

# Design of a Manually Operated Washing Machine for Rural India



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**Keywords:** Manual, Usability, Compact.

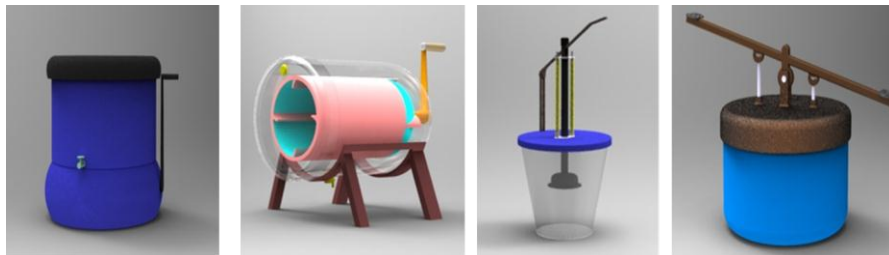
**Abstract:**

Washing clothes is a task performed by every person in the world from old times to the present day. There have been frequent changes in the washing methods. In modern the environment, this washing practice or activity is done generally by a washing machine which is either manually or electrically operated. In washing machines, water is used as opposed to dry cleaning. Clothes are added into the wash tub along with water and detergents and this mixture of clothes and the detergent water is agitated by means of electric power or manually for a period of time. By this action the dirt in the clothes is removed.

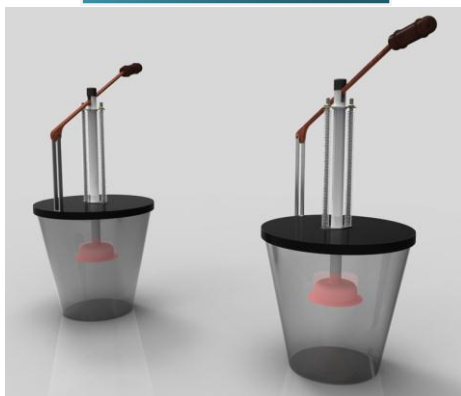
The proposed project aims to produce a manually operated washing machine for use especially in the rural sector. A product study of the existing washing machines was carried out. The mechanism and working principle of the existing washing machines were evaluated. Product study with respect to the product environment was done for the targeted customer. Data analysis was carried out and QFD matrix was developed to arrive at the PDS. Concepts were developed based on mood board, lifestyle board and visual theme board of the targeted customer. Based on the customer requirement final concept was selected using the weighted ranking method for further development.

The final concept was developed using visualization software like ALIAS Studio tools, CAD tools like CATIA and final rendering was done using Keyshot software. A prototype was developed to validate the proposed design. Design evaluation was carried out with the user group and the feedback was positive and satisfactory.

