

Rural Water Fetching Aid's Ergonomics Design and Evaluation Using a Digital Human Modeling Approach

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ABSTRACT

Water fetching is a day-to-day routine work in the rural parts of India. Generally, rural women are more engaged in water fetching activities. By curtailing the postural stress that rural women experience, this study aims to produce an efficient and durable water fetching aid. Based on the findings, it was clear that rural women's postural loads during water collection were quite significant. In this analysis, BSA analysis and RULA ergonomic method was used to examine postural loads, stresses, forces at joint and moment. New design was proposed to resolve the established posture load, stress and moment which may have been cause of development of recorded WRMSD (Work related musculoskeletal disorder). The latest concept has been tested for RULA (Rapid upper limb analysis) scores and BSA (Biomechanical single action analysis) analysis using automated human computer model in CATIA V5 software. The evaluation of new design shows RULA score, stresses, reaction and moments are low at some modification. The outcome of new design meets ergonomic implications and water fetcher's requirements.

Keywords- Fetching; water fetching aid; DHM, RULA.

I. INTRODUCTION

In rural areas, where there is a greater problem of water scarcity, water extraction activities are more common. It is estimated that over 20 crore people lack access to direct and safe drinking water. In order to get water, rural Indian women must walk three to five kilometres, and during the summer, this distance increases significantly [1]. Woman bring around 50 liters of water, and she takes her child with her several times as she picks up water [1-3]. Tanks crammed with water are transported. During hindering, people from the solapur and latur districts participate in the study of the health

assessment. During summer, the catching of water becomes very difficult for people to assemble at the source of water to attend in line and to fetch the water. one. Women in rural India must walk 2-3 kilometres to get water, which can be much longer during the summer. The typical method of holding water on the pinnacle is one, two, or three 15-20 litre pots, as shown in Fig.1. The most usual period spent gathering water is around 40 minutes in Jharkhand, 33 minutes in Bihar, and 30 minutes in Rajasthan.

A woman brings about 50 liters of drinking water for her family every day. It is clear from figure 1 that the methodology of water processing is completely

traditional and conventional. These modern methods for the storage of water have stayed virtually unchanged as well. As an outcome, the majority of rural women neglect the mechanism of the ergonomic enhancement system. This study helps to describe how the Virtual Digital Human Modeling (DHM) approach is adapted to emphasis on the ergonomic, user-centric model elements of the new water fetching aid. In this study, the ergonomic aspects of the comfort analysis are considered. The user requirement is considered in this study from the point of view of water fetchers. This research also focuses on the redesign of water recovery aid with a view to reducing musculoskeletal pain that could improve the water fetching capacity.

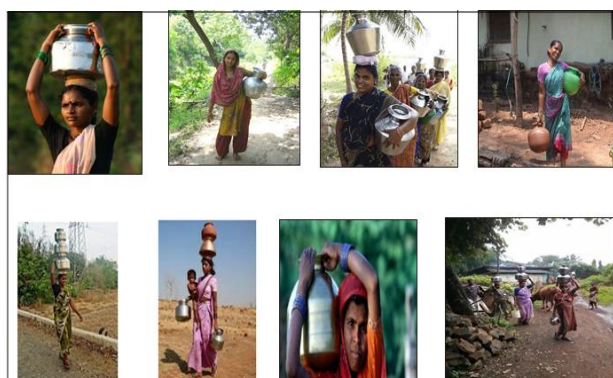


Figure 1: Awkward posture of women while water fetching activities

II. METHODOLOGY

The In the Solapur district and sangli district of the state Maharashtra in India, survey on field was conducted about to check work-related water fetching activities in rural areas. There are places of Mangalwedha, Latur, Jath, Kavathemahankal, Barshi taluka that were considered for field research. The whole report, particularly for female operations, was emphasized on water fetching activities. The entire report, particularly for female operations, was emphasized on water activities. This study included the participation of female water fetchers from the Solapur, Sangli and Latur district.

- (1) Complete study of the activities of water Fetching.
- (2) Identification of different issues with the musculoskeletal disorders (MSDs) in different water collecting activities.
- (3) Designing the development of water fetching aid.
- (4) Virtual DHM simulation for ergonomic assessment new water fetching aid.

