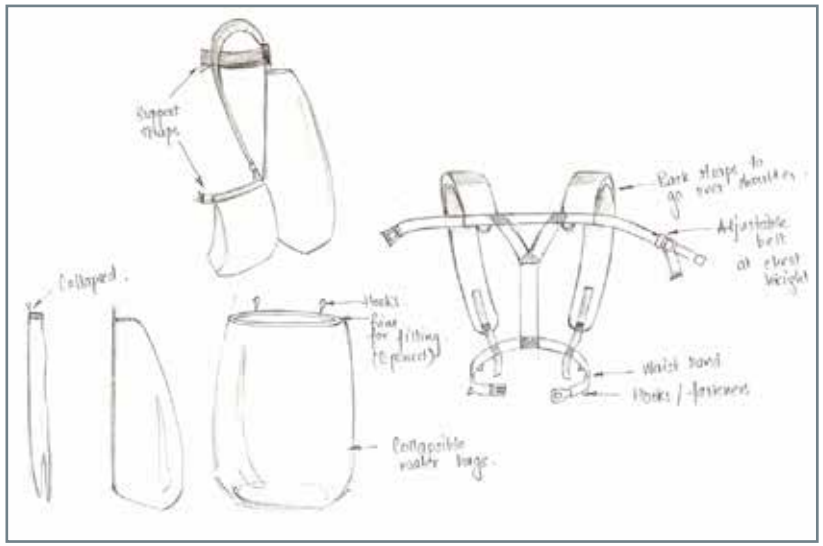



Fig 5.11: Vest design for water bags

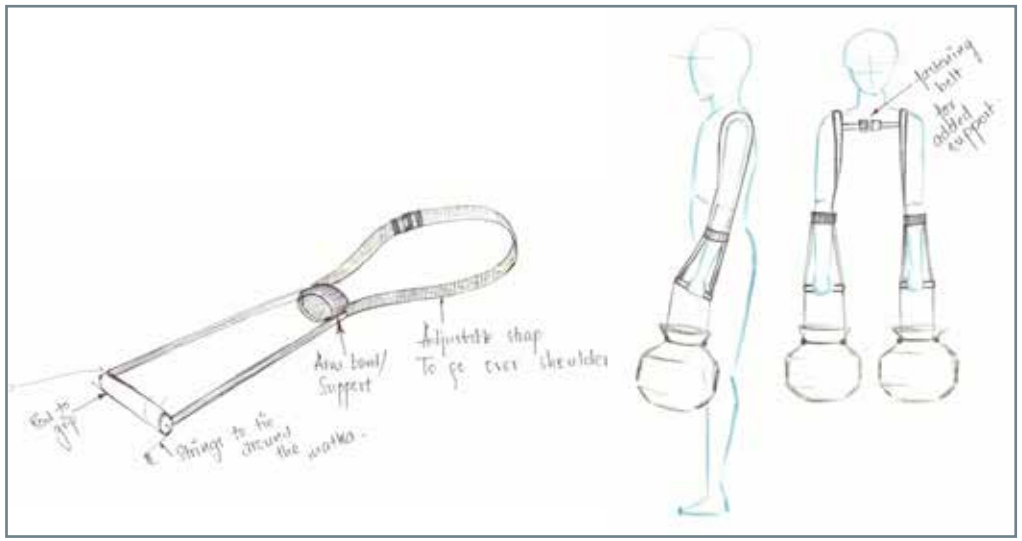



Fig 5.12: Hand held

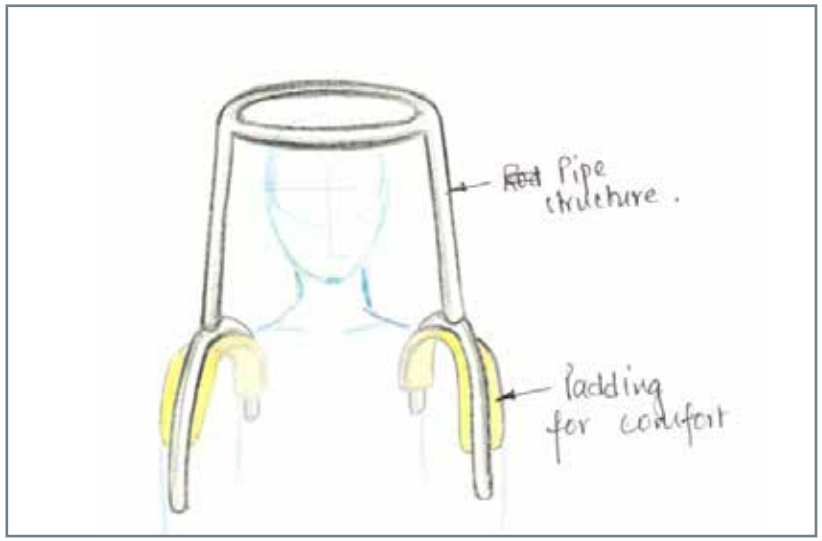



Fig 5.13: Shoulder brace

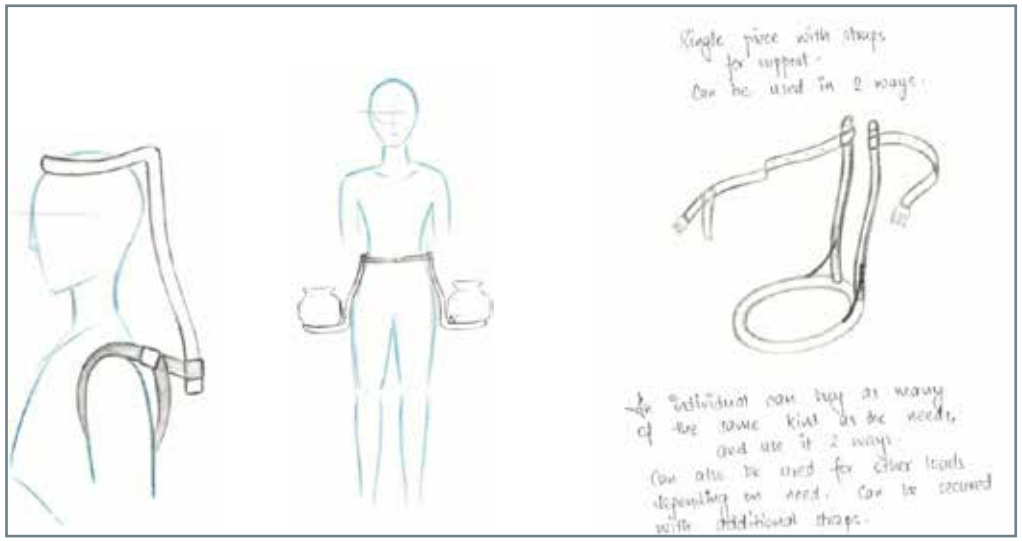



Fig 5.14: Two orientations

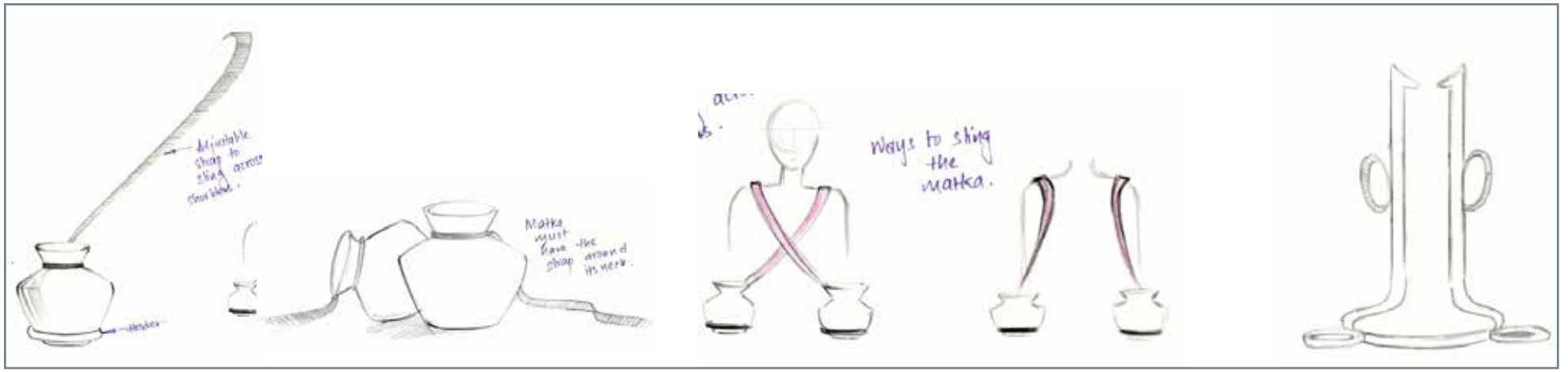



Fig 5.15: Slinging matkas

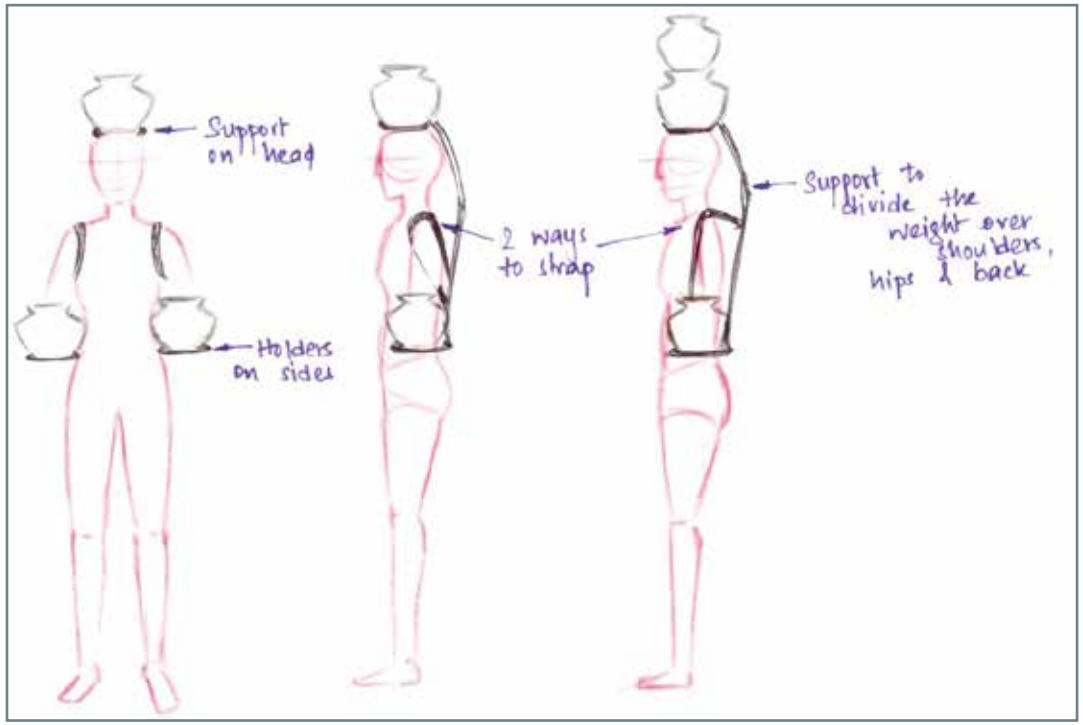



Fig 5.16: Shoulder supported along with side holders

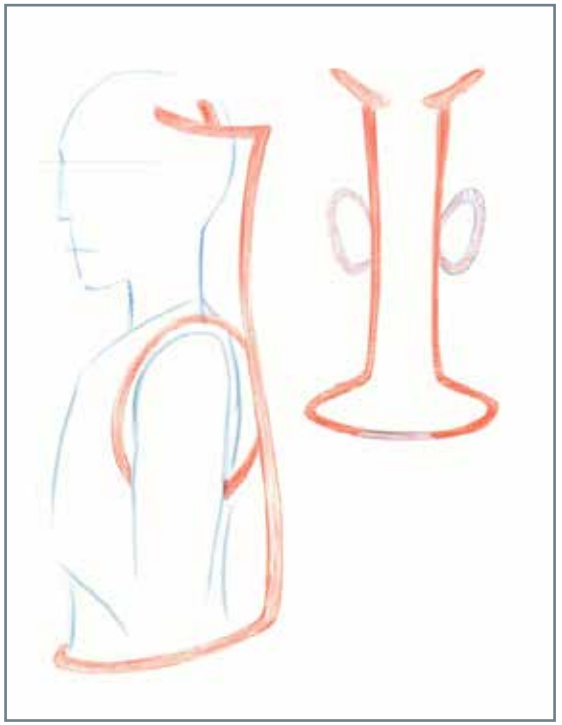


Fig 5.17: Head, shoulder and waist supported

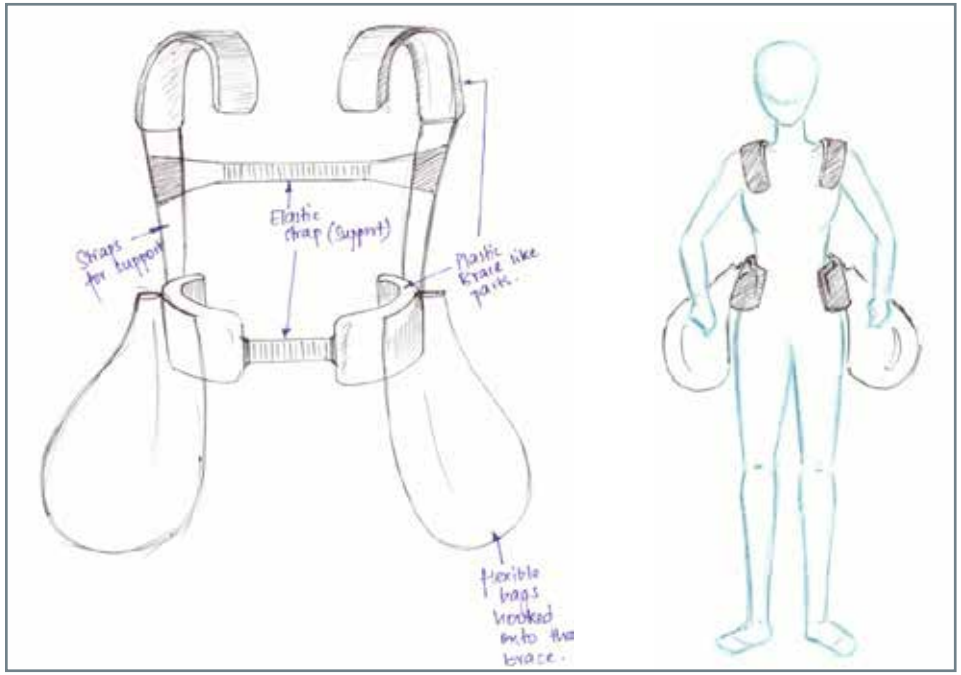



Fig 5.18: Flexible bags

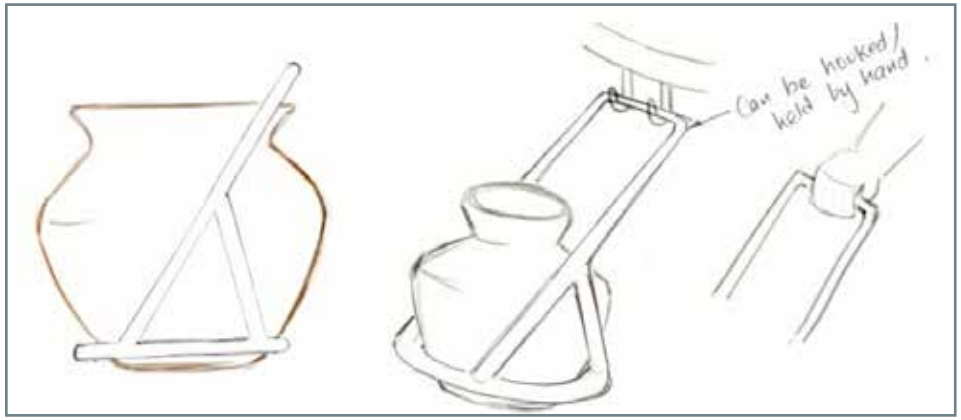



Fig 5.19: Hand held, can be hooked

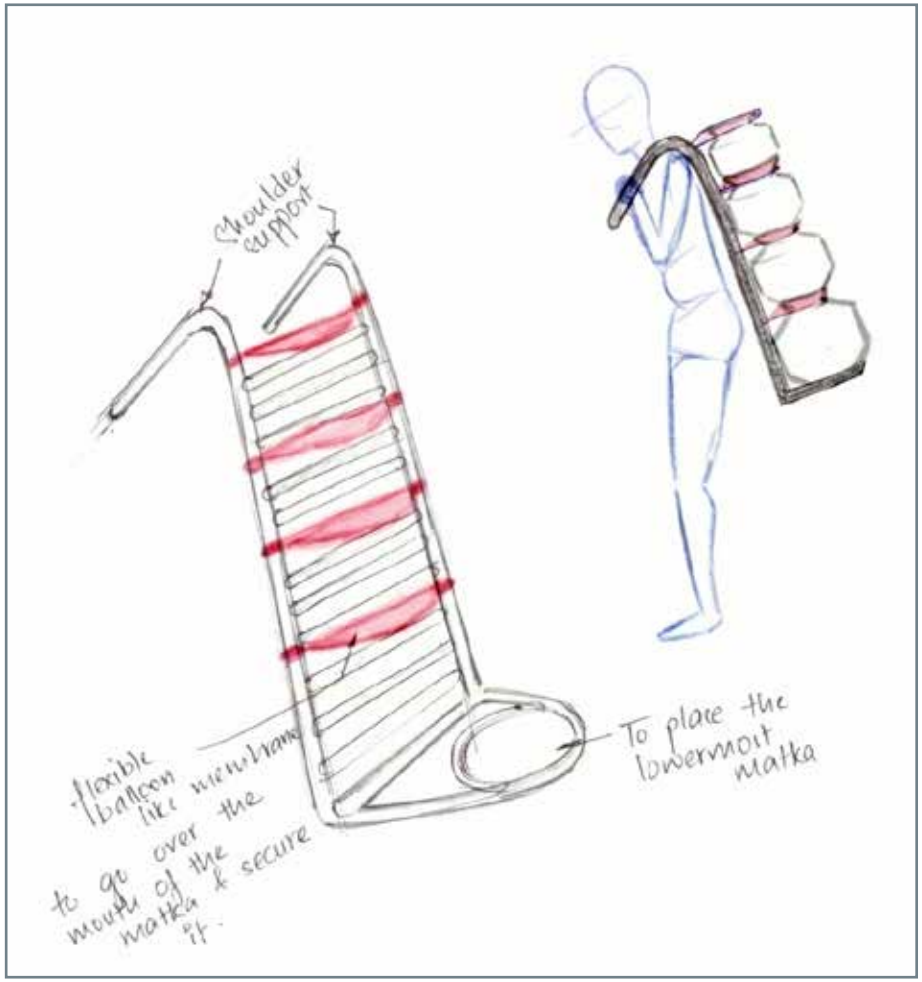



Fig 5.20: Carried on back

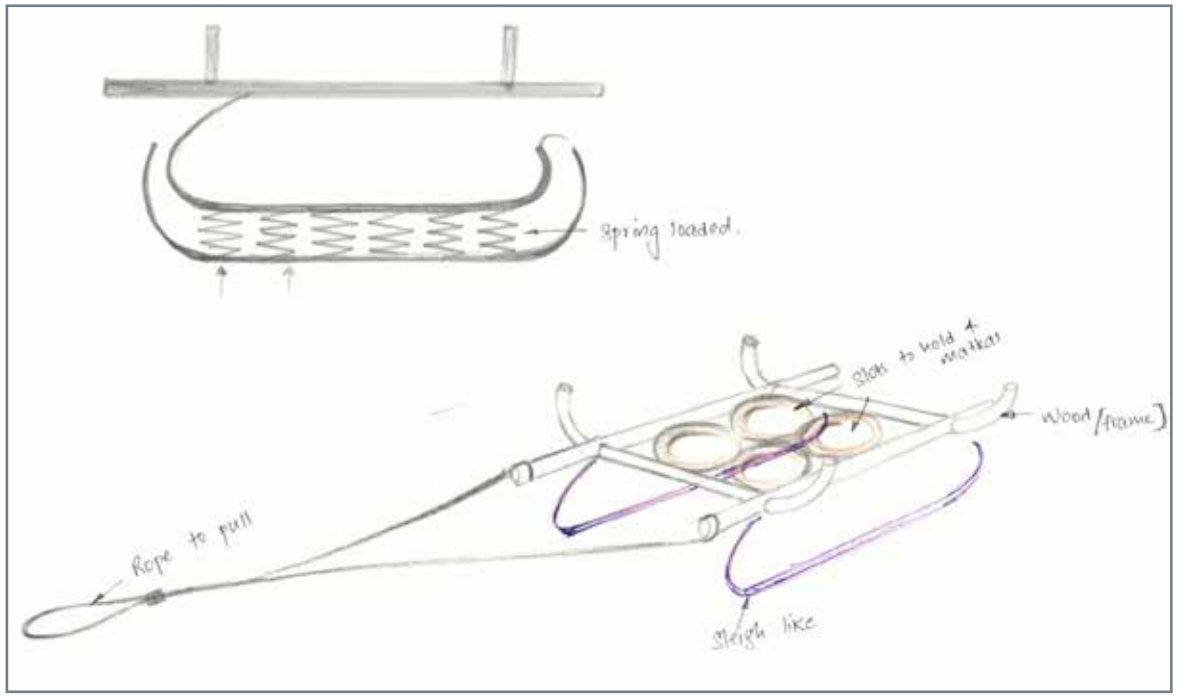



Fig 5.21: Sled. spring loaded

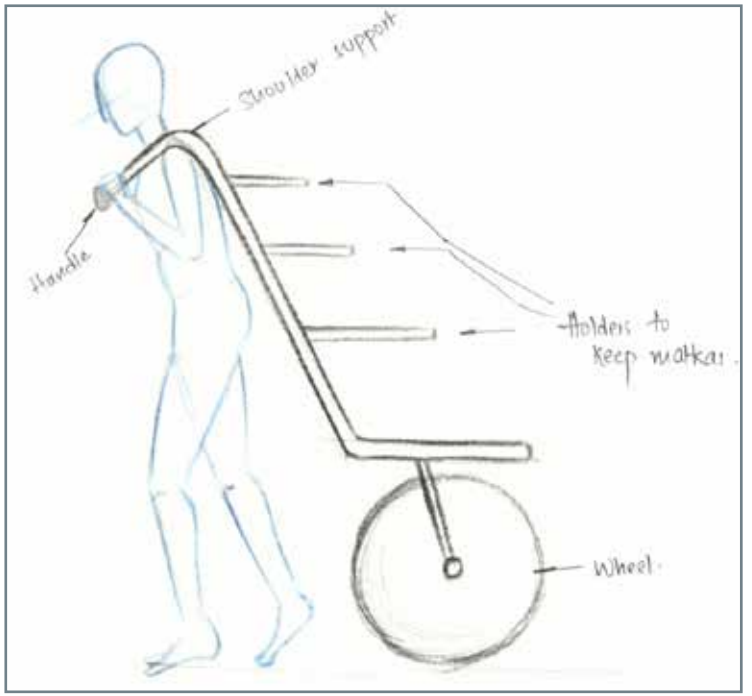



Fig 5.22 : Back load, with wheel

Fig 5.23: Flexi-wheels

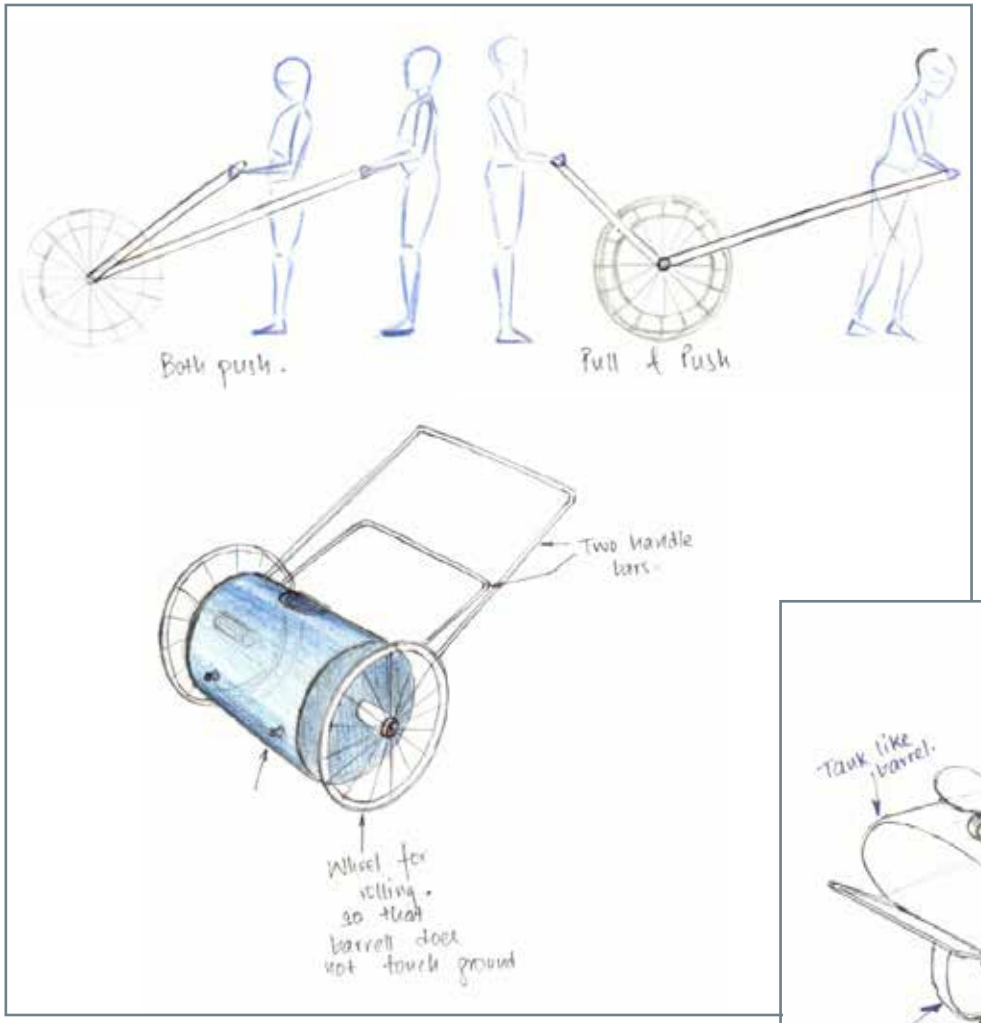



