Eliminating Bad Work Posture by Proposing an Alternative Ergonomic Workstation Design in the RMG Industry

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Abstract

On the edge of being recognized as a developing country, Bangladesh now holds the 39th position in the world economy in nominal terms. And this achievement has been possible for the active contribution of Readymade garment (RMG) sector. In 2019 Readymade garment (RMG) sector has contributed 84.21% or $34.13 billion to the total export receipts. Growing market amenities, abundant & efficient workforce at low cost, duty benefits in export destinations are some of the vital reasons for the success of the RMG sector in Bangladesh. According to a survey conducted by the Centre for Policy Dialogue (CPD) in 2019, there are 3.5 million workers, of which 60.8% are female and 39.2% are male working in 3,596 active RMG factories. Minimum monthly wages in Bangladesh is $ 95 where China is $ 155, Cambodia $ 140, India $ 137, Vietnam $ 107. But the environment at which these workers are working is not good for their health as well as production. Workers face severe pain as a result of their bad posture and unnecessary movement.

To remedy the situation, the design of an alternative workstation is proposed which is more ergonomic, worker-friendly. Necessary anthropometric measurements and RULA analysis are used. SOLIDWORKS &Microsoft EXCEL are some software used in this perspective.

Keywords
RMG, ERGONOMICS, WORKSTATION, ECONOMY, ANTHROPOMETRY.

1. Introduction

In ready-made garments (RMG) industries workers have to do the operations of cutting, sewing, and finishing. Among these operations, sewing is one of the most vital operations done by the workers. They have to work more than eight hours repeatedly either by sitting or standing in one position. However, due to the poor design of the sewing table and sitting chair there developed various stress in the musculoskeletal system. As a result, workers face various types of physical problems like back pain, neck pain, fatigue, blood circulation problem, discomfort, etc. These problems have direct and indirect relations with the anthropometric factors of ergonomics. Ergonomics is the process of designing or arranging workplaces, products, and systems so that they fit the people who use them. It is a branch of science that aims to learn about human abilities and limitations, and then apply this learning to improve people's interaction with products, systems, and environments. It can improve workers' productivity, provide workers with safety, physical and mental comfort as well as job satisfaction. The aim of ergonomics is the evaluation and design of facilities, environment, jobs, training method, and equipment to equal the capabilities of the users and workers, and thereby to condense the probable for fatigue, error, and unsafe acts[1]. Whereas anthropometry is the study of human measurement. It is one of the basic parts of ergonomics that refers to the measurement and collection of the physical dimension of the human body. It is used to improve the human fit in the workplace or to determine problems existing between facilities or equipment and the employees using them [2]. Anthropometric data are used in ergonomics to specify the physical dimensions of workspaces, equipment, furniture, and clothing to "in shape, the task to the man" [3] and it also helps us to avoid any kind of dimensioning mistakes of products and equipment. Anthropometrics measures are usually expressed by percentile. A percentile is defined as a measure used in statics representing the value below which a given percentage of observations in a group of observations fall. The previous studies only show the design and dimensioning of the workstation but in our study, we not only show the design and dimensioning of the workstation but also implement a workstation including sitting chair and sewing table to understand the physical improvement of workers by measuring RULA score before and after implementing the workstation.

2. Methodology

For the purpose of this study 100 workers are taken from a particular garment industry to measure the RULA score of upper arm position, lower arm position, wrist posture, neck position, trunk position and leg position. Dimensions of existing furniture also taken by a standard measuring tape in order to, mismatch with anthropometric measurements. Anthropometricdimensions were also taken at standard sitting and standing position as well as wearing light cloths and barefooted. Workers body dimension were taken when they were sitting at flat surface, their upper and lower legs were at right angle (knees bent at90^0) and feet positioned at flat surface. After that comparison have been made between the existing furniture dimensions and our calculated furniture dimensions which we consider for designing a better ergonomic workstation. Using our calculated dimensions, we have designed a workstation and measured the RULA score of following positions again of same workers and compared the RULA score of existing and designed workstation. For determining the percentile value, we have used Microsoft Excel.In this study, 5^{th} percentile and 95^{th} percentile was taken as the limit range.

