

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly Peer Reviewed Journal)

Vol. 5, Issue 2, February 2016

Assistive Aid for Women Workers Carrying Load on Their Head: A Case Study

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ABSTRACT: An exercise of developing affordable and acceptable technological solution for reducing drudgery of women workers involved in transportation of load on their head is carried out. The issues associated with non acceptance of available solutions were discussed with women workers. Technological solutions based on their requirements were developed and their feedback was recorded. The final aid, preferred by most of the women workers comprises of perpendicular cross bars of cane mounted on commonly used *indoli*. The study also revealed the need of active involvement of stakeholders whenever such exercise of design and development are carried out.

KEYWORDS: Head load, drudgery, assistive aid, Biomechanical; carrying load

I. INTRODUCTION

In most developing countries, rural women's triple responsibilities of farm work, household chores and earning cash to supplement family incomes are well documented by World Bank [1]. The amount of time spent on each of these tasks and the way in which they are carried out, varies from region to region and from country to country as well as within countries. Studies of Joshi and Veerkumar[2] have shown that the Indian women work upto 14 hours a day to carry out the most arduous activities on farm and at home. Many times they have to carry heavy load on their head for a long distance. Research has indicated the ill effects of carrying load on the head. Study of Jager et al.[3] revealed exacerbates degenerative change in the cervical spine due to axial strain of load-carrying on the head. Joosab et al.[4] also studied the effect of load-carrying to the structural integrity of cervical spine in rural Zimbabwe. Results indicated that age led to significant degeneration of the fifth intervertebral disc space as well as significant straightening of the lordotic curve. Load carrying seems to accentuate the straightening of the curve. The results also suggest that head loading creates a shift in the degeneration from the fifth intervertebral disc space to higher levels. Carrying heavy loads on the head alters the pattern of degenerative changes of the cervical spine. Echarri[5] did research on 'Influence of the type of load on the cervical spine of African head bearers' by analyzing clinical changes and radiographic degenerative signs in comparison with a control group. He observed that load bearing on the head, particularly bearers of heavy loads, produced more radiographic degenerative signs, much stiffness in the neck and more reported pain than the control group. Research of Gheere et al. [6] has also revealed ill effects of carrying domestic water in South Africa by women and children on their head. The prevalence of spinal pain was 69% and back pain was 38% among respondents. Pandey[7] evaluated effect of carrying fuel wood on posture through evaluation of cranio-vertebral, cranio-horizontal and sagittal shoulder postures angles. The study resulted that carrying fuel wood had a significant effect on the postures in comparison to standard. The effect in the posture may be of permanent in nature. These changes may

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lead to craniofacial pain, headache, neck-ache and shoulder pain, muscle stiffness and tenderness however clinical validation is essential before subjecting to some regulations.

The above mentioned research shows ill effect on spine and head due to carrying load on head; hence one can think to use different modes like carrying load on shoulder. However the findings of Sharma and Singh[8] don't support this concept. Their research indicated that carrying load (water in their research) is safe only for head mode. Carrying load on shoulder and waist may result injuries. By considering the stresses such as cardiovascular, muscular and biomechanical and also by psycho-physiological evaluation they concluded that carrying load for the head mode should be around 15 kg and for shoulder and waist mode should not be more than 10 kg at the walking speed of 3.5 kmph.

However, these suggested load limits are generally not possible to be followed by people engaged in the job of carrying different loads (eg. luggage, construction material, farm produces, etc). Hence, efforts are required to be made to reduce the drudgery by providing some assistive devices so that load is not hold on the head directly.

In consultation with Ahmedabad Cloth Markets & Shops Labour Board, Labour & Employment Department, Govt of Gujarat; Team of National Innovation Foundation-India (NIF) has surveyed different methods adopted by workers engaged in lifting load on their shoulder or head and travelling for a distance in narrow streets and climb the stairs up with the load. The paper reveals the approach for developing an assistive device for reducing drudgery in laborers, especially women laborers involved in transportation of load on their head.

