Ergonomic Safety Study of The Furnitures in Industry With Anthropometric Measurement

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Abstract- *The poor designed ergonomic writing desk and sitting table in industry is considered one of the major causes of severe posture problems for workers. The most industry activities involve sitting for long period of time, with little or no breaks like meeting, documents work, sitting work etc. The poorly designed furniture fails to take account of anthropometric measurements & characteristics of its user has a negative influence of the human health. The purpose of study was to examine the anthropometric match of the writing desk and sitting table with standard ones. The dimensions of the writing desk and sitting table are available by measuring industry furnitures. The writing desk were made up by composite wood which is covered by thin layer of mica sheet. The sitting table were made up of massive wood. The structural defect of the writing desk and sitting table like cracks, scratches and breaks .*

So it is needed to develop an anthropometric measurement data base of industry writing desk and sitting table. At the time of renewal this data are taken into consideration in order to design much more ergonomic safety of writing desk and sittingtable for industry workers in future.

Keywords- ergonomics, design, anthropometric measurements, workers, industry, safety, furniture, dimensions

I. INTRODUCTION

Ergonomics is a science concerned with "fit" between people and their work. It puts people first, taking amount of their capabilities and limitations.

Ergonomics is the design of workplace & work environment has gained attention from researchers over the last few decades. Though industry environment represents the "work" environment for billions of workers, it has not attracted the proper attention from ergonomists proper implementation of industry.

Ergonomics is needed for the maintenance of good health, improvement in performance, working and preventing disorders. The most important element of the sitting work is the furniture. The major function of industry furniture is to support the workers when writing or drawing or operating on the working surface. Besides, a industry has to facilitate improvements to increase the work efficiency of the workers by providing a comfortable and stress free working environment suitable for intellectual activities.

Industries are the places from where we get qualified workers to work which then help in building the organization. Therefore, it is very important to make the workers in industry comfortable and suitable for workers so that as they can concentrate and work as talented Individual. workers spend a major time on the chair and desk, during working hours. Hence it is necessary that the industry furniture should fit the environments of the workers. Therefore, the industry furniture should be made on the basis of anthropometric dimension of the users. It should permit space for flexible movements of the body and provide place for all the working activities. Although all the components of industry furniture are important, yet furniture for seating requires special attention as it facilitates the functioning of the workers in a industry. Hence, the design of work chair and table requires anthropometric data which are appropriate to the population of users for when the plan is intended.

Anthropometric data is a collection of the dimensions of the human body and are useful for ergonomic design of the workplace . It has been noted that anthropometric data vary considerably for individuals. The use of anthropometry in design may improve the well being, health, comfort and safety of the user of the product. The use of anthropometric data in the design of bench and tables in almost all developed countries has been acknowledges. One of the conditions to support productivity is to ensure that the workplace and the furniture that worker use confirm the anthropometric characteristics of the user. Appropriate anthropometric requirements should also be considered for seating, for seat and work surface dimensions, legroom and clearances for getting in & out (Chakrabarti. 1997).

The discomforts of muscle contracture of neck and back problems are due to sitting for a long time at

inappropriate posture, resulting from using furniture that is not consistent with anthropometric characteristics of the users.

A. OBJECTIVES

- To collect the relevant anthropometric data of workers using industry furniture.
- To determine the ergonomic suitability of furniture and their user friendly attributes.
- To explore the opinion of workers about fitness of furniture.
- To give recommendation and guideline of designing of suitable industry furniture.

The various anthropometric measurements suggested by him aregiven below

- Popliteal height
- Sitting eye height
- Sitting height
- Sitting elbow height
- Thigh clearance
- Knee height
- Buttock knee length
- Elbow to elbow breadth
- Hip breadth
- Sitting shoulder height
- Sitting lowest rib-bone height
- Sitting upper hip bone height
- Fore arm finger tip length
- Buttock popliteal length
- Stature

II. METHODOLOGY

This chapter provides a detailed description of the procedure adopted for conducting the research on "A study on Ergonomic Evaluation of Industry Furniture for Workers". After reviewing the literature relevant to study and formulating the objectives of the study, the methodology for this study is established.