2.1Existing Situation

Most ofworkers in RMG sectors modify their seats according to their comfort. Their temporary hacks can provide them relief for a certain amount of time but in the long run they can cause long term bad effects on spine. Back pain severity can't be denied as well as neck pain is also associated with this.
Several initiatives are taken by the management to deal with this problem. This kind of injuries are mainly caused by poor posture and faulty seats which do not follow the anthropometric guidelines. Management allows 10-15 minutes every few hours for the workers to get up from their seats and stretch. But most of the workers don't follow any of

these rules. Figure 01 shows some of the examples of workers modifying their workstation by adding cushions which not only disturbs the work posture but also paves the way for future physical injuries.

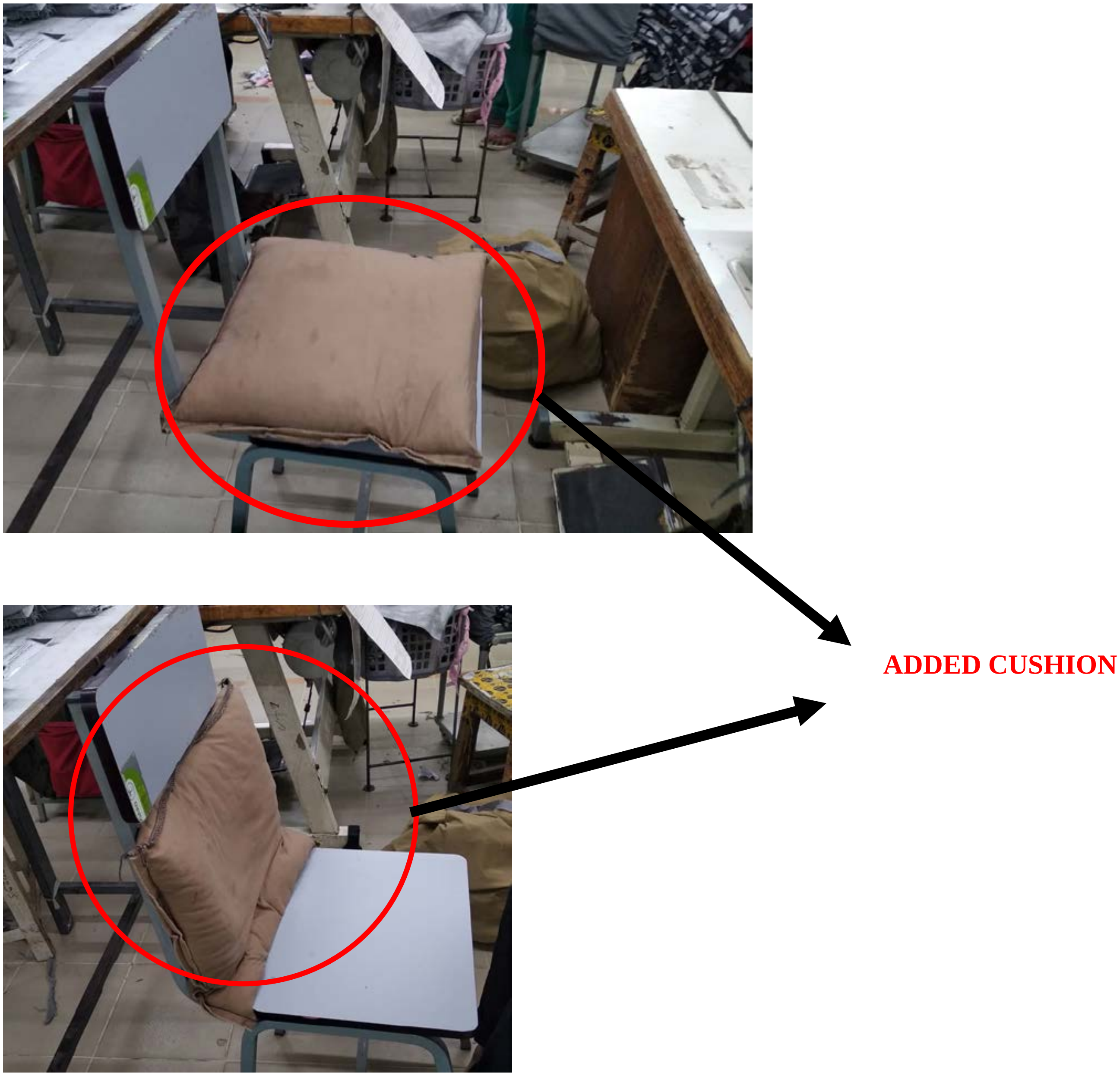

Figure 01: Workers add cushion to their workstation without knowing the long-term effects

2.2 RULA ANALYSIS [2] :

RULA (Rapid Upper Limb Assessment) is an ergonomic assessment tool to evaluate the exposure of individual workers to ergonomic risk factors associated with upper extremity MSD (Musculoskeletal disorder). The RULA considers biomechanical and posturalload requirements of a job tasks/demands on the neck, trunk and upper extremities. Based on the evaluations,the evaluator will assign a score for each of the following body regions: upper arm, lower arm, wrist, neck, trunk, and legs. After the data for each region is collected and scored, tables on the form are then used to compile the risk factor variables, generating a single score that represents the level of MSD risk.For example, where score 1-2 indicates negligible risk and no action required, there score 6^{+} indicates very high risk and implement change now.

2.3 Garments Furniture Measures:

Some parameters which are used to determine the furniture dimension are:
Seat height (SH): The vertical distance from the ground to the highest point on the front of the seat.
Seat depth (SD): The horizontal distance from the back to the front of the sitting surface of theseat.
