REDESIGNING DEPLOYABLE MOSQUITO NET STRUCTURE FOR TRIBAL SETTLEMENT

Product Design Project-II (IDP602)

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कोणताही ताप हिवताप असू शकतो

येता कणकण तापाची करा तपासणी रक्ताची

Kavach

Deployable mosquito net structure for tribal settlement

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Product design project -II
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Declaration

I declare that this written submission 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 not misrepresented or fabricated or falsified any idea/date/fact/source in my submission. I understand that any violation of the above will cause a disciplinary action by the Institute and also can evoke penal action from the sources which have not been properly cited or from whom proper permission has not been taken when needed.

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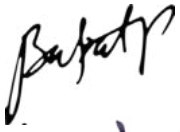
Approval Sheet

The Product design Project-II titled " Redesigning Deployable mosquito net structure for tribal settlement" by Hirom Ulemba Meetei, is approved for partial fulfilment of the requirement for the degree of 'Master of Design' in Industrial Design.

Guide: 

Chairperson: 

Internal Examiner: 

External Examiner: 

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Lastly, I take this privilege to thank my parents and family for supporting and encouraging during the course of the project

Abstract

Malaria is always been a life-threatening disease from the time it has been known. Probably it's one of our oldest enemy of all time, taking more human-life than any other disease. Each year millions of people died and around half the population of the world is put in risk due to this dreadful disease. Sub-Saharan Africa being the highest affected region followed by Southeast Asia and others, this disease spreads all over the world. In India itself, every year, thousands of people lost their life and another million were still living under the burden of this disease, with most of the case coming from rural areas (especially the tribal areas).

Though we have known how to cure malaria from the beginning, it got an entirely different story in most of the tribal inhibited areas, often a darker one. It has been reported that 30% of the total cases in India come from this regions. Apart from poverty, poor health facilities and lack of proper education, the tribal regions are most of time isolated from the mainstream not only geographically but also socioculturally. Despite taking measures to prevent malaria including mosquito nets and other programs, the cultural barriers make it difficult to control the same.

To understand the problems more critically, a field trip was planned with the help of SEARCH organization and visited different villages in Gadchiroli, Maharashtra. One of the most important issue which come out from this study was the lack of seriousness about this disease in those areas. When further research is done, it opened up to many issues from economical to educational to cultural. But as part of this project, the focus is put only into the specific problems related with usages of mosquito net in this area.

In the early stage, the project try to question the most common attitude of people toward the difficulties of not using the mosquito net, which were given to them through government. It also try to critically analyze the problem from the lens of cultural obstacles, the climatic hindrances and the typology of the houses toward this behavior .
In the later section of the project, the issues is taken up to a design level problem and try to solve using different design approaches and methods. This includes mind- mapping, ideation, concept generation system design etc.

Finally, as a deliverable of the project a deployable mosquito net structure named “Kavach” is created, which can be easily made by the local people, using locally available materials with minimum cost.

Contents

In 2015, approximately 3.2 billion people nearly half of the world's population were at risk of malaria…
- WHO report 2015

1 Introduction

Despite the continuous attempt to eliminate malaria from the surface of mankind , malaria still remains one of the most dreadful killer disease of all time , responsible for taking life of 438000 people in 2015 alone and putting approximately 3.2 billion people in risk worldwide.

Global Malaria

About 91% of the total malaria deaths and 81 % of the total malarial cases coming from Sub-Saharan Africa, marking the highest region to share global malaria burden, followed by South-East Asia Region (10%) and the Eastern Mediterranean Region (2%), according to World Malaria Report 2015. In South-East Asia region, 58% of the total malaria cases is accounted from India followed by Myanmar and Thailand .

Indian scenario

In India, the maximum cases of malarial death was reported from rural India (i.e. approx.90% of the total cases). Tribal areas are the mostly affected zone as far as it come to rural India They are the section of people which are mainly deprived from all the facilities whether it is about medical or education or transportation. Many of them are still inhabits in one of the most remotest area of India. The lack of proper health facilities and poverty leads this area one of the most malaria prone area in India . The language and cultural barriers are another difficulties which worsen the burden of malaria in these places. Central and north-eastern India are some of most affected tribal area in India.

Malaria

Malaria are caused by a parasitic protozoans belong to the genus *Plasmodium.* There are more than 100 species of plasmodium which infect both human and animal species such as reptiles, birds and various mammals. Out of which there are four species of plasmodium which are mainly known for infecting humans from the beginning .
They are

- *Plasmodium falciparum*
- *Plasmodium vivax*
- *Plasmodium ovale*
- *Plasmodium malariae*

Plasmodium falciparum and *Plasmodium vivax* are the most common species . *P.falciparum*, being the most deathliest of all follows by *P.vivax* , are carried by their primary vector female anopheles mosquitoes. These type of mosquitoes are more active during dusk,dawn and night.

Different methods to control malaria

Some of the earliest methods of preventing malaria includes protection from mosquito bites ,mosquito eradication and prophylactic drugs. In olden days spraying DDT and other insecticides were more common for controlling malaria . Mosquito net remains one of best solution of all time in preventing mosquito bites. Proper education on malaria and its symptoms has reduced the number of cases in many rural areas

1.1 About the Project

About the Project

The project come to the picture after my visit to one of the tribal area in Kerala as a part of Bamboo workshop. Being one of the most dreadful disease of all time, they are well aware of malaria, even though some of the perceptions are built up out of superstitions and cultural influences.

As like any other rural places in India, the most common way of protecting themselves from mosquito bite is using mosquito net. Most of the time these mosquito nets are given to them through government NGOs. But the real problems is due to hanging problem and other difficulties they used these mosquito for different purposes like fishing. Thus, despite having mosquito net at their home they're still not able to protect themselves from mosquito bites

The project will try to look critically the possibility of not using the mosquito net in these regions and its solutions through design process.

Problems of mosquito net in tribal

Despite being the cheapest solution to prevent mosquito bites, mosquito net are often not used in tribal areas

Some of the reasons behind are :

- Cost of mosquito net
- Hanging problem
- Cultural hindrances
- Not having a proper bed
- Not enough space inside the house
- People negligent behaviour
- Lack of proper knowledge about malaria etc.

Above Image : *A hospital scene in Multan district showing the difficult situation of putting mosquito net on the patient bed.*

Below image : *A men sleeping outside a refugee camp in Sukkur, Pakistan, trying to protect himself from mosquito and other insects .*

2 Literature Study on Malaria

"In 2015, there were 214 million new cases of malaria worldwide …"

"According to recent report of WHO 2015, there were 214 million new cases of malaria worldwide (range 149–303 million). 88% of the global cases were accounted only from Sub -Saharan Africa region followed by the South- East Asia region (10%) and the Eastern Mediterranean Region (2%). Figure 1. Shows the data of ongoing Global transmission of malaria which are collected from 96 countries and territories and from 5 countries that have recently eliminated Malaria . But on the better story, from 2000 to 2015 the total malaria cases have been reduced by 37% globally, and 42% in Africa"

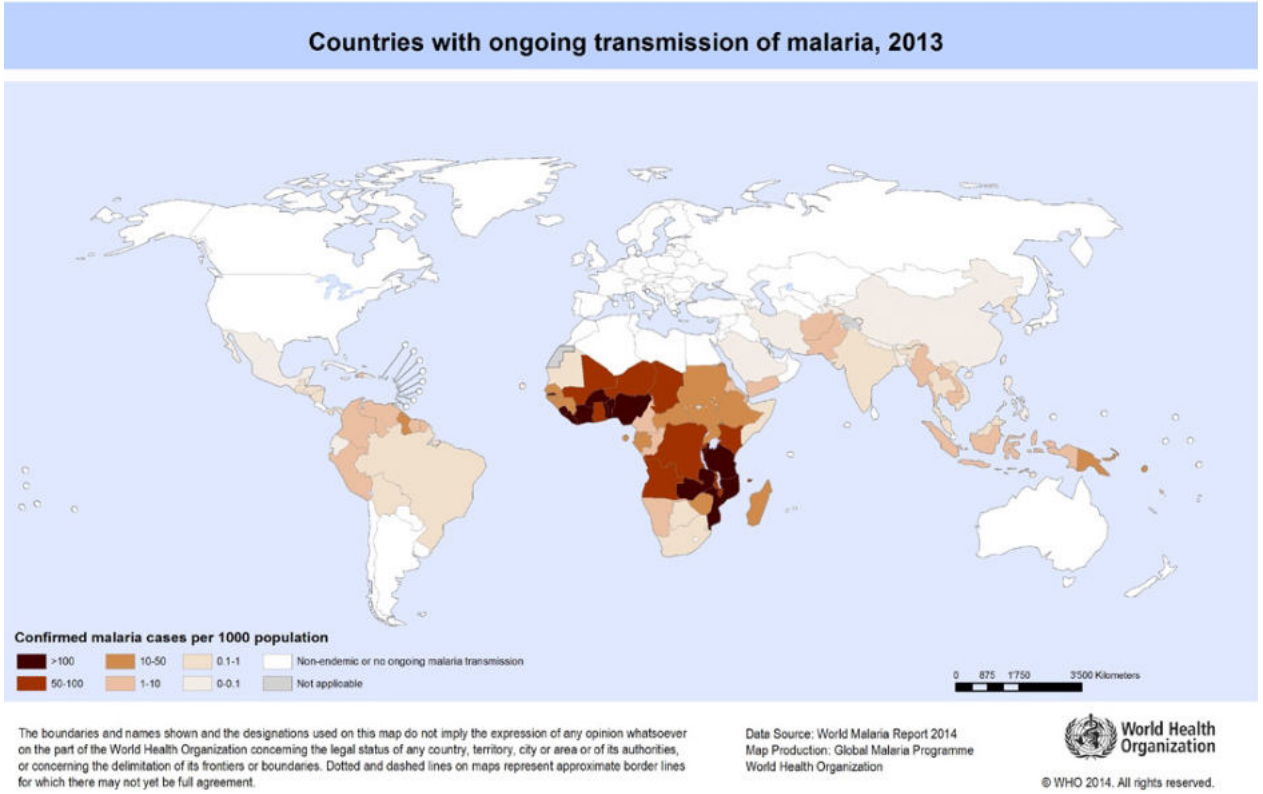


Fig 1. Transmission of malaria across the countries until 2013
Source .heykickstand.com/free-big-idea-no-1/

2.1 World Scenario

Malaria is the one of the major global disease burden which mainly put pressure on tropical and sub tropical area of the world . In 2015, an estimated 438000 malaria deaths were reported worldwide. About 90% of these deaths were reported from Sub-Saharan Africa region , 6% from South- East Asia, 2% from the eastern Mediterranean,1 % from Latin America and another 1 % from western pacific (figure 2.)
The main age group who have the most deaths count is under 5 year of age . More than two-third (70%) of the malaria deaths occurs in this age. Another group of people who are consider at higher risk from malaria are Pregnant women.
It was reported that during 2000 and 2015 the malaria mortality rate fell by 60% globally and about 6.2 million deaths have been averted globally since 2000 .
The global under five deaths rate fell by 67% globally which means approximately 5.9 million child are saved from this dreadful disease .

