Application of Human Factor Engineering in the Design and Development of Products

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Abstract: Several studies have shown that there is a need of ergonomically fit sewing machine workstation so that sewing machine operators can perform their faddy tasks comfortably. The present study was initiated where worker's perceptions were measured by preparing questionnaire to find out difficulties during sewing machine work. Questionnaireswere filled up by 100 sewing machine operators from different parts of the region. Questionnaire included the different modules which are Perceived posture, localized postural discomfort andestimatedendurance time. Worker's perceptions were analyzed by finding their critical values.Based on the criticality index, recommended parameters were performed on selected operators.Nine sewing machine operators performed experiments at twelve different combinations of table height, desk slope and pedal position. ANOVA technique was used to analyze the data obtained from nine selected sewing machine operators after performing experiments and the dimensional adjustment of sewing machine workstation was made, in relation to desk height, desk slope and pedal position. The recommendations were formulated in order to minimize the load on the musculoskeletal system during operation in terms of anthropometric dimensions with respect to sewing desk height, desk slope and pedal position.

Keywords: Sewing machine, Worker's perception, Worker station, Posture, ANOVA.

I. Introduction

The introduction of the sewing machine in the workplace has led to numerous reports of health distress from its use. A typical workstation includes work surfaces, space for all activities and components of the task, seating for operator, pedal for operating foot. It has been found that a well-designed convenient sewing area large or small saves time and energy. Knowledge of the determinants that lead workers to adopt a particular working posture increases the feasibility of posture prediction. It is required to improve the working posture and reduce the number of complaints; quantitative recommendations for the adjustment of the workstation are needed, which take these postural constraints into account and founds that employees encounter several risk factors at sewing workstation, such as awkward arm, neck, trunk, and leg postures. These postures are influenced by the size of the worker and the design of the workstation [1]. Repetitive motion caused by the foot petal can lead to CTDs (commutative trauma disorders) in the foot. Excessive noise and poor lighting can also lead to hearing and vision problems [2].It has been that studied musculoskeletal disorders of the neck and shoulders in female sewing operators [3].It has been found that a well-designed, convenient sewing area large or small saves time and energy [4].Improved design modifications based on ergonomic principles of chute and a height difference of platform and a chute can reduce the possibility of injuries among thresher operators [5].Sewing machine operators can perform their faddy tasks comfortably by using this ergo-work seat [6].Ergonomic intervention improves working conditions for sewing machine operators [7].

II. Methodology

Questionnaires were prepared to record the perceptions of sewing machine operators. This method of data collection is quite popular, particularly in case of big enquiries. A questionnaire was consisted of number of questions printed in a definite order on a set of forms. The questionnaires were directly filled up by the sewing machine operators. Questionnaire was structured based i.e. there were definite, concrete and predetermined questions and questions were presented with exactly the same wording and in same order to all the sewing machine operators and these questionnaires were filled up by sewing operators directly by approaching to them. Questionnaires were filled up by 100 sewing machine operators from different parts of the region. Workers' perceptions were recorded by a questionnaire, containing four questionnaire modules. Critically Index was calculated in each of the module of the questionnaire, in order to find out the critical areas. Critically Index was calculated as:- Multiply point scale of that module of the questionnaire with their individual score of concerned

part and add then divide the obtained result with total of the point scale of that module of the questionnaire. Critical areas were found related to perceived posture, localized postural discomfort, estimated endurance time, Judgment on whole workstation adjustment modules of questionnaire. Based upon these critical areas, recommended Parameters related to sewing machine workstation, were decided. Experiments were performed on various recommended parameters on selected sewing machine operators. ANOVA technique was used to analyse the data obtained from selected sewing machine operators after performing experiments and recommendations were drawn for sewing machine workstation.

2.1 Perceived posture

The operator was asked to rate his perception of the posture of the neck, back, left shoulder, right shoulder, left upper arm, right upper arm, left lower leg, right lower leg, left foot, and right foot.

Table 1 Response of sewing machine operator related to perceived posture

Parameter *	Posture of neck (A)	Posture of back (B)	Posture of left shoulder (C)	Posture of right shoulder (D)	Posture of left upper arm(E)	Posture of right Upperarm (F)	Posture of left lower leg (G)	Posture of right Lowerleg (H)	Posture of left foot (I)	Posture of right foot (J)
1	32	23	47	46	49	49	40	40	50	50
2	06	08	05	05	06	06	06	06	02	02
3	54	46	46	47	43	43	41	41	39	39
4	02	05	02	02	02	02	04	05	02	03
5	05	16	00	00	00	00	09	08	05	05
6	00	01	00	00	00	00	00	00	02	01
7	01	01	00	00	00	00	00	00	00	00
Criticality index	8.78	10.35	7.25	7.32	7.07	7.07	8.42	8.39	7.71	7.64

2.2 Localized postural discomfort

The operator was asked to rate his postural discomfort in 30 regions shown on diagram of the rear view of a human body using a scale ranging from 0 to 5.