II. MATERIAL AND METHOD

Survey of workers in cloth market, Ahmedabad

The survey was done in the cloth market, Ahmedabad. It reveals that both male and female workers of age group (20 to 65 years) are involved in the job. The male workers prefer to lift the load on their shoulders while female workers prefer to carry on their head (Fig 1 & 2). They carry weight ranging from 20 to 100 kg in the 5 to 100 m wide lane and 2 to 15 m vertically in congested market and through narrow staircases.



Fig.1

shoulder



Fig. 2 : Female worker carrying load on her head

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Personal interviews of ten women workers (randomly selected) of above said age group (Average 39.7 Years with standard variation of 10.58) were conducted to understand the physical, social, cultural and economic problems. They have average income Rs 250 per day (Standard variation 20.41). Most of them take pain killers atleast 2-3 times a week to overcome stress related to load. They have reported headache, neck muscle strain, problems of visibility and head movement issue as serious welfare risks while carrying load over their head.

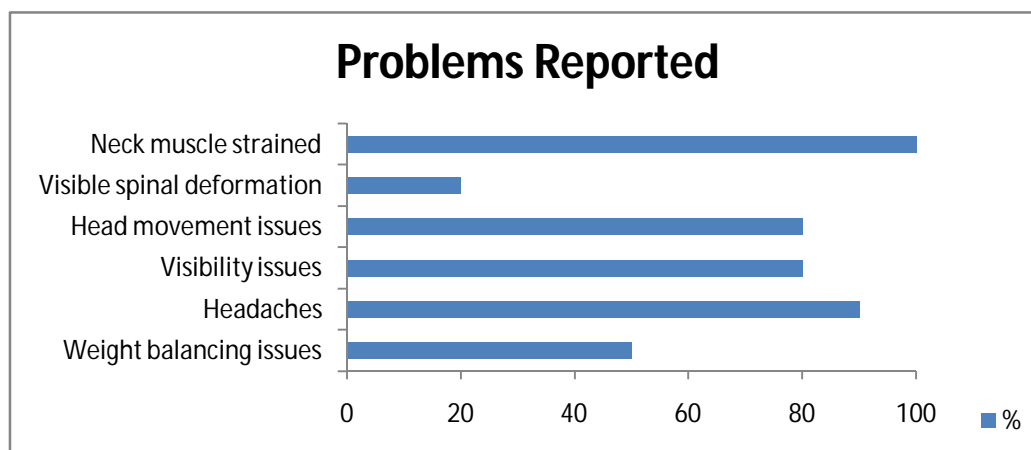


Fig.5 : Problems reported by women workers

Load survey : Dimensions of few extremities of sacks of cloths were taken to get an approximate value of the dimensions of load. This will help to design the device based on the available surface area.

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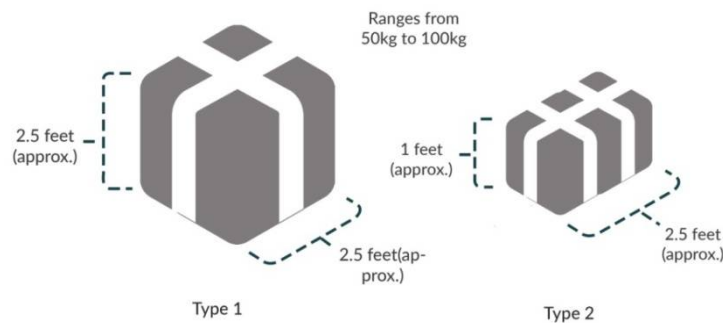


Fig.6 : Details of load

Issues regarding loading- unloading: Along with other problems loading and unloading is also a major issue, additional person other than one who is going to lift the weight, is required to help while loading /unloading on/from his/her head. Bending along with free movement of head and torso is also required.