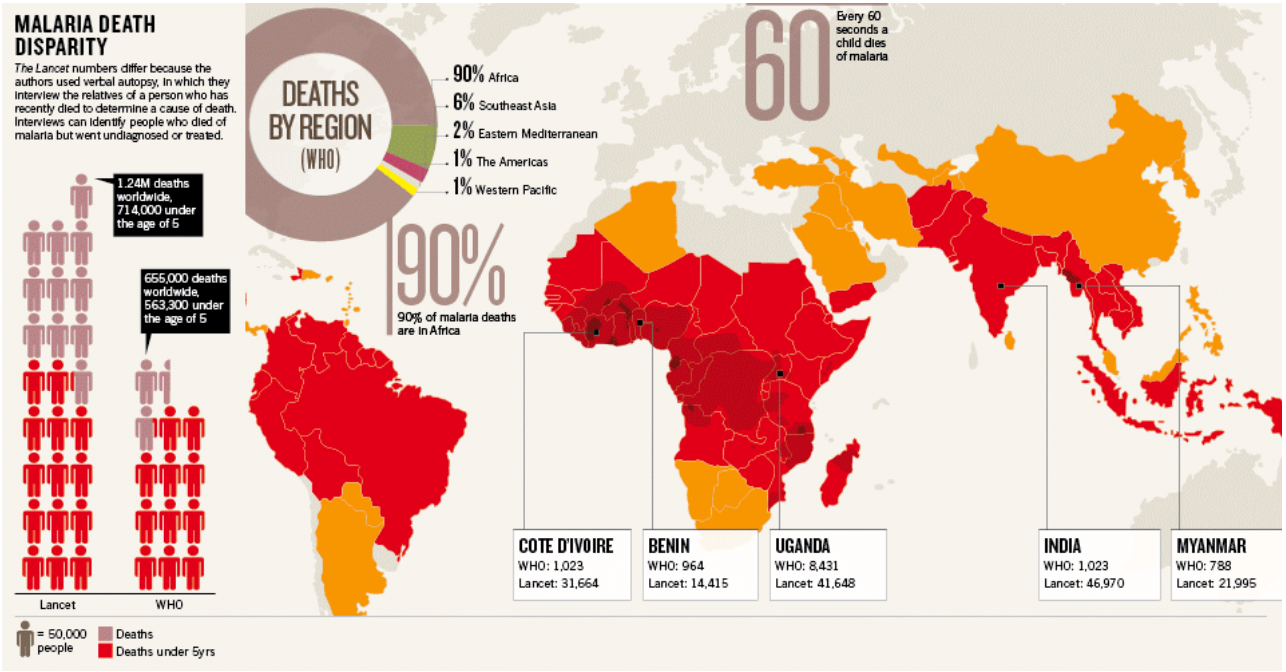


Figure 2. Global infographic on malaria death disparity
Source : www.amplino.org/wp-content/uploads/2012/07/Malaria-Death-Disparity.png (seen on august 2015)

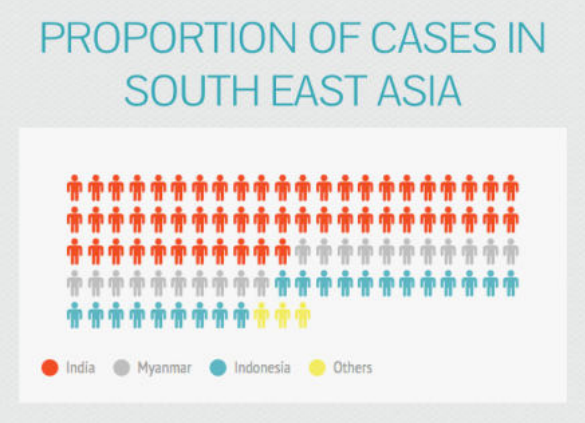
" In 2015, malaria killed an estimated 306 000 children under 5 year of age globally, including 292 000 children in the African Region"
-who report 2015

2.2 Malaria In India

The South-East Asia region accounted 10% of the total global malaria cases, next to the Sub-Saharan Africa region. India accounts for 61% of the total malaria cases and 41% of the malaria deaths in entire South-East Asia region. Figure 3. Shows the comparison of the malaria cases in SEAR (South-East Asia Region) countries.

In India, according to NVBDCP (National Vector Borne Disease Control Programme), in present there are 0.7-1.6 million confirmed cases and 400-1,000 deaths annually
The Lancet published on 20 November 2010,

Figure 3. *(Below)* Transmission of malaria across the countries until 2013



reported that "malaria causes 205 000 malaria deaths per year in India before age 70 years (55 000 in early childhood, 30 000 at ages 5-14 years, 120 000 at ages 15-69 years)"
Some of the most affected states in India are Orissa, Chhattisgarh, Jharkhand and Assam respectively

"According to the World Malaria Report 2014, 22% of India's population (275.5million) live in high transmission (>1 case per 1000 population) areas, 67%.(838.9m) live in low transmission (0–1 cases per 1000 population) areas and 11% (137.7m).live in malaria-free (0 cases) areas"

Fig.4 (*Right pictures*) A small girl testing for malaria in rural area .
(*Below* pictures)Total number of malaria cases and deaths from 2013 to 2015 (*refered from mail online india 13may 2015*)

Malaria cases in India

2015	2014	2013
Malaria cases across India **1,29,852**	Malaria cases across India **10,70,513**	Malaria cases across India **8,81,8730**
Deaths **30**	Deaths **535**	Deaths **440**

2.3 Tribal Settlement and Malaria

India pollution according to 2015 is 1.29 billion, out of which 8.6 % is the tribal population. This small group of population contributes 30% of the total malaria cases and 50 % death cases in India, which largely proved that it is a very big issues in those areas .

Until now 93.8 million people are still lives in rural areas and most of them stay near to hill, forest and mountains . Thus, they are not only isolated geographically but also economical as the transport and market facilities are not properly established. Thus it make it more difficult to eradicate malaria from these regions.

The poor knowledge and attitude toward the disease, poor health and sanitation and poor medical services also intensify the endemicity of the disease in this particular area .

Apart from all the reasons the most important is people there often consider malaria as normal part of life despite witnessing the effect of this deathly disease. This could be due to their poor financial condition or their strong cultural

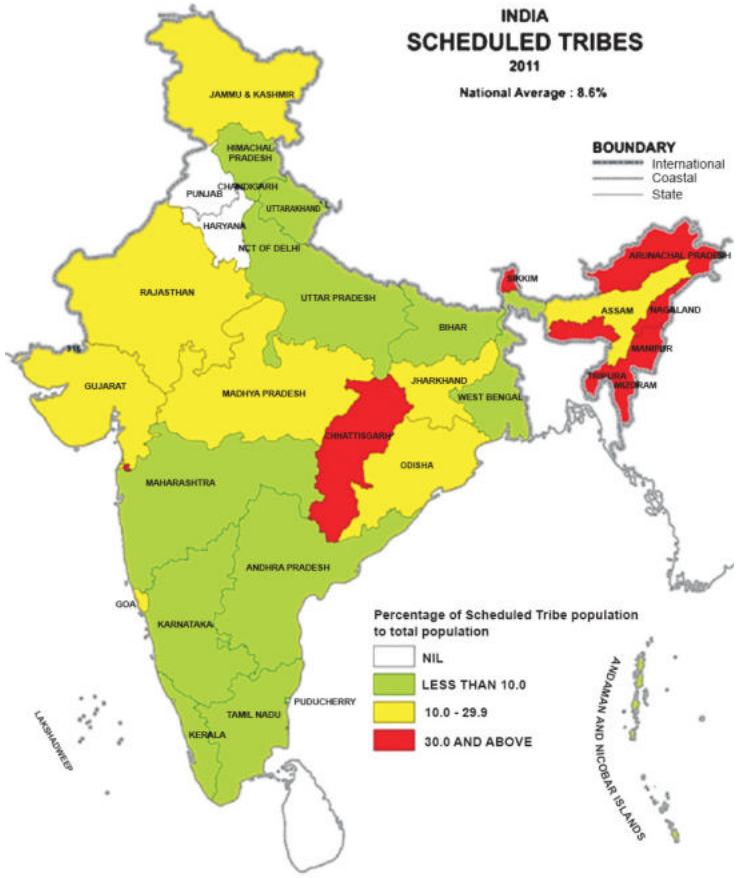


Figure 5. Map showing the distribution of tribal population in India

2.4 Malaria Facts

Malaria, the life threatening disease is caused by a parasitic protozoans of genus *Plasmodium*. This singled-cell microorganisms is usually transmitted through a bite of infected female anopheles mosquito. This kind of mosquitoes are more active during dusk, dawn and night time
A simple infographic on how does malaria spread is showed in figure 6.
There are more than 100 species of malaria parasites, but four of them are commonly recognized as infecting in human. They are
- *Plasmodium vivax*
- *Plasmodium malariae.*
- *Plasmodium ovale*
- *Plasmodium falciparum*

P.falciparum is the most lethal among all .They are very common in southern regions of Africa. Even though *P.falciparum* is the most dangerous parasite , one need to be treated the other three remaining parasites also as they often leads to other health problems..

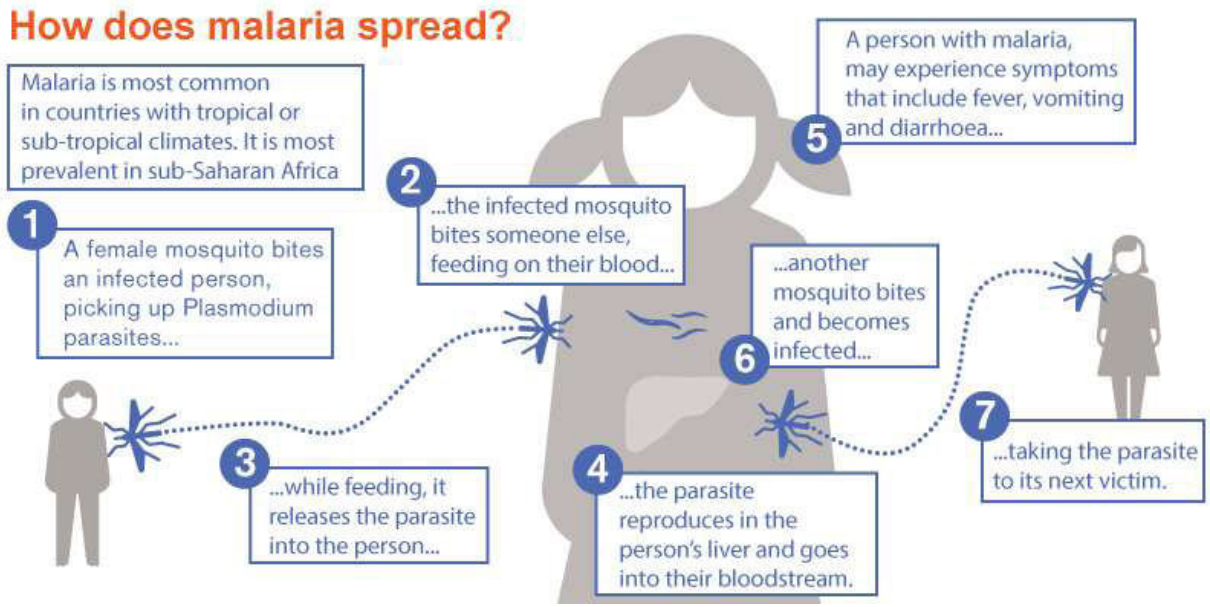


Figure 6. Inforgraphic on how malaria spread ?
Source : www.gsk.com/en-gb/behind-the-science/access-to-healthcare/malaria-life-cycle-of-a-parasite, *seen on october 2015*

SEARCH, GADCHIROLI
MOBILE MEDICAL UNIT TEAM

From Right to left : Dr. Hrishikesh Munshi (Head of the team); Swati Meshram (Nurse); Vinod Alam (Driver); Jitendra Shahare (Pharmacist); Dilip Turate (LAB technician)

3 User Research

As a part of the project user study and also to witness the hands-on problems of the tribal people regarding malaria and its burden A trip was planned with the permission from **Dr Abhay bang**, founder of SEARCH (Society For Education, Action and Research Community Health) organisation. With the help of their Mobile medical Unit Team leaded by **Dr. Hrishikesh Munshi** (*picture on left*). every morning we went to different village to do a proper check up for malaria . They also maintained a strict record of all the pepole, from young to old for each village. All these villages are mixture of tribal and non tribal people and most of them lives in cluster of ten houses. In my whole journey we have visited around six villages and two ashrams(schools). They are

- Kharkari
- Chatghao
- Shakeratola
- Pastola
- Bhavpara
- Yedampayli

Two Ashram (Government)

- Sode
- Godhalwahi

Picture 1. The MMU team Bus

Picture 2 . A map of Gadchiroli seen in front of an Ashram

3.1 People and Houses

3.1.1 User Observation

Typology of the houses

Most of the houses have three important parts , one common room for everyone, one kitchen where the elder sleeps at night and a courtyard for grandfather to sleep.

In average, there are five to six members in a family, most of them are joint family.

Therefore, there is always problem for space inside the house, in many cases either the father or grandfather sleeps outside in the courtyard. It is also mention that the head of the family especially the father always get the prevalence to sleep under mosquito net.