Table 2 Response of sewing machine operators related to localized posture discomfort.

PARAMETERS	No of operators rated their perception									
	A	B	C	D	E	F	G	H	I	J
No discomfort	91	94	58	86	90	99	97	81	81	40
Some discomfort	07	03	25	07	05	00	02	13	14	42
Minordiscomfort	01	01	14	03	03	01	01	03	03	15
Majordiscomfort	01	02	03	04	02	00	00	02	02	02
Severe discomfort	00	00	00	00	00	00	00	01	00	01
Verysevere discomfort	00	00	00	00	00	00	00	00	00	00
Criticality Index	0.8	0.73	4.13	1.66	1.13	0.13	0.26	1.93	1.73	5.46

2.3 Estimated endurance time:

The operator was asked to estimate. On the basis of his perceptions, how long he could operate at the experimental workstation adjustment without difficulty during a regular, working day.

Table 3 Response of sewing machine operators related to estimated endurance time.

Estimated endurance time	
Five point scale	No. of operations rated their perception
1 (> 8 hours)	39
2(6-8 hours)	42
3 (4-6 hours)	14
4 (2-4 hours)	05
5(<2 hours)	00

2.4 Desk height

Height of person varies from person to person. That is why desk height was tested related to individual elbow height of sewing machine operator taken as:+ 5 cms above elbow height, + 10 cms above elbow height & + 15 cms above elbow height.

2.5 Desk slope

Desk slope taken as:0° based on desk slope at shop of sewing machine operator (normal desk)and 10° slope towards sewing machine operator.

2.6Pedal position

Pedal position was taken as: 4 cms.to the operator's side of the needle tip and 6 cms.to the opposite side of the needle tip. These two readings were taken on the behalf of sewing machine builder's perceptions. Experimentation phase was consisted of 12 sets of experimental conditions.

Total SEC (set of experimental conditions) = 12

On the behalf of these 12 sets of experimental conditions, which are represented by different combinations of desk height, desk slope and pedal position are shown in table 3.8, response of 9 treadle sewing machine operators were considered. Response of 9 treadle sewing machine operators was considered by performing experiments with different combinations of desk height, desk slope and pedal position.

III. Results And Discussion

In experimentation stage, 12 sets of experimental conditions were tested for different combinations of desk height, desk slope and pedal position. The existing parameters of the sewing machine operators were measured when they were asked to work for 40 minutes and the following were the findings.

Result we obtained by testing 12 sets of experimental conditions for different combinations of desk height, desk slope and pedal position. Analysis of data collected from 9 treadle sewing machine operators was done by ANOVA technique. Thus result obtained from analysis of data is shown that there is significant relation between desk height, desk lope and pedal position. So sewing machine workstation design is said to be best fitted only if it will have following combination as given in table 4.5 and shown as under:

Table 4 Dimensional adjustment of sewing machine workstation

Desk height (above elbow height)	+10 cms.
Desk slope	10°
Pedal position (i.e. pedal axis behind the needle)	- 4 cms

IV. Conclusions

- This was further extended to recommend the dimensional parameter of sewing machine workstation to be used by an Indian male, with the desk slope as10°, pedal position as -4 cms. The following table recommends the desk height of sewing machine for Indian male.
- From the questionnaire part, the conclusions related to four modules of questionnaires, were drawn with the criticality index on order to find the most critical areas and given as under:
- **Perceived posture:** The critical areas in perceived posture discomfort reveals that the most critical posture of left lower leg, posture of right lower leg.
- **Localized postural discomfort:** Localized postural discomfort reveals that the most critical areas is discomfort of whole body and the others discomfort of back, discomfort of left leg, discomfort of right leg, discomfort of upper neck/back.
- **Judgment on workstation adjustment:** Judgment on workstation adjustment reveals that judgment by operator for desk slope, desk height, pedal position and judgment of operator for whole workstation have an average effect on sewing machine operator.

So from questionnaire part, it was concluded that there was a need of ergonomically for sewing machine workstation, which the researcher has proved.

REFERENCES

[1]. A. Kumar, N. Ishii, Development of grain threshers based on ergonomics design, International journal of industrial ergonomics,33,2002,503-507.
[2]. J.F. Buneo, Flanders , Moving effortlessly in three dimensions arm movements, The journal of neuroscience,15,1995, 6271-6280.
[3]. G. Verma, Cutting And Tailoring Theory(Asian Publishers.2005).
[4]. N.J. Dellmen, Working posture-prediction and evaluation, doctoral diss., TNO, the Netherlands, Ph.D., 1999.
[5]. S.N. Shan, Work Study & Ergonomics (Dhanpat Rai & Sons, 1999).
[6]. McCormick, Human factors in engineering and design (Tata McGraw-Hill Publishing company, 1976).
[7]. Genaway, C. David, ERGONOMICS: Environment: Energy: A brief primer for site preparation,Technicalities,9,1989, 10-12.