Seat width (SW): The horizontal distance from the outer left side of the sitting surface to outer right side of the seat.
Backrest height (BH): The vertical distance from the top side of the seat surface to the highest point of the backrest.
Table height (TH): The vertical distance from the floor to the top of the front edge of the table.
Table thickness (TT): The vertical distance from upper to lower point of a table.

2.4 Anthropometric dimensions of the worker:

The anthropometric measurements (Fig.1) were collected in the seated and standing positions in a bare foot. The following anthropometric measurements were taken for each worker:
Functional forward reach:The linear distance from shoulder to the maximum distance of forward control.
Tibial height: The vertical distance from the ground to the top of the kneecap in standing position.
Elbow height: The vertical distance from the ground surface to the lowest point of the elbow in standing position.
Shoulder height: The vertical distance from the ground surface to the highest point of the shoulder in standing position.
Stature: The vertical distance from the ground surface to the highest point of the head in standing position.
Thigh clearance: The vertical distance from the sitting surface to the top of the thigh at horizontal position with the knee flexed at 90 degrees
Sitting elbow height: The vertical distance from the lowest point of the elbow to the sitting surface when the elbow is flexed at 90 degrees & the upper arm hanging horizontally.
Sitting shoulder height: The vertical distance from the sitting surface to the highest point of the shoulder in sitting position.
Sitting eye height: The vertical distance from the sitting surface to the eye in sitting position.
Sitting height: The vertical distance from the sitting surface to the highest point of the head in sitting position
Buttock knee length: The horizontal distance from the back of the buttocks to the front of the knee, when sitting with the knee flexed at ninety degrees.
Buttockpopliteal height: The horizontal distance from the back of the buttocks to the back the knee, when sitting with the knee flexed at ninety degrees.
Hip breadth: The maximum horizontal breadth across the hips or thighs in sitting.