This means all the family members doesn't get the chance to used mosquito net while sleeping

The common room are always engaged with household activity at day time while at night time they all spreads their bed for sleeping. Every morning they have to remove the mosquito net and keep the bed upside down so that the space can be made available for daytime activity.

Many of them explains , the tedious work of tying and untying the mosquito net everyday ceased them to used mosquito net.

Seasonal woes

In winter many people sleep outside near the fire because it's not always convenient to have fire inside the house

And they ends up sleeping without mosquito net at night , which is also one of the root cause for increasing malaria during winter.

The cases usually rises up in the month of rainy season and winter.Most of the distributed mosquito net are use for fishing

Why government spraying doesn't works ?

Spraying is always done in this village but the government 's sprayer come around at 11 a.m to 5 pm. During this time most of the villager went outside their house to work, so it wouldn't cover the inside part of the house, they will leave after spraying nearby surrounding.

Cultural barriers

When a baby is born, until the naming ceremony the mother and baby are kept outside the house in a temporary hut . This hut are often build in hurry and many a time they don't have proper place to hang the mosquito net .

Korma

Korma is a small house specially built for the girls who attend menstrual period to stay. No men are allowed to come near this place, even the male doctor. Sometime as many as six girls are stayed together in this small place without proper space to sleep.

Malaria cases

Most of the malaria cases are found under the age of 14 .There are three common malaria cases which are severe to this places . They are
Plasmodium falciparum (68.29%)
Plasmodium vivax (36.70%)
Mix of both (4 persons are recorded for this year) Small children and pregnant women are in more risk then any other ages groups

3.2 Student and Ashram

3.2.1 User Observation

1. Godhalwahi Ashram

All the students in this Ashram are come from nearby tribal areas. They all sleep in a large halls which is like a dormitory .The boys dormitory have beds (foldable bed made from iron)and each student have one trunk to keep all their stuff like clothes, books, utensils etc .
Every morning is there duty to fold up there bed and clear the hall for using morning prayers.
The windows in the rooms are all shield up with window mesh. These window meshs uses velcro which can be easily removed. Most of time student use the window bar for drying their wet clothes during which most of the screen got damaged(*a high reason for mosquito to enter inside the hall*)
Though they have ceiling fans inside the hall ,due to irregular electric supplied they remains off .
Another observation is in the entire hall there is no bar where one can hang mosquito net. Therefore most of the time the student sleep without mosquito net .
Since the place is also used for eating purpose , all the bed have to fold back and clear up for space every day .(*a reason for not using mosquito net as it take time to remove and pack mosquito ne*t) .
On the good side of the observation , they teaches the student about malaria as a chapter in their syllabus . They also welcome the weekly check up drive from mobile medical unit, SEARCH and ensure the student are free from malaria .

2. Sode Ashram

Soda ashram is a girls school. They proudly mention that their school got award for its cleanliness across the country.
The ashram have two girls dormitory . One of the dormitory have double bunker bed while other one doesn't have any.
Most of their mattress are thin and have to fold up specially for the one which doesn't have bed .
Same as the previous ashram the windows are all shield up window mesh with velcro for easy removal. They also have fan which they hardly used Here the awareness is more whether is about malaria or sanitation . They have posters all around explaining malaria and its symptoms.
The teachers follows a strict check-up for each and every students whenever the mobile medical unit come to their Ashram.

4 Design Brief

Project focus :

The whole project has been initiated considering the challenges face by the tribal people against the burden of malaria which get even worsen due to poverty-stricken condition, poor health facilities and lack of advanced technology.

The primary focus of the project is to look upon the various issues faced by the villagers and tribal people, while using the current existing mosquito net .

Objective:

Its main objective is to search the most effective and most reliable solutions toward prevent of malaria in tribal regions by favouring their way of living .

Design brief

To redesign a deployable mosquito net structure using locally available materials (bamboo), that improves the usages of mosquito net amongst tribal people.

Design Considerations:

- It should be affordable
- The structure should be stable, light-weight and aims in space-saving
- It should be easily repairable either by themselves or with the help of local skilled person
- Its should give some sort of aesthetic as well as aspirational value to them

5 Design Process

Mind mapping

An opportunity mind map is carry out with some core words as tribal settlement, mosquito net and structure etc. The process become really helpful in farming an overall structure of the project.

In tribal regions, apart from problematic geographical access and its poor economical status, many a time their strong cultural and traditional believes makes it more difficult to eliminating malaria.

The other projection of the mapping includes the kind of mosquito nets they used, different means of preventing malaria, issues in hanging mosquito net, the kind of structure used for hanging mosquito nets, stability of the structure .Also the cost and material which need to be considered .

From the above mind mapping process some key words are noted down which acts as a building block for further ideation and concept generation.

Key words

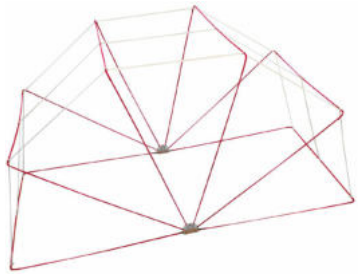
- Affordable
- Aspirational
- Bamboo
- Rope
- Joinery
- Inflatable
- Collapsible
- Space-saving
- Easily repairable
- Dependent and independent structure
- With bed or without bed
- Improved local craftsman

5.1 Existing products Research

Above:
-A simple one-bar hanging mosquito nets
-Need prior arrangement for tying the rope
-Can used the normal net.
Below:
-Sleeping bag concept
-Opening is on the top end
-Best for travellers..

Above:
-Side foldable wire
-Required a proper bed for keeping in tension
-Expensive and required two person for folding.
Below:
-Collapsible with iron frame
-Difficult to used for bigger size.

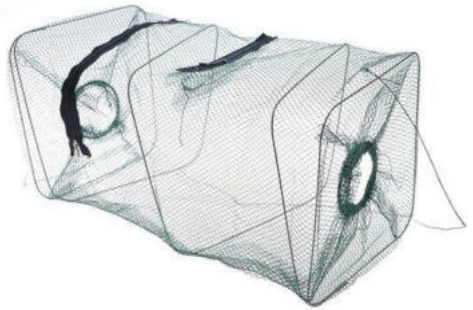
Above:
-Bigger size mosquito net structure
-Can fit more people in it .
Below(left)
-Collapsible wire frame structure
-Expensive, good for smaller size
Below(right)
-Inflatable balloon frame, good for smaller size



5.2 Parallel products Observation

Image1. Foldable camping bed with tent

Image 2. Collapsible Structure for tent



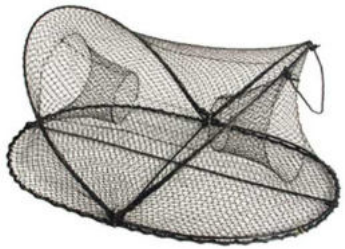


Image 3 & 4. A foldable fishing trap made with wire frame.

With idea of space-saving and easy to transport, different range of products are compared to get an insightful knowledge about the mechanism as well as their advantages. A foldable camping bed with tent which shows the different joinery and details about how the clothes is wrapped around the metallic frame (image 1& 2). A clothes drying rack which can be fold from both side is simple yet a very good example of rigid structure (image 8). Different kind of fishing traps are used with the concept of collapsible with metallic wire (images 3,4 & 6) A wall mounted clothes hanger which can be stretch out is another good example of foldability (image 5). A simple foldable wooden laundry basket explains different way to tie the clothes around the frame .

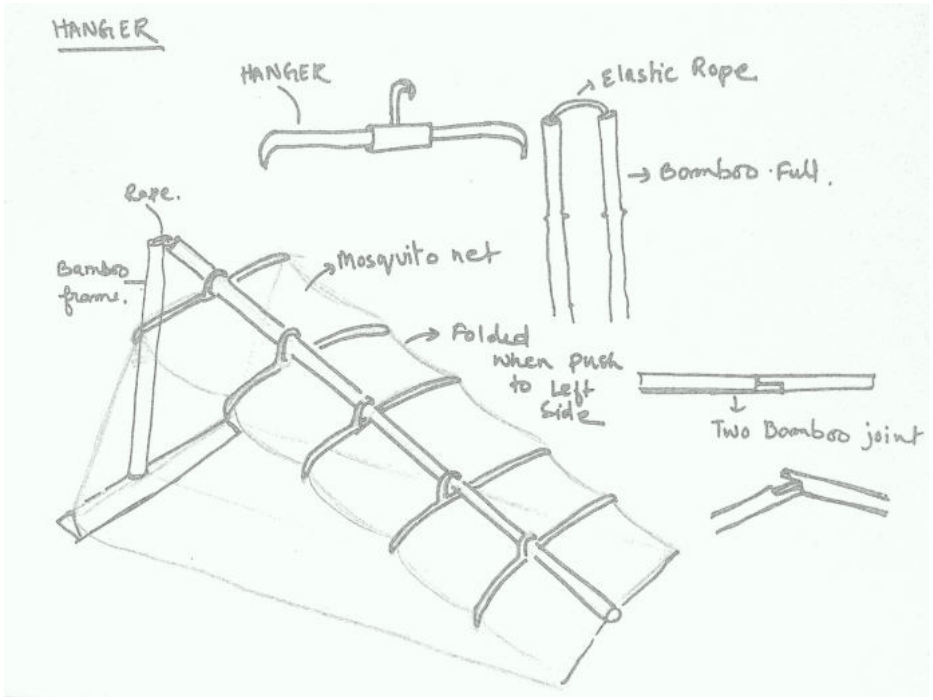
Image 5. Collapsible Wall Hanger

Image 6. Fishing trap

Image 7. Foldable Laundry basket

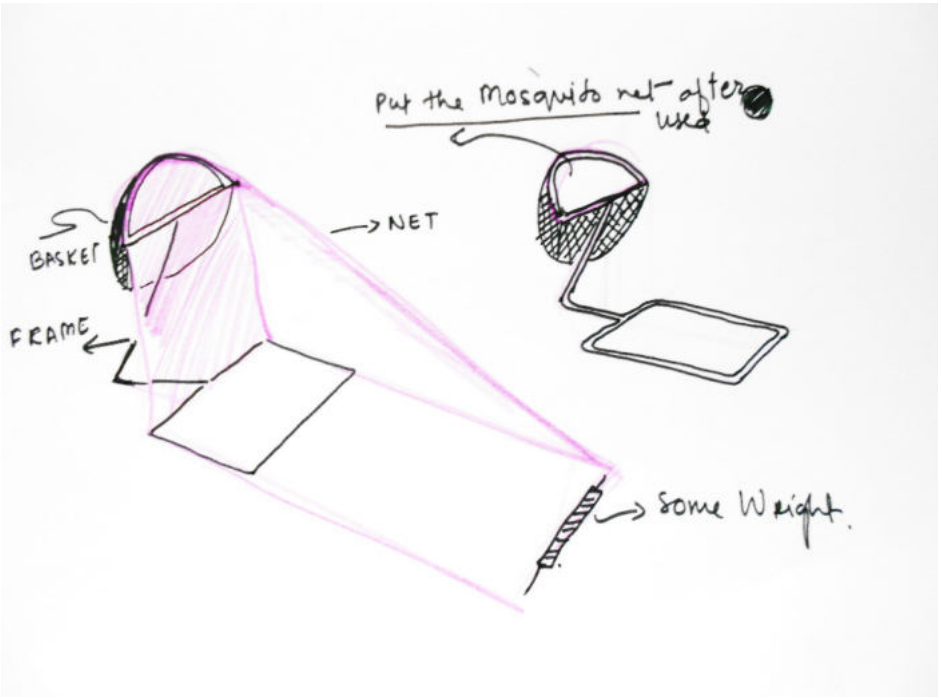
Image 8. Foldable clothes drying rack

5.3 Ideation



Ideation 1

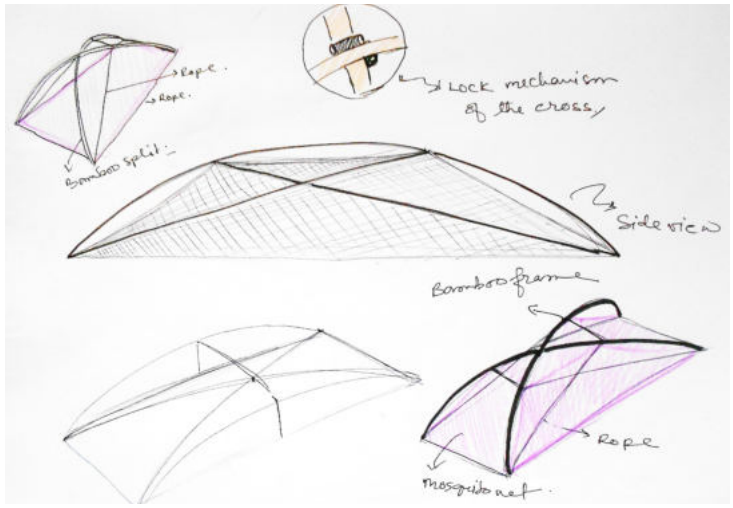
The idea is inspired from the image of clothes hanger inside the cupboard . A frame which can be pull down when you want to put up the mosquito net. There are lot of hangers which holds the mosquito net and can be pull up whenever not required. The main idea behind in this concept is easy to make the mosquito net easy to use and fold it back. the foldable part could be connected with elastic rope.