Fig 5.24: Drum on wheels for two people

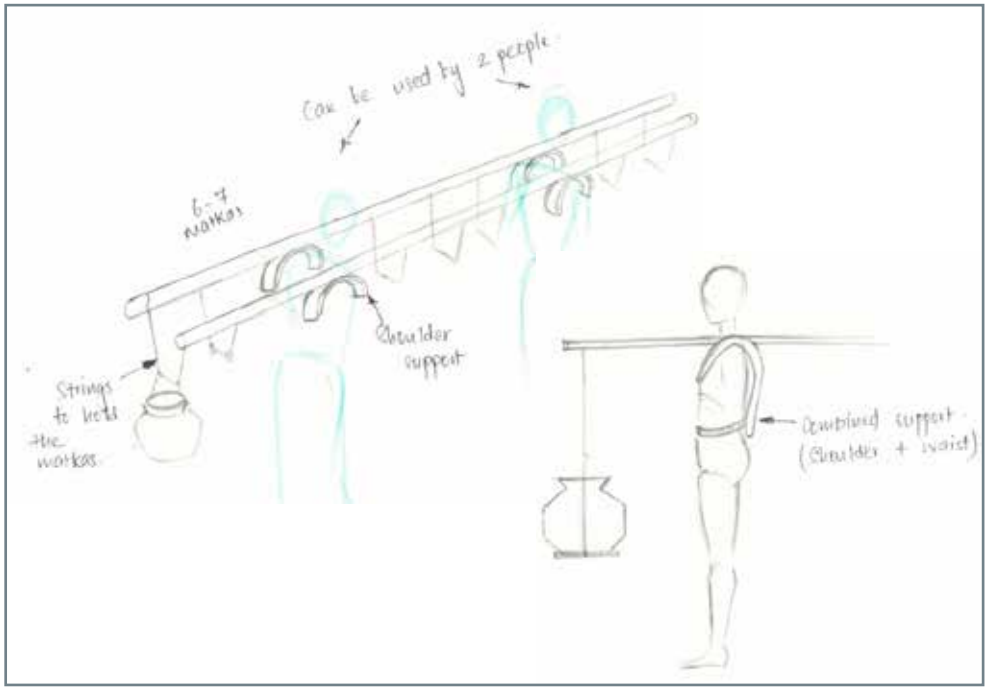



Fig 5.25: Suspended matkas

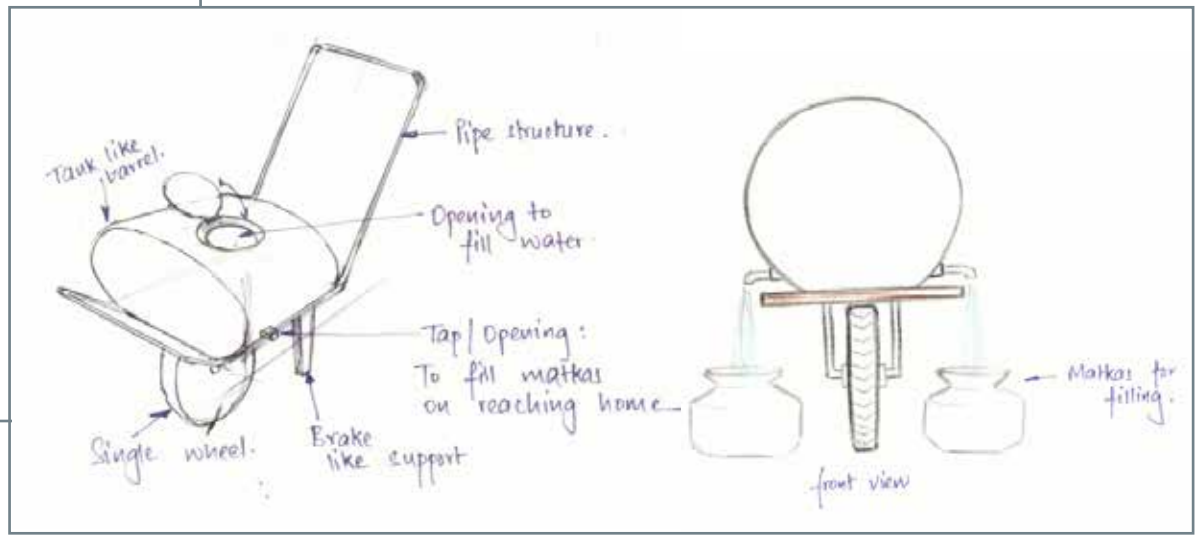



Fig 5.26: Container on trolley

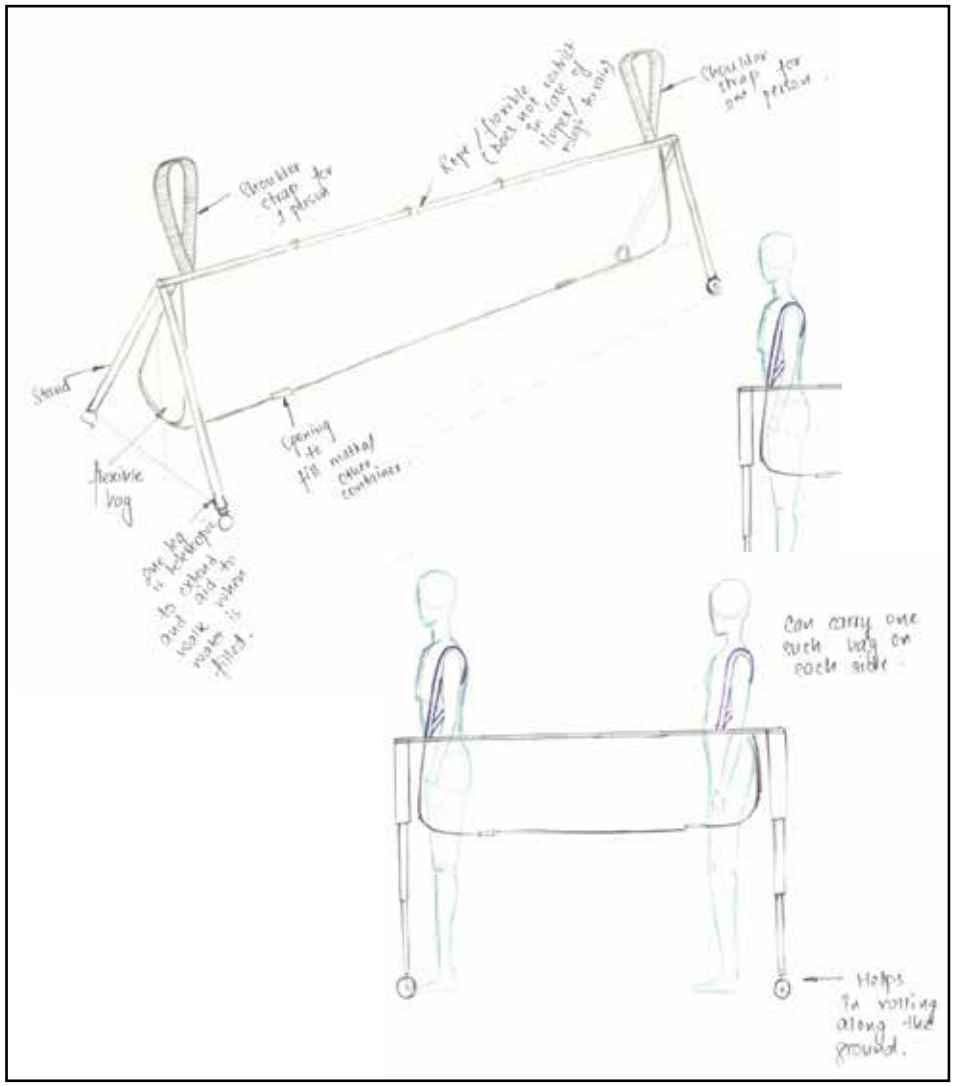



Fig 5.27: Big flexi bag, shoulder strapped

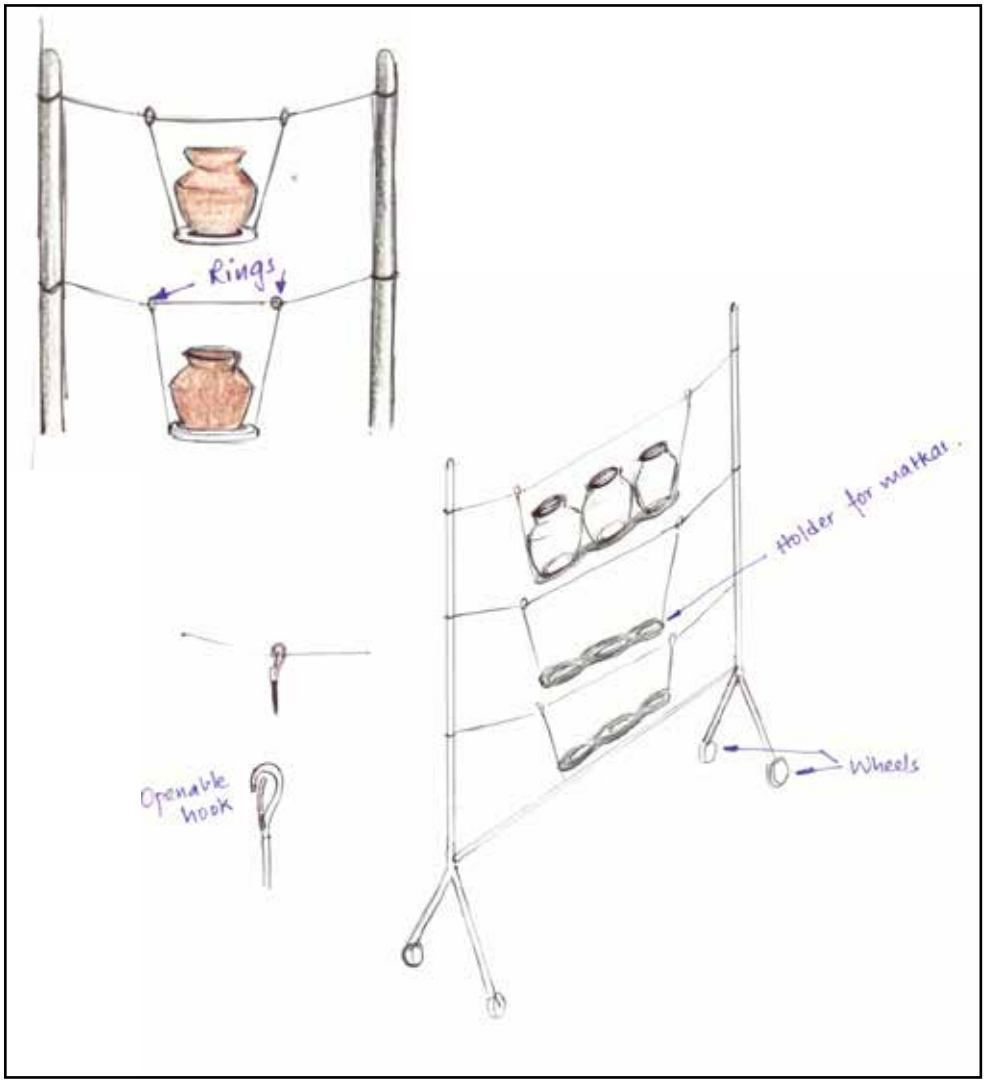



Fig 5.28: Suspended matkas from rings

## Concept clusters from the ideation

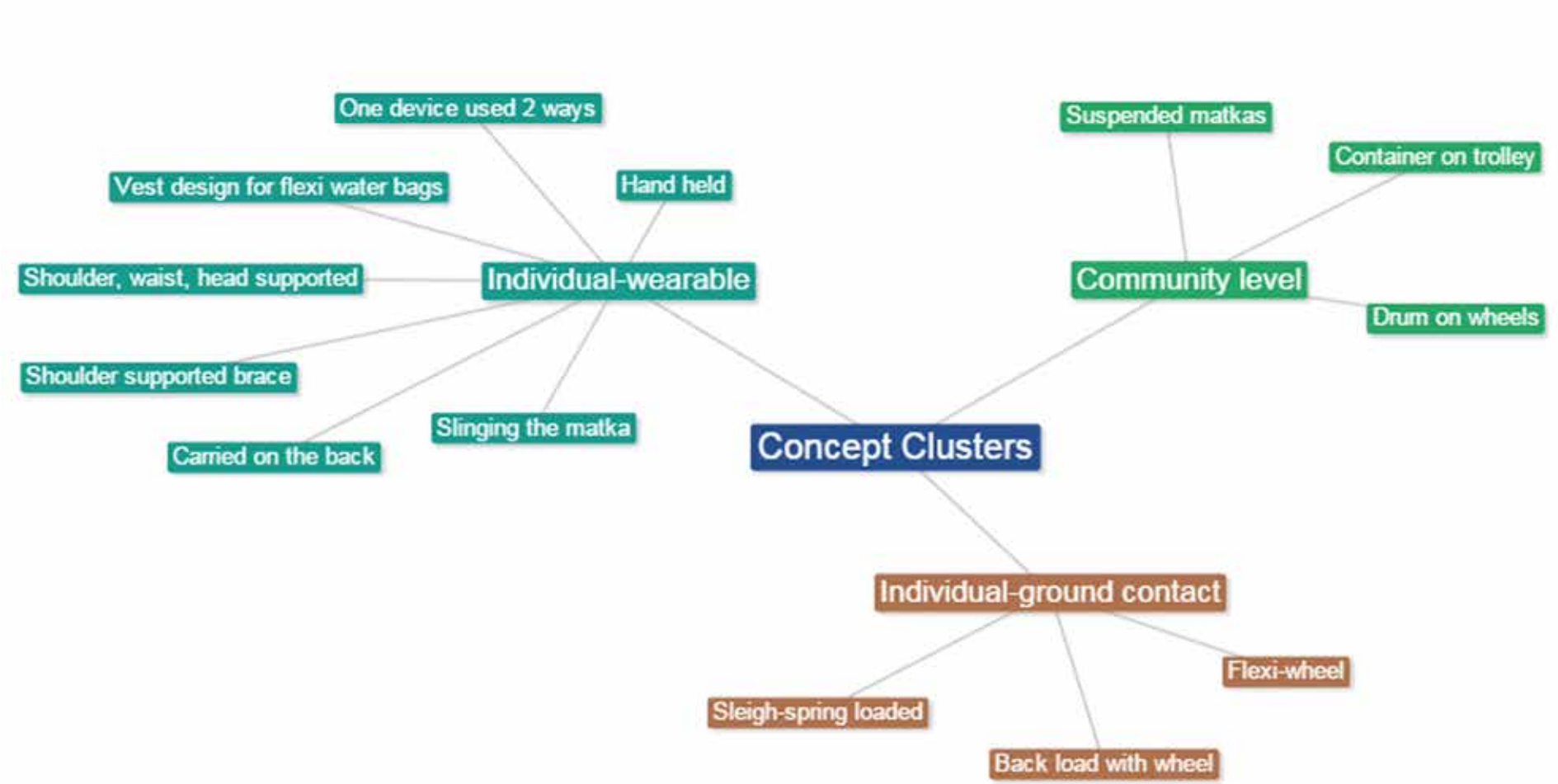



Fig 5.29: Concept Clusters

# Evaluation of Concepts from field

Since the ideation was very diverse and covered a lot of modes of carrying the load, it was necessary to narrow it down based on feasibility and acceptance. There are some pre-concieved notions about the acceptability of every concept. Thus, it was decided to go back to the field to get feedback on the designs and understand the opinion and acceptance of these products by the women there.
The following images were shown and the ideas were explained to the villagers. Their opinions regarding the various designs were recorded. The opinions were divided into likes and dislikes

## Drum :

**Likes:**

- The drum type design shown in Fig 5.30, can carry 40 litres of water in one trip. It can be modified to accommodate more water per trip. This cuts down on the number of trips needed to be made by a woman per day. She can bring in the amount of water needed in one time.
- This device can be used by two people as well. If it is being handled by two women, then the capacity of the drum can be increased to accommodate more water. Example : 2 women can carry 60 litres of water. Two families can share the cost of one such drum and it will satisfy the need of two families.
- During the summer season the distance travelled to bring water is more [9]. The women need to go to a different well to collect the water. The water requirement also rises, since everyone needs more water to drink in the heat. In such a situation the drum brings in a lot of water in one trip thus reducing time and number of trips.

