DESIGN OF A WATER STORAGE AND PURIFICATION SYSTEM FOR RURAL INDIA

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Abstract

The aim of the project was to design and develop a storage type water purification system for rural India by considering cost, usability and hygiene. Water is one of the basic necessities for our survival like air and food. Two thirds of human body weight is made up of water and water is required for each and every cell and organ for its proper functioning. At present purifiers help to deliver pure water which is 100 percent free from impurities, but in rural areas lack of knowledge, affordability and usability issues have impacted the effective usage of purifiers. In this project an attempt is made to resolve the issues of purifier through product design so that an efficient and affordable purifier is developed for use by the rural people. Even though water covers 70 percent of the earth its availability for drinking is only 1 percent, therefore knowing the source of water is important.

In this project, research has been conducted around rural areas of Bengaluru, by asking several questions to understand the requirements of the rural people and also during the research some simple traditional purification technologies adopted were studied. Later a market study was done to understand the present day water purifiers and mainly product like TATA Swach and Pure IT compact were measured by considering the needs of the rural people. Finally TATA Swach was considered as the bench mark product for concept generation. Five concepts were developed by considering Quality Function Deployment (QFD) and Product Design Specification (PDS) and finally one concept was selected by weighted ranking method. This selected product was further modified for improvements.

The final design has been modelled using acrylic incorporating a TATA Swach standard bulb along with the traditional method of purification. The volume of the product was also a very important consideration while designing the final concept. User validation was carried out and the results were positive and satisfactory.

Keywords: Rural, Usability, Features, Ergonomic

Abbreviations

QFD	Quality Function Deployment
PDS	Product Design Specification

1. INTRODUCTION

Water is one of the basic necessities for our survival like air and food, the two thirds of human body weight is made up of water and water is required for each and every cell and organ for its proper functioning like oil for running of the vehicles. The water we take inside should be hygienic, not only free from visible impurities it should be free from all pathogens like Bacteria, Viruses so that water borne diseases which constitutes for around 50 percent of hospitalization each day. Rural Indian people due to their lack of awareness and affordability the usage of impure water is on rise, due to this annually 37.7 million people will be affected by water borne diseases annually and around 2 lakhs inhabitations are provided with poor water quality. Indian Rural Population is around 700 million residing in around 1.42 million habitants, the survey results show that 70 percent of the Indian population lives in rural places.

In present days Purifiers helps to deliver the pure water which is 100 percent free from impurities, but in rural area lack of knowledge, affordability and usability issues are impacted the effective usage of purifiers. In this project an attempt is made to resolve the issues of purifier through product design so that efficient and affordable purifier is developed for its best use by rural people.

2. LITERATURE SURVEY

2.1 Literature Survey

Literature survey is a first step of collecting data to understand the type of appliances present in market and in use by the users. Data is collected by referring books, online publications and articles, journals, magazines, user manuals and articles. This gives the better understanding about the present water sources, technologies used for purification of water and type of purifiers present in the market.

2.2 Water Sources

Water is one of the most important and exciting gift to mankind. Water is a key component in determining the quality of our lives and to maintain good health and survival. Even though water covers 70 percent of the earth its availability for drinking is only 1 percent, so knowing the sources of water is important [1].

2.2.1 Sources of water in Rural India

Deep Ground water – Deep ground water is pumped through wells and Bore wells for human use, Deep groundwater is usually greatly affected bacteriological quality [2].

Upland Lakes and Reservoirs: These reservoirs can be of two types, if they are located near the human habitation then they will be more impure and if they are far less impure. But in these presence of many contaminants and chemicals make it unsecure for drinking [2].

Fig. 1 Upland lakes and Reservoirs

Rivers, canals and low land reservoirs: These water sources will be contaminated by large amount of suspended particles and significant amount of pathogens and bacteria's. This water is impure for direct usage [2].

2.2.2 Articles to understand the water Quality in Rural India

Article 1 [3]: Even though the efforts are made to improve the access to drinking water in rural India, the percentage of illness and death caused by water borne diseases is not in inclination. The reasons for this are Impure water consumption and usage, the Indian population is one rise but the pure water supply remains one of the biggest issues to Indian government. The adaptation of water purification systems can reduce the problem of water borne diseases in rural India.