Study of the technologies for reducing drudgery

Technologies available in art and market for reducing head load drudgery were studied and discussed with stakeholders.

Panihari developed by grassroots innovator Khimjibhai Kanadiya [9] has two extended supporting rod from circular disk that is put on the head to keep the vessel. Any women can place these two supporting rods on her shoulder, which in turn raises the circular disc just above her head. It costs Rs 350/-.

Load Carrier for Labor developed by VikramPanchal[10], is a simple, durable, light weight and cost effective carrier is intended to reduce the pressure put on the spine when load is carried on the head. There is also a good hand grip which reduces stress on the spine when load is carried on the back or while pushing a cart. Ergonomically the load is distributed on the shoulder and at the lumbar support by softer material. It can take load upto 50 kg and costs Rs. 500.



Fig. 7 : Panihari, a load reducing device developed by Khimjibhai Kanadia



Fig. 8: Load carrier developed by VikramPanchal

Relief for labourer women developed by A Priya[11] is quite similar to solution developed by Mr Panchal. It can be used to carry a load of 20- 30 kg per trip at one time and costs Rs. 700.

Vajra developed by Raghunath Lohar [12] is a vessel desk like device which distributes load of a worker from his head to shoulders with the help of a vertical support assembly. Its lower part is fitted to the body with the help of flexible belts and the upper part can be fitted and removed as per requirement. It reduces cumulative trauma like headache,

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backache and other body strains. There is no need to balance the objects. It can take weight upto 75 kg and costs Rs. 700/-.



Fig. 9: Load carrier developed by A Priya



Fig. 10: Load carrier 'Vajra' developed by R Lohar

Feedback of stakeholders on existing products: When discussed about the above mentioned technologies, most of them felt that the load carrying capacity of these solutions is not adequate. None of the above devices can take weight upto 100 kg, which is sometimes required. Also female workers find it uncomfortable to walk around with something bulky and almost covering their torso. Cost is also an important factor because of which these products were not readily accepted by these workers. Since they earn Rs. 5 for each round, it becomes difficult for them to afford anything costing more than Rs. 200.

As the available solutions were developed considering different applications. Generally the technological development and transfer programmes are carried out on the assumption that these technologies are either gender neutral and sometimes men are considered the main users and decision makers. This is often incorrect because women have quite different technological needs than men due to their different ergonomic characteristics, skills and gender related factors.

Design considerations: In consultation with stakeholders following criteria were decided before starting the ideation for developing effective affordable solution.

It should be light in weight, easy to manufacture, affordable in cost (preferably less than Rs 200), facilitate better visibility and free movement of hands while carrying load, improve load distribution uniformly across the head with possibilities of load transfer to shoulders, etc.

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Design thinking: Ideation



Fig. 11: Design thinking, 'ideation'

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Development of prototypes:Based on the ideation to solve the problem, three prototypes were developed.

Prototype 1:Considering that the concept of wearing helmet by workers is already in practice, atleast at construction site, helmet was modified by welding a disc on it.

Prototype 2:Inspired from the existing technologies to reduce the head load drudgery (as found in prior art and market survey), another prototype is developed with adequate cushion pads at head and shoulders. Different materials were explored for making the prototype. Carbon fibre was found to be the best suitable material for the application, as it has high tensile strength. However, the manufacturing process was found to be tedious job. Considering Manufacturability, Tensile strength, Load carrying capacity and Weight into mind, Bamboo and cane were found to be most suitable materials. This is due to nature of bamboo as it doesn't have rays or knots. This characteristic of material allows it to withstand more stress throughout the length of each stalk. Bamboo's sectional anatomy, both as cane and on a microscopic fiber level, enhances its structural integrity. High silica content in bamboo fibers means the material cannot be digested by termites. It has higher tensile strengths than many alloys of steel. Alade et al.[13]reported The average tensile strength for Ridang cane of bamboo family was found to be between 204 N/mm² and 250 N/mm² [Obilade and Olutoge, 14]. Hence, it was preferred for developing the prototype.