### Concepts



### Final Concept



### Final Working Model

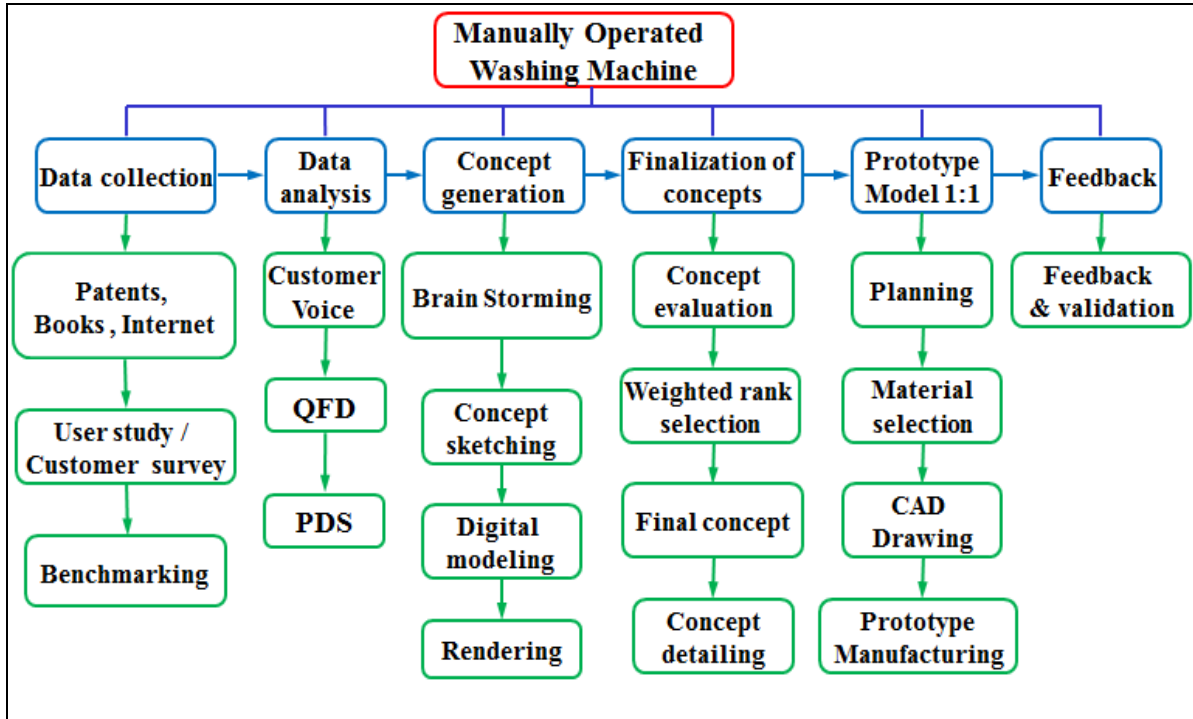




- QFD generation based on the user requirements and corresponding technical requirements, and PDS will be generated prioritizing the features in the QFD.
- Concepts will be generated by sketching and CAD Modeling.
- Here there is a plan to generate concepts and the digital model will be create with the detailed features by using Alias studio tools, CATIA V5 and Adobe Photoshop software's.
- Concept evaluation for selecting the final concept will be selecting by weighted ranking method.
- Working model will be made with detailed features and feedback will be collected.

Table 4.1 shows the Design Methodology which has been carried out throughout the project.

**Table 4.1 Design Methodology**



### 5.3 Doodling

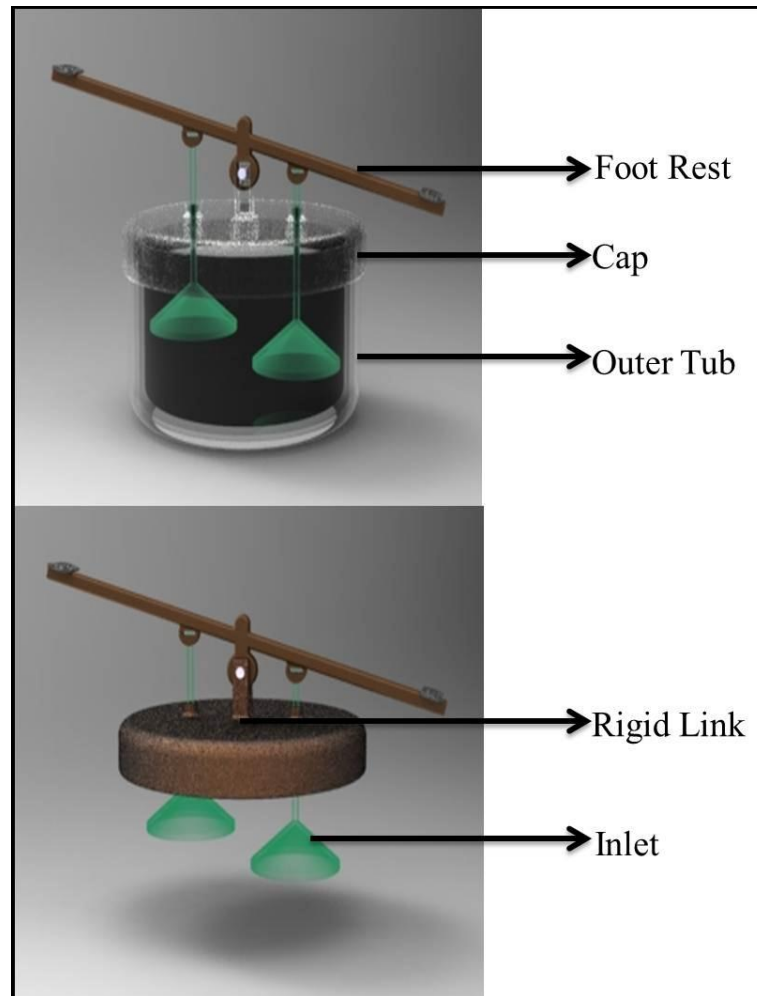
Ideation is the first step of concept generation. Ideation depends upon the customer requirements which have been derived in PDS. This is the simplification of the problem, from ideation doodling of the concept were generated which leads in concept generation.