Article 2 [4] : Indian Rural Population is around 700 million residing in around 1.42 million habitants, The survey results shows that 70 percent of the Indian population lives in rural places. The rural people due to their lack of awareness and affordability the usage of impure water is on rise, due to this annually 37.7 million people will be affected by water borne diseases annually and around 2 lakhs inhabitations are provided with poor water quality.

2.2.3 Simple Water purification methods adapted in Rural India

The following are some of the simple purification technologies that are using in the in rural areas of India, following are some of the methods [5, 6]:

Boiling: This is Simple and Effective method of water purification. Here water is heated still it reaches boiling temperature and later cooled to use it. Many microbes and organisms need higher temperature to get kill, which is above boiling point of water.

Distillation: Here water is heated to form steam and is trapped to get the pure water which is free from bacteria and protozoa's.

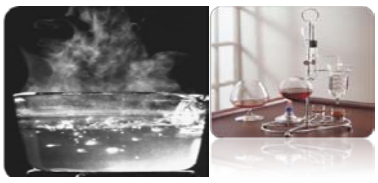

Fig. 2 Water Purification Method – Boiling and Distillation

Sunlight Exposure: In this method water is exposed to sunlight by keeping the water stored in clean bottle and wait around 5-6 hours to get the clean water.

Chlorination – Here boil the water for 5 minutes and add the bleach to water and wait for 30 minutes, later which water can be used.

Filtration – Filtration is one of the easiest methods of purifying water. Here water is filtered with the help of semi permeable or cloth, so that water particles which are more then the size of the pores will be filtered out.

Three pot treatment -Here the water is poured from one bottle to other with a gap of as many hours as possible so the water contaminants will settle at the bottom providing fresh water.

Fig. 3 Water Purification methods - Filtration and Three pot Treatment

2.2.4 Filtration of water using natural materials

2.2.4.1 Bio – sand Filter

Bio-sand filters are one of the easy available and cheaper methods of water purification, in this method impurities in the water are removed by combination of many process like sedimentation, straining, adsorption, chemical and bacteriological action. Overall this purification method can be defined as Mechanical and Physical – chemical process. After the first set up of this purification sediment and organic matters forms the thin layer on the sand surface and this acts like a purification layer. Most impurities, like bacteria and viruses, are removed from the raw water as it passes through the filter skin and the layer of filter bed sand just below.

This method of water purification is cheaper, and purification mechanism extends from the filter skin to around 0.3 to 0.4 m below. This type of purification method is suitable for treating waters with low colours, low turbidities and low bacterial contents [7].

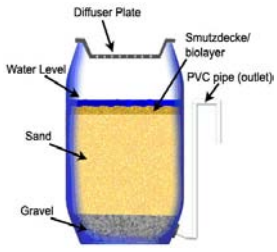

Fig. 4 Bio-Sand Filters

2.2.4.2 Water Filtration Using Charcoal and Gravel

Water purification using charcoal is very ancient method, and it has been used for water purification from centuries, possibly dating back as far as ancient India and Egypt. Charcoal the main material used in charcoal and gravel water filter is having

elemental carbon in its graphite configuration, this exhibits an exceptionally high surface area per volume: one gram of industrially produced activated carbon may have a surface area of 400 – 1500 m2 which is half the size of a regular football field. These large surface areas available on the charcoal are effective in attracting the non-polar molecules dissolved in water, thus purifying the water [8].

Fig. 5 Water Filtration using Sand and Gravel

2.2.5 Modern purification technologies

These purification technologies give 100 percent safe water, which is free from all micro – organisms. Reverse Osmosis: It is the process opposite to osmosis, here the external force is applied to separate the minute particles from the impure water. Cellulosic, fully aromatic polyamide and thin film composite are some of the membranes that are used in reverse osmosis process [9].

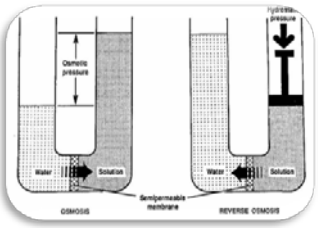

Fig. 6 Reverse Osmosis Process

UV technology: This process works in 3 stages:

First Step: Helps in filtration of suspended particles like dust, rust and mud up to 5 microns.

Second step: Here organic impurities, foul smell and taste, pesticides and lead will be absorbed.

Third Step: In this third step UV rays will going to act on micro – organisms like viruses, bacteria and inactivate them [10].