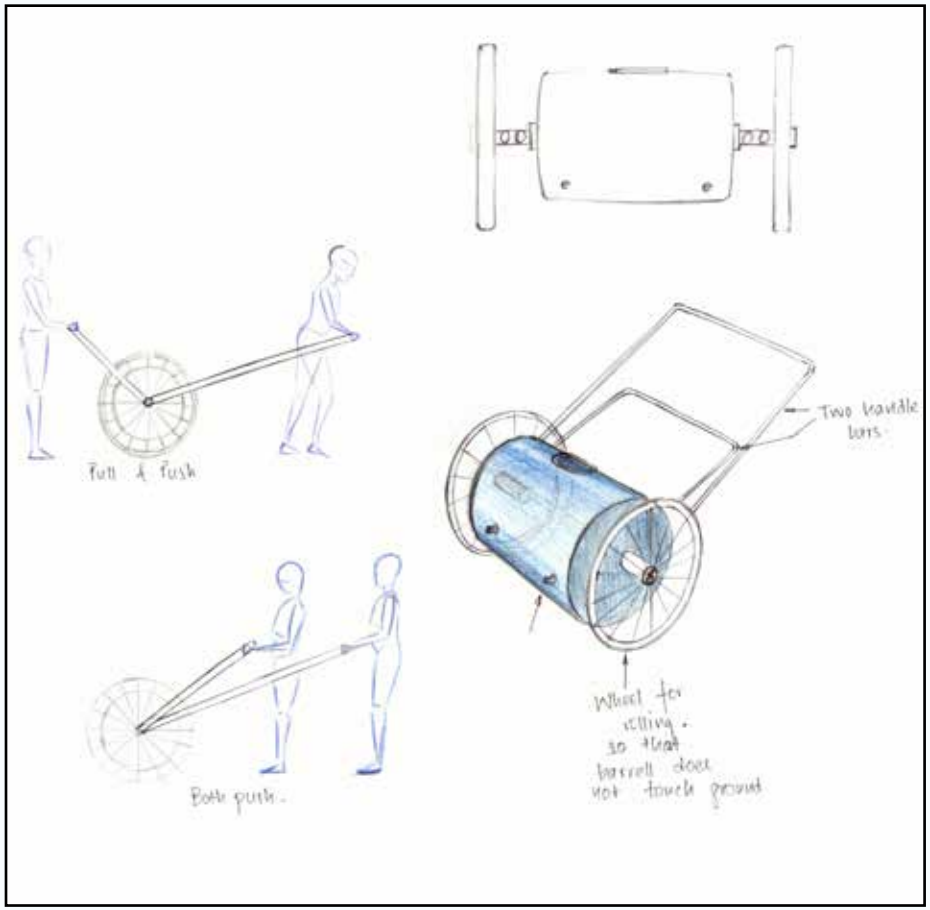



Fig 5.30: Drum on wheels

**Dislikes:**

- The terrain is rough and there are a lot of stones, bushes, mud and rocks on the way. This will lead to the wheels wearing off very soon. Durability of this product may be a problem.
- At all times atleast two people will be needed to roll this drum. This is because the terrain is rough and the drum is heavy. It will be extremely difficult for one woman to handle it. Thus, if only one person is available and there is a need to fetch water, it will not

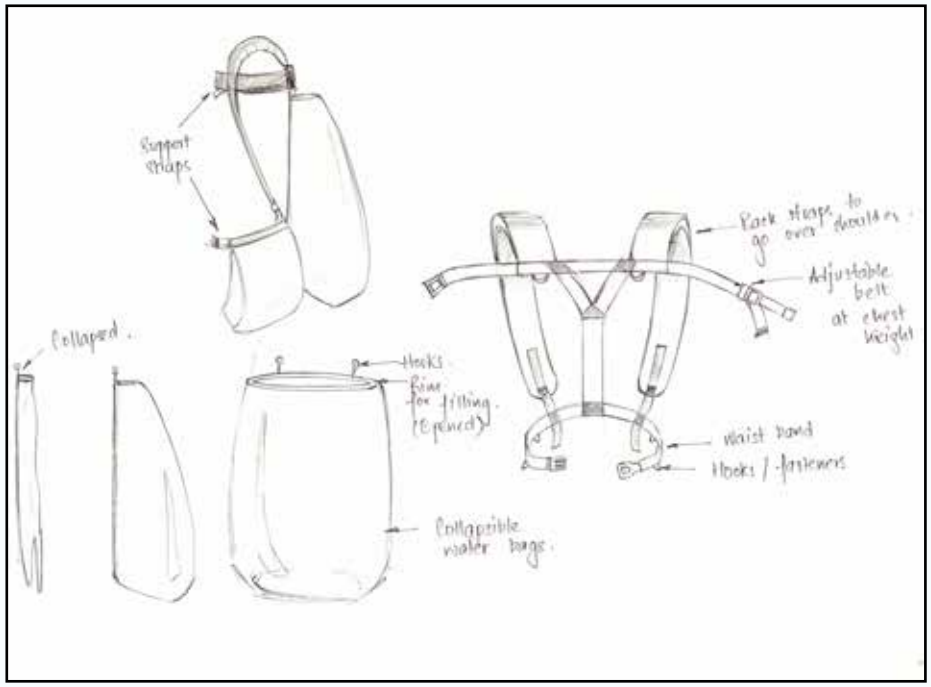



Fig 5.31: Vest for carrying water

be possible or the container will come back half full.

- The drum may be too heavy once full. The size of the drum may make it difficult to handle and clean it.
- Since the drum is on wheels, it cannot be taken over stairs. Most of the houses in the village have a few steps at the entrance to the porch. Thus, there is the added hassle of transferring the water from the drum into handas.

## Vest :

**Likes:**

- The design of the vest as shown in Fig 5.31 had safety straps to secure the containers in place. They felt like the safety straps made the entire product look and feel safer.
- Since the vest is made out of fabric, they felt like fabric would suit women better as compared to the rigid structures which made the entire structure look uncomfrotable.
- Instead of carrying the load on the head, they preferred the concept of carrying load on the back and body. By doing so, the movement of the entire body would be less restricted.
- The water vest gave them a sense of novelty. It was something new for them to use and looked interesting.

**Dislikes:**

- The water vest could not carry large volumes of water like the drum.

# Concept Evaluation

Based on field study, criteria were defined for the evaluation of the concepts and then weighted to bring out the prioritization of these criteria.
The first step was to define what each criteria meant and with respect to what was the score given as shown in Table. 5.1

| Criteria | | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|
| A | **Reduction of effort** | Compared to the current mode of carrying water, no effort has been reduced | | | | Effort reduces drastically as compared to current method |
| B | **Ease of use** | Problematic steps involved in current method still exist or have increased | | | | No. of steps has reduced or has been simplified |
| C | **Ease of loading, unloading** | Does not improve the laoding unloading method | | | | Reduces the effort required in loading and unloading of the containers |
| D | **Easy transferring** | Transferring water for use is hassled | | | | Transferring water for use in the kitchen is hassle free |
| F | **Volume of water per trip** | Lesser volume of water per trip than current method | | | | Volume of water equivalent to the need of the household per day |
| G | **Ease of cleaning** | Takes more time and is difficult to clean | | | | Takes less time and is easy to clean |
| H | **Level of acceptance** | Not acceptable to users | | | | Acceptable to users |

Table 5.1: Criteria for evaluation

| | | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|---|
| Reduction in effort | A | 1 | 0 | 1 | 0 | 1 | 0 | 0 |
| Ease of use | B | 2 | 1 | 2 | 0 | 0 | 1 | 1 |
| Ease of loading, unloading | C | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
| Easy transferring | D | 2 | 2 | 2 | 1 | 2 | 1 | 0 |
| Volume of water per trip | E | 1 | 2 | 1 | 0 | 1 | 0 | 0 |
| Level of acceptance | F | 2 | 1 | 2 | 1 | 2 | 1 | 1 |
| Ease of cleaning | G | 2 | 1 | 1 | 2 | 2 | 1 | 1 |
| **SUM** | | **11** | **7** | **10** | **4** | **9** | **4** | **4** |
| **Weighting Factor** | | **1** | **0.64** | **0.91** | **0.36** | **0.82** | **0.36** | **0.36** |

Table 5.2: Comparison of criteria

## Comparison of criteria:

To select a final concept from the ones presented above, discursive evaluation method was used. In the first step, we defined the criteria for the evaluation which were important to the users(Table 5.1 ). Furthermore, we chose a rating scale for the different criteria. The ideal value is 4 and if it is barely acceptable the value is 0.

After setting the criteria, a pairwise comparison was made to determine the weighting factor of the different criteria (Table 5.2). This takes into account that not all the criteria are of the same importance. In the following step, the solution properties of the concepts were assembled. It was then discussed based on feedback from users and inferences from research, which rating value from 0-4 should each concept get for the different criteria. In the last step, the part and total value of the concepts was calculated(Table 5.4). For that purpose, the rating value was multiplied with the weighting factor in table 5.2 of the criteria. The normalised sum of these weighted rating results in the ranking of the concepts.

## Prioritization of criteria:

Based on the weighted factors, the criteria could be prioritized. This was important since not all criteria were of the same importance. The weighted factors will help in evaluating the concepts correctly with due importance given to each criteria with respect to the concept. The criteria in their order of priority is shown in Table 5.3.

| Criteria | Priority |
|---|---|
| Reduction in effort | 1st |
| Ease of loading, unloading | 2nd |
| Volume of water per trip | 3rd |
| Ease of use | 4th |
| Easy transferring | 5th |
| Ease of cleaning | |
| Level of acceptance | |

Table 5.3: Prioritization of criteria

| Criteria | Weighting coefficient | Concept 1 | | Concept 2 | |
|---|---|---|---|---|---|
| | | Not weighted | Weighted | Not weighted | Weighted |
| A | 1 | 2 | 2 | 3 | 3 |
| B | 0.64 | 3 | 1.92 | 4 | 2.56 |
| C | 0.91 | 3 | 0.3 | 3 | 0.3 |
| D | 0.36 | 1 | 0.36 | 3 | 1.08 |
| E | 0.82 | 4 | 3.28 | 2 | 1.64 |
| F | 0.36 | 3 | 1.08 | 2 | 0.72 |
| G | 0.36 | 2 | 0.72 | 3 | 1.08 |
| **SUM** | 4.45 | 18 | 9.66 | 20 | 10.38 |
| **Rank** | | **2** | | **1** | |

Table 5.4: Evaluation result

## Evaluation Result:

Based on user feedback and discussion with guides, points were given to each concept based on the criteria as shown in Table 5.4. After doing so, the weighted value of each score was calculated. The sum of the weighted values gave the ranking of the concepts.

The vest design for carying water around the trunk of the body got better scores as compared to the drum design.

The criteria in this desgn which got a low score were taken into consideration for improvement and refinements in the design

# Further exploration of the vest design

## Flexible bags:

The container can be a semi- rigid container. It can collapse when not in use. A mock up of such a bag was tried using platic and wire as shown in Fig 5.32. When water is filled in the container, it would stay rigid, once the container was emptied, it could be collapsed.

## Weight testing:

The weight of 20 litres of water had to be tested to be carried on the body in different ways. To do so, 20 balloons were filled with 1 litre water each and then a backpack was gradually filled with these balloons as shown in Fig 5.33. Approximately 10 litres of water on the back seemed manageable to carry. Beyond 15 litres, the C.G. of the body tends to shift backwards and there is a pulling feeling towards the back to counteract which one must bend in the front. It was learnt that it wasn't possible to carry beyond 15 litres of water solely on the back.

Fig 5.32: Flexible bag mock up

Fig 5.33: Weight testing

## Form exploration of the container

Form exploration for the container was done for making the container hug the human body so that the swaying motion of the water in the container does not affect the person's C.G. much.
1:5 scale models of the container was made as shown in Fig 5.34 after making cad models of the container to get the correct volume.