New water fetching aid (for water collection activities) was linked to Digital Human Models (DHM) to allow for fast evaluation of the upper limbs (RULA). Figure 2, shows water fetching is depends on the different parameter. Water carrying is depends on mode of water fetching, water carrying container and the analogies used for the water fetching. Before progressing in the study topic, a short survey and questionnaire was prepared, as shown in table 1.

Table 1 Questionnaire and Survey response

Q. No.	Question	Response Options	Greater than 85%
1	What is your age group?	Below 18 / 18–30 / 31–45 / 46–60 / Above 60	18-30
2	What is your primary method of fetching water?	Head carrying / Hand carrying / Supported (stick/rope) / Device (specify)	Head carrying
3	How far do you typically travel to fetch water?	<1 km / 1–3 km / 3–5 km / >5 km	3-5 km
4	How much water do you usually carry per trip?	<20 L / 20–40 L / 40–60 L / >60 L	<20 L
5	How much time do you spend daily on water fetching?	<30 min / 30–60 min / 1–2 hrs / >2 hrs	30-60 min
6	Do you experience any physical discomfort while fetching water?	Yes / No (If yes: Neck / Shoulders / Back / Arms / Legs)	Yes/ Shoulders
7	How frequently do you experience pain due to water fetching?	Rarely / Sometimes / Often / Always	Sometimes
8	What challenges do you face during water fetching?	Distance / Heavy load / Poor terrain / Waiting time / Lack of equipment	Distance/Poor terrain
9	Have you used any water fetching device?	Yes / No (If yes: Rate – Poor / Average / Good / Excellent)	No
10	What features would you prefer in a new device?	Easy to use / Low cost / Durable / Suitable for rough terrain less effort / Child-friend	Durable+ Suitable for rough terrain

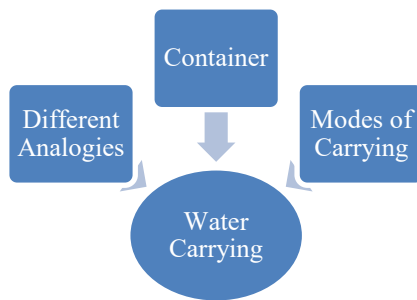


Figure 2: Dependable parameter of water fetching activities

III. RESULTS

3.1. Current Scenario of water fetching during Field Visit

The primary goal of the study was to identify the existing state of water fetching, the effort taken by rural women during drought in water catchment, the extent of action, the equipment and tools used etc. The entire study was focused on numerous unplanned interviews with water fetchers from rural areas covering all the above detail. During field visit, all water fetching tasks were found to be manual. Rural water fetching was emphasized throughout the report, especially deadly efforts by rural women. Participated during this study were female water fetchers from solapur and sangli district (from different villages). Data was obtained from water for 57 female participants. All 57 water fetchers participated in field survey with signed consent, after knowing the research objective. During this field survey, videographer and photography techniques were accustomed to examining water-fetching operations of various people. Table 2 presents demographic details of the 57 female workers. The age of the ladies water fetchers was between 12 to 65 years (mean = 43.15 years; SD = ± 12 , the typical water fetcher weight and height were 161.2 ± 4.8 cm, respectively, and 57.2 ± 10.4 kg. the bulk of rural water fetchers were married (92.5%) and water fetchers level of education was secondary (7.5%), primary (27.5%) and an alphabet (65%). The feminine water fetcher was asked for various views / suggestions on creating new water fetching aid. The female water fetcher was asked for various views suggestions on creating new water help.

Table 2: Demographic details of female water fetcher from rural area (n=57)

Study Variables	Values
Age(Years)	43.15
Mean (SD)	12.62
Range	12-65
Mean (SD)	57.2(9.98)
Range	23-80
Mean (SD)	161.2 (11.77)
Married	92.5
Single	7.5

Illiterate	65
Primary school	27.5
Secondary school	7.5

3.2 Background of water fetching activities in Solapur and Sangli district

As already mentioned, maximum female were involved in the water fetching process. Figure 3 and figure 4 shows the risky efforts made by rural women from the well; the people are gathered at the source of water and waiting in line for the water to be collected. Small children, too, get water from a long distance [9]. The water situation gets really poor during the summer season, so that people get water from the tanker. Because of the question of water shortage shows the government took the decision to supply water to the village by tanker. At the tanker, all people are gathered and then the water is transferred through the process. Most of time water fetchers use traditional method (conventional methods) of fetching water. More than 20 years of experienced water fetchers are considered a skillful water fetcher and can deliver high. Suggestion of such an experienced taken into account for making the water fetching new device. Such a suggestion from the experienced are become helpful for the developing the water fetching new device.