Ideation gives the clear picture of the parameter which requires in concerned with manual operated washing machine. Doodling was done by hand sketching then it was developed using cad tools.



**Figure 5.5 Doodling**

Below figure shows the details of concept 4



**Figure 5.13 Concept 4 detailing**

In this type of concept it consists of two parts where the working mechanism is fixed to the cap and the other part is bucket. Rigid link is fixed into the cap foot rest link is attached to the rigid link which is as shown in figure 5.13.

Two vacuum cups is fixed on either side of the rigid link where it is fixed to the foot rest link. As one of the vacuum cups is downwards the other one will be upwards this position can be reversed by the help foot rest link. Now clothes inside the bucket are clean and fresh.

## 5.5 Concept Selection

The concepts were developed with the help of PDS and QFD. Concepts were selected based on the following factors which were initially obtained by the customer.

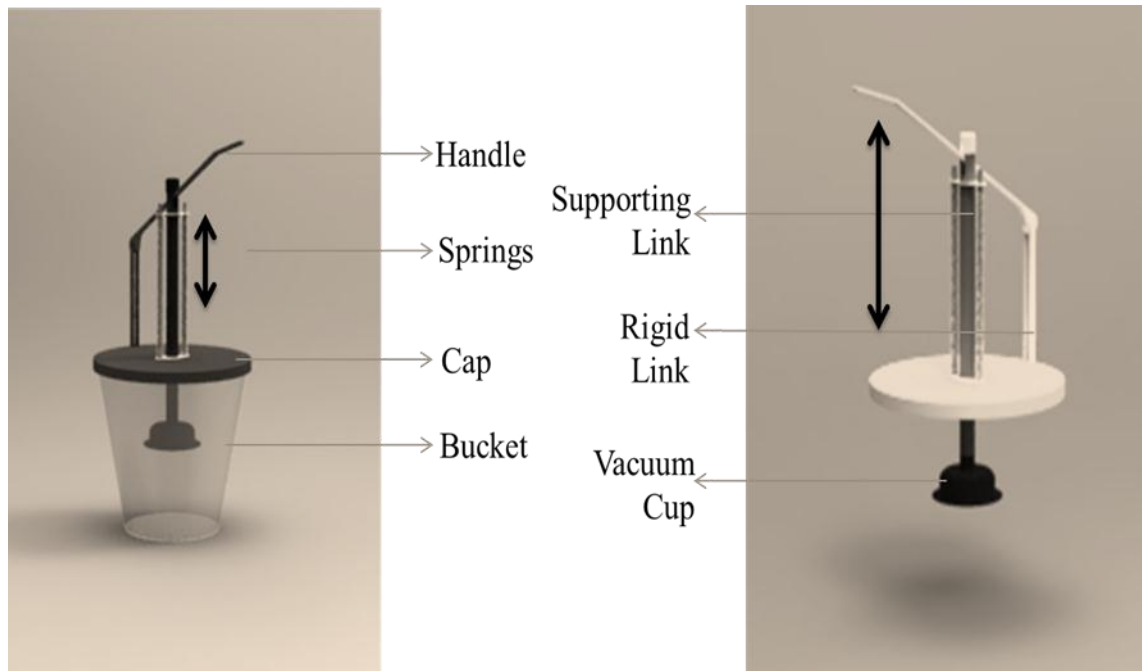
- **Usability** - Must be Easily operated there must be no confusion while operation
- **Features** - Simple in design and must be simple looking and consumption of water should be considered.
- **Reliability** - Must be user friendly can be operated by any one.
- **Aesthetics** – Form, colour, and shape.