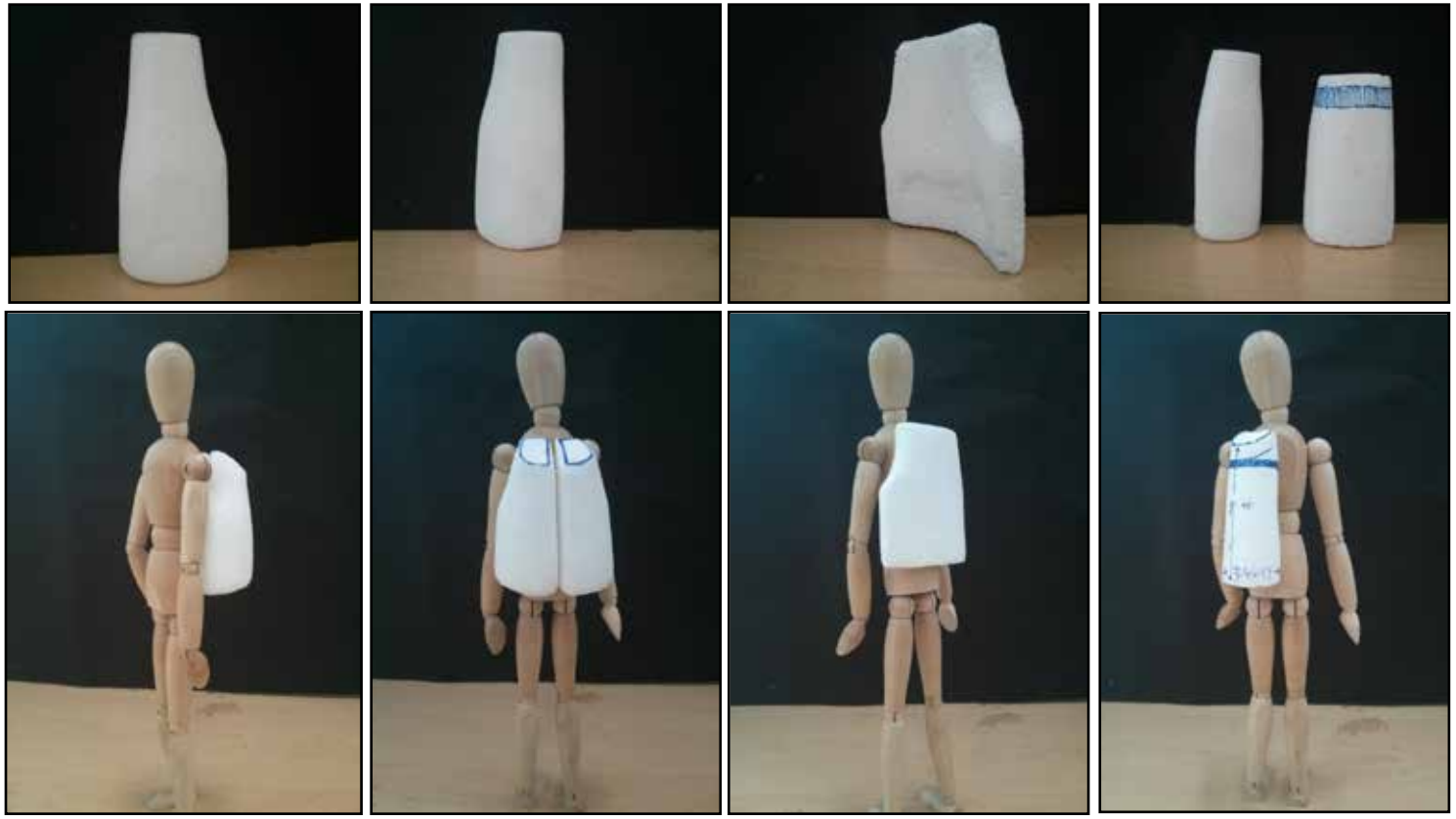


Fig 5.34: Form explorations of container

# Mock-up of the harness

A mock up was made using foam, nylon straps, and nylon cloth as shown in Fig 5.35. Carbiners were attached to the backpack straps for hooking on the bags of water. 1 litre water filled balloons were used to simulate the weight of 18 litres of water. 2 bags with 6 balloons each were hung from the carbiners on the back, and 2 bags with 3 balloons each was hung from the carbiners attached in the front.

A scarf was also given from the back to the front as a handle as shown in Fig 5.36. This allowed the user to engage her hands, while pulling the scarf to bring the weight closer to the body. This reduced the effort of carrying the weight slightly.

The scarf brought in an element of Indian-ness and also covered the backpack straps. A scarf is a widely accepted part of a woman's outfit in India. Instead of using regular nylon straps to make the handles, the use of a scarf could make it look more personal, customized and natural.

## Inferences from the weight testing:

- 18 litres of water can be carried on the body by 1 person as shown in Fig 5.37 without any major discomfort.
- The bags of water need to be secured in a more sturdy manner such that they don't move while walking.The hooks are not enough for carrying the weight of the water bags.
- Holding onto the scarf and pulling it as shown in Fig 5.38 reduces the effort required for carrying the load.

Fig 5.35: Harness

Fig 5.36: Harness with scarf

Fig 5.37: Testing 18 litres

Fig 5.38: Testing with scarf

# Final Concept

Concept sketches for the harness and containers was made. Various adjusters, buckles, details of flaps and connections were made. The concept sketch shown in Fig 6.1 was then used to get the harness stitched.

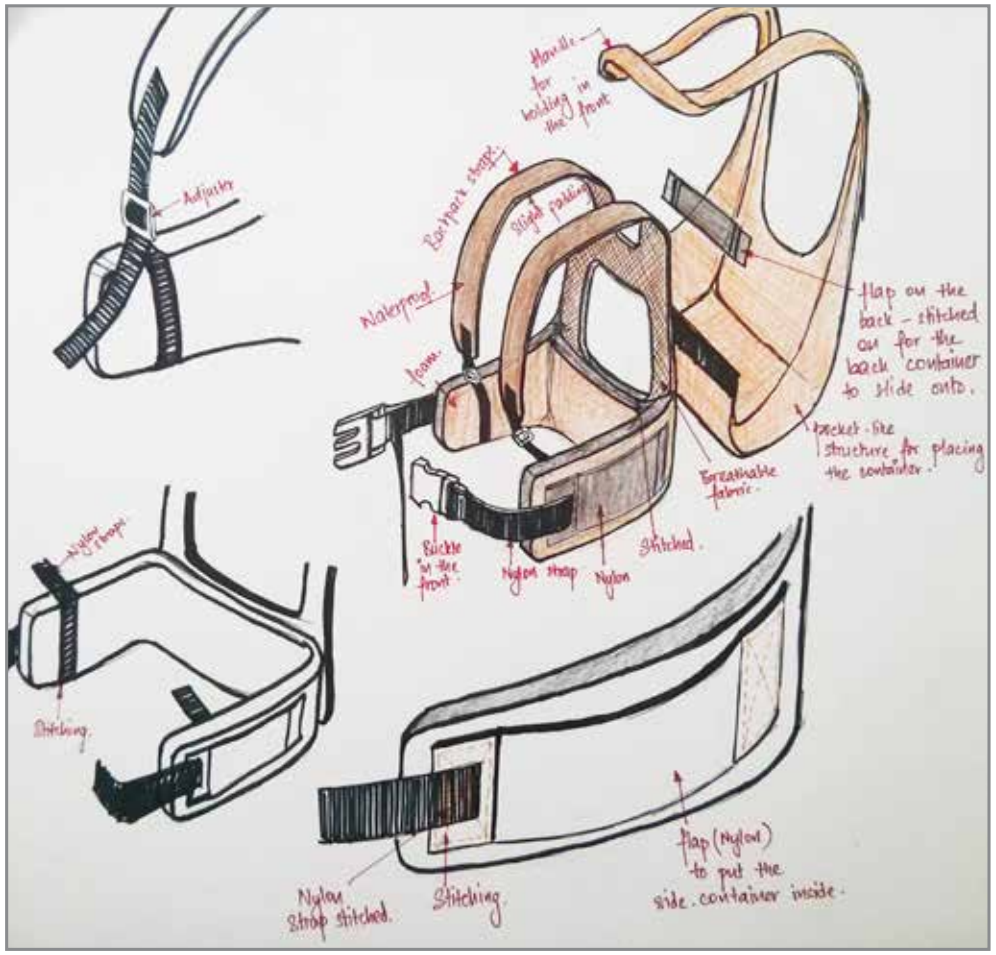



Fig 6.1: Concept sketch


Fig 6.2: Big container

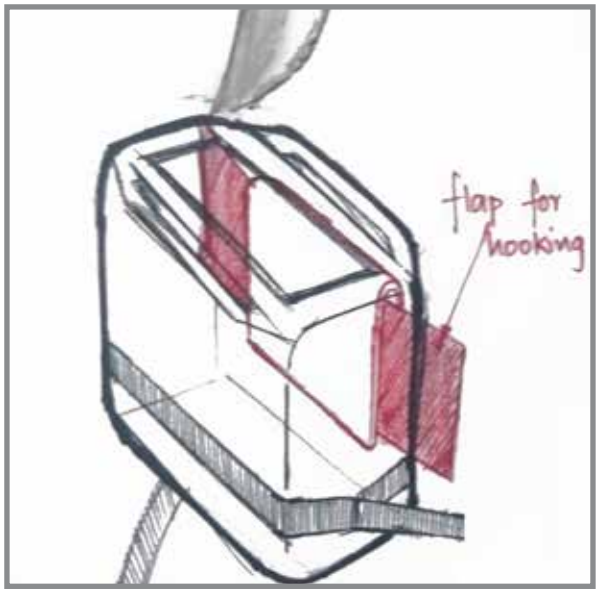



Fig 6.3: Hooking small container onto the side

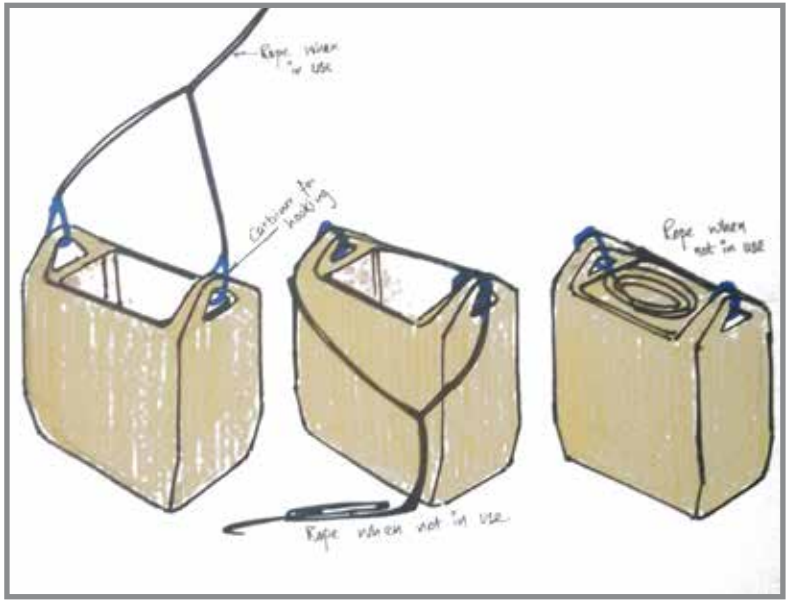
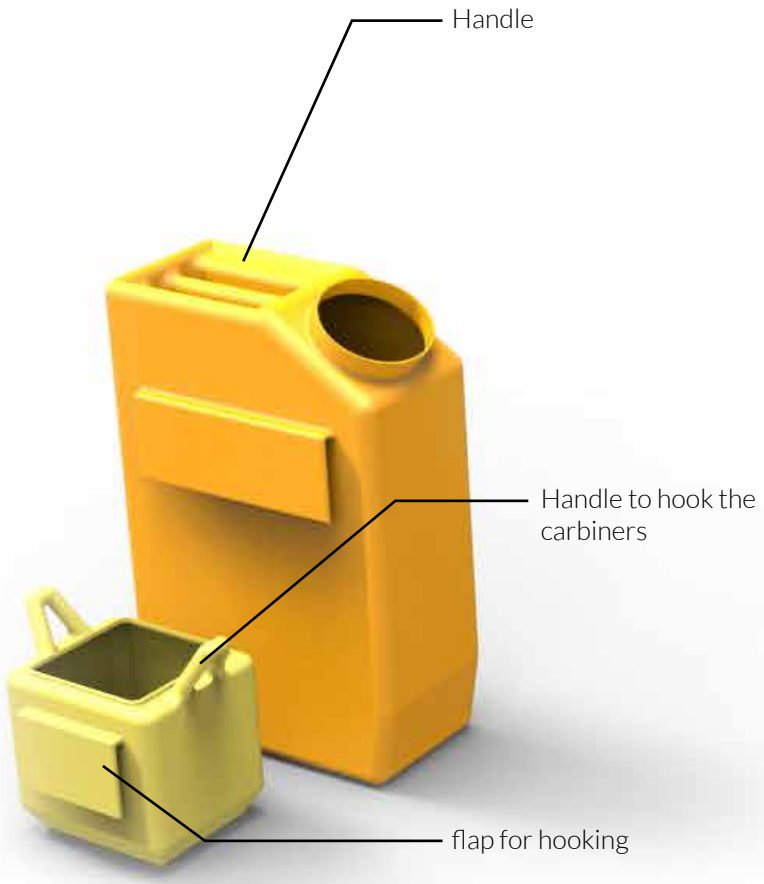



Fig 6.4: Rope attachment to small container



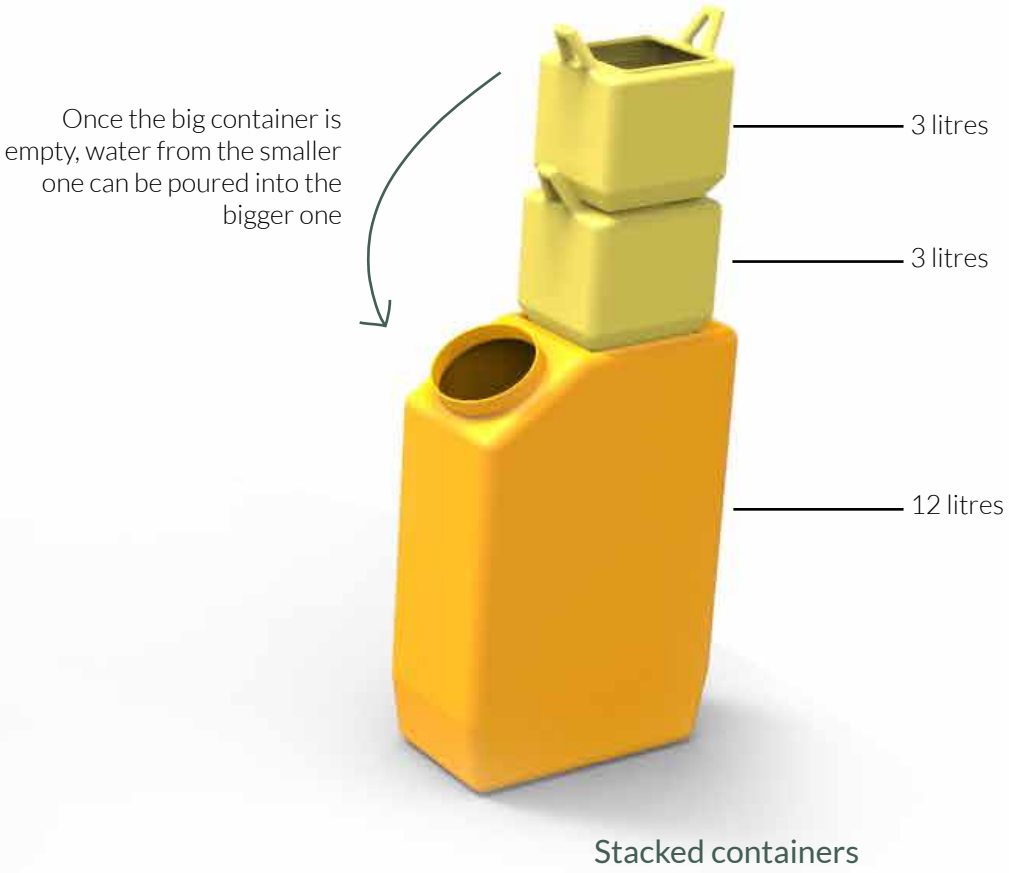




Fig6.5: Stacked containers

# Testing the mock up in the field

A mock up was made for the harness as shown in Fig 6.6. The harness was stitched by a backpack salesman in the form of a modified backpack.
It has padding for comforting the back, a strap at the waist with a buckle for support. A pouch on the back-side allows the user to place the container inside it. A scarf like cloth is used for handles which can be held onto and pulled in the front. On either side, there is a pouch made of cloth for holding the small containers. These have nylon straps to secure them on top of the pouch.