Figure 3: Current scenarios of water fetching and efforts taken by rural women for water



Figure 4: Water collection people gathered at water source

3.3 MSD problem reported in water fetching activities

MSD problems are observed using the qualitative Nordic questionnaire and also the RULA score of 57 rural water fetchers was calculated during activities. The research found that during the last 12 months 80 percent of water fetchers confirmed cases of MSD. Particularly within the neck, hand, leg, and upper back, lower back pain was felt within the regions of the

feminine body. The "A" and "B" RULA posture levels were found to be 7 and 8 respectively. It was found that the grand score of the water fetching awkward pose was 7, and also the level of action suggested on investigating and introducing improvement. In separate handcrafted footwear systems, researchers also examined different body regions such as the lower and upper back, arm, and shoulder pain recorded during activity [5, 6]. From a family 5-45 pairs are working in a footwear manufacturing with a high repetition produces high pain [3, 4]. Different factors, such as long working hours, uncomfortable postures and monotonous activities, working with traditional hand devices, continuous work and telephone pressure can lead to high risk of MSD [2, 7]. From the sphere study and water fetcher involvement, it had been told that there is no equipment or device reduces the force exertion, repetition, carrying, lifting and lowering the water. Therefore, it had been decided that to reduce postural load of water fetcher with relevant and new intervention. The relevant research focuses solely on the water fetching activities and their intervention as water fetching aid.

3.4 Design Process

A design method of originality or an adaptive design method of variations may be used in the design intervention process. The design method chosen is determined by the surroundings of the design issue. It also depends on the user's/water fetcher's/needs customers vs. the product's present availability [8].

3.4.1 User/water fetcher's requirements

The rural water fetcher specifications for the redesign have been compiled from the "Focus Groups verbal dialogue" method, which helps to put together a gaggle of female water fetchers (n=57) to deal with very revealing problems and requirements. In fact, it has helped to under-represent the marketplace for water fetching aid. The water fetcher has been asked to clarify how they work or how they work to make it accurate.

Therefore, it was attempted naturalistic observation. An in-depth study together with video documentation was the sole. Thanks to grasp the character of water fetching and intervention activities. Through this, recognition of context specific criteria for the fetching aid has been realized with greater understanding of the essence and efforts taken while fetching water. The overview of requirements arising from questionnaire discussion and conceptual observations is given below:

- New water fetching device should be useful in Indian rural area, terrain area, and small width of road.
- Water fetching efforts should be reduced by utilizing modern water fetching products.
- New intervention should be cheaper, simple to handle and use by illiterate water fetcher.
- Water carrying drum should be clean easily by using the new product of water fetching.
- Durability of the product should be higher.
- Small children also use the product easily to fetch water.

3.4.2 Market study on existing water fetching device

A market survey was conducted to meet the requirements of currently available rural water fetching device. Online manufacturer's wello water wheel and Q drum Fig.5 found some of the established water fetching aids. These types of water fetching aid are not suitable for most of Indian rural conditions i.e. rough terrain and small width of road.

It also requires large effort in upward gradient condition. Secondly, durability of drum as well as wheel is less because of not designed and manufactured for Indian rural condition.



Figure 5: Existing water fetching aid "Q" drum and "wello water wheel"



Figure 6: RULA score of awkward postures while fetching water using traditional method

Wello water wheel and "Q" drum is the water fetcher available, but they are not appropriate for the rough surface of the ground. When using the available water fetching tools, some deflections are created in the human body. Maximum deflections occur in the upper and lower back parts of the spine. There is a need to pay attention to the modern water fetching system to reduce these stresses in the body. Existing water fetching aids are not popular in the rural area and economically that product is not reached in rural area. So that rural women use the traditional method of water fetching Fig. 6 which having the RULA grand score is 7.

As a result, the discussion session on water-fetching activities and the consumer quest for current goods provides a solid foundation for selecting a creative intervention strategy for our analysis as an adaptable design tool. The methods utilized to develop the product are reflected in this design approach. Furthermore, as a way of designing originality, it does not necessitate concept production (ideation) and screening [8]. As a result, it was decided to upgrade the current "water

fetching" system to include certain extra capabilities required by rural water fetchers.