Silver nano-technology:

In this technology the rise husk ash is impregnated with silver nano particles. Here Rice husk contains silica and activated carbon, silica helps to reduce the turbidity of water and Activated charcoal has the property of binding non- polar materials. The silver particles in the system help to destroy the pathogen activities and filtration of minute particles [11].

Fig. 7 Silver Nano technologies

2.2.6 Patent Study

Patent -UV Water works from Ashok Gadgil

- **Patent number - 5780860**

The working and construction of this method can be implemented in purifier for low cost purification. The water fed from gravity, Pump or pressure will go through the curved pan and unshielded fluorescent fixture helps to disinfect the water [12].

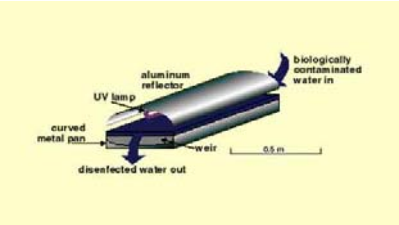

Fig. 8 UV technology - patent work

Patent – Water purification straw

- **Patent number - 4995976**

After the pressure is applied by human to suck the water makes the water to pass through the number of filtering stages and in the mouth we get purified water. The water will pass through number semi permeable membrane, anti bacterial phase to deliver pure water [13].

Fig. 9 Water purification using straw – Patent work

Results of Literature Review:

- Water sources need to be prevented from contamination and pollution, this should be the primary goal.
- Even though in the present days water availability is easy in rural areas, the lack of knowledge and affordability is making rural people to use it directly without purification this makes the people to suffer from water borne diseases.
- Some people in rural area are adapted simple water purification technologies to purify the visible impurities and some micro organisms but these processes are ineffective to kill disease causing viruses and bacteria's.
- Bio sand filter and water filtration using sand, gravel and charcoal are proven to be the cheapest techniques to pure the water up to certain extent.
- Present day purification technologies and latest patented inventions can be implemented to produce the product for rural people.

2.3 Market study

Around the world 1 billion people are lack of access to pure drinking water, in this maximum percentage will be in Developing countries like India. In India around 1 lakhs people will die of water borne diseases every year.

Literacy rate is increasing which is causing the increased awareness among the people in rural India, which constitutes around 70 percentage of the population, creates a very good opportunity for Purifier Market, some other facts and points that boost up this Purifier market for Rural India are [14]:

- The market share of the Water purifiers is 1500 crore in India, as it grew exponentially 22 percent in the year 2011.
- The water purifier's market share is expected to grow in the further years also until 2016 at an average of 20 percent.
- This water purification business is undergoing rapid changes to adjust not only in technology but also in lowest pricing to the targeted customers.
- The product differentiation and innovation are the two important things to drive this water purifier business.
- In this 42 percentage of water purifiers are equipped with RO Water purifiers.

2.3.1 Major Water Purifiers Manufacturers in India

The top three manufacturers are:

Kent

HUL [Hindustan Unilever Limited]

Eureka Forbes

The Other manufacturers in India are:

Eureka Forbes Ion Exchange Usha-Brita, Alfaa

Tata Chemicals, Phillips, Whirlpool ,Luminous

Fig. 10 Water Purifiers in present market

2.3.2 Purification Technologies and market share

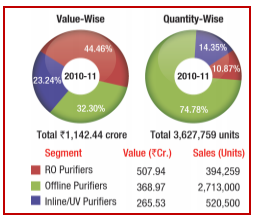

Fig. 11 RO Purification technology

RO Purification technology holds the highest market share of around 507 crore, followed by offline purifiers and UV purifiers as shown above [15].

2.3.3 Company shares of RO purifiers, Offline Purifiers and UV Purifiers

Eureka Forbes has the highest turnover in the segment, estimated at over 510 crore. It is present in all the three categories – RO based, inline/UV based, and offline purifiers – through its brand Aqua Sure. HUI turnover is around 300 crore [15].