The containers used for testing are jerrycans of 10 litre and 5 litre capacity. One 10 litre jerrycan goes on the back and two 5 litre jerrycans are kept on either side.

Fig 6.6: Mock up testing

# Activity analysis

Fig 6.7: Activity analysis of mock up testing

# Activity analysis

An activity analysis was done using the mock up and the various steps were studied as shown in Fig 6.7

1. Put the empty container in the pouch
2. Pick up the bag by one of the backpack straps
3. Hold the scarf along with the backpack straps
4. Put one strap over shoulder
5. Put second strap over shoulder
6. Divide the scarf straps over the two shoulders
7. Carry the empty jerry cans in the hands along with the sieve
8. Walk towards the well
9. Upon reaching the well, put down the two jerrycans on the ground.
10. Place the backpack on the ground against the well wall
11. Take out the big container and place it next to the others
12. Start the filling process
13. Put jerrycan into the well, let it sink, pull it out
14. Pour the water into the narrow mouth of the larger jerrycan
15. Place the big container in the pouch of the backpack
16. Lift up backpack by the two backpack straps
17. Hold the scarf straps along with the backpack straps
18. Bend down, pick up one of the smaller containers
19. Stand up straight, put it into the pouch
20. Another person holds the pouch open
21. After putting the jerrycan in, fasten the nylon strap
22. Repeat the above process for the second small container
23. Hold onto the scarf straps and start walking back
24. Reach home, unbuckle one side
25. Hold onto the handle while unbuckling, pull it out, keep it on the kitchen platform
26. Repeat for other jerrycan
27. Take off the bag
28. Lift up the jerrycan and pull it out of the pouch
29. Place it down on the kitchen platform
30. Keep the harness aside against the wall
31. Take out water for use from the tap on the big container
32. Once the water in the big vessel is over, pour water from one of the smaller containers into the big container.

# Inferences from field testing and activity analysis

After testing the mock up and doing an activity analysis, the problems with the mock up were analysed and the feedback of the users was recorded.

- The scarf straps must be made more hassle free. They need to be held very carefully while loading the vessel to make sure the jerycan is secured. The number of steps to wear the harness and then to hold it correctly can be reduced if the scarf straps are secured in the product itself, using hooks or loops over the backpack straps. They need not be kept loose and add complexity to the usage of the product.

- A provision to carry the sieve and the rope attached to one of the small containers must be incorporated. Currently, the sieve is being carried separately and the rope attached to the small container hangs loose or is wound around the hand.

- The jerrycans used for this testing were standard jerrycans. These have small mouths and hence it requires a large time to fill them. There is also a lot of spillage of the water on the outside of the containers when the lady is pouring the water into the jerrycan. It also requires more concentration as the user needs to aim into the small opening of the mouth of the jerrycan for the water to get filled into the jerrycan.

- The small mouth of the jerry can also does not allow the user to be able to clean the inside of the jerrycan. It is a regular practice for the women to first clean the container before filling it with water. However, that is not possible to do in this case as the hand cannot be put inside the jerrycan from such a small mouth.

- It was found to be very cumbersome for the woman to put the side containers into the pouch. It needed another person's help to hold the pouch open and then to secure the straps. Once the containers have been secured on the side, walking along with them isn't problematic. But since it is difficult to put them into the pouch, it is likely that the user would simply carry the two jerry cans in their hands instead of taking the effort of putting it into the pouch.

- The material used in the making of this harness can be drastically reduced and the harness can be made more seamless. The current design has an entire backpanel. The support provided by the whole backpanel can be provided by backstraps as well. The harness needs to look more seamless and minimal.

# Refined design

## Features of the new design :

The refined design as shown in Fig 6.8 has the following features:

**The frame structure:**

The frame shown in Fig 6.11 has been included to give the entire structure some rigidity. The rigidity would allow the woman to place it down near the well easily without having to make it lean against the well wall. The entire structure can be kept on the kitchen platform like one unit. The problem of loading the side containers would also become simpler because the need to fasten it with an additional strap is removed.

**Frame for side container:**

The frame for the side container is attcahe dto the waist support. It is attached to the main frame using another metal member.

**Reduction in material:**

The material for making the harness and safety straps is reduced drastically. The entire design is more seamless and uses much lesser material.

**Containers:**

The containers are like jerrycans as shown in Fig 6.9 and Fig 6.10 designed to fit into the frame.
There are two container capacities, one has a 12 litre capacity and two have 4 litre capacities. The 4 litre container is also used to draw water from the well. This reduces the need for carrying an extra jerrycan with a rope attached to it.