3.4.3 Proposed concept

Fig.7 shows a definition that was developed with the idea of current products, product requirements, and specific design rules for related industries in mind [7, 12]. A brief CAD prototype of recently constructed water fetching was prepared based on the design and practically tested for its aspects of ergonomics. The Functional Description of proposed water fetching aid with its parts is as follows:

- Handle is provided for pulling and pushing the water fetching device. This would make the task easier controllable and faster.
- Adjustable rod is helpful for the adjustment of water fetching device with respect to every water fetcher's height. The locking mechanism operates in such a way that two metal strips connected one is fixed and other is movable.
- Clamping jaw is provided for the holding the drum and it is movable. It moves upper and lower with respect to the height of drum.
- Water drum is provided for the carrying water with respect to all water fetching activities of filling water, emptying water. This adjustment of drum is at the centre of the carriage. Drum is rest on the whole assembly of the steel plate and wheel arrangement. The water carrying drum is prepared in such a way that cleaning of drum become easy.
- A fork is provided for the lifting the drum from ground and lift it and rest on water fetching device with respect to carriage.
- Wheels are provided for the carrying whole load of assembly of water fetching aid and reduce the friction between the road surface and the water fetching aid. Wheels are provided to reduce manual effort taken by rural water fetcher. Wheels are provided to water fetching product so that water fetching on the up slope becomes easy. There are three wheels are provided one is at rear side and other two area at front side. Front side wheels are used to decide the direction depends on the ground surface and road. Rear wheel hold the equipment at the stable condition. It has get movement in 3600 angle which helps to support and direction of equipment.
- Carriage is provided for the carrying the drum weight with steel plates.

The concept proposed has various adjustable features such as adjustable rod with water fetching system height and angular / forward / backward adjustment of the mobile clamping jaw shown in (Figure 6). Theoretically, the adjustable ranges are fitted with the clamping jaw and the adjustable rod. Such adaptations were suited to rural water fetchers. This suits, the ideal combination of height adjustments and jaw clamping. Water fetchers can make appropriate changes while using the device, depending on the individual body measurements. Influencing the

improvement features of the design parameters in the CAD model and checking the RULA score in CATIA will obtain the best design parameters [21-25]. Within the later parts of the present article, this is a method called iterating concept parameters. Using the virtual DHM process, this kind of comparability evaluation of the design proposed for a target human population will be possible. This approach will also help to figure out whether the holding rod clamp changes match for water-fetching activities to be comfortable. In addition, this method saves the cost and time of physical prototyping in the exponential initial design [7, 13, and 14].

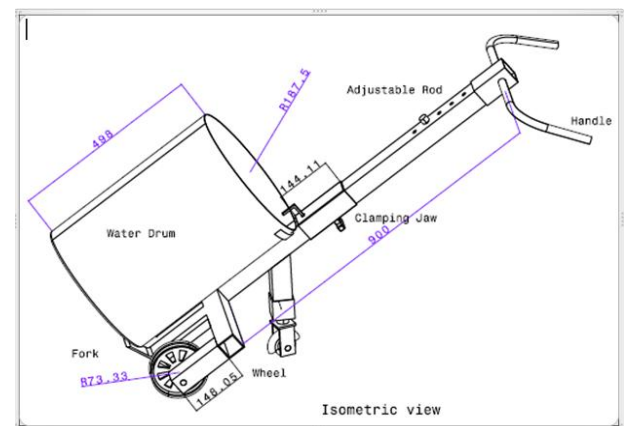


Figure 7 Proposed water fetching aid and its major parts. [All dimensions are in mm]

