Case-IV: Designing a brick carrying device for improving ergonomics and efficiency of labourers at construction sites

(I) Introduction

The problem taken up by this team is important as it involves a lot of pain and drudgery for people especially women who have to carry the load on their head. Hence it is important to understand the bio-mechanical aspect of this.\(^1\) The construction industry in India is the second largest economic activity after agriculture. Safety consciousness is yet to percolate to these construction sites where majority of the workers work under hazardous conditions. There are many small contractors and firms who are oblivious of this condition and hence the practice of carrying bricks on head continues since ages.\(^2\)

The idea thus focuses on developing a device to improve the safety of carrying bricks by focusing on ergonomics.

Carrying bricks on head is the most common practice adopted by the labourers at construction sites in India and the other developing countries. Most of these labourers are women especially in India. Carrying bricks/load on head might cause injuries in brain and neck, pain in muscles and other spinal problems. Bricks on back using a rope, on shoulders using wooden plank, etc. are few others ways of doing the task of transporting bricks on construction sites. However, these solutions may not be safe and comfortable, though they increase the efficiency. Wheel barrows and pulleys are also used at large construction sites but at small scale the brick carrying is done by labourers. There are many prototypes/devices are available which are not in use or well accepted by the labourers. The main reason behind this could be no interest of contractors and other stakeholders due to the cost, efficiency and durability of previous solutions. The other reason could be the labourers did not find these devices useful and comfortable.

Source: Summary of project; Nikhil Gehlot, Krunal Dave, Vishal Chitara

They had a few conversations with people regarding the problem and the need to design a device for carrying bricks. One of the team members, Nikhil had already worked on a solution for carrying bricks. The problem take up was also because he had the idea in mind. However the device designed had a lot of drawbacks, most important being that it wasn’t suitable for female workers. So he was asked to rethink again as the summer school is the best opportunity. Even though the team worked hard, but the initial design was stuck in their mind. This is something to ponder over. How to get more deas and think

\(^1\) Professor P V M Rao: The problem is related to bio-mechanical. Define the need- whether to improve the efficiency or ergonomic aspect. Find the existing methods of safety and existing solutions.

\(^2\) Capacity Building for the Promotion of Labour Rights for Vulnerable Groups of Workers, The Ambedkar Institute for Labor Studies, Mumbai
different from the original design in mind? Feedback from mentor at this stage was important to make them think in a different direction before jumping on to the solution.³

**Conversation with Contractors/Builders/Engineers**

While interacting with contractors, builders and engineers, we got similar response. They all complained about the carelessness of workers for wearing safety equipments while carrying bricks. When asked, “Are you concerned about the safety of workers?” They said they provide safety equipments like helmets, gloves, belts, glasses, etc. But labourers don not use them. “They use them only when we are monitoring”. They also don’t prefer any carrying devices given to them. Changing their behaviour and approach is quite difficult. We cannot force, else we will have no labour to work”.

**Conversation with women workers**

We asked the women workers “whether they would use a device for brick carrying?” They replied “hum garib log hai, kaise layenge aisa device. Then we asked them if we give you this device for free, will you use that?
They then said “we are quite habituated with the way we carry bricks. It will be difficult for us to use this device. Also we do multiple jobs and hence it will be waste when we are not using that.”

*Source: problem definition presentation; Nikhil Gehlot, Krunal Dave, Vishal Chitara*

(II) Understanding the need to design: Why, what, who and how?

Before starting the process of ideation, the team was asked to understand the whole process so that they can get important insights of the design process.

³ Prof P V M Rao: Try to analyse the reasons for which they can reject it. Try to design the product that is satisfactory for the contractors too. Solutions can be in two forms- designing a device or educating the people. Talk to ‘occupational therapist’, an important stakeholder. Do prior search before designing. Review information.
The team reviewed the existing solution that was made in the 2013 summer school. They even tried to use the device to get a feel of how the new solution can accommodate the limitations in this design. An important missing was the involvement of workers at this stage. They could have given the already existing device for use and taken specific feedback for improvements. Reviewing the existing solutions is important to understand the need to design. It was pointed out very clearly by Katherine Johnson⁴ that “it is not important to design new solutions every time; one can work on the existing ones and improve upon them”.

Prof Aguinaldo gave his real life example of carrying bricks and working in construction sites. He said the team should think of a ‘leapfrog’ solution for the problem. He emphasized the use of wheel barrows to make the construction site for people more organized rather than keeping it messy and unsafe for the workers carrying load on head. He gave examples of wheelbarrow for use in brick carrying (see below). He concluded by saying “consider leapfrog to achieve a higher level of innovation⁵”.