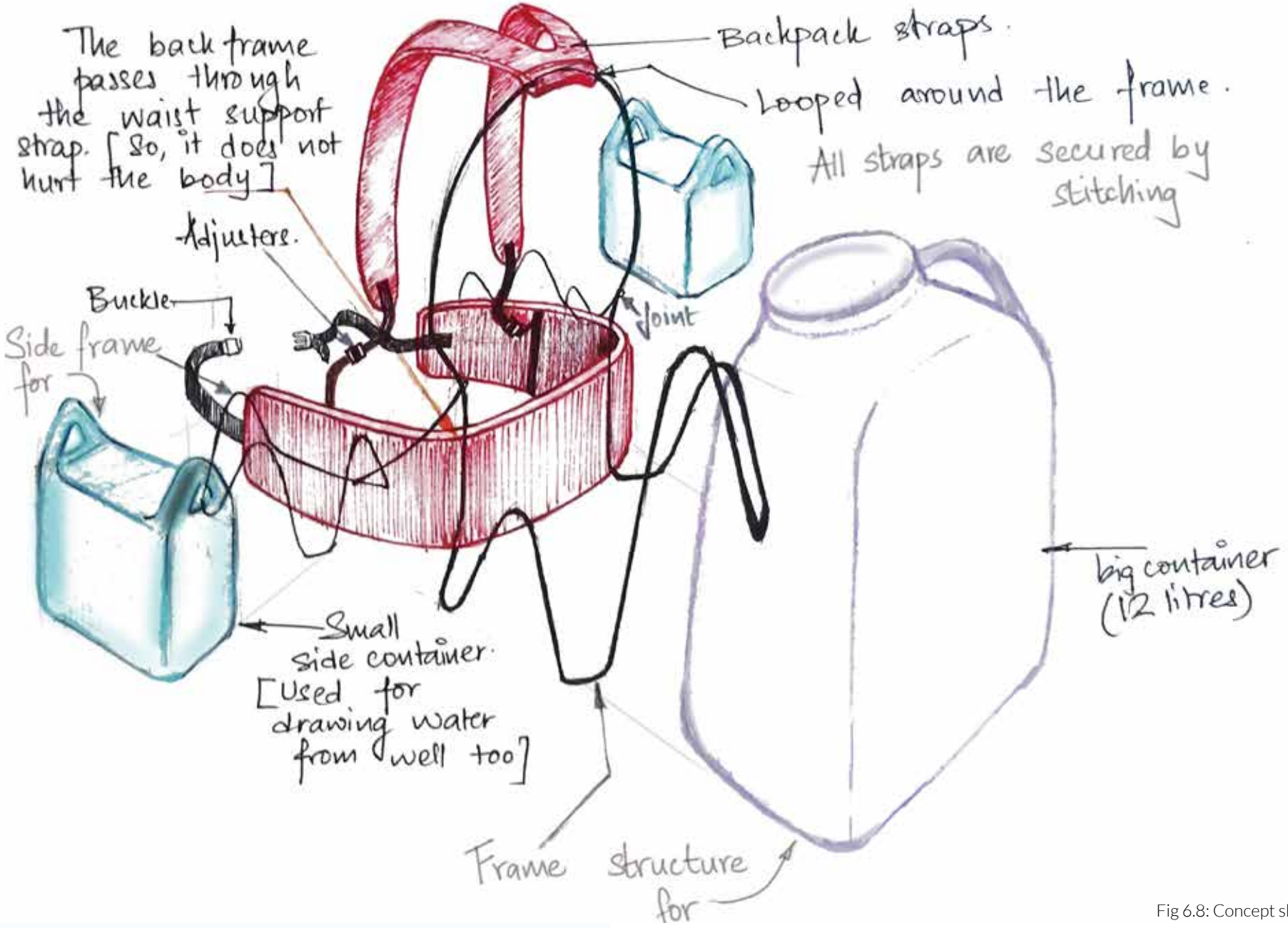



Fig 6.8: Concept sketch

# Renders

## Big container: 12 litre capacity

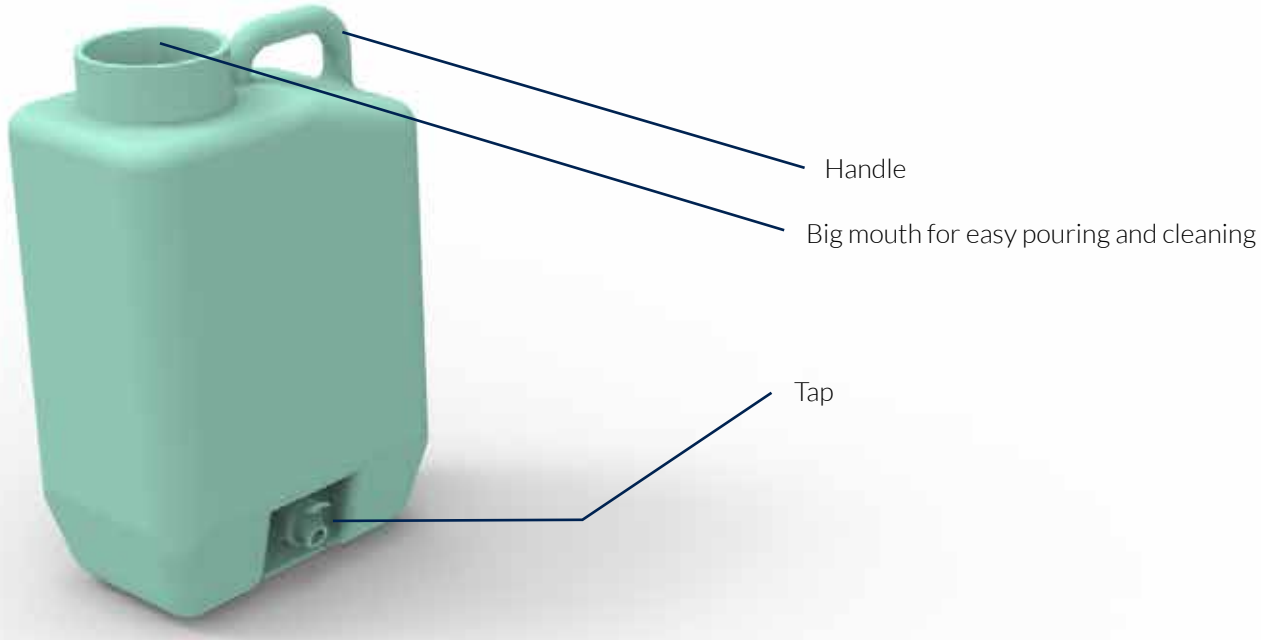



Fig 6.9: Big container

## Side container: 4 litre capacity

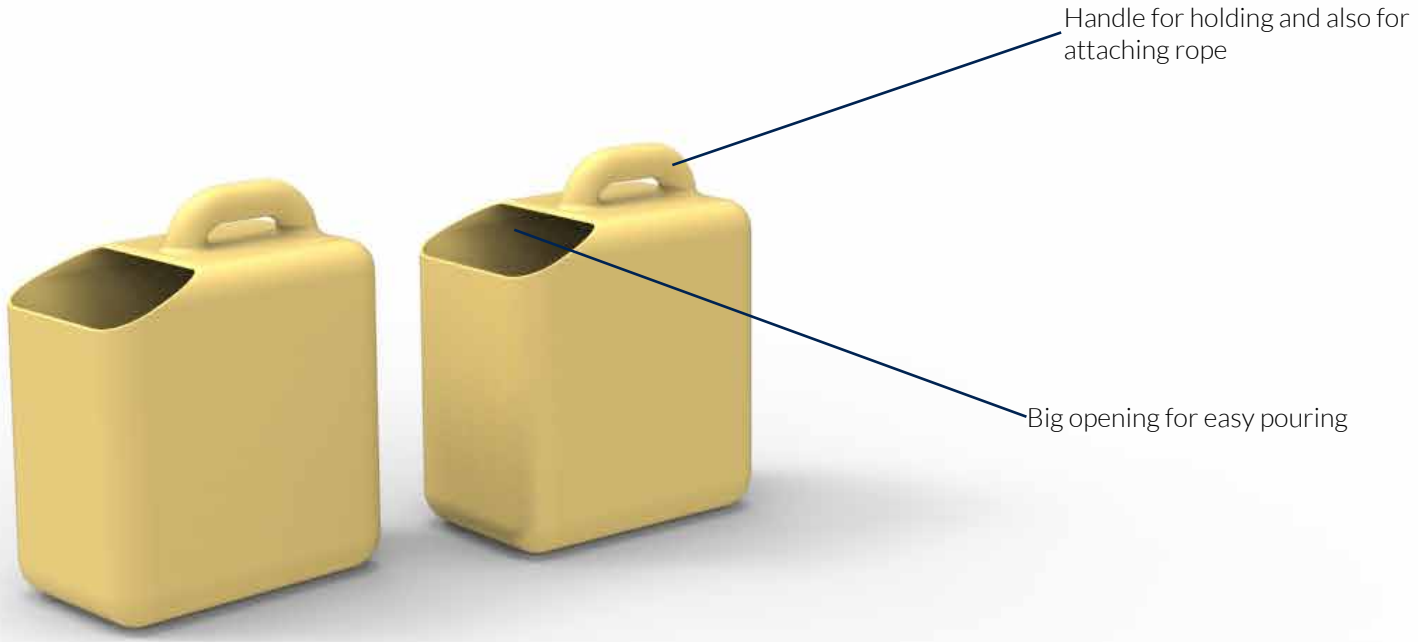



Fig 6.10: Small container

## Full frame along with support straps

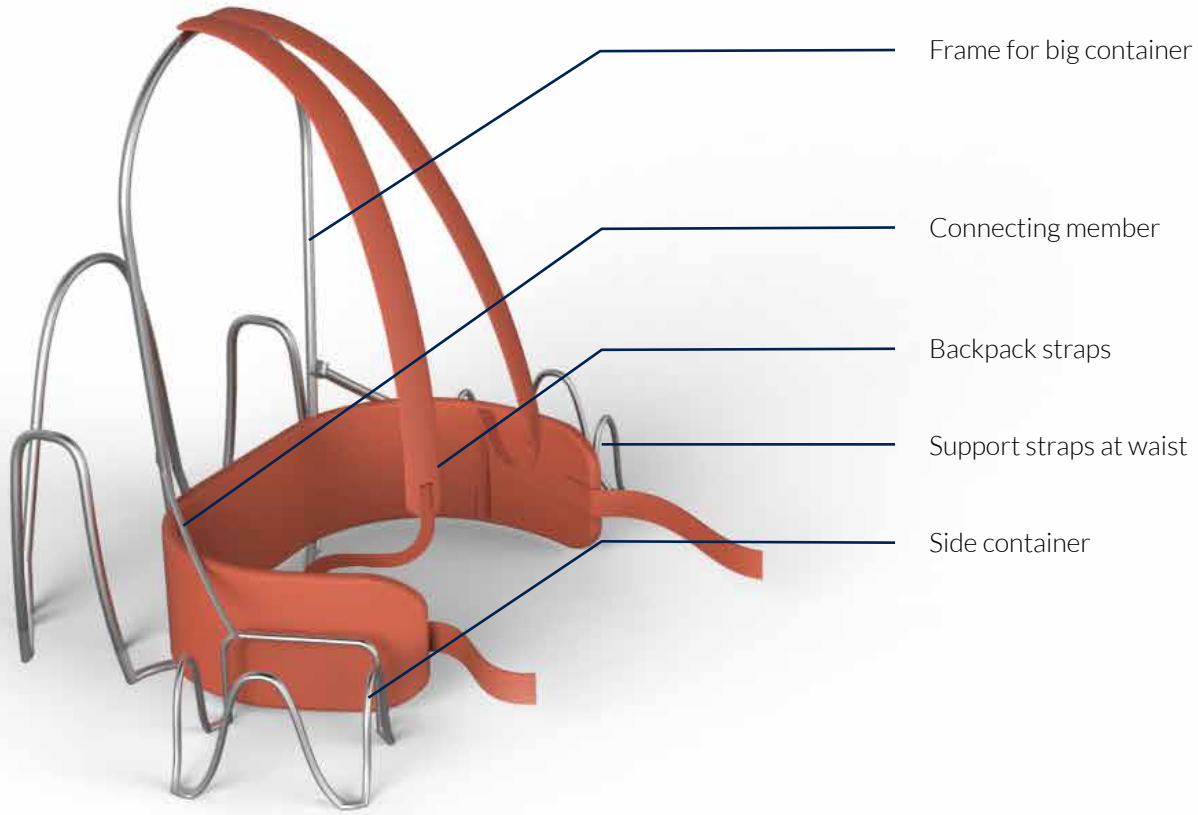



Fig 6.11: Full frame with support straps

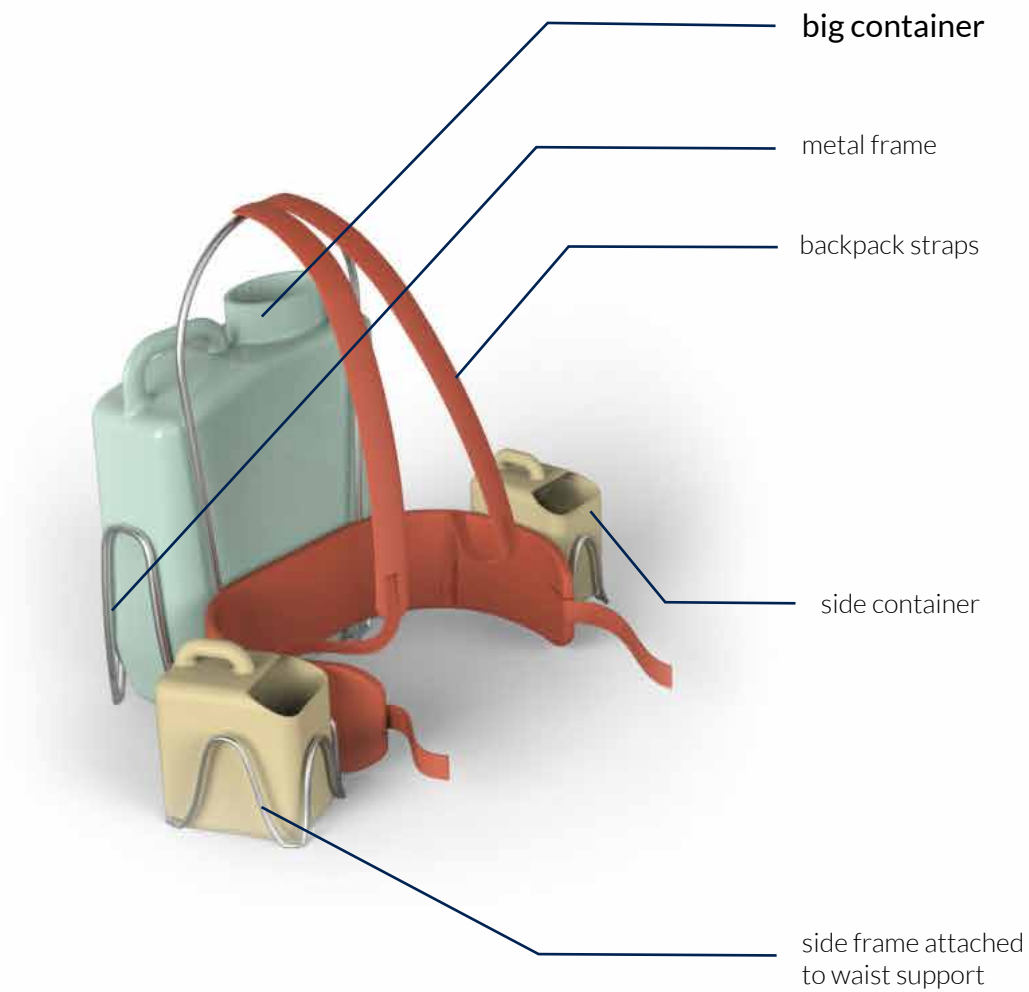



Fig 6.12: All parts assembled

Fig 6.13: Jerrycan held in the metal frame

Fig 6.14: Side frame joint to main frame

# Final prototype

The prototyping process was started so that the product could be tested out in the field. 5mm SS rod was used for making the frame which would hold the jerrycans as shown in Fig 6.15. Each frame was individually bent into shape in a metal workshop.

A canvas harness was made for being worn by the user. This harness was then stitched onto the metal frames as shown in Fig 6.16.
After the harness was stitched onto the big frame, the two smaller containers were stitched onto the sides of the waist support.

Small pockets were also stitched onto the sides of the waist support to hold the rope that is used to throw the jerrycan into the well for fetching water.

Fig 6.15: Metal frame being made

Fig 6.16: Canvas harness being stitched onto the metal frame

Fig 6.17: Harness prototype

Fig 6.18: Prototype complete with holding the jerrycans

Fig 6.17 shows the prototype once the harness has been stitched onto the metal frames.

The metal frame allowed for the user to keep the product on the ground while fetching water from the well. It gave it some stability so that the jerrycans would not topple over in case the ground was uneven.

The metal frames for the side containers also allowed the side containers to be loaded in one step each. Thereby reducing the hassle that was involved in loading them in the previous concept.

Most of the women usually go to fetch water in groups and thus have some help in loading and unloading in case it is needed.. However, scenario for the whole process being done without any help has also been considered. This entire process could be done by one person without additional help.

Fig 6.18 shows the harness holding the three jerrycans in their respective frames.

# Other features

Since the entire product was being placed on the ground near the well two or three times throught the day, it could require cleaning once in a while. Thus, the waist support was made removable by keeping slots for the metal frame to pass through as shown in Fig 6.19. The waist support strap could be pulled out and washed.

An instruction manual was made with illustrations. It is made on sticker paper and stuck on the side of the jerrycan as shown in Fig 6.20. Even though the product is intuitive, any confusion could easily be resolved by the illustrations. The ilustrations allow illiterate people to understand usage as well. Only the title is written down and that is written in Marathi.

A safety pamphelt was also printed for the women as shown in Fig 6.21. Most of the owmen or their family member sare not aware of the problems associated with load carrying and its harmful effects. Women of all sizes carry very large loads and regularly bend down to lift up these heavy loads. Pregnant womena lso carry these loads and bend down to lift them up. Thus, a system level intervention was required to slowly inculcate good postural practices and explain to these women the harmful effects of poor posture and heavy loads. The Safety pamphlet has illustrations and text in Marathi, the local language for better understanding. It has a suggestion to install a platform next to the well for keeping the containers so that the women don't have to bend down.

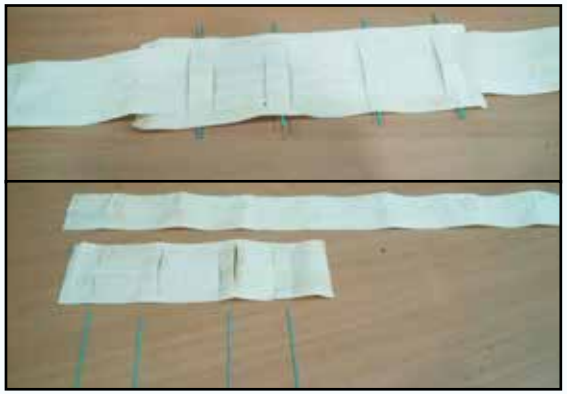


Fig 6.19: Removable canvas harness concept

Fig 6.20: User instruction manual

Fig 6.21: Caution pamphlet

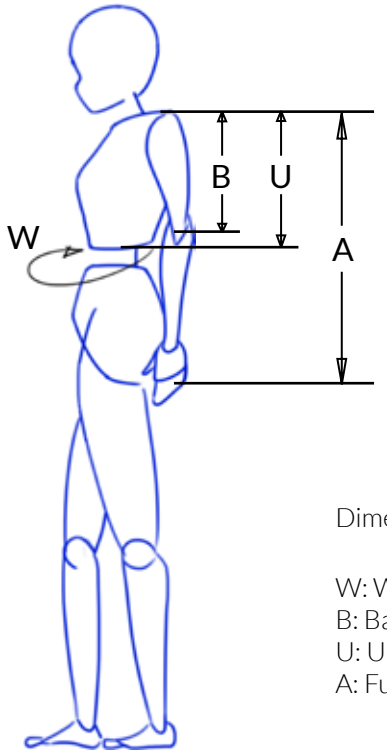
# Anthropometry

Fig 6.22: User 1

Fig 6.23: User 2

Fig 6.24: User 3

The dimensions of the harness were planned with respect to standard backpack sizes which are available in the market.
However, these dimensions turned out to be bigger for these women in the first user evaluatioin. So, the women of this village were measured and important dimensions were noted. These were used to modify the dimensions of the harness.
The final dimensions were finalized based on these dimensions and existing backpack dimensions, and then adjustments were provided for the straps to accommodate differences.




Dimensions are in mm

W: Waist with sari
B: Back
U: Upper arm
A: Full arm

| | W | B | U | A |
|---|---|---|---|---|
| User 1 | 270 | 143 | | 230 |
| User 2 | 252 | 120 | | 220 |
| User 3 | 238 | 139 | | 244 |
| **Final Dim** | **250** | **140** | | **220** |

# Product testing in the field

User evaluation of the final prototype was done in the village of Dengachimet. The user evaluation was done right from the kitchen in the house to the well and back to the kitchen. The whole process was done with 2 women. Three other women wore the product filled with water to its maximum capacity and walked around the rough terrain. They also loaded and unloaded the containers.

Fig 6.25 shows the product placed in the user's kitchen. It is conviniently placed in the kitchen along with the harness and frames. The harness could easily be taken off for cleaning once the containers are empty.

It was proposed that the big container could have a tap which could be used to dispense the water. Once the big container was empty, the water from the small container could be emptied into the big container and then it could dispense water again. This idea was welcomed by the users since it improved the usability of the product and the experience since water had to be dispensed all the time for cooking and drinking.

Fig 6.26 shows the user wearing the product when the containers are empty. It has been picked up from the kitchen top and then worn. Once the product is worn with the big container, the two smaller containers are loaded onto the sides.

Fig 6.25: Placing product in context

Fig 6.26: User evaluation 1

Fig 6.27: User evaluation 2

Fig 6.28: User evaluatrion 3

It was found more comfortable for walking on the rough, hilly narrow path as shown in Fig 6.27. The women felt like there was more freedom of movement and they could even look down or turn back if they needed. This made it much more comfortable and safer to walk especially because most of the women go for fetching water bare feet.