The details of methodologies adopted to the investigation is stated under the following section :

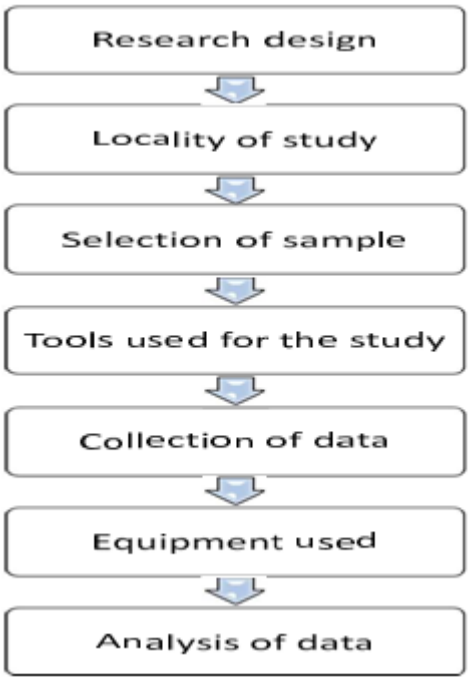

Figure 1 . Flowchart of methodology

A. Research design

Research design refers overall strategy to choose and integrate the different component of the study in a coherent and logical way, thereby, ensuring one to effectively address the research problem. It constitutes the blue print for the collection, measurement & analysis of the data .The design followed for the study is an exploratory research. The objective of exploratory research is to gather, preliminary information that will help to define problems & suggest hypothesis. The research design is adopted to determine the ergonomic suitability of industry furniture for all workers.

B. Locale of the study

Location of the study area should be appropriate to achieve the objective of research. The study is carried out in private industries to explore the types of furniture user and their suitability with the user population. This industry is selected for the reason to study about ergonomic safety design for industry furniture because it has not been studied earlier.

C. Selection of sample

Sampling is a process of selecting a number of participants for a study in such a way that they represent the larger group for which they are selected. A data sample is a set of data collected and selected from a statistical population by a define procedure. Purposive random sampling techniques are adopted for the study to avoid bias. Around 30 numbers of

workers from "L.G.Balakrishnan & Bros Ltd" are selected as a sample. Their age range between 20-35.

D. Tools used for the study

The tools selected for collecting the data was an Observation of anthropometric survey sheet. In the 1stsection, general information regarding respondent's age, working industries are included. In the 2nd section it means specific information regarding anthropometric measures of respondents, dimensions of industry furniture observed & obtained.

E. Collections of data

Anthropometric Measures:

Anthropometric measurements are considered as the basis for the design of furniture ergonomically .Hence, different anthropometric measures of the workers are taken by adopting proper definition and standard measuring techniques (Chakrabarti,1997). Accuracy and repeatability of measurement was achieved by practice prior to the data collection. All the subjects were wearing light clothes and were bare footed during measurements. During measuring body dimensions under sitting conditions, the subjects were asked to sit in such a way that the upper leg and lower leg remained at right angle to each other. Height was taken standing erect without shoes. The following human body dimensions, which are essential for seating & work surface design, according to literature survey, were measured in this study. The different anthropometric dimensions measured are stature, sitting height ,sitting shoulder height, popliteal height, Hip breadth, Elbow rest height (sitting), Buttock popliteal length, Buttock knee length, Thigh clearance, Sitting eye height, Shoulder breadth, Knee height, forearm hand length, Weight. Indian anthropometric Dimensions, National institute of design publishers, Ahmedabad.

F. Furniture Dimensions

Industry must be designed to promote a level of comfort & effectiveness, which will promote optimum conditions for working, monitoring, listening, & interaction .Hence ,the dimensions for Desk height, Desk depth, Desk length, Desk slope, Seat height, Bench length, Back rest height, Bench depth, Back rest slope, foot rest height, distance between chair & bench ,thickness of bench etc. are given importance to increase utility & convenience of furniture in industry.

G. Equipment used

The equipment used for anthropometric measurement & to measure furniture dimensions are height measuring scale, weighing balance, measuring tape and a plastic half circle protactor, steel scale. All the measurements were recorded in centimeters except the seat slopes and desk slopes which are measured in degrees.