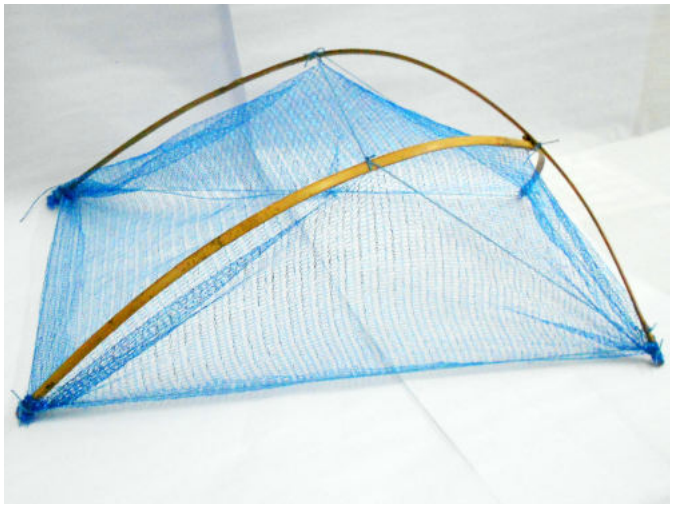


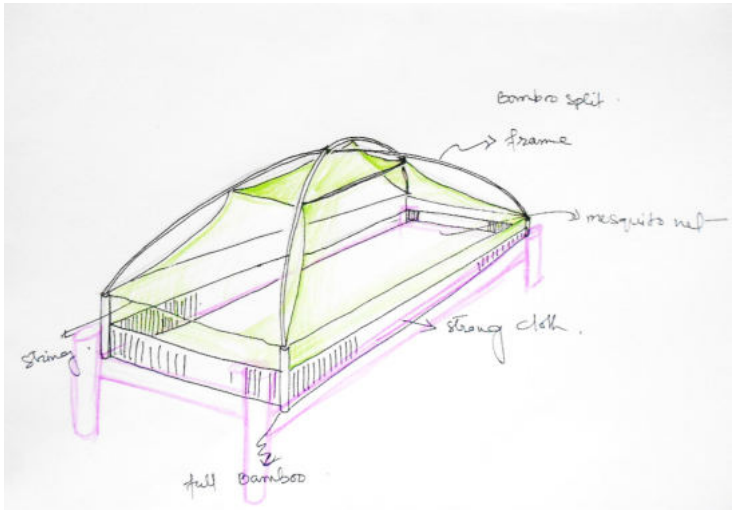
Ideation 2

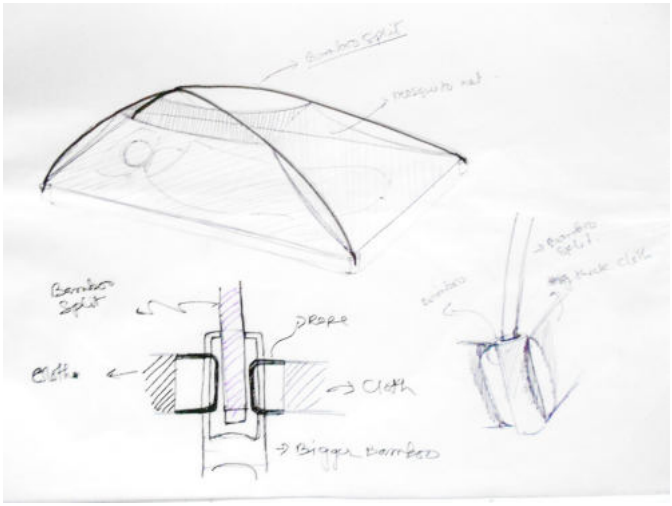
A structure with a basket on it .Whenever the mosquito net is not in used a mechanism can pull the mosquito net inside the basket , thus it can be easier to manage the mosquito net from tangling up .
While opening the weight in the other end of the mosquito is tuck inside the mattress so it can maintain the stiffness of the whole set up.

5.3 Ideation (*continued*)





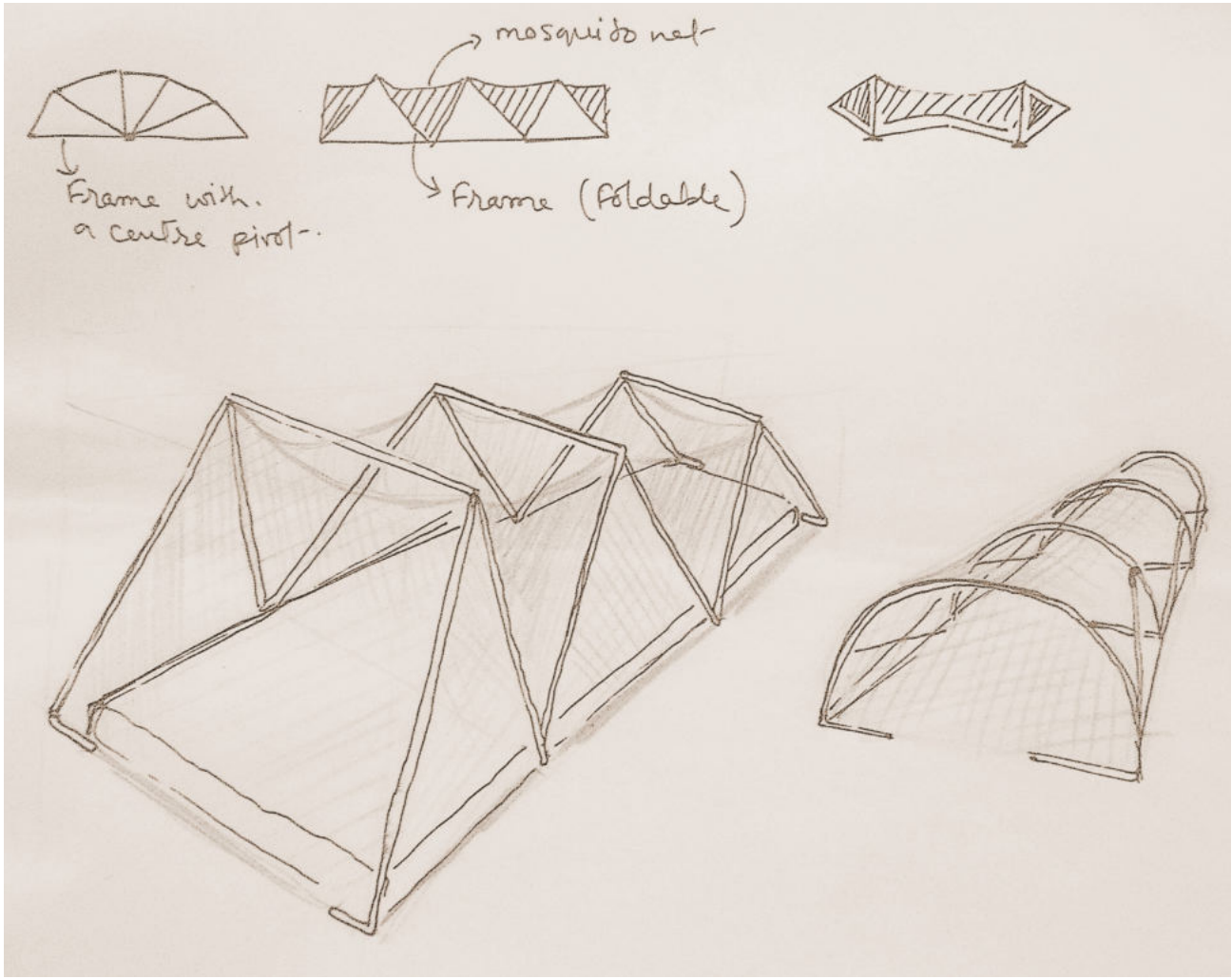




Ideation 3

Using two bamboo splits which are locked in the structure of a Chinese fishing net and maintaining a tensile force at the bottom using the mosquito net span . The side frame can be adjusted using a pivotal hinge in the intersection point.
This structure could be used for both with bed and without bed.

5.3 Ideation *(continued)*



Ideation 4

A simple collapsible structure which can be folded when not in used and can be stretch out when one want to used. Its consist of either square or semi-circular frames connected with hinges to make it more easier to fold . The mattress will provide more support when the frame is opened up.

Image 9. A foldable fishing trap made with wire frame.

5.4 Concept Direction

Direction:

A mosquito net structure can be look from four directions :
1) with using bed
2) without using bed
3) for single person used
4) for more than two persons and above(specially for ashrams)

As, many of them doesn't have proper number of bed, the design approach is fixed in building a mosquito net structure for single person used without using the bed . Thus, the ideation (4) is carry forward considering the cost and simplicity of the structure .

The concept exploration starts with the following points in the mind

Cost effective :

Since most of the tribal people have very low income , the first priority is to make the structures affordable to them

Collapsible:

Another point to mention is the space, in the traditional hanging style of mosquito net occupied a lot of space

Bamboo :

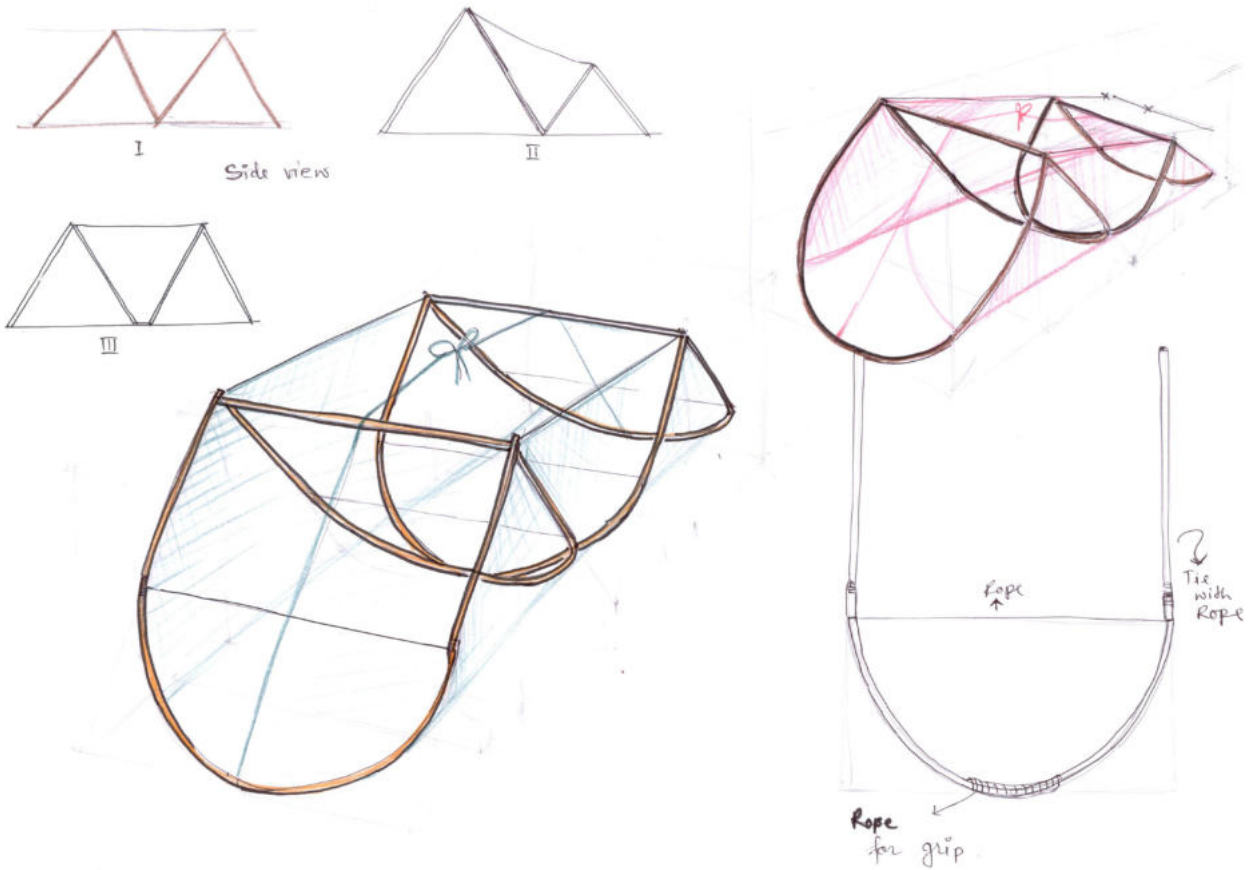
Availability of the material is another aspect in reducing the cost of the product

Base remain rectangle :

Rectangular base because of optimum space to fit in bed size.