Loading the containers onto the body was also found to be much simpler than loading the vessels onto the head from the ground. Since the frames were rigid, the containers could be loaded without additional help as shown in Fig 6.28. The big container is placed before the harness is worn, and then the smaller containers are loaded. The harness being made out of cloth, allowed enough movement for easy bending, turning, walking etc. Jerrycans are very cheaply available in local markets and can be replaced easily if broken or lost. They also appreciated the idea of having a tap on the big jerrycan so that water could be used directly from it.

The product allows one woman to carry 18-20 litres of water per trip which is considered ergonomically safe if well distributed around the trunk of the body. The pamphlet for good posture also explained how it is harmful in the long run to bend down repeatedly to lift up very heavy weights. While this is a small step to explain the benefits of good posture, it is a start nonetheless.

## Comparison of the two methods

| | Existing method | Proposed method |
|---|---|---|
| Volume of water | 20 litres approx. | 20 litres |
| Terrains | Difficult to use over hilly, rough terrain | Can be used over different terrain |
| Weight | 2 Kg | 1.8 Kg |
| Usability | Loading the matkas onto the head is difficult | Loading, and walking is easy |
| Ergonomic considerations | Causes strain on neck muscles | Reduces strain on neck muscles |
| Maintainability | Repair-work is difficult | Repair-work is easy |
| Cleaning | Cleaning the matkas is simple with hand | Cleaning the jerrycans is difficult due to smaller mouth |

# Materials used

**Frame: Steel rod (4mm thickness)**

- Will not rust
- Strong
- Can bear the load of the water containers

**Water containers: HDPE (food grade)**

- Durability of HDPE is good
- It will not crack or break by falling or rough use

**Support straps: PU foam, canvas cloth**

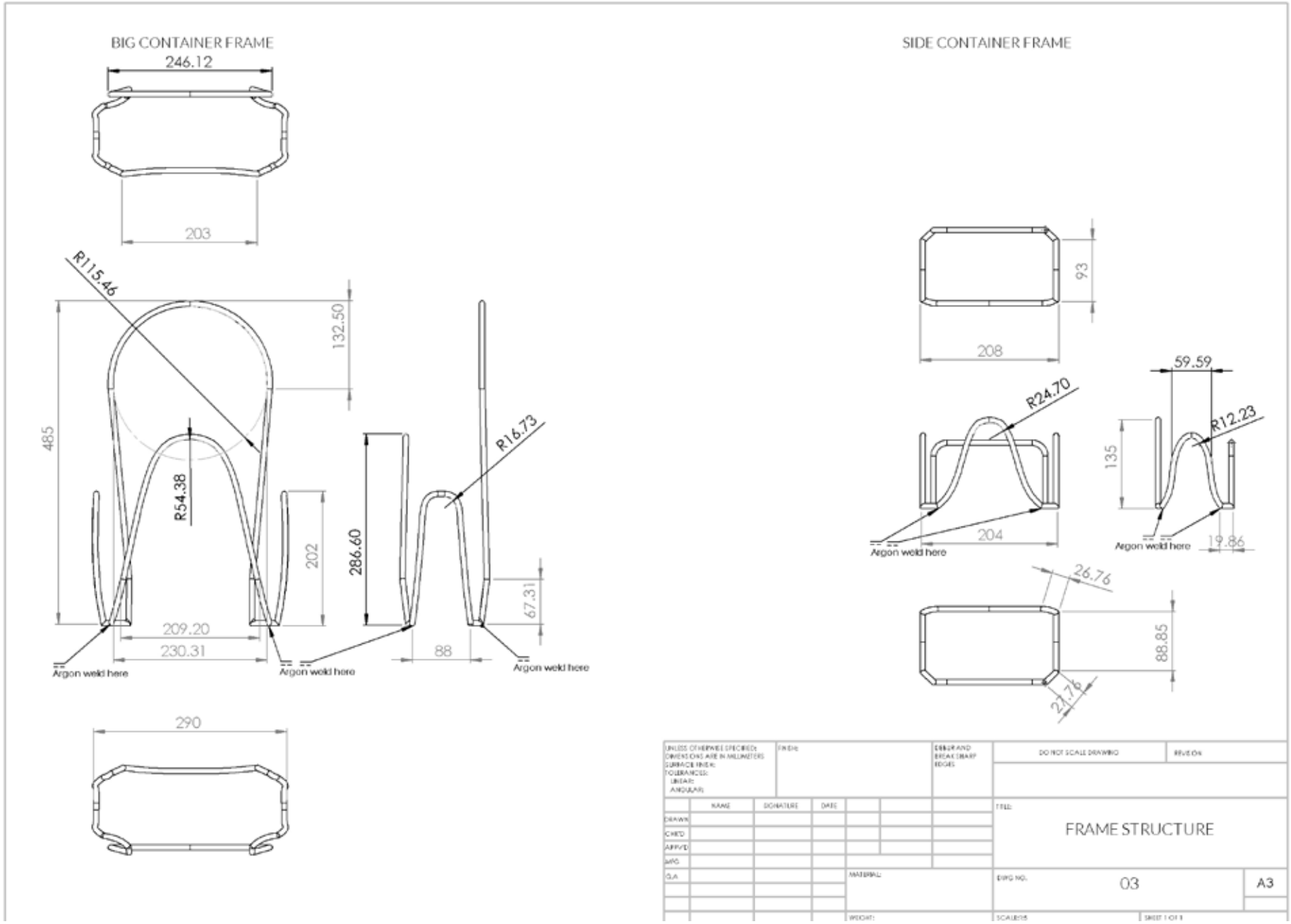
- PU foam will provide padding
- Canvas cloth is strong and highly durable

# Conclusion

The final concept of a vest design was well accepted amongst the women of the village. They found it easier to load and unload the water. It also helped them have more control over their movement in the rough terrain. However, since the product is a new, wearable product for women, some of them were a little hesitant to try it. The women of the village felt like they would benefit from this system, and the men in the family were also supportive of the effort.
Awareness campaigns in such villages must be done over long periods of time continuously by providing support wherever needed. The caution pamphlet was a start for the same.

## Future Scope

This project can be implemented with the help of local industries since the product is very simple to fabricate. The parts can then be assembled and then sold to the families. Since the cost of the product is less than the combined cost of all the existing handas (vessels), it can be expected that they but the vest instead when they have to buy new handas.
The campaign to promote good postures can also be taken forward. More awareness about safety of the women can also be spread.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Argon weld here
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286.60
R16.73
67.31
88
Argon weld here
290
SIDE CONTAINER FRAME
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204
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59.59
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135
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UNLESS OTHERWISE SPECIFIED:
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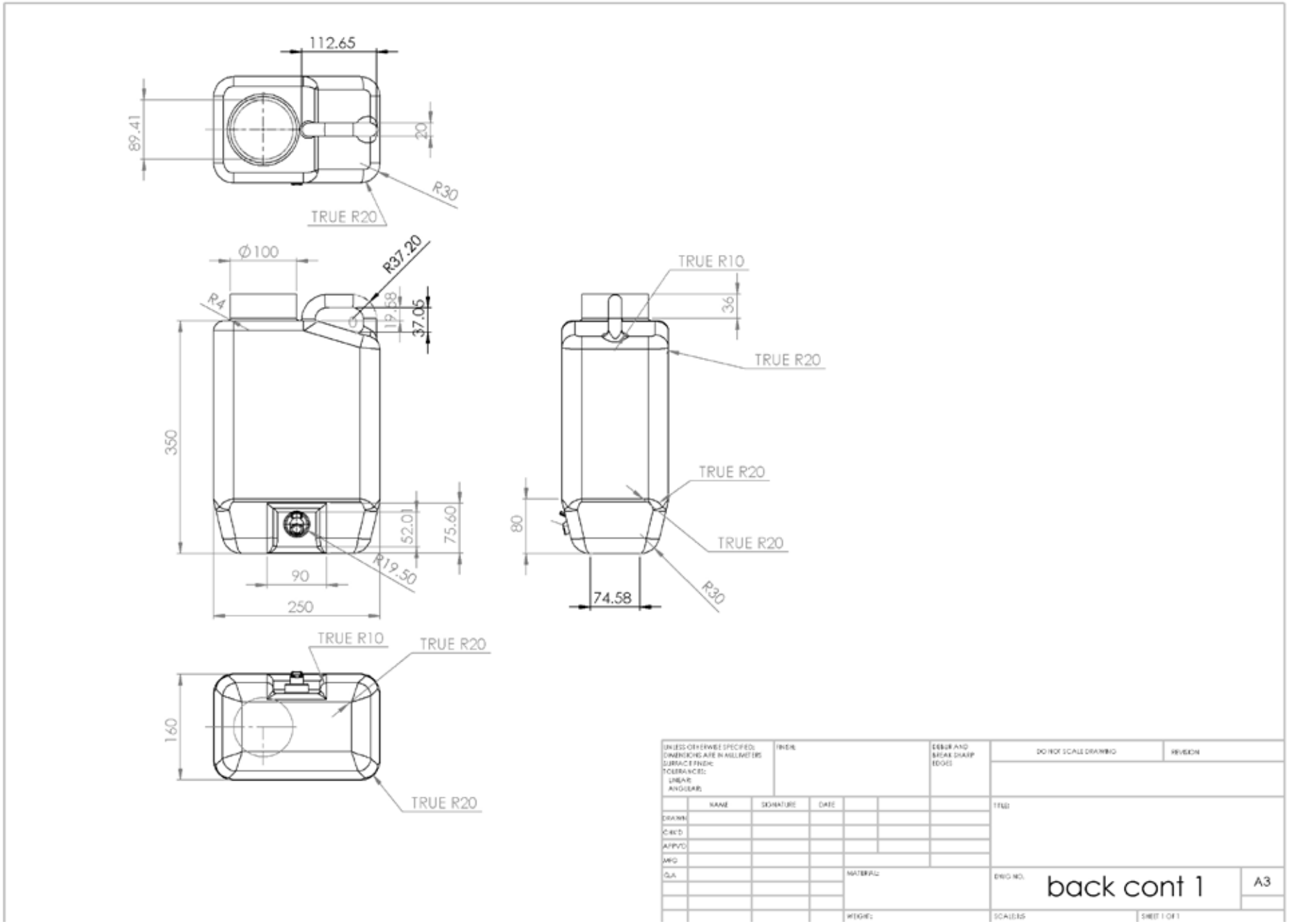
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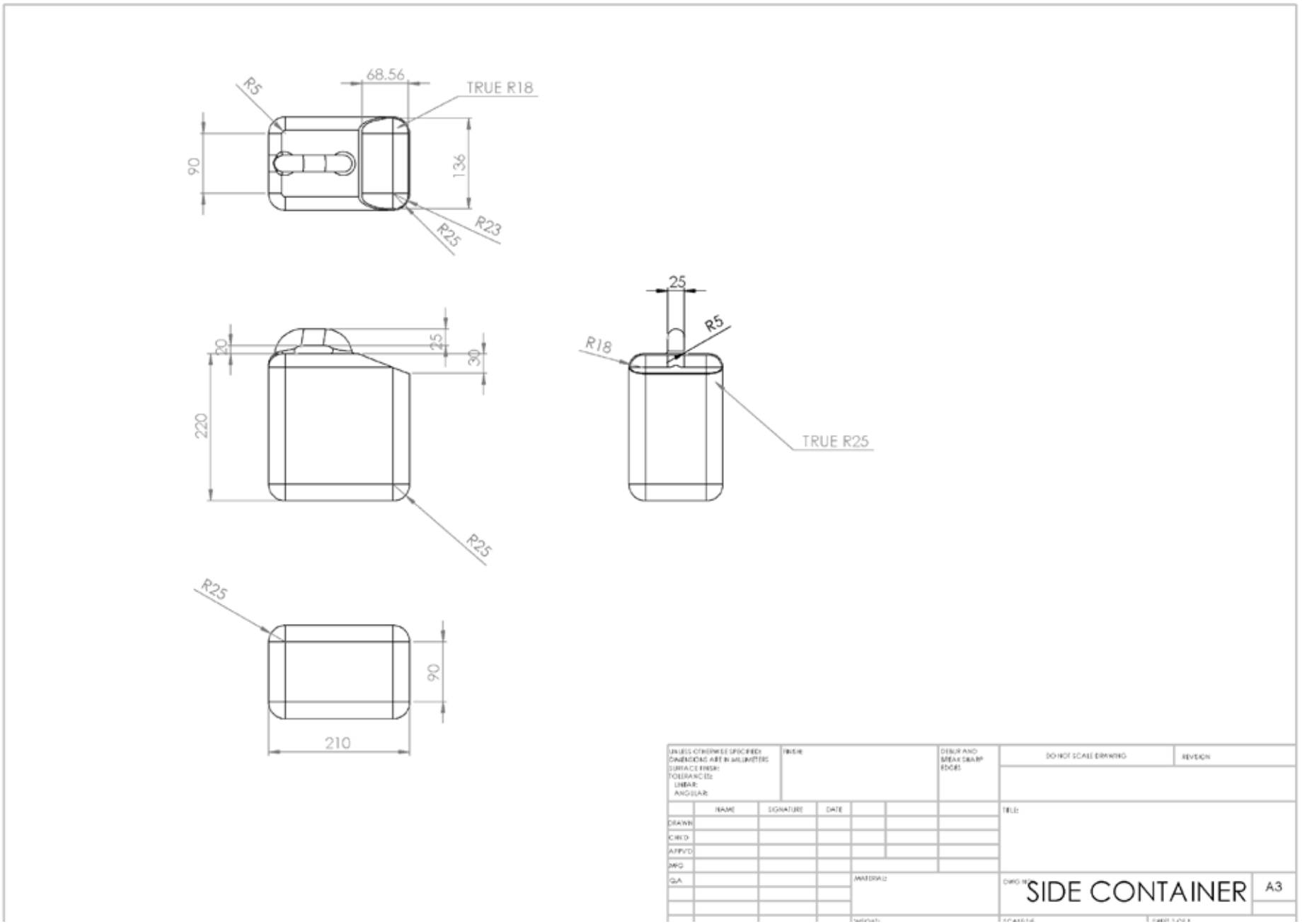
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MFG
QA
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SIDE CONTAINER
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