A final concept was selected through Pugh's Weightage Ranking method. Below table 5.1 shows the Pugh's Weightage Ranking method.

**Table 5.1 Pugh's Weight Ranking Method**

Concept Rating		Concept 1		Concept 2		Concept 3		Concept 4	
Criteria	Weightage	Rating	Score	Rating	Score	Rating	Score	Rating	Score
Usability	70%	5	3.5	5	3.5	4	2.8	3	2.1
Features	10%	2	0.2	4	0.4	2	0.2	2	0.2
Reliability	10%	3	0.3	4	0.4	2	0.2	2	0.2
Aesthetics	10%	3	0.3	5	0.5	3	0.3	2	0.2
<b>Total Rating</b>		4.3		4.8		3.5		2.7	
<b>Ranking</b>		2		1		3		4	
<b>Decision</b>		Discard		Develop		Discard		Discard	

### 6.2.1 Final Concept Detailing



**Figure 6.2 Final Concept detailing**

Detailing of final product is as shown in figure 6.2 mainly the working mechanism of this washing machine is adopted on the cap, in other words the cap is the main part of the washer where it sustain the load applied while operation. Vacuum cup is fixed into the supporting link where it is fixed to two stud bolt with spring loaded which is held with the help of bracket. When the handle is pressed downwards the vacuum cup with supporting link also moves downward due to the pulsate action of the vacuum cup on the clothes leads to the removal of dirt.

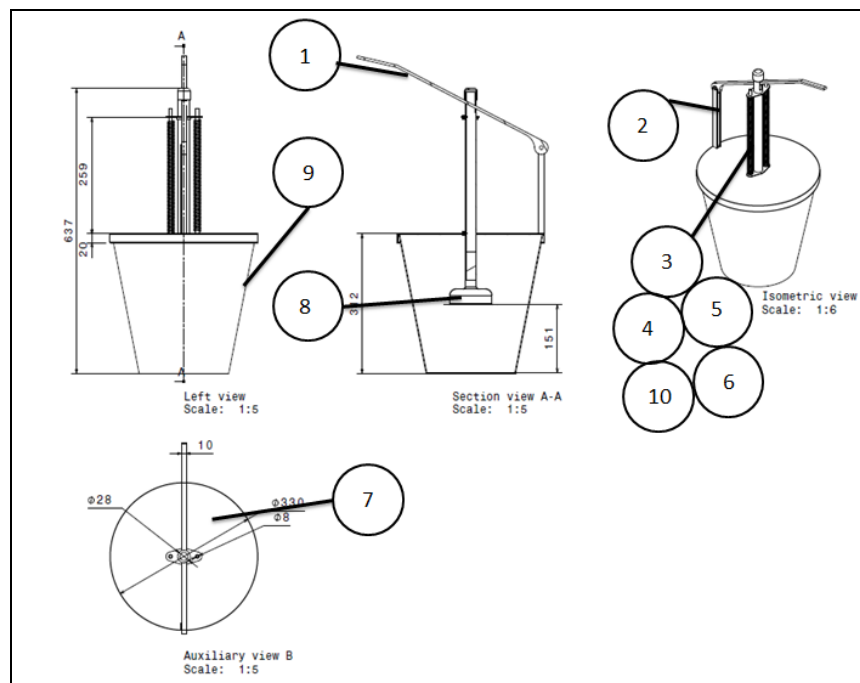
Clothes inside the bucket will hit the bottom of the bucket when the vacuum cup is pressed over it. Due to the spring action the handle with supporting link intern vacuum cup will moves upwards. This creates the pulsate action on cloths inside the bucket. This washing is hand operated washing machine.