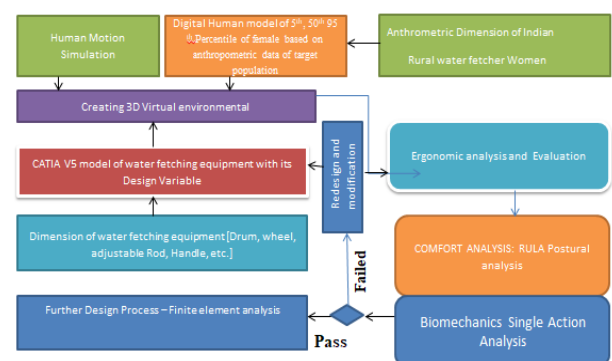


Figure 8 Virtual DHM simulation for water fetching aid

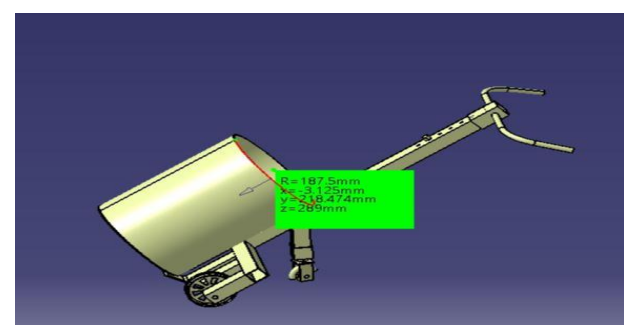


Figure 9 New water fetching device model in CATIA V5 software

3.4.4 Virtual DHM simulation for ergonomics assessment

Digital simulation of DHM is based on a Concerted Approach to assessing ergonomics (shown in Figure 8). The proposed concept CATIA model for the use of commands such as component features – extruded and revolved, sketching and assembly features such as shift, join, etc. Customizing inbuilt populations (Japanese, Korean, Canadian, French, and American) in CATIA's human creator module has produced digital human manikins. The customized DHM models followed Indian females' anthropometric and range of motion data provided by Chakrabarti [15]. Factor List under 'Human Measurement Workbench' used to manually feed anthropometric data for optimization of embedded DHM models. Population clusters consisting of the smallest, mediumest and largest body measurements are defined by the corresponding 95th percentile, 50th percentile and 5th percentile Indian women. The female height of the 95th percentile is 1640 mm, female of the 50th percentile is 1580 mm and female of the 5th percentile is 1492 mm. CATIA's human builder module support features such as axis shift, snaps, posture editor, etc. have succeeded in interfacing female DHM models with water fetching tool model following appropriate working posture. H-point of DHM models included as level of matching point of reference to interface the DHM models with the water fetching unit.

From the initial observation, it was found that rural water fetcher's working posture requires a forward-posture for a better water fetching operation. However, the water fetching system pulling and pushing mechanism helps to minimize rural water fetcher pain. It helps to collect 50 liters of water in one journey shows in Fig. 9.

3.4.5 Comfort analysis using RULA

In fact, the water fetching activities were described as physically active and newly built water fetching device demands pull and push working posture. Therefore, RULA was implemented for recognition of postural loads. Following human-analyses, Fig.11 shows comfortable body position assessment was conducted utilizing RULA under following conditions: (1) the type of awkward posture considered to be repeated, (2) the frequency of repetition indicated as > 4 times / min, (3) the load / effort required for water extraction to be approximately 10 N, and (4) arm support and arms water fetching across the center line are not considered for analysis. The design parameters are continuously changed to achieve a minimum RULA grand score of 1 to 3 (meaning a negligible or low-risk level). All such testing conditions and iteration processes followed in the comfort analysis to all quartiles. The scores noted as RULA grand score of 3, posture scores "A" and "B" are 2 and 3, respectively, to all declines, indicating a minimal level of risk to all percentiles.

3.4.6 Biomechanical Single Action Analysis

This ergonomic method analyses the biomechanical data of a water fetcher in a given position.

Through the existing mannequin position, the Single Action Analysis Fig.10 and Fig.11 method measures and produces details such as spinal loads (abdominal force, abdominal pressure, body movements) and mannequin structural forces and moments [25-27]. All results included in the design are focused on research findings and techniques reported by the research community. The biomechanical single action analysis is used for both postures for traditional methods of water fetching and new design of water fetching aid gives us a force produces in the Mannequin and such forces are as follows;

- Abdominal Force and Pressure, Ground Reaction
- L4-L5 Compression
- L4-L5 Moment
- Abdominal Force and Pressure, Ground Reaction
- L4-L5 Joint Shear

Table.3, Table.4 and Table.5 shows Abdominal Force and Pressure, Ground Reaction, L4-L5 Moment, L4-L5 Compression, L4-L5 Joint Shear and Moments in X, Y and Z direction. From this study of Biomechanical Single Action Analysis it has been clear that the stresses, proximal and distal reaction, proximal and distal moment, joint compression and joint shear produced in posture no.2 are less as compared to posture1 [28]. Posture1 indicates the awkward posture of rural water fetcher which produces maximum stress, reaction, moments as compared to the posture 2 which indicates the water fetching with the new device.