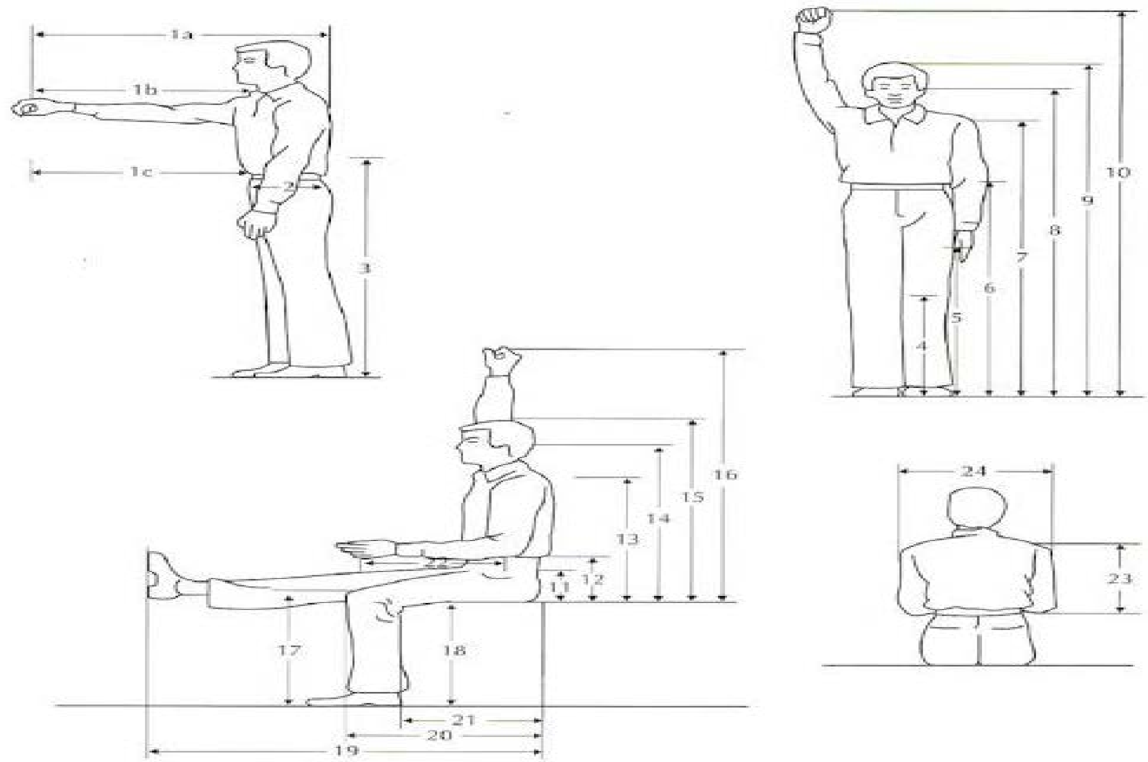

Figure 2: Anthropometric measurement [6]

3. Data collection and calculation:

Measurements of 100 workers are taken from a particular ready-made garments industry in working and non-working situation.

3.1 Anthropometric measurements:

Anthropometricdimensions were taken at standard sitting and standing position as well as wearing light cloths and barefooted. Sitting dimension were taken when they were sitting at flat surface, their upper and lower legs were at right angle (knees bent at90^0) and feet positioned at flat surface. And by statistical analysis, the value of mean, 5th percentile and 95th percentile is presented in Table 1.

Table 1: Anthropometric measurements in centimeter of people of particular garment industry