## 6.4 Product Specification

- Name : Manually operated washing machine
- Mode of operation : Hand Operated
- Load Capacity : 1 to 1.5 Kg (10-12 liters)
- Weight : 2 to 5 Kg approx. (without load)

## 6.5 Part Description with material selection

For any product which has to be manufactured, part description is the important process carried out in concern with the material required for that part. By this process knowledge of material which has to be selected for the particular components will be known. This is carried out based on the load acting on the particular component in the product. The below figure 6.6 and also table 6.1 shows the part description of the final product.



**Figure 6.5 Part Description**

## 7 – Prototype Model Making

### 7.1 Mock-up Model Making

After getting the individual part description of the product, model making process was carried out. By considering the impact of the part on the product material was selected to build the working prototype.

### 7.2 Material Selection for Cap

As the concept was selected for making prototype of 1:1 ratio, materials was selected to do so. As from the concept shows the mechanism of washer is held on the cap itself so material to manufacture cap was the most important than any other component in the product. While studying these process the material from which the cap has to be build should be stiffer, should with stand high external force and also withstand sudden impact load. These properties of the material can be obtained through material FRP (Fiber Reinforced Plastic.) the following factors boost up the use of FRP as material in manufacturing of cap.

- They are very light in weight. This helps in easily transferable.
- They are corrosion resistant material which best suited for the cap making
- They can be easily assembled.
- They have the property of easily mounted on any other components.

The following details of the manufacturing process are briefly explained.

In manufacturing of the cap using FRP materials a pattern of the cap is made up using wood. This wooden pattern is as the size of the cap which has to be formed using FRP. Later on by using Mat type of fibre is used to make the FRP moulded part. Mat of the fibre is placed around the wooden pattern. Now epoxy resin is mixed with hardener then coating is done throughout the mould of the cap pattern. Based on the thickness required the number of mat fibre is increased then resin coating is applied throughout. This is usually done by hand lay-up method. Once this is completed the mould is let to curing.



Cap for the bucket is designed based on the size of the bucket, after the design of the cap is done operation like drilling is carried out on the cap. Basically centre hole is done on the cap so it has to help the spring mechanism to operate easily. This spring mechanism consist of two stud screw with both end is threaded portion. Then this spring mechanism is held firmly using M S packing. One end of the supporting link is attached to the vacuum cup and the other end is fixed to the spring mechanism this is as shown in below figure 7.3.



**Figure 7.3 Spring Mechanism**

Rigid ‘U’ shape link is fixed to the other end of the cap in such a way that when handle is fixed to this rigid link handle can be easily moved towards upward and downward. This rigid link is made up of MS material. One end of the wooden handle is fixed into the rigid link and the other end is free to the other side this is as shown in figure 7.4



**Figure 7.4 Handle with rigid link**

Below figure 7.5 shows all the component mounted on the bucket.



**Figure 7.5 Final product**

### 7.3 Validation

Validation of the final manually operated washing machine is done to ensure whether the product output fulfills the user needs, requirement and expectation. This model of manually operated washing machine was manufactured to validate the usability, function ability and ergonomics related issues. Manufacturability issues of the designed concept were also validated. The outcome of product was shown to the targeted customers to get feedback. Design evaluation was carried out with the user group and the feedback was positive and satisfactory.

Validation of the working prototype is as shown below figure 7.6



**Figure 7.6 Validation of product**