2.3.4 Water Purifiers developed for Bottom of Pyramid

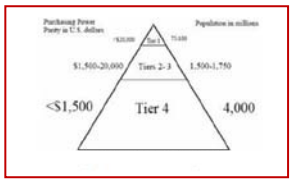

Fig. 12 Economy Pyramid

As shown in the above figure 12, maximum percentage of people lives at the bottom of pyramid with annual income less then 1500 us dollars, even in India percentage of buyers for the product reduces as the product cost increases there are some companies that are produced the water purifiers by keeping these people in mind they are:

Company	Product range name
Eureka Forbes	- Aqua sure
Hindustan Unilever limited	- Pure IT compact,
TATA chemicals	- TATA Swach smart,

2.4 Product Study

In this product study two lowest cost purifiers are compared to select the best one for **Benchmarking of the Product.**

Comparing the many parameters like – Cost of the product, Operational cost, Life of the bulb and Capacity of the container and also study on the customer complaints the TATA Swach is considered as Bench marked product.

Table 2.1 Comparing TATA Swach and Pure IT

		
Key Features	TATA Swach	Pure IT compact
Cost	`899	`1380
Technology	Silver Nano technology also known as TSRF technology cleans the water.	4 stage purification technology in which each stage performs its function to give the pure water.
Refill / operational cost	`450	`350
Life of bulb	3000 liters	1000 liters
Capacity of the Purifier	18 liters	14 liters
Time taken for purification	9 liters for 1-5 hours	3-4 liters per hour

Fig. 13 Comparing TATA Swach and Pure IT

2.4.1 Study of Bench Marked Product – TATA Swach

TATA Swach a product of TATA chemicals is considered as Bench mark product.

Design and Construction: TATA Swach as got two containers, Pre filter, Main purification unit [TATA Swach Bulb], Tap as shown below

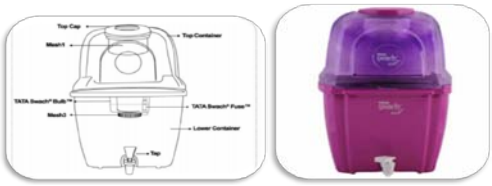

Fig. 14 Main Parts of TATA Swach

Top Container: This helps to store the impure watr and send it across the TATA Swach bulb for purification, its capacity is 7.5 liters.

Bottom Container: Bottom containers help to store the purified water, its capacity is around 7.5 liters.

Mesh 1: This Mesh helps to prevent the visible impurities and suspended particles to reach the top container.

Connector Cap: This helps to hold the TATA Swach bulb in position that is in between the top and Bottom container so that impure water flows through the TATA Swach bulb before reaching the Bottom container.

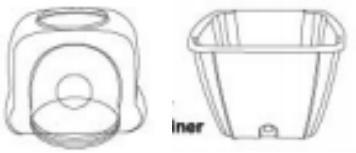

Fig. 15 Parts of water Purifier

2.4.2 Working of Silver Nano technology in TATA Swach bulb

TATA Swach bulb is the main purification unit of TATA Swach purifier, it as been adapted with patented Silver Nano technology also called as TSRF technology. The Bulb capacity is to purify 3000 liters of water, but this is largely depends on the quality of impure water. Fuse helps to indicate the life of the Bulb. This bulb costs around 450 ₹ in the market.

2.5 User Study

User study was conducted in around 8 villages in Bangalore, Chitradurga and Bellary district meeting many rural people and they have been asked with series of questions including there family size, Present purification technologies and affordability as shown below.

Findings from personal Interviews:

- Many people in rural India are only worried about the visible impurities and they are not worried about other pathogenic organisms.
- Most of the people are getting the drinking water in the near by taps, the only problem with them is to store. So here Storage type water purifier will definitely serve the purpose
- The people required the volume of the container that is bigger then present one.
- The people are not satisfied with purification unit or bulb of the purifier due to its short span of time and lower water purification capabilities.
- Higher cost and unawareness also reduces the water purifier popularity

Fig. 16 Users

3. DATA ANALYSIS AND PDS

3.1 Quality Function Deployment (QFD)

QFD is made by considering the customer voices from rural India are tabulated in the left hand side of QFD, these voices or requirements are converted in to technical voice. Here in technical voices some low cost water purifying technologies are added to meet the rural Indian needs and also some other technical requirements like volume of the purifier, material used, ergonomic design are taken into consideration, as it can be seen in the below Quality Function Deployment.