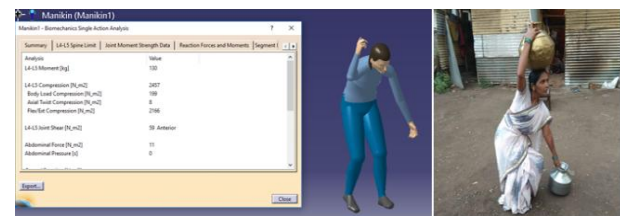


Figure 10 Posture1 selected for the Biomechanical Analysis with a Single Action Analysis

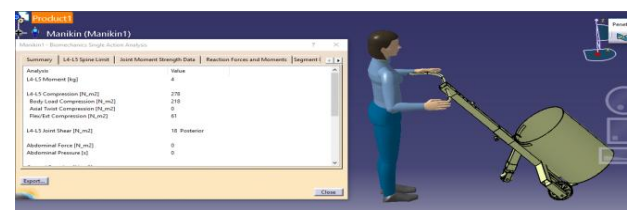


Figure 11 Posture 2 selected for the Biomechanical Analysis with a Single Action Analysis



Figure 12 Corresponding 95th, 50th and 5th percentile Indian women mannequin

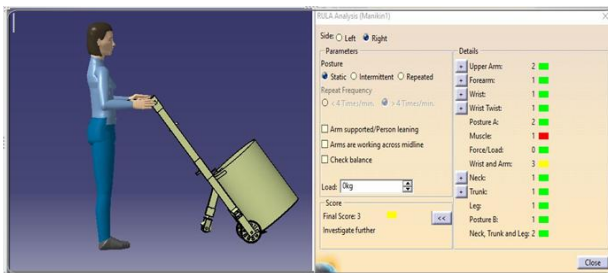


Figure 13: Comfort analysis with RULA score of 5th, 50th, 95th Percentile female

Table 3: L4-L5 Information in Biomechanical Single Action Analysis with Posture 1 and Posture 2

S. No	Analysis	Posture 1	Posture 2
1	L4-L5 Moment (N-m)	130	4
2	L4-L5 Compression (N)	2457	278
3	Body Load Compression (N)	199	218
4	Axial Twist Compression (N)	8	0
5	Flex/Ext Compression (N)	2166	61
6	L4-L5 Joint Shear (N)	59	18
7	Abdominal Force (N)	11	0
8	Abdominal Pressure (N-m2)	0	0

Table 4 Ground Reaction in Biomechanical Single Action Analysis with Posture1 and Posture 2

S. No	Analysis of ground reactions	Posture 1	Posture 2
1	Total (X)	0	0
2	Total (Y)	0	0
3	Total (Z)	631	432
4	Left Foot (X)	0	0
5	Left Foot (Y)	0	0
6	Left Foot (Z)	359	216
7	Right Foot (X)	0	0
8	Right Foot (Y)	0	0
9	Right Foot (Z)	272	216

Table 5 Spine limit data in Biomechanical Single Action Analysis with Posture1 and Posture 2

S. No	Forces	Posture 1 (N)	Posture 2 (N)
1	Compression	1185	278
2	Joint Shear Limits	59 posterior	18 posterior

3.4.7 Final water fetching Device and mannequin along with dimension

Figure 10 shows the implemented water fetching aid and mannequin. Figure13 and figure14 shows water fetching aid including dimensions. All modifications have

also been made to the mannequin together with the dimension so the mannequin can modify the able to work position as desired.

3.4.8 Comparison of postural load on pre and post design of water fetching

Figure 12 and figure 13 shows correlation between both final RULA scores as well as segmental RULA scores of the actual and planned water collection activities. RULA score demonstrated modified water fetching mechanism improved "A" work posture (earlier score: 7; current score: 3). "Posture B" level is significantly reduced from 8 to 2 shown in Fig.13. This review shows how the level of risk throughout all vertebral sections was minimized by adjusting uncomfortable positions related to the current proposed configuration of the water fetching aid. In the revised water fetching method, the final grand RULA score obtained as "7" for previous case has now been lowered to new level as "3". As per Biomechanical single action analysis stresses produced in the pre design are more as compared with the post design of water fetching aid. In every segment stress and moment and reaction produced are less in the post design of water fetching.