Prototype 3: Considering that the workers would prefer taking load on head, not on shoulder, another prototype of cross platform of bamboo was also developed. At the centre of the platform, a conventional *indoli* was tied, which was in direct contact with head and also provide cushioning support.



Fig. 12: Prototype 1



Fig. 14: Prototype 3

III. RESULTS AND DISCUSSION

All the three prototypes were given to women workers involved in study to use for few days and their feedback was recorded.

It was observed that prototype one was strong enough to take the weight, looks like a helmet hence seems easy to accept and do not have problem in visibility; however, users felt it bulky. It was also observed that keeping load on the metallic surface resulted in tendency to slip.

In case of the second prototype weight appeared to be distributed to the shoulders and design and development was opined to be simple but movement of head was restricted. Different persons have different height; hence space between head and shoulder cannot be same. Therefore the need of customized device in this design was felt. Also the workers reported lack of comfort due to bulkiness.

The design of third prototype got advantage of human psychology due to use of conventional *indoli*. It allowed free movement of neck and also acted like a handle. In this prototype, load was found to be distributed across the head and also through hand supports. The issue of visibility was also solved. However, weight remained on the head and did not distribute on the shoulder, which was initially thought, in order to reduce the drudgery.

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Overall the third prototype was preferred by the workers. The feedback of users is presented here.

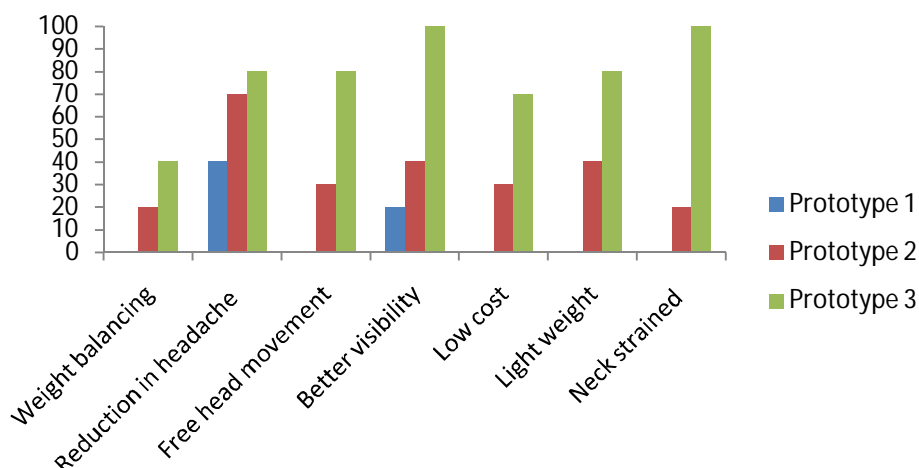


Fig. 15: Feedback of stakeholders

IV. FURTHER IMPROVEMENT IN THE REFERED PROTOTYPE

After getting the feedback on the three prototypes following improvements were made in the preferred(third) prototype.

- 1) The two wings of the third prototype were made perpendicular to each other to increase the surface area and provide visibility in all directions.
- 2) A soft padding of foam and cloth was provided on the 'Indoli' so that it does not hurt the person using the device.

The feedback of stakeholders viz., workers, traders and government officials at regular interval during design thinking, prototyping and trials of different concepts have been a positive factor. During the course of trials, change of behaviour of labours who were opposing such interventions at the start of this research was observed. At later stage, those workers were found interested in borrowing such product. The desire was felt to buy among workers after keenly observing other workers using the devices given during the trial. The traders were also found interested in promotion of such device after observing reduction in damage of parcels because of holding them on a flat platform.