Image 9. Different size of bamboo. *(left)* the rectangular base of the bed .

5.5 Concept Generation



Concept 1 :

A frame is made using a bend bamboo and its extended using two straight bamboo. These frame are join using a hinge like mechanism so that it can fold easily .Another same concept is making the frame as square shape

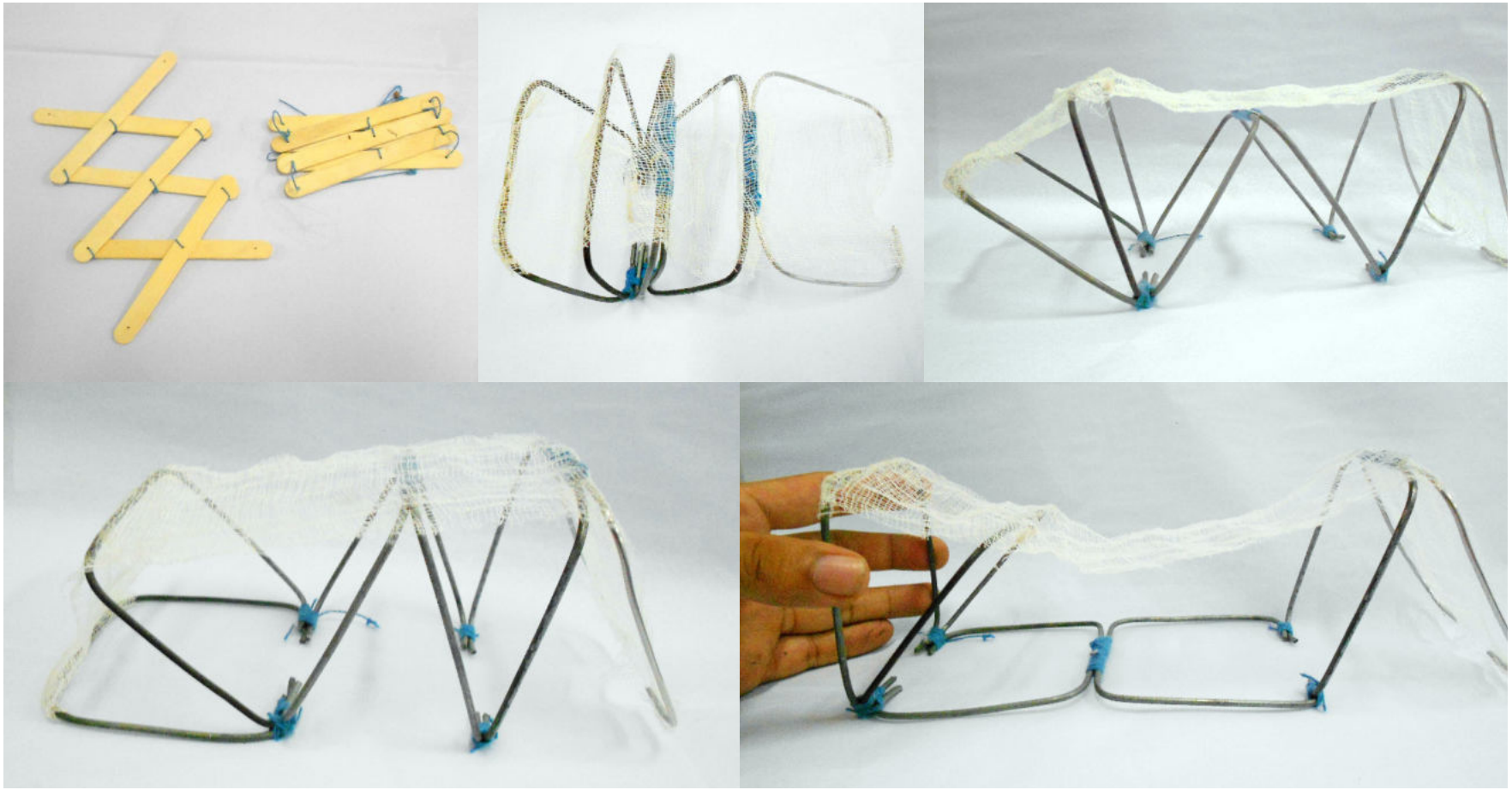
Advantages :

- Can be folded
- Easy to make
- Light weight structure
- Use lesser cost material

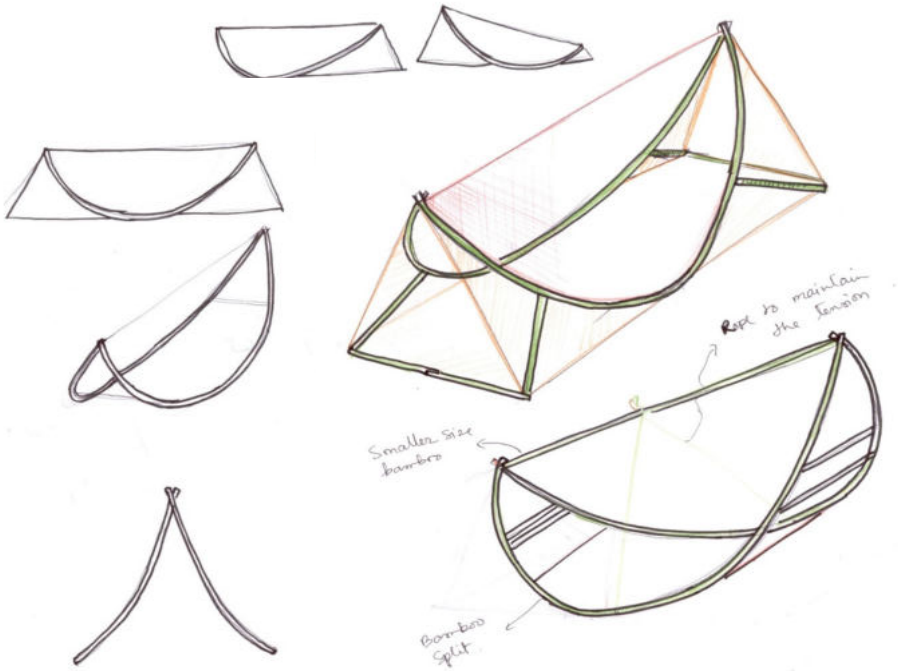
Disadvantages :

- Cumbersome to unfold
- Many movable joint
- More materials

5.5 *(Mock-up model)*



5.5 Concept Generation *(continued)*



Concept 2 : Bow structure.

Considering the flexibility of bamboo splits, the structure is made using to longer bamboo split which bends in the shape of a bow with help of a string .

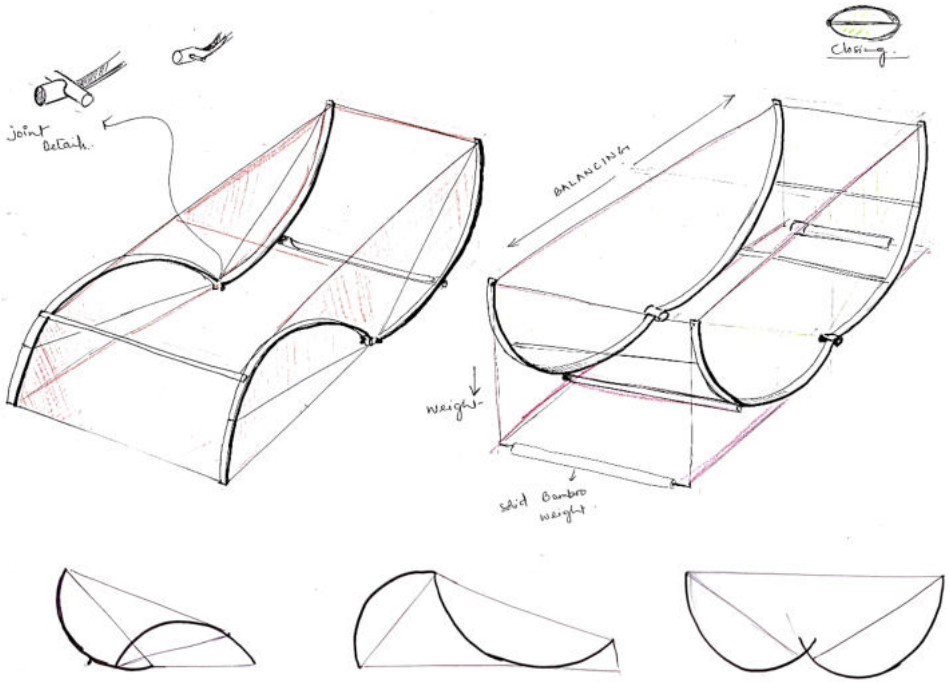
Further, some small structure are build around to prevent it from rocking

Advantages

- Side-way folding, less material
- Easy to build , less hinges

Disadvantages

- Sightly rocking structure
- Difficult to insert mattress



Concept 3 : Half -folding structure.

Instead of bending a long bamboo splits, the bamboo is divided into two parts and bends which make it more stable. Two pivotal hinges are used for folding the structure in half .