⁴ I have found a bookchapter on “Construction in industrially developing countries”; it may offer some further insights to your project.
⁵ I have to confess that, having transported bricks myself when I was younger, I have a high level of prejudice for manual transport of bricks, which does not uses wheels. People doing such tasks often have back problems late in their life that hinders their prospect of have a better life when comes the later stages of their life. It results of reduce productivity, which affects directly their income. We did assess the effect of such transportation on their first vertebra (first bone on the spine from bottom to top). 50 kg of transportation implies double of the maximum capacity of that vertebra!
Proof of concept

Even though a lot of feedback was given on the ergonomics and alternate solutions for brick transportation, the team focussed on their initial idea of having a load carrying device with straps. They made a sketch and described the idea of making this prototype. At this stage, the team lost the track of feedback and the need to design and focused solely on the idea they had in their mind.

As we identify the problem of brick carrying, we analyse the previous solution. The traditional activity of the labourers is the most common. So we thought to provide the solution nearby their practice. We have to transfer the load from head to shoulder.

The idea designed is based on the concept of the equilibrium load transformation on the shoulder and hand supported. The nylon straps are provided on the frame which is used to hold the frame on the shoulder.

In the construction sites there is no lift-pulley/wheel-barrow facilities available we need labourer help to moving bricks and for that make a device can help them to carry load easily.

Since we have gone to various sites at Chandkheda, Navrangpura, GIFT City, IET, GTU and KCG Gujarat University etc, we observed the way they carry the load including loading and unloading of bricks. From then to load the bricks are two ways:

1. When the bricks are height of labourers, they use to put the bricks with their hands maintaining the centre of gravity.
2. When labourers are not at that height, in that case a second labourer is there to help in loading the bricks.

**UNLOADING**

Most of the labourers do the unloading by just throwing the bundle of bricks at an angle that the bricks didn’t get broken. It is sometimes harmful and also not safer method, and also its cost much if we keep one more labourer for unloading and loading.

**PROOF OF CONCEPT**

When we observe the activity we realise that to put the load on the shoulder so we have to create a design which easily transform the load and maintaining the equilibrium. So we adopted the concept of equilibrium and designed a frame based device.

*Source: Proof of concept report; Nikhil Gehlot, Krunal Dave, Vishal Chitara*

**(IV) Prototyping and feedback from users/mentors**

The team designed a device as described in their proof of concept stage. They got it made with the help of a local fabricator and went to test it in the field to get user feedback.

They got feedback from labourers and also demonstrated the use of the device. The important thing missed in the feedback is the use of device by women since 51% of the workers carrying bricks on their heads are women. Thus uniform design of solutions will not work and it is important to have perspective of all the stakeholders.
<table>
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<th>Function &amp; reviews</th>
<th>User 1</th>
<th>User 2</th>
<th>User 3</th>
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<td>8-12</td>
<td>12-14</td>
<td>8-10</td>
<td>10-12</td>
<td>10-12</td>
<td>10-12</td>
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<tr>
<td>Age</td>
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<td>17</td>
<td>22</td>
<td>18</td>
<td>19</td>
<td>20</td>
</tr>
<tr>
<td>User reviews</td>
<td>Little unsatisfied</td>
<td>Satisfied and suggest reducing size of frame.</td>
<td>Problem while loading unloading of bricks, Balancing problem.</td>
<td>Easy to transport and comfortable.</td>
<td>Need some size reduction in frame diameter.</td>
<td>Make it light weight if as possible, otherwise</td>
<td>Balancing problem, Size reduce Ease of carrying</td>
</tr>
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</table>

There was also important feedback given on the prototype by different professors. Prof M P Ranjan said to reduce the frame size for better balancing, resolve the stripping of strap problem, and even think of alternative materials like, plastic. Prof Rao said that you can relook into the entire process of design again and think if the device can be redesigned taking the feedback from all into consideration. Prof Kate said to look at the loading and unloading part of the device.6

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6 Professor M P Ranjan” How many bricks can the frame carry?” he advised to explore the safety aspects as the two protruding spokes are dangerous. He asked, “Is it possible to fold this device?” He also asked to explore the
(V) Redesigning the device based on feedback
The team realised the need to redesign their idea based on the feedback from users and mentors and once again went to the workers to get some more insights before redesigning. Just on the last day of the exhibition and presentations, they were able to make a second improved version which was much easier to carry bricks as compared to their first design. This emphasizes the need to test and iterate the ideas and get feedback at every stage.

idea of making the frame using cycle rim or use rolling shutter material for frame. He advised, “See the available technology resource. Think widely and broadly.”

Professor P V M Rao: His concern was that lot of free space was needed to move the frame. He suggested them that they can even use large diameter hollow tube and the handle can also be made convenient to use. He even commented that, “You can completely redesign if you want.”

Prof Katherine: Your device looks like it would be hard to load first and then “wear”?

7 Prof Sanjay E Sarma: Follow the cycle of ethnography, cycle of tests and solutions through multiple experiments
In the end the team managed to make two prototypes. However a lot of work needs to be done in terms of the material and costing. The important learning from this project was the importance of getting user context at the ideation stage and keeping the ideas open. Getting feedback at every stage and testing with users is the most critical part of design process.