IV. DISCUSSION OF RESULTS

The conditions of rural water fetchers in the newly planned design have been incorporated according to fetcher's feedback [30-33]. In the planned new design, the adjustable rod arrangement provided raised from the ground, making the appropriate modifications, such as forward and backward, inferior and posterior movements. This current planned model resolved the challenges with the current condition of water fetching aid. As per the water fetcher requirement, the clamping jaw arrangement was provided for the solution of their present difficulty in holding drum and adjustable rod is provided in such a way that every person can handle the equipment. The new proposed design is simple to use. It was found that the majority of postures were regarded as marginal risk and category of low risk in the proposed water fetching design parameter shown in Table 6 with justification. It has been established from the literature that due to the use of DHM, the need for a replica model, real workers trials with real physiological setup, is minimized or eliminated [17, 23, 21]. DHM helps in validating the conceptual design model for the specified populations until the actual human model is developed [18.19]. From the numerous literatures [16-18, 20-22,24], it has found that the DHM method has been used to increase production and overall performance in many manufacturing sectors.

Binoosha et al. (2017) [11] made assessment of piston factory staff and lowered the RULA score from "7" to the agreed value "3" by changing existing water fetching system and by using the RULA system. Mohan et al. (2008) have used RULA procedure to evaluate functioning behavior of foundry staff and, by redesigning the workstation, reduced the final RULA score from "7"

to a reasonable value of "3." Kushwaha and Kane (2016) [12] obtained a similar response in another study by changing the configuration of the crane cabin staff. DHM results indicate the benefits in view of reliability and production in Indian plastic precision machined industry

[14]. Due to new water fetching aid stresses produced in water fetcher's body segment will be goes on reducing which is shown in Table.3-5 and Table 6 shows the product component with the justification and reduction in RULA score with reference taken from [25-27].

Table 6: Improved RULA score with Design Variables and justification

Design Parameter	Anthropometric parameter	Percentile data (mm, unit)			Justification
		95 th	50 th	5 th	
Height of handle equipment from ground	Standing Height	849	828	745	This Parameter requires Percentiles data of 5 th to 95 th percentile ranged from 849mm to 745mm from the ground for handling the equipment. Useful for all percentile so awkward postures load reduces.
Adjustable rod	Wrist, Upper arm and lower arm	702	523	460	Adjustable rod is provided for the handling the equipment by all percentiles from 5 th to 95 th .By providing the adjustable rod RULA score reduces. Adjustable rod has holes so we can adjust rod as per requirement. It ranges between the 702 mm to 460mm.
Horizontal distance between the equipment and mannequin	Wrist, Upper arm and lower arm	1193	1145	1112	Horizontal distance between the mannequin and the equipment. Horizontal distance between the 5 th to 95 th percentile is ranges between the 1193mm to 1112mm. Adjustment made with respect to the ground surface, pulling and pushing the equipment which reduces the efforts. Minimum stresses produced in body segment.
Clamping jaw	Wrist, Upper arm and lower arm				Camping jaw is used to clamp the water carries drum and release the drum easily. So postural load becomes less.
RULA score	Posture A (Wrist, Upper arm and lower arm)				2
	Posture B (neck, trunk, leg)				1
	Grand final Score				3

The final RULA score attained in the existing research on water fetching also conforms to all of these findings. The proposed concept for water storage is versatile. For every selected population, the proposed water fetching concept is versatile to implement. Due to uncomfortable working postures, for work-related challenges, design is a potential solution. Because of a lack of time, it was not feasible to enforce the intervention on the field and collect data on real long-term impact of such actions on skill. The next stage in the research process is to fulfil a finite element analysis that would make it easier to decide the strength, flexibility, stress / strength of the final design. Basically, content of separate parts will also be selected from Ashby charts.

This graph approach of product availability helps the product with mechanical issues and reduces the product's cost. Currently, the suggested water fetching system costs must not be determined; thus, in the potential

scope of the research, "costs-benefit analysis" can be performed. Appropriate screening would be a user interface test that would cover community feedback from the user over the time span of use.

Furthermore, this test approach would allow researchers understand potential influence of newly planned design on working conditions. Fig.14 shows the Proposed water fetching aid with mannequin along with dimension. Fig.15 shows the all stresses, forces produce, joint compression limit, axial twist, flexion compression, abdominal force and joint shear in the pre and post design of water fetching aid and from Fig.15 concluded that the all stresses and forces at joint in pre water fetching activities are maximum as compared with the new water fetching aid. Details about the spine limit and the stresses on spine in L4-L5 are joint shear, L4-L5 moment are shown in Fig.15.