Fig. 16: Prototype

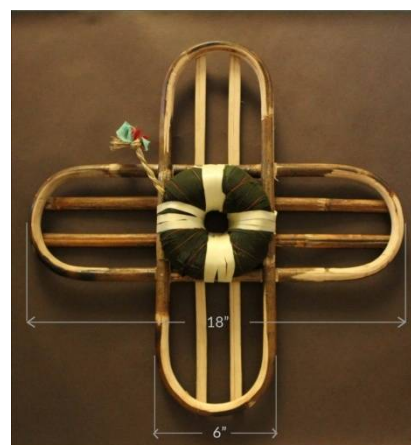


Fig. 17: Final prototype

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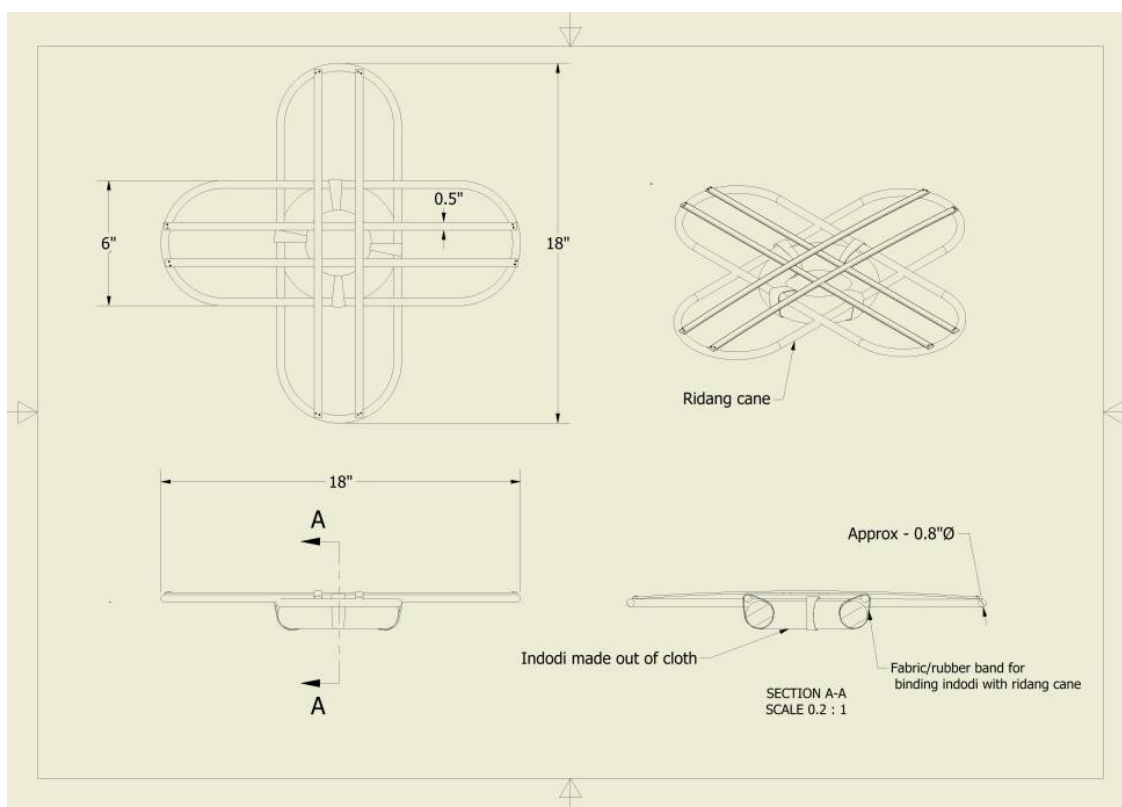


Fig. 18: Engineering drawings of Final prototype

V. CONCLUSION

The research has yielded a technology developed considering social, gender and cultural issues of women workers involved in carrying load on their head. After trials of few ideas, the final device is based on traditional INDOLI which is used by most of women while carrying load. The device was found to reduce drudgery of workers including women. The study would also inspire technology developers for active involvement of stake holders, irrespective of their education and professional hierarchy. Technologies developed without considering their appropriate feedback have poor level of acceptance.

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