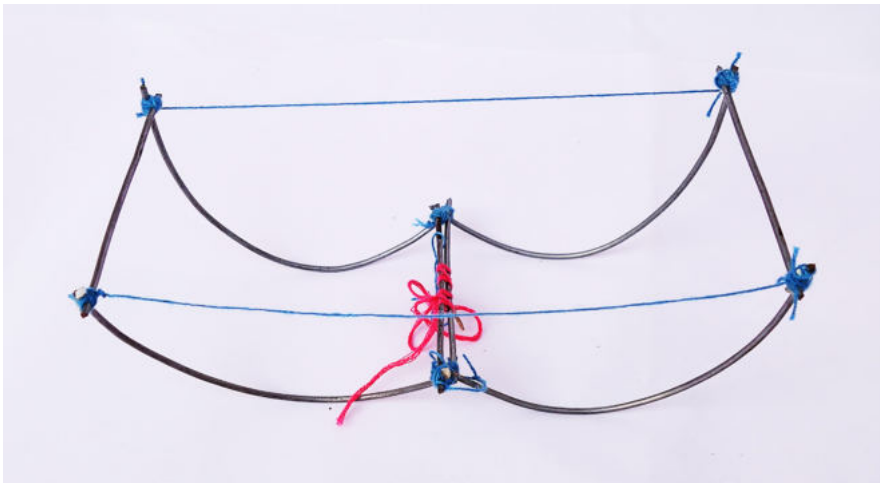
Advantages

- 50% space-saving, less joint
- Very stable structure, easy to build

Disadvantages

- Slight issue with space
- Need customize mosquito net

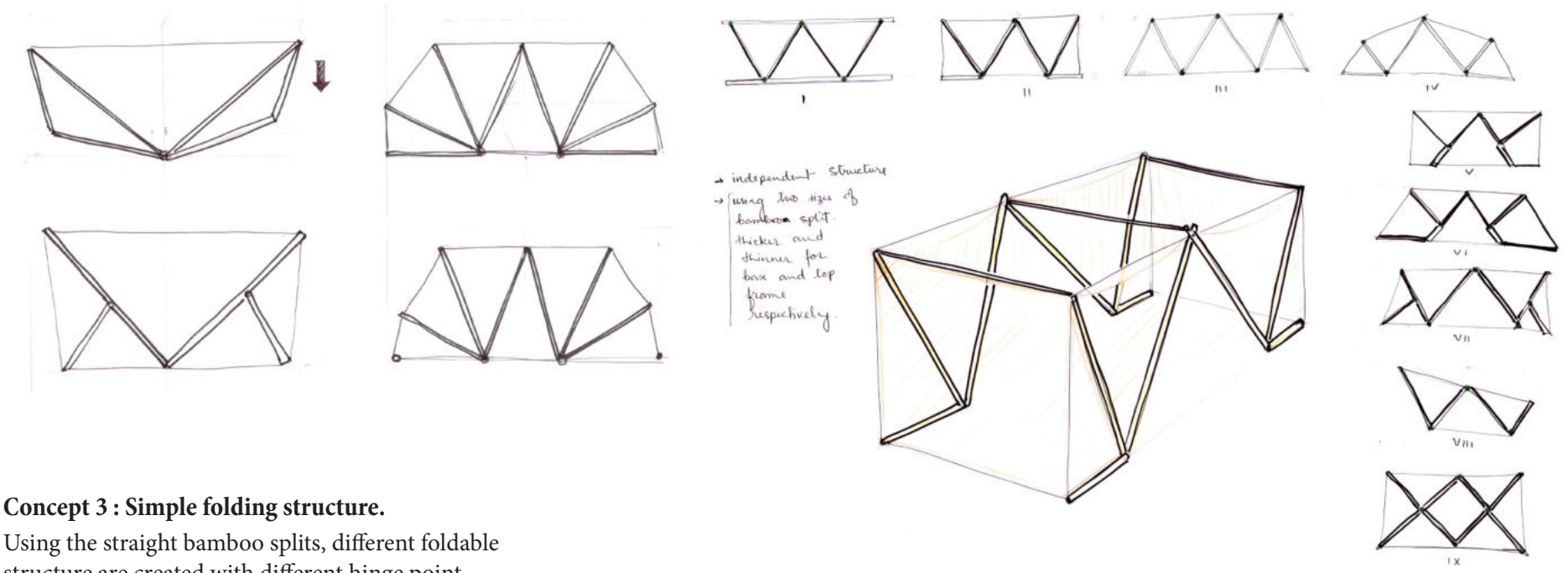
5.5 *(Mock-up model)*



Mock up:

Further exploration reveals some more interesting structure which consider volume of the structure and also the stability of it. Different orientation of the same structure like in case of half structure also help in discovering the new structure which are much more stable then its previous structure .

5.5 Concept Generation *(continued)*



Concept 3 : Simple folding structure.

Using the straight bamboo splits, different foldable structure are created with different hinge point. It also mainly focus around the idea of giving maximum volume inside and minimum space occupied from outside. This structure also play with gravity and its stress on the string used around it . .

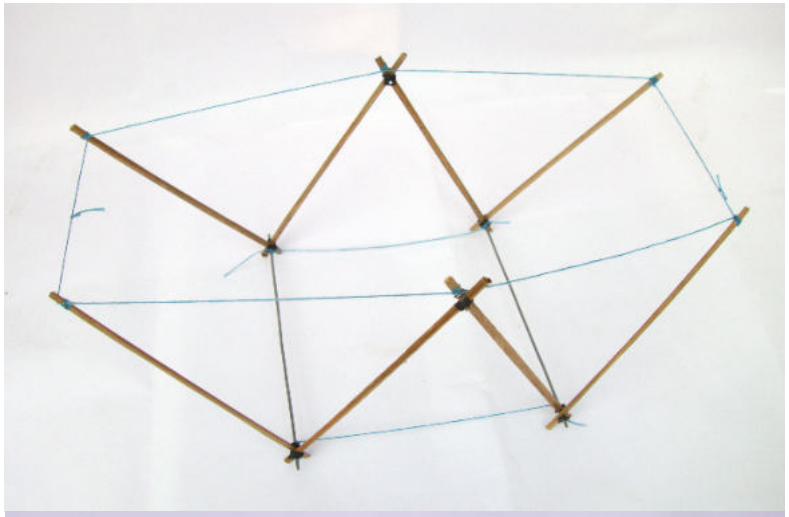
Advantages

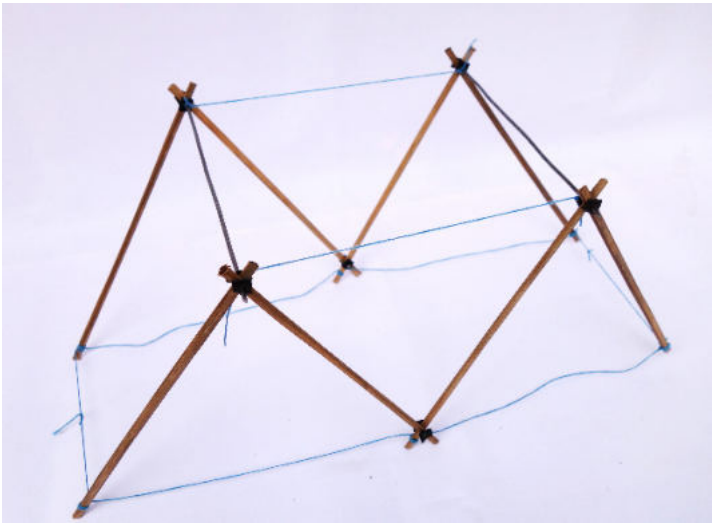
- Occupied less space
- Stable structure,
- Easy to build
- Maximum volume inside

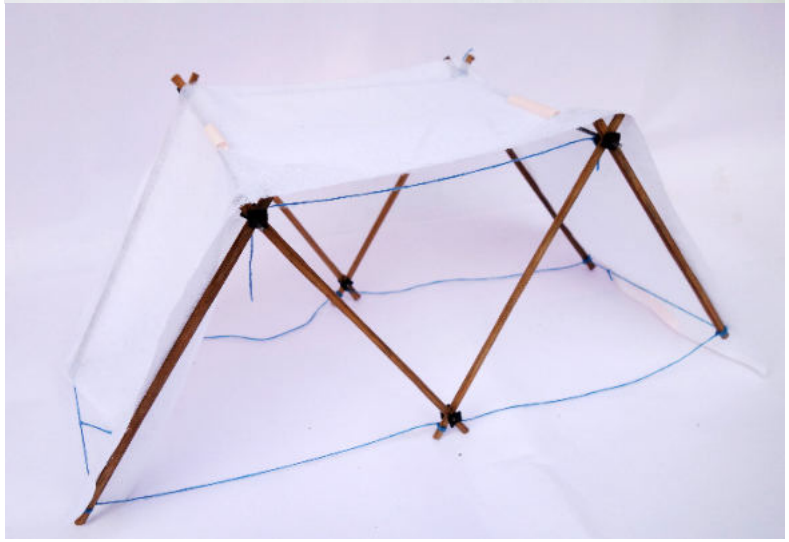
Disadvantages

-Slightly cumbersome in folding and opening
- Limitation of the materials in using hinges

5.5 *(Mock-up model)*







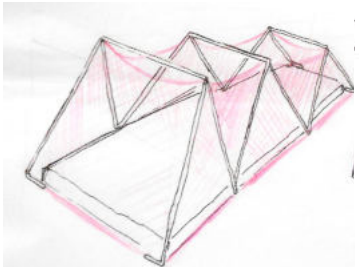
Mock up:

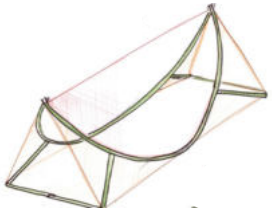
To clarify the volume and height of different structure a small mock up model is made and put in different orientation. Also the concept of how the clothes can be wrapped around it, has been put up .

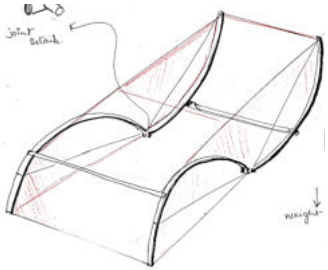
5.6 Concept Evaluation

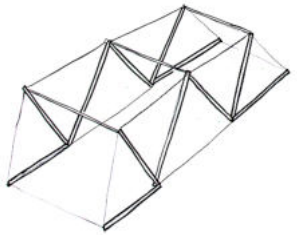
Criteria

3 = favorable
2= less favorable
1 = least favorable









Sl no.	Parameters	Concept 1	Concept 2	Concept 3	Concept 4
1	Stable structure	2	2	3	3
2	Space saving when folded	3	1	2	3
3	Cost	2	2	2	2
4	Time taken to open and close	2	2	3	3
5	Simplicity of the structure	2	2	3	2
6	Repairable and manufactural	2	2	2	2
7	Scalable	2	1	1	3
8	Aspirational	1	2	3	3
9	Storage	1	1	2	3
10	Transportation	2	1	1	3
	Total	19	16	22	27

5.7 Concept Refinement

After a careful concept evaluation session, it is come to following points
1) It should be simple yet a stable structure
2) It should take less time to open and close
3) it should be easily repairable
4) it should be scalable
5) it should be affordable
From the following points the most suitable concept turn out to be **Concept (4) simple folding structure**