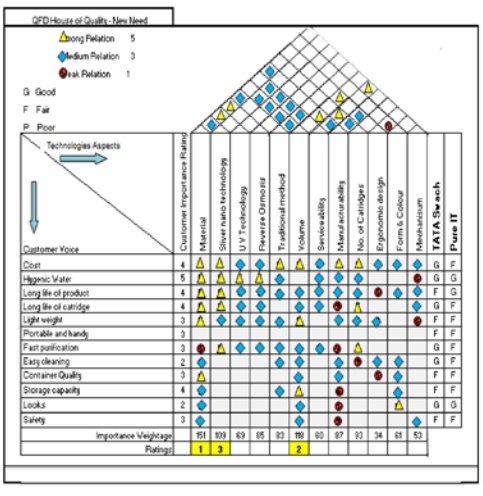

Fig. 17 Quality Function Deployment

3.2 Product Design Specification (PDS)

The product design specification for the product to be designed is generated, as seen below in table 3.2. PDS shows the total characteristics of the final product so it helps to make estimation,, and the product design specification helps the product designer in

generating the possible solution within a particular boundary.

PDS for Water Purifier		
Sl. No	Factors	Specifications
1	Performance	Continuous water purification
2	Environment	Rural, Durable and Light weight
3	Life span of product Life span of Cartridge	4-5 years 1 year
4	Safety	Providing pure hygienic water, avoiding sharp corners
5	Target Customers	Rural people
6	Packaging	Packed in boxes with thermocol
7	Shipping	Transporting product through local transportation
8	Quality and Manufacturing	Mass production with good quality
9	Size	200 - 400 x 200 – 400 x 500 – 1200 mm
10	Weight	2- 4kgs
11	Aesthetic	Form, Appearance and Colour
12	Ergonomics	Cleaning, Reachability and Accessibility
13	Material	ABS, PC
14	Process of manufacturing	Injection moulding and inspection
15	Cost	₹ 600/- to ₹ 1300/-
16	Competitors	TATA chemicals and HUL

Fig. 18 Product Design Specification

4. CONCEPT GENERATION

4.1 Concepts Generation

After understanding the Customer needs and converting it into Technical voice, the result was PDS. This PDS is taken as base while generating the below mentioned five concepts. The five concepts are generated by using software's like CATIA, Google Sketch up and final rendering is done in Key shot software.

The concepts are designed by keeping the Bench Marked product TATA SWACH in mind and generated PDS, some of the other points that as to be kept in mind by the user are -

- Here implement the Silver Nano technology that is TATA Swach bulb and build the new outer structure around it.
- Increase the volume of the container to occupy the more water.
- Increase the life of the TATA Swach bulb by combining traditional method with the TATA Swach bulb.

The product should also overcome the issues of bench marked product TATA Swach, that is - joining of top and Bottom half of the container, Water leakage at the joining of top and bottom container, ergonomic design, transparency of the containers

4.1.1 Life Style Board

The Life Style board helps to indicate the Social, Personal life of the targeted customers. The Life Style is board is done to understand the targeted customer's life style. This also is done in understanding the mood, likes and dislikes of the people.

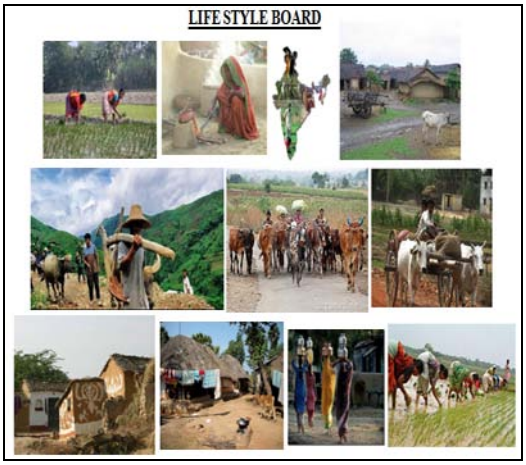

Fig. 19 Life Style Board

4.1.2 Mood Board

Mood board explains about the feeling, Sentiment arises to the customers when they see the product for the first time. This board is derived from the life style board. It helps for knowing the customer requirement up to some extent. Here the mood of the targeted customer will be captured for creating the board, without concentrating on the products

Fig. 20 Mood Board

4.1.3 Visual Theme Board

In this board the concentration is given on the number of products that are used by the targeted customers, this board is derived from mood board. As this board is derived from the mood board the number of products reflects the mood of the targeted customers.