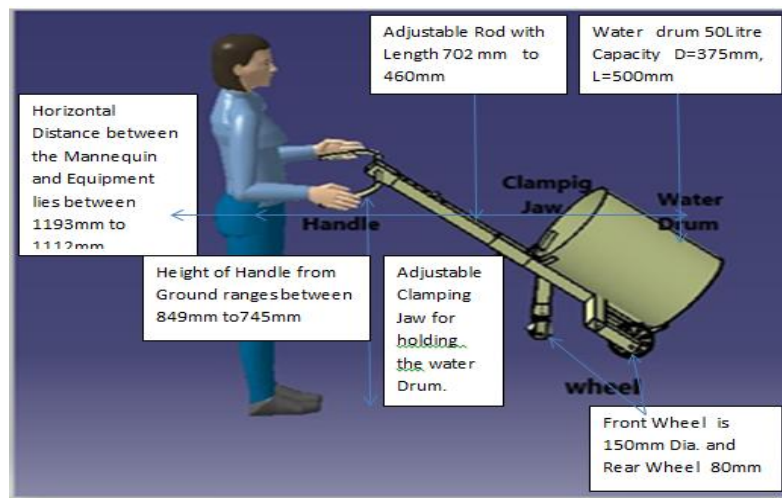


Figure 14: Proposed water fetching aid with mannequin along with dimension

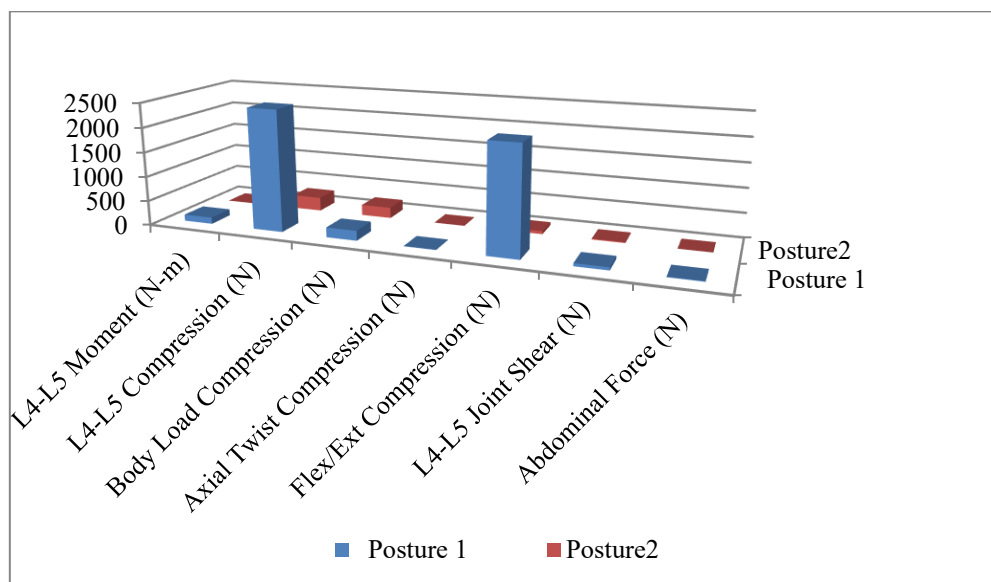


Figure 15: Comparison of stresses before and after design Intervention of water fetching aid

V. CONCLUSION

The research undertaken, explained a virtual DHM assessment method for a water fetching design that could ultimately solve the responsive constraint of existing water fetching aids, product requirements and reliability issues (operating body position as well as MSD). This type of assessment is important even though MSD challenges and body position discomfort are reported times from the same aspect of function in a number of related research articles. However, a lot of work still needs to be done in order to provide a product to end consumers (female water catchers). The work focuses on the power and ability of the virtual DHM system in the development process while building devices for use in a facility that creates ergonomic problems and requires a certain amount of comfort. This study presents a water fetching device, for a rural water fetcher and

describes the process of developing it and predicts the stresses; moment reaction produced in the water fetcher in different body segments. From the study of BSA [Single action analysis] it is clear that stresses produced in the traditional method of water fetching is maximum as compared to the new designed water fetching aid. In this way the new water fetching device reduces the effort of women while collecting water.

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APPENDIX I

S. No.	Abbreviation	Description
1	BSA	Biomechanical single action analysis
2	RULA	Rapid upper limb analysis
3	WRMSD	Work Related Musculoskeletal Disorder
4	DHM	Digital Human Modelling