Some Iteration of the concept

Some of the iteration on concept 4 are shown in figure 7

Iteration 1
-Lower height on both side
-Base support bar

Iteration 2
-Mid frame support
-Weight for balancing

Iteration 3
-Normal height
-Base support bar

Iteration 2
-Different height on both side
-Weight for balancing the side

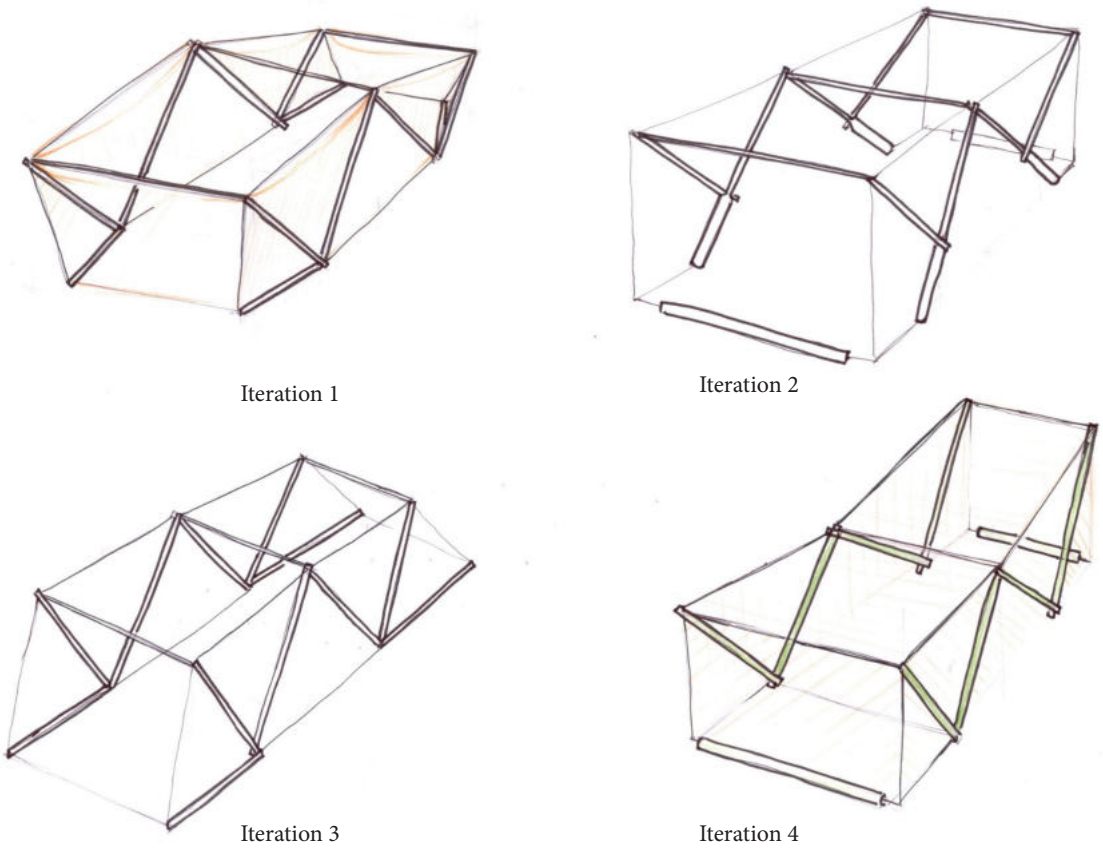


Figure 7..Iteration of concept 4

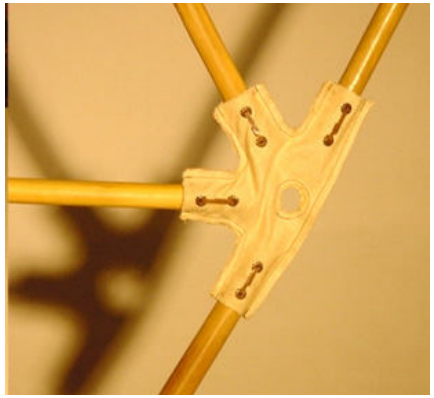
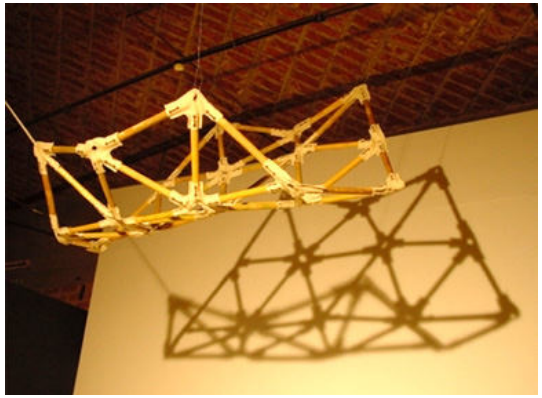
5.8 Existing Joinery

Different joinery from the different product are considered
1) The simple rope joinery
2) The elastic rope joinery in square robot toy
3) ordinary wood peg joint
4) Jointing details using leather in wood
5) bamboo joinery with clothes





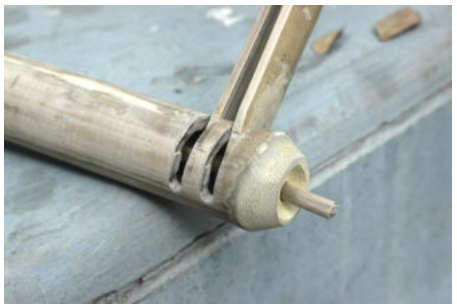


5.9 Joinery Exploration





1)Bamboo Joinery using two slot.
2) Joinery using nuts and bolts with rubber gasket. To make it more easier while folding up.
3) Using spring wire , so that it can bends in any direction


5.10 Material Research

In the hunt of a material which is low-cost, lightweight and locally available, an in-depth study about the properties of different materials are performed. Some of the considered materials are metallic wire, rubber tube, wood bamboo, fibre and iron. Further analysis in terms of cost, availability in that area and easy to construct, Bamboo is chosen considering the charming properties it have and also specially because of the abundant availability in that areas

Bamboo

Being the fastest growing grass in the world , it can be transforms to many different constructive materials . It can be used as whole bamboo or can be split into many members and used . Different variety of bamboo are chosen to understand the different properties they have (image). Size of the diameter is another important aspect if agreed to used the whole bamboo(image) while wall thickness for splits (image).

Image5. A kind of small bamboo species which are available in Meghalaya.

Image5. Showing different diameter bamboo which can be used for making the frame

Image5. Different size of bamboo splits

5.11 Market Research




To be able to give the option of various mosquito net fabrics ranging from cheaper nylon to high price cotton is another outcome of market study. Various small markets in lohar chawl and mulund have shown the wide range of mosquito nets which are common to different section of people . The lining or boundary clothes also need to be carefully choose as most of the time nylon mosquito curls up from the bottom. Packaging clothes is a part of consideration too as not only it will be easier for transportation but also give some aspirational value to them.

For standardisation of the product, choosing a good quality bamboo having similar size is also much needed task. Places like Lower Parel and Vikhroli have quite a variety of bamboo from different region. One will get various bamboo species around here. .




5.12 Insights from Market Study

Choosing of materials

After market study, all the material from the market are put up on a board under category like mosquito net fabrics, boundary clothes, packaging clothes, rope and gasket .

1) Mosquito net fabrics

There are three common used mosquito net fabrics

- Nylon
- Cotton
- Nylon-cotton mixed

2) Boundary clothes

- Heavy cotton clothes with bright colour
  (Both for aesthetic as well as functional purpose)

3) Packaging clothes

- Canvas clothes and Jute clothes .
  (Cheaper in price and more durable)

4) Rope

- Different cotton and jute rope
  (Cheaper in price and more durable)

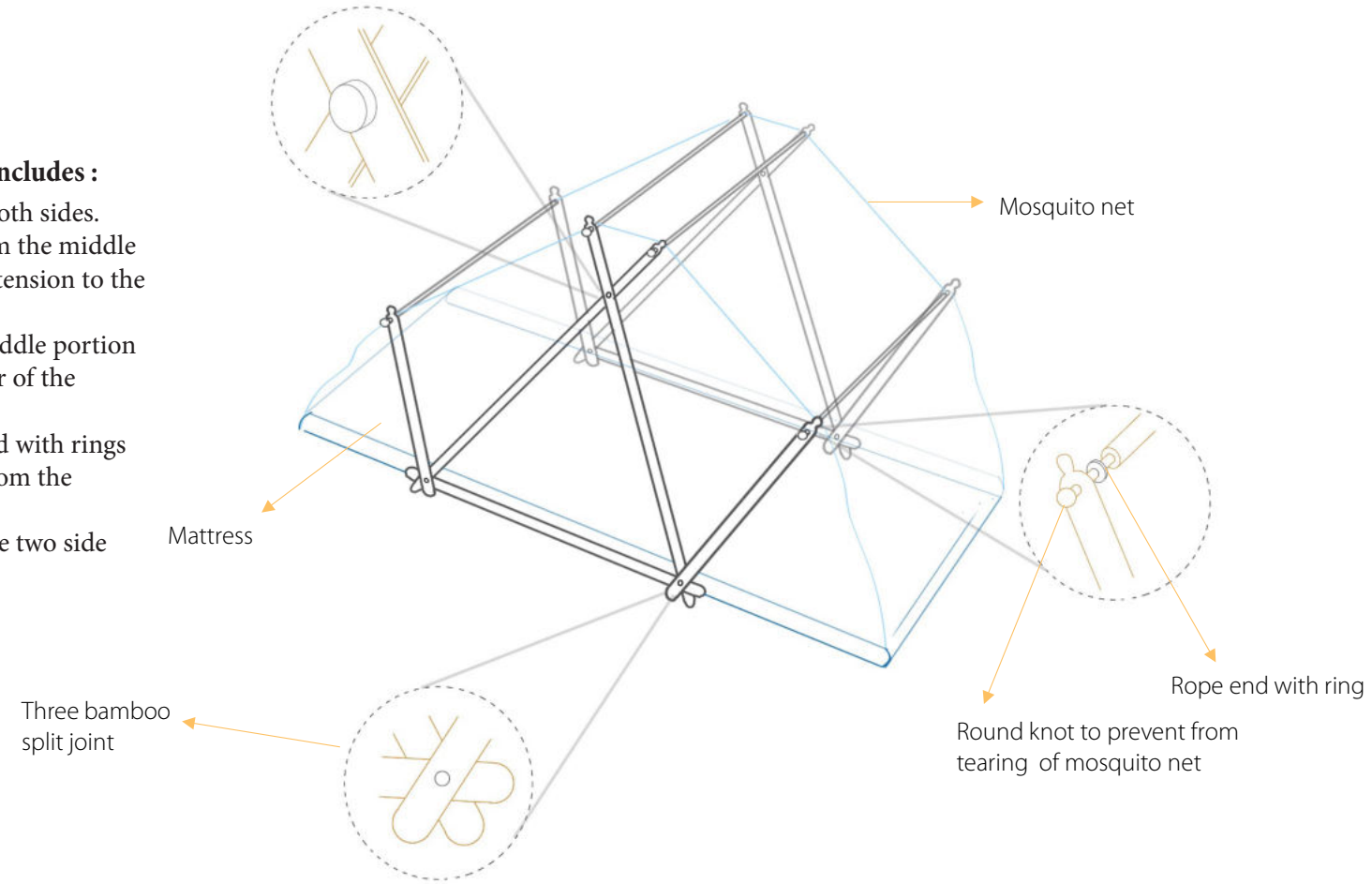
5) Gasket

- Metallic (copper, brass , aluminium and iron)
- Also rubber and silicon

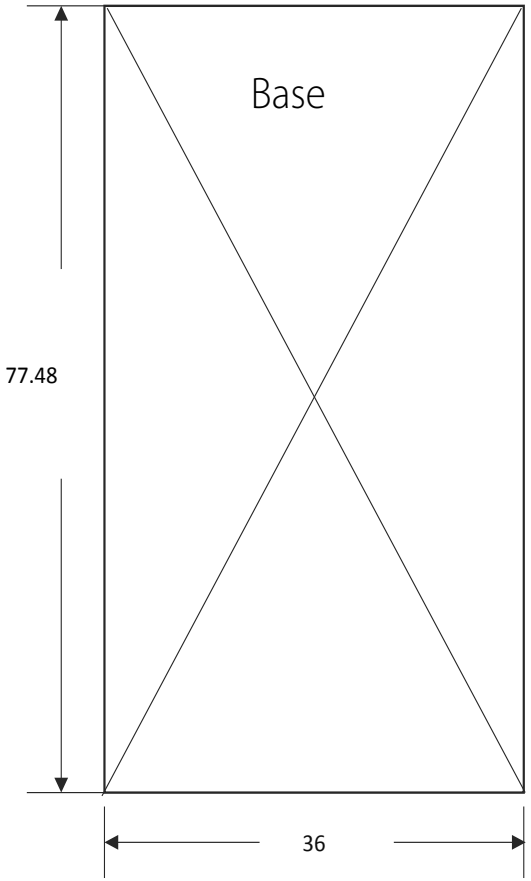
5.13 Final Concept

The final concept of the products includes :

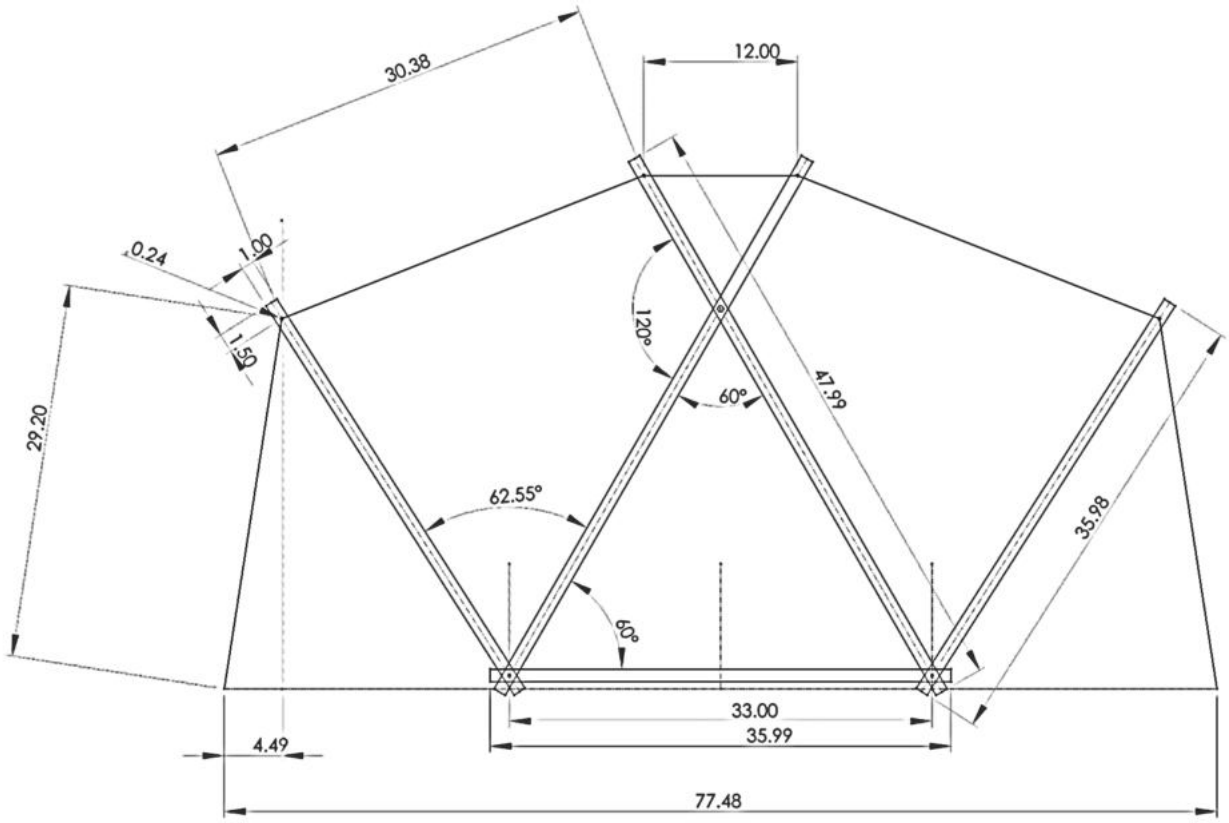
1 A structure which are lower on both sides.
2 Both the side frames are pull from the middle structure by the ropes creating a tension to the entire structure.
3 Two triangular frames in the middle portion which serves as the basic member of the structure
4 The end of the rope are connected with rings for maintaining equal distance from the middle portion.
5 Four top members connecting the two side triangular frames