Fig. 21 Visual Theme Board

4.1.4 Ideation and Doodling

In this stage number of parameters related to the product, here for Water purifier is brain stormed. The number of main branches in purifier are -User, Environment, Aesthetics, Ergonomics, Usability, Containers of the water purifiers are further brain stormed to get the better ideas for doodling.

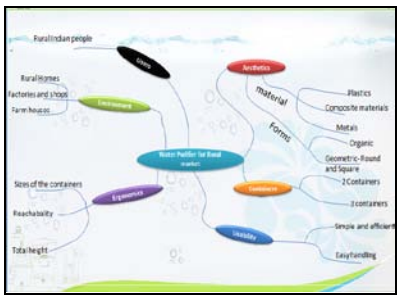

Fig. 22 Ideation

4.2 Concept Generation for Water Purifier

All the above points are considered for generating the concepts and finally one concept is selected by Concept selection method for further modelling.

4.2.1 Concept 1

Below concept as many advantages like combination of traditional method and TATA Swach bulb, larger volume of the container. This concept differs from the other concept because it has portable water carrier, this helps the rural people to bring the water from far places. The elegant design and transparent outer body adds some additional value for this concept.

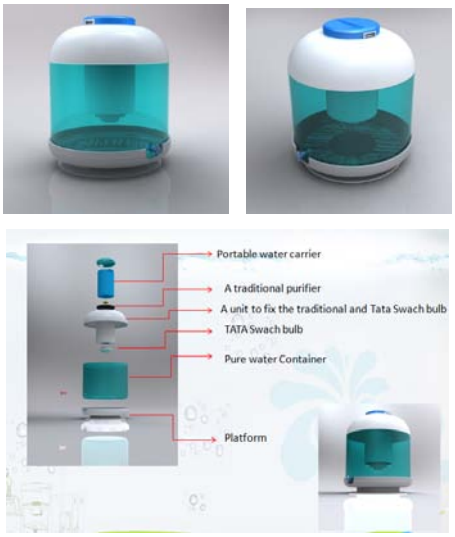

Fig. 23 Concept 1- Water Purifier

4.2.2 Concept 2

Below concept was easiest of all the concepts, this concept uses the available water bottles and fixing the traditional and TATA Swach bulb for water purification, as most of the rural people in India are poor and there affordability is less. So the water purifier of this type helps in full filling there needs at reasonable cost.

Fig. 24 Concept 2 – Water Purifier

4.2.3 Concept 3

Below concept also comprises the combination of traditional and TATA Swach purification methods, some of the other particularities to mention in this water purifier are – Rectangular cross section of the water purifier, last two concepts were having circular cross section, Aesthetically appealing design, three containers instead of two as present in regular water purifiers.

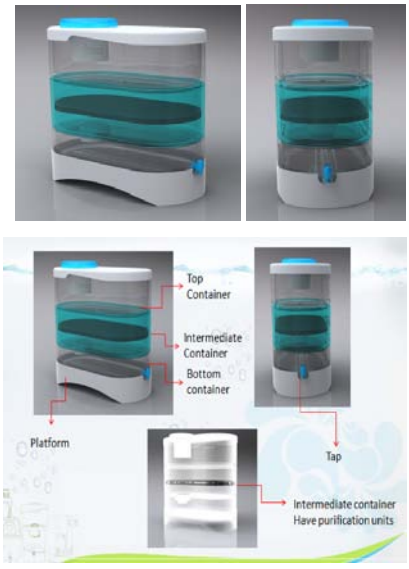

Fig. 25 Concept 3 – Water Purifier

4.2.4 Concept 4

This concept is developed to overcome the some of the disadvantages of bench marked product TATA Swach, this concept as got some of the advantages some to mention are – A place for keeping the tumbler below the tap, rectangular cross section of the body to occupy more volume of the water, a combination of traditional and TATA swach to increase the life of cartridge.

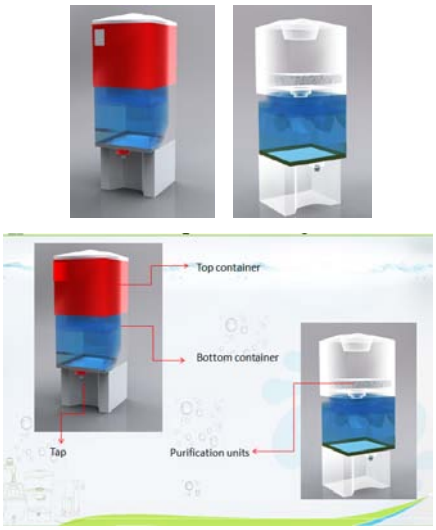

Fig. 26 Concept 4 – Water Purifier

4.2.5 Concept 5

This concept is developed mainly concentrating on the family systems of the rural India, as some of the families are very big that constitutes around 10 family members and some are nuclear families which constitutes around 2 to 4 people. In this water purifier the top container as a collapsible bellow like material, so the volume of the top container can be adjusted. Even this purifier resembles the existing low cost water bottles, so these can be manufactured in mass production for less cost.