Dimension	Male			Female		
	5th	Mean	95th	5th	mean	95th
1. Functional Forward Reach	61.0	67.575	76.475	55.8	65.509	118.4
4. Tibial Height	48.050	52.770	58.0	10.0	14.327	20.0
6. Elbow Height	98.0	106.775	118.950	89.6	97.318	104.2
7. Shoulder Height	130.025	139.967	152.9	108.4	125.582	134.2
9. Stature	166.5	168.275	181.9	143.0	151.627	163.0
11. Thigh Clearance	10.0	15.203	19.975	10.0	14.327	20.0
12. Sitting Elbow Height	16.050	21.942	29.0	18.0	22.691	28.0
13. Sitting Shoulder Height	51.050	58.375	65.950	48.6	67.6	55.291
14. Sitting Eye Height	66.050	76.058	105.050	61.6	72.055	116.2
15. Sitting Height	72.2	86.990	108.3	73.8	83.309	125.2
20. Buttock Knee Length	48.5	54.617	59.0	43.8	51.358	58.0
21. Buttock popliteal length	38.0	44.892	50.975	35.8	42.118	48.2
25. Hip Breadth	24.050	31.0	37.9	22.0	32.736	41.2

Neck Posture Score	Table B: Trunk Posture Score											
	1		2		3		4		5		6	
	Legs		Legs		Legs		Legs		Legs		Legs	
	1	2	1	2	1	2	1	2	1	2	1	2
1	1	3	2	3	3	4	5	5	6	6	7	7
2	2	3	2	3	4	5	5	5	6	7	7	7
3	3	3	3	4	4	5	5	6	6	7	7	7
4	5	5	5	6	6	7	7	7	7	7	8	8
5	7	7	7	7	7	8	8	8	8	8	8	8
6	8	8	8	8	8	8	8	9	9	9	9	9

Table A		Wrist Score							
		1		2		3		4	
Upper Arm	Lower Arm	Wrist Twist		Wrist Twist		Wrist Twist		Wrist Twist	
		1	2	1	2	1	2	1	2
1	1	1	2	2	2	2	3	3	3
	2	2	2	2	2	3	3	3	3
	3	2	3	3	3	3	3	4	4
2	1	2	3	3	3	3	4	4	4
	2	3	3	3	3	3	4	4	4
	3	3	4	4	4	4	4	5	5
3	1	3	3	4	4	4	4	5	5
	2	3	4	4	4	4	4	5	5
	3	4	4	4	4	4	5	5	5
4	1	4	4	4	4	4	5	5	5
	2	4	4	4	4	4	5	5	5
	3	4	4	4	5	5	5	6	6
5	1	5	5	5	5	5	6	6	7
	2	5	6	6	6	6	7	7	7
	3	6	6	6	7	7	7	7	8
6	1	7	7	7	7	7	8	8	9
	2	8	8	8	8	8	9	9	9
	3	9	9	9	9	9	9	9	9

Table C		Neck, Trunk, Leg Score						
		1	2	3	4	5	6	7+
Wrist / Arm Score	1	1	2	3	3	4	5	5
	2	2	2	3	4	4	5	5
	3	3	3	3	4	4	5	6
	4	3	3	3	4	5	6	6
	5	4	4	4	5	6	7	7
	6	4	4	5	6	6	7	7
	7	5	5	6	6	7	7	7
	8+	5	5	6	7	7	7	7

Figure 2: Table used in RULA analysis [7]

3.2 The RULA score of existing design:

Arm and Wrist Analysis:
Upper arm position: +2
Lower arm position: +1
Wristposition: +2
Wrist twist: +1
So, posture score from Table A is 3.
The muscle use score: +1
Force/ Load score: 0
The Wrist / Arm Score: 3+1+0 = 4
Neck, Trunk and Leg Analysis:
Neck position: +3
Trunk position: +3
Legs: +1
Posture score from Table B is 4
Neck, trunk and leg score is 4+1+0= 5
So from Table C the RULA score is 5.
This means there is medium risk and changes are needed.

3.3 Dimension of existing workstation:

Seat height (SH): 48 cm
Seat depth (SD): 44cm
Seat width (SW): 31cm
Table height (TH): 77cm
Table thickness (TT) : 5 cm.
Pedal height from ground: 5cm.
distance between two workstations is 43cm

3.4 Dimension of existing workstation:

Designed furniture dimensions are based on anthropometric measurements which are presented in Table 1.