H. Analysis of data and interpretation

Analysis is the critical examination of the assembled & grouped datafor studying the characteristics of the object under study. The data thus collected is 30 selected respondents are tabulated & analyzed. Descriptive statistics of mean maximum value, minimum value, Standard deviation, percentage, percentile value are used appropriately to summarize the collected data.

III. EXPERIMENTAL SETUP AND PROCEDURE

A. ANTHROPOMETRICMEASUREMENTS

Anthropometric dimensions are considered as the foundation for designing ergonomically fit industry furniture. Therefore, anthropometric measurements were taken according to the needs.

- Stature: Top of the head, standing in erect stretched posture. The vertical distance from the floor to the vertex (i.e. the crown of the head)
- Sitting height: Top of the head sitting in a normal relaxed posture.
- Sitting mid shoulder height: Height of upper most point on the middle level of the shoulder.
- Popliteal height: Height of the underside of the thigh immediately behind the knee.
- Hip breadth: Maximum horizontal distance across the hips.
- Elbow rest height: Distance between seat and lower most part of the elbow.
- Buttock popliteal length: Horizontal distance from the most posterior point on the uncompressed buttocks to the back of the lower leg at the knee.
- Buttock knee length: Horizontal distance from the most posterior point on the uncompressed buttocks to most anterior point on the knee.
- Thigh clearance: The vertical distance from the seat surface to the maximum bulge on the anterior surface of the thigh was measured with a shortened anthropometer.
- Sitting eye height: Height of inner corner of the eye sitting in normal relaxed posture.

- Shoulder breadth: Maximum horizontal distance across the shoulders,
- Forearm hand length: Maximum distance between elbow to the middle finger in hand.
- Knee height: Height of uppermost point on the knee.
- Weight: Total body mass of the body.

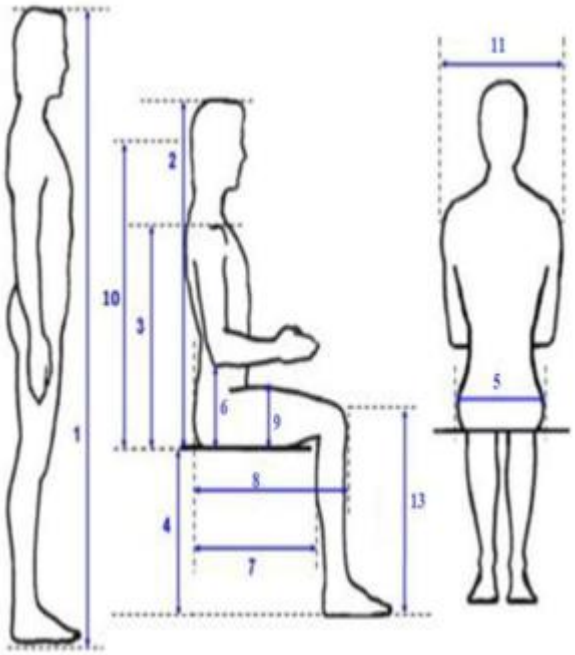

Figure 2. Anthropometric dimension measures

B.FURNITURE MEASUREMENTS

The most common type of furniture model used. These furniture items are made by furniture manufacturers with the absence of standard ergonomic safety measurements. To identify the potential mismatches, the following measurements of the existing industry furniture is considered.

- Seat Height (SH): Seat height is measured as the perpendicular distance from the floor to the middle point of the front edge of the seat.
- Seat Width (SW): Seat width is measured as the horizontal distance between the lateral edges of the seat.
- Seat Depth (SD): This is the minimum distance measured horizontally from the front edge of the sitting surface to its back edge.
- Seat to Desk Height (SDH).This is the vertical distance from the top of the front edge of the seat to the top of the front edge of the desk.
- Seat to Desk Clearance (SDC). This is the vertical distance from the top of the front edge of the seat to the lowest point below the desk.
- Desk Width (DW). Desk width is measured as the horizontal distance between the lateral edges of the desk.
- Desk Height (DH). Desk depth is the distance from the back to the front of the top surface of the desk.
- Back Rest Height (BRH): Measured from the bottom of the backrest post to the top of the backrest canvas. Backrest height depends on the degree of disability and level of support required.