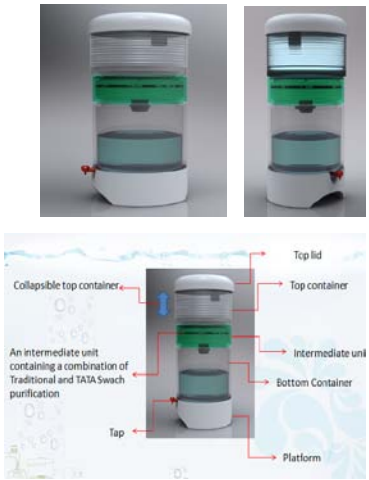

Fig. 27 Concept 5 – Water purifier

5. CONCEPT SELECTION AND FINAL DESIGN

5.1 Concept selection and Final design

In this concept selection weighted ranking method is used for selecting the final concept, and later it follows by some small modifications to get the final touch of design. This concept as been shown to around 15 people for selecting the best model, each of these concepts is not only measured in terms of Usability, Features, Reliability and Aesthetics.

5.2 Weighted ranking method of Selection

Here the overall Weightage of the criteria should be added to 100, that is each of the criteria will between the points 0 % to 100 % and customer rating is given between 0 to 5. At last these points are added to get the correct result

Concept Scoring		Concept 1		Concept 2		Concept 3		Concept 4		Concept 5	
Criteria	Weightage	Rating	Score	Rating	Score	Rating	Score	Rating	Score	Rating	Score
Usability	50%	5	2.5	3	1.5	5	2.5	4	2.0	3	1.5
Features	30%	2	0.6	2	0.6	4	1.2	2	0.6	4	1.2
Reliability	10%	3	0.3	2	0.2	4	0.4	2	0.2	2	0.2
Aesthetics	10%	3	0.3	2	0.2	5	0.5	3	0.3	3	0.3
Total Score			3.7		2.5		4.6		3.1		3.2
Ranking		2		5		1		4		3	
Decision		Discard		Discard		Develop		Discard		Discard	

Figure 28 Weighted Ranking Method

Usability – Volume of the container, Easy filling, Cap design, Container form, table design, easy cleaning

Features – Mechanism for automatic locking, Life Span of the Bulb, water cleaning capacity

Reliability – Plastic Quality, Thickness of the material, Form of the container.

Aesthetics - Colour, Shape, form. By conducting this weighted ranking method concept -3 is selected for final modelling and prototype making. It has got major advantages in usability and features.

5.3 Modifications in the Selected Model

1. Traditional Purification- Here change the design of traditional water purifying material binding, as these materials will going to disturb while regular working and this shown concept as got more traditional materials then the required for purification.

2. Shape of the Container – The radius makes the less water to occupy and difficult for manufacturing

3. TATA Swach bulb – A mechanism that can be adapted to prevent the over filling of the water

4. Top mesh length – Increase the length or diameter of the Top mesh for easy and fast filling.

Modifications:

Traditional Purification- In this Traditional purification material like Sand and Charcoal are packed inside conical box which will be fixed to the bottom of the Top container. Shape of the Container – The Shape of the container is made to square shape to occupy more water and easy manufacturing.

TATA Swach bulb – A water locking mechanism is added to prevent over filling of the bottom container.

Top mesh– Length of the Top mesh is increased

1. More Volume with Less space Consumption

In this water purifier rectangle cross section container is used so it collects more volume of water for less space, the capacities of each container are:

Top – 12 liters, Middle – 8 liters, Bottom – 16 liters

2. Robust designed bottom table to hold the Water tank in Position, this product as well designed robust bottom so it holds the bottom container firmly and it also designed to improve the aesthetics of the product.