5.14 Dimension Details



Single **bed**



5.15 Concept Prototyping

Prototyping :

The able to relate the condition in tribal areas , most of the prototyping was done using very simple techniques The local street tailors are intentionally chosen to translate how the customise mosquito net can be made for the frame. Also the possibilities of modifying the existing mosquito net are also discussed as the frame itself can be used with normal available net.

5.16 Final Prototype without Mosquito Net

Picture 3. Shows the full scale model before putting up the mosquito net

5.17 Final Prototype with Mosquito Net

Picture 4. Shows the full scale model after using the customised mosquito net

5.18 Features of the Product

Some of the significant features of this structure are :
The canopy is entirely constructed with very low cost and locally available materials like bamboo, cotton rope, nuts and bolts and rubber gaskets.

The form of the structure is arrived in such a way that it give maximum space inside the canopy (*in the middle portion*).

For easy ingress and egress a string pulley system is introduced which when pull the bottom ends will automatically opens up.

Normal mosquito net can be still used with minimum modification like stitching the boundary lining for protection from tearing the net.

When the frame is not in used , it can be still used for secondary purpose like drying clothes and hanging things.

The whole structure is a DIY structure with less part to assemble

5.19 User Testing and Feedbacks

Most of the people commented about the stability of the structure . For current concept, it sways side wise a little bit , this is due parallel connection of the side frame , it can be improve by stressing the string in cross fashion. Also once the mosquito net bottom is tuck inside the mattress and supported by it less chance of shaking the entire structure.
The structure could have folded further, but the limitation of using bamboo restricted me from putting lot of hinges .

The additional pulley system inside the structure is another parts which people appreciated about. When you pull the string inside the bottom ends of the frame open up . This make it more easier for the person inside to come out.
The structure can easily fit two person in sitting position .
Another value added part of the structure is it can still used normal mosquito net which are available in market with minimum changes .

When not in used it can be use for other purposes like hanging clothes and other things.
Some of the Shopkeeper shows keen interest in buying the product as they explains most of the time they have to sleep outside for guarding the shop.
Since the structure is made from bamboo and other cheaper materials it will of course cost less .Labour charge is something one have to paid only .

Some of the comments :

"It will be perfect for resort and hotels"
" ...should sells in FabIndia"
"... will aslo be perfect for camping "

5.20 Branding

KAVACH

The logo is derived from the side image of the structure , while the name “Kavach” is taken from the Hindi words meaning protection or shield.
Different concept of packaging are explored as shown in figure 7. While choosing the concept, it is keep in the mind that the package should be done in minimum cost but should be convenient and aesthetically pleasing to carry at home.

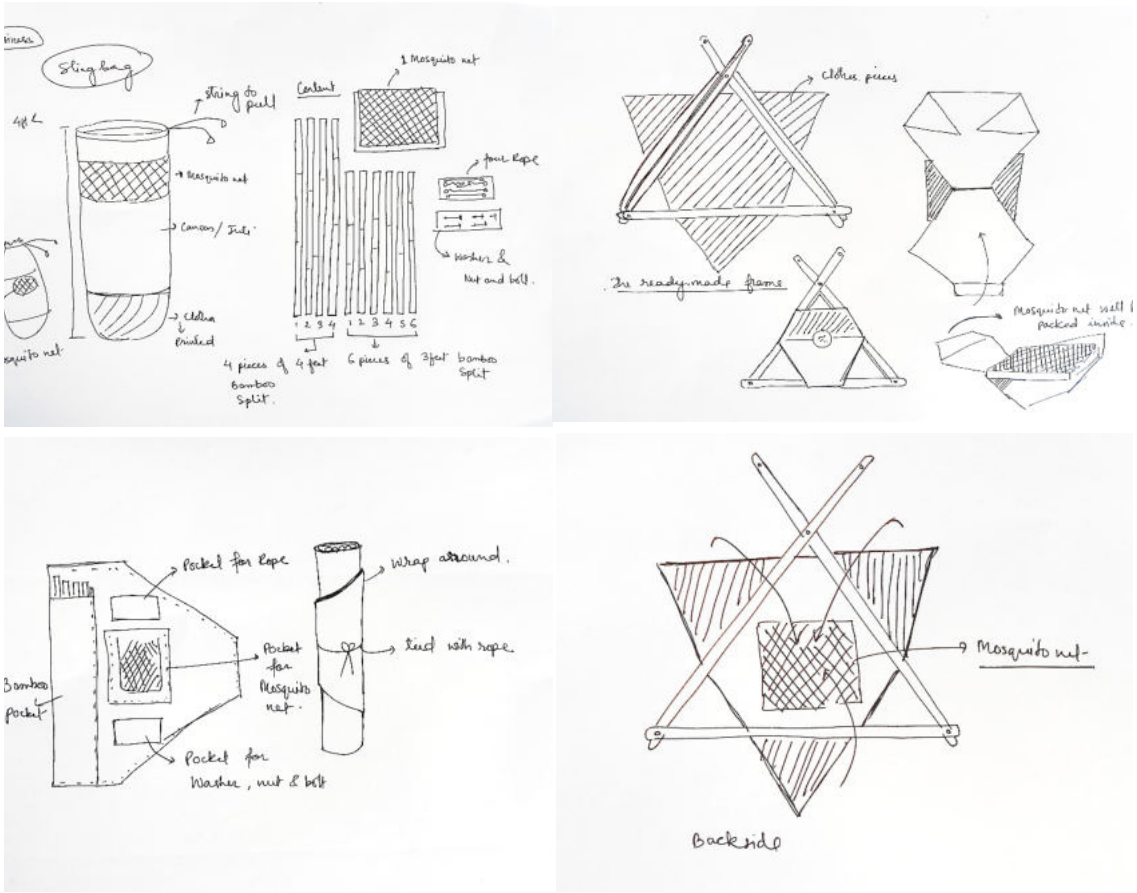


Figure 7. Different exploration of packaging

5.21 Packaging and Transportation

Figure 3. Different stage of packaging

Figure 3. Final Packaging concept

Figure 3. Carry the final product

The packaging can be done in two way either all the members are put in a bags and make them assemble from the beginning or the triangular frame is assemble first and included all the accessories as part of the packaging . While the former consumed lot of time latter is much more convenient in term of assembling at home

The different stage of packaging is shown in figure . The fully finished product look like the one which is shown in figure .
It can be easily carry by an adult , it comes with whole set of accessories like mosquito net, nuts and bolts, the bamboo members, strings .

5.22 Costing of the Product

Costing :

A rough estimation of the model comes around Rs. 610 for only the frame and Rs 1200 with mosquito net .
But this costing are made for single prototyping under limited time . So, in real scenario in will come under Rs.300 or 400 more may be less than that if one provide bamboo to the craftsman.
Also the price which are put up in figure will changes from places to places , In a region were bamboo is available abundantly, there you need to pay only for mosquito net and labour charge .

	Total costing						
Sl no.	Materials	Quantity	Price per unit	Total price			
1	bamboo	1 full (15-18ft)	120	120		materials of mosquito net	price per meter(Rs.)
2	Nuts and bolts	6	5	30		nylon	45
3	Washer	20	1	20		polyster	50
4	Mosquito net (ready made)	180	1	180		cotton	60
5	mosquito net (trailor charge)	300	1	300			
6	mosquito net clothes	8meter	35	280			
7	linning clothes	3 meter	20	60			
8	packaging clothes	1 meter	55	55			
9	colour						
10	tailorung charge			400			
11	labour charge	1 person	1 frame	250			
	total cost			1445			
	model cost with customized net						
sl .no	material	price					
1	bamboo	120					
2	mosquito net and clothes	340					
3	washer	20					
4	nuts and bolts	30					
5	packaging	80					
6	tailoring cahrge	400					
7	bamboo labour charge	200					
	total	1190					
	model cost without net						
sl .no	material	price					
1	bamboo	100					
2	mosquito net	180					
3	washer	20					
4	nuts and bolts	30					
5	packaging	80					
6	bamboo labour charge	200					
	total	610					

5.23 System Design

Community level

Until now the concept are made for single person used only, but a huge mosquito net structure can be also constructed just like that of foldable canopy tent (figure 8) . If this kind of structure is installed in public place like hospitals and ashrams that then the problem of not using the mosquito net will be reduced which mean the number of malarial cases can be reduced eventually .

Employment opportunity

The product development can be like a small cycle , bamboo can be grown by villagers . They can either sells this bamboo to craftsmen or local NGOs, the Local craftsman and NGOs can developed the product which will be sells to the villagers in a cheaper rate . Thus the cycle can continued . In the meantime, the local craftsmen also get job, the NGOs also get benefit by selling the product and the villager also get the product in much cheaper rate .Further the product can be send to different market which improve the total economy of the area.

Figure 8 Foldable canopy tent

Source. chennai.all.biz/designer-canopies-g155266#.V5h-X1V97Dc

Available resource

Bamboo grows much faster than any other trees and also they are abundantly available in tribal areas, so this could be stepping stone for them to re-look the available material for better life. The can opens if the possibility to look for different product in the area

5.24 Conclusion

Even though the project can't cover all the issues which rises up during the user study, at its best, it try to address the most common issues of hanging the mosquito net for people who doesn't have bed.

The user testing and feedback session was quite fruitful as it give the chance to critical study the real issues with the current concept. For now the mosquito net is folded randomly but it should be properly fold while closing the structure , one major issue which need to keep in mind.
For the current concept , the structure is built for single person but it can be also look for two or more persons, another area which need to work out

Lastly, even though the project lack user testing in tribal area due to time limitation, this project will always remain an entry point in fighting against the malaria in tribal settlement .

5.25 Future Scope

In the current concept, the structure is built for only single person used. This can be further extends for two and more person, which will be helpful for places like ashrams, hospital and community centre

Another aspect of the project could be to look upon the concept of integrating with the existing bed, as many of them have already have bed at their home.

For different target audience, one could have explore more concept with different materials like that of metallic wire ,wood, rubber or even fibre .

There is always further scope for designing mosquito net structure for different area and places , like for example local street shops, as many of the shopkeeper sleeps outside their shop. They prefer to have a foldable mosquito net structure which can be only used at night time. One could be for homeless person and another for refugees camp and disaster relief camp.

The concept can be even extended for places like resorts and hotels as everyone prefer to have mosquito net to protect themselves from malaria or other insects. There is also a large possibility in the area of travelling and camping

Lastly the project got lot of potential in terms of eliminating the malaria from rural areas, also to provide small business for craftsmen or skilled person in the locality.

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