C. FURNITURE AND BODYDIMENSIONS MISMATCH

Mismatch implies as the irregularity between the industry furniture dimensions and the worker anthropometric measurements. Identification of a match or mismatch is important for designing and evaluating industry furniture.
To characterize the range in which every furniture dimension is viewed as fitting, related anthropometric measurement and ergonomic standards can be utilized. Different relations have been established to identify a match or mismatch. The most common relations are described below.

1) Popliteal Height (PH) against Seat Height (SH):

The seat height (SH) is required to be balanced in respect to the popliteal height (PH) and enabling the knee to be flexed so that the lower legs shape a greatest of 30 edge with respect to the vertical. PH ought to be higher than the SH. The lower leg constitutes a 530 point with respect to the vertical and Further more the shin-thigh edge is in the vicinity of 95 and 120 .Typically, PH does not have an esteem higher than 4 cm or 88% of the PH . PH and SH are characterized when the seat stature is either >95% or <88% of the popliteal tallness and it is conceivable to build up a model for SH. For this examination work, 3cm correction for shoe stature is incorporated to the popliteal tallness. In this way, a match model is built up as indicated by the following condition

$$(PH + 3)\cos^{\circ} \leq SH \leq (PH + 3)\cos 5^{\circ}.$$

2) Buttock Popliteal Length (BPL) against Seat Depth (SD):

Seat Depth ought to be no less than 5 cm not as much as the buttock popliteal length. In any case, the thigh would not be upheld enough if the SD is significantly not exactly the BPL of the subjects. Different scientists clarified that the seat depth ought to be measured for the fifth percentile of the BPL appropriation so that the backrest of the seat can bolster the lumbar spine without pressure of the popliteal surface. Along these lines, a crisscross among SD and BPL is characterized

when SD is either <80% or >95%of BPL. In this way, a match model is built up as indicated by the following condition:

$$0.80BPL \leq SD \leq 0.95BPL.$$

3) Hip Breadth (HB) against Seat Width (SW):

The seat width must be sufficiently extensive to oblige the client with the biggest hip expansiveness to accomplish solidness and allow space for horizontal developments. Different inquiries have demonstrated that the HW ought to be more slender than the SW keeping in mind the end goal of having an appropriate fit in the seat and an ideal seat width is chosen for the 95th percentile of HW conveyance or the biggest HW. The updated proposed condition shows that the SW bought to be no less than 10% (to oblige hip broadness)and no more than 30% (for space economy) bigger than the hip expansiveness. Along these lines, a match rule is controlled by the following condition:

$$1.10HB \leq SW \leq 1.30HB.$$

4) Sitting Elbow Height (SEH) against Desk Height(DH):

Various reviews demonstrated that the elbow height is measured as the central point for the work area stature. As the load on the spine decreases, the arms are upheld on the desk and the desk height is liable to the shoulder flexion and shoulder snatching edge which is obtained by the fifth percentile. Thus, the work area stature ought to be 35 cm higher than the SEH. Subsequently, a match measure is set up with a changed condition that acknowledges the SEH as the most minimal stature of DH and considering that the extraordinary tallness of DH ought not to be higher than 5cm over the SEH.

$$SEH \leq DH \leq SEH + 5.$$

5) Thigh Clearance (TC) against Seat to Desk Clearance(SDC):

The reasonable seat to work area should be more noteworthy than thigh freedom keeping in mind the end goal of making leg development accessible. The minimum perfect seat to desk clearance ought to be 2 cm higher than thigh clearance. In this manner, a match paradigm is perceived by the following condition:

$$TC + 2 < SDC.$$

Table 2. Dimensions of the existing desks

S. no	Furniture part	Readings
1.	Desk Height	84cm
2.	Desk Deapth	42.5cm
3.	Desk Length	109cm
4.	Desk Slope (degrees)	15°
5.	Bench Height	51cm
6.	Bench Length	106cm
7.	Bench Deapth	30.5cm
8.	Back Rest Height	40.5cm
9.	Back Rest Slope (degrees)	95°
10.	Foot Rest Height	8.5cm
11	Distance Between Desk And Bench	29.5cm
12	Thickness	1.9cm

IV. RESULT

Anthropometric survey was done in the present study in order to measure the various anthr opometricmeasurementswhichwerefurtherusedtoformulatetheg uidelines to design suitable furniture according ot here quirements of the workers.Anthropometric data are widely use dindetermining the dimensions of furniture.