3. Easy Filling of Water to the Top Tank

As the top mesh length is increased the top container can be filled in less time compared to the bench marked product – TATA Swach.

4. Traditional Method of Water purification – Sand and Charcoal Method removes many minerals specially chlorine which reduces the life span of Water purifier bulb in TATA Swach.

- Removes bad odour

- Removes Colour

5. Larger and Transparent Bottom container

This Bottom container shows the water level and increases the aesthetics.

6. Auto – Shutoff Mechanism to prevent the Spilling of Water

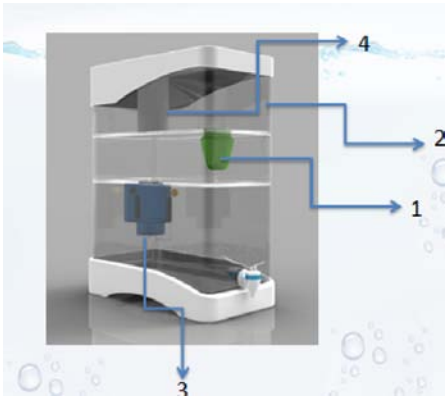

Fig. 29 Modified Final Design and Prototype

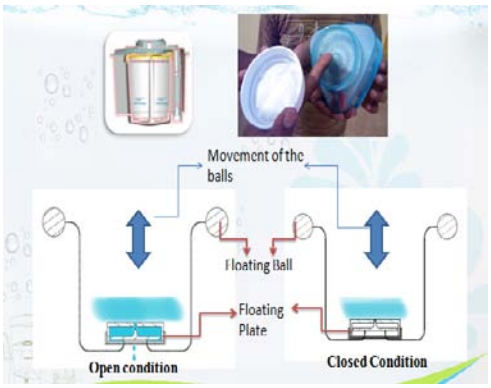

Fig. 30 Auto –Shutoff Mechanism

In this auto Shut off mechanism is added to prevent the over filling of the water, when the water reaches the particular level in the bottom container it pushes the floating balls. These balls are connected to the pin that blocks the TATA Swach purification bulb outlet hole.

5.4 Ergonomic Study

Ergonomic study is nothing but human interaction with product. For that Indian anthropometric data for developing the existing product, and also considering human dimensions and postures adapted.

6. MODEL MAKING

In this part at first the Pattern is developed using a wood and giving a nice radius at the corners, then the acrylic is formed to the shape of the pattern.

Later 3 containers of different length are drawn and arranged one over the another and proper holes are done to fix the TATA Swach bulb, Traditional method, Top Mesh and Top enclosure and Bottom holder are done with white acrylic to increase the aesthetics.

Fig. 31 Model Making

Fig. 6.3 Final Model

7. PRODUCT VALIDATION

Validation of the Water Purifier designed for rural India was done to ensure that the product as satisfied its customers or not. Here the working prototype of the scale model 1:1 is validated with the people for checking reachabality, usability, and ergonomics related issues. The users find our product as very aesthetically appealing and even the features that

are designed to overcome the issues of TATA swach was find satisfactory.

Fig. 32 Product Validation

8. OUT COME

Many research methodologies were followed to understand the customer requirements. QFD and PDS were generated by analyzing these research data findings. Later the concepts were generated by keeping QFD and PDS in mind, and a final concept was selected by weighted ranking method. A working prototype of the final concept was done and in this final model, purification capacity of the bulb was increased along with increased volume capacity. Additional important features included were like ergonomically designed purifier, three stage purification systems, transparent container body and auto shut off mechanism to prevent over filling of the water from the bottom container.

8.1 Conclusion

The project design of water storage and purification system for rural India helped in understanding the complete process of design and development of any new product in the market, by keeping the customer aspirations in mind.

The project involved research to final prototype manufacturing and getting the feedback. The research part of the project has been done through literature survey, patent study, product study, user study, market study and data gathered was analyzed for creating the Quality Functional Deployment (QFD) and Product Design Specification (PDS). Later the bench marking of the product was done by considering the existing products in the market which were particularly designed for rural India. In the later design stages the concepts were developed by keeping the requirements of the rural people in mind, these concepts were finalized; 3D modelling and rendering were carried out to visualize the product. Finally out of these concepts one concept was finalized by weighted ranking method.

The working prototype of the product was submitted as the final output of the project. This project helped in understanding the research methods, material selection process, designing for manufacturing and manufacturing methods.

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