All the anthropometric measurements are taken with the subject in a relaxed and erect posture. Each worker is measured in light clothing and without shoes. workers dimensions are taken with worker seated erect on a flat horizontal surface (with exception of height and weight)with knees bent 90 degree and feet(without shoes) flat on horizontal surface. Height is taken standing erect without shoes by height measuring scale. Various human body dimensions, which are essential for seating and work surface design, are measured in this study.

Table 2. Anthropometric measures of the body dimensions of the workers

S. NO	Contents	Min Value	Max Value	5*Percentile	50*percentile	95th percentile	mean	Standard deviation
1.	Stature	141	182	147	161	172	160	8.78
2.	Sittingheight	61	91	67	79	90	79	7.12
3.	Shoulder height	38	73	46	54	67	55	7.44
4.	PoplitealHeight	30	49	34	40	45	41	3.2
5.	Hipbreadth	26	43	30	34	38	34	2.76
6.	ElbowrestHeight	13	31	16	20	28.5	20	2.6
7.	Buttockpopliteal length	21	53	37	44	49	44	3.83
8.	Buttock kneeHeight	32	65	41	50	64	50	6.82
9.	ThighClearance	11	18	11.5	15	17.5	14.5	1.7
10.	Sitting eyeSight	55	80	57	68	79	67	8.2
11.	ShoulderBreadth	26	52	31	40	48	40	5.25
12.	Forearm handLength	42	52.5	43	47	50	47	3.9
13.	Knee height	32	95	40	47	54	47	4.88
14.	Weight (in kgs)	58	87	62	72	85	72.5	6.78

V. RECOMMENDATION

Table 3. Recommended dimension for new furniture

Features	Anthropometric Measures	Proposed Design Dimension	Criteria
Desk/Table Height	Seat height+Elbow height+Shoe heel allowance	70.3cm	Maximum table height=5th percentile of seat height+5th percentile of functional elbow height(sitting)+shoe heel allowance
Desk depth	Forearm hand length	50cm	95th percentile of fore arm-hand length
Desk length	Hip breadth	104cm	95th percentile of hip breadth+ 15% allowance for clothing+ 15% allowance as clearance
Desk slope		15 degree	Enhance support to feet
Bench/seat height	Popliteal height	36cm	5th percentile of popliteal height+2cm shoe heelallowance
Bench length	Hip breadth sitting	39.9cm	95th percentile of hip breadth sitting+ 15% allowance forclothing
Bench depth	Buttock popliteal Length	49cm	95th percentile of buttock popliteal length
Back rest slope	-	110 degree	Enhances support to lumbar region
Back rest height	Sittingshoulder height	46cm	5thpercentile of sitting shoulderheight

VI. CONCLUSION

Industries are the places from where we get qualified workers to work which help in building the organisation. Prolong static posture puts on extreme physical strain on muscles, the ligaments and in particular on the discussions. Correct sitting posture is an important factor for the prevention of their disorder as well as enhances the work efficiency of the workers by providing a comfortable and stress free working environment suitable for intellectual activities.

Recent researchers have documented an increase health problem related to poor sitting posture. Neck, shoulder and back pain problems are common among the workers. Workers experience such problem due to low quality design desk and bench. Hence, it is necessary that the furniture should fit the requirements of the workers. Matching furniture to anthropometric measurements is an important factor that should be taken into account in industry furniture design. During the past decade, research in ergonomics has led to an improvement in the technology of work and furniture design based on the bio-mechanics of the human body. However, the largest work place of all. Thus there is a need to focus attention on industry furniture.

Considering the importance of ergonomically designed furniture for workers, the present study is planned with the following objectives.

- To collect the relevant anthropometric data of workers using industry furniture.
- To determine the ergonomic suitability of industry furniture & their user friendly attributes.
- To explore the opinion of workers about fitness of furniture.
- To give recommendation & guideline of designing suitable industry furniture.

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