3.4.1 Seat Height (SH):

Literally popliteal height (PH) is considered for the seat height (SH) which should allow the knees to be flexed so that the lower legs form a maximum angle of thirty degrees relative to vertical axis [3]. For this study, 5cm correction for pedal height is included as the measured pedal height is 5 cm from ground. Therefore, the seat height,
$(PH+8) \cos 30^{o} \leq SH \leq (PH+8) \cos 5^{o}$
SH (maximum, minimum) = ((47+5) cos 5, (36.2+5) cos30) = (51.8, 35.68) cm

3.4.2 Seat depth (SD):

The seat depth (SD) should be designed for the 5thpercentile buttock popliteal length distribution so that the backrest of the seat can support the lumbar spine without compression of the popliteal surface. Therefore, measurement of women is considered, as it is lower.
Thus the seat depth = 35.8 cm

3.4.3 Seat Width (SW):

Seat width should be designed for the 95% of hip breadth distribution so that people can easily sit on it. We consider the male measurement in this purpose.
Therefore, the seat width is 37.9 cm

3.4.4 Backrest height (BH):

According to many researches the backrest should be lower than or at most on the upper edge of the scapula (which is 60% to 80% of shoulder height) [3]. Therefore, an equation for calculating BH is
$0.6*SSH \leq BH \leq 0.8*SSH$
So BH (maximum, minimum) = (0.8*58.37, 0.6*55.29) = (46.7, 33.17) cm

3.4.5Table height (TH)

Table height should be adopted to elbow height from ground. If this distance were significantly greater than the elbow height, he/she would be required to work with both arms in a degree of abduction or scapular elevation to compensate for the higher work surface. Again if the seat to table distance were significantly lower than the sitting elbow height of the sitter, the sitter would be required to stop to work effectively at the table [4]. Elbow height from ground is the sum of sitting elbow height and seat buttock popliteal height. Therefore, the table height
For man is (29 + 51) = 80 cm
Forfemale = (18+35.8) = 53.5 cm

3.4.6 Table thickness (TT)

Table thickness should allow the foot of worker to be under the work table. It should be within the difference of sitting elbow height and sitting thigh height. Male measurement of 95th percentile is considered in this purpose.
Table thickness is 29 – 19.97 = 9.03 cm

3.4.7 Swivel handle: A swivel handle of 45cm is used to facilitate the passing of material as distance between two workstations is 43cm.

3.5 Comparison between dimensions of existing workstation and design workstation:

Seat height of existing workstation is 48 cm. But it should be within 51.8cm to 35.68cm. So the existing chair is appropriate for only people of specific dimension, not for all as it is not adjustable. So an adjustable seat should be provided whose height can be varied from 51.8cm to 35.68cm. Seat depth of existing workstation is 44cm. But it should be 35cm. So a number of people cannot sit here comfortably due to their dimension.Seat width of existing workstation is 31cm. But it should be 37.9cm. So people with larger width, taller height cannot sit here comfortably.An adjustable backrest should be provided whose dimension is varied from 33.17cm to 46.7cm. Table height of existing workstation is 77cm. But it should be within 53.5cm to 80 cm. So people with lesser width and height like women of 5th percentile cannot work comfortably. So an adjustable table should be provided whose height can be varied from 53.5cm to 80cm. Table thickness of existing workstation is 5cm. And it should be within 9cm. so only this dimension is aligned with our desired dimension.

4. Result

We designed an adjustable chair and an adjustable table based on the calculated measurements. The table should be tilt to fifteen degrees. The slanted work surface results in less bending of the neck, more upright trunk and less trunk flexion than does the horizontal surface [5]. So it helps to reduce the bad posture like the bent neck, bent trunk etc. Edges of table and chair are rounded. We also added a custom SWIVEL HANDLE with the chair so that the worker can easily pass the goods to the front and to the back workstations which saves them from twisting their back to give out to pass work items.

Figure 03: Proposed design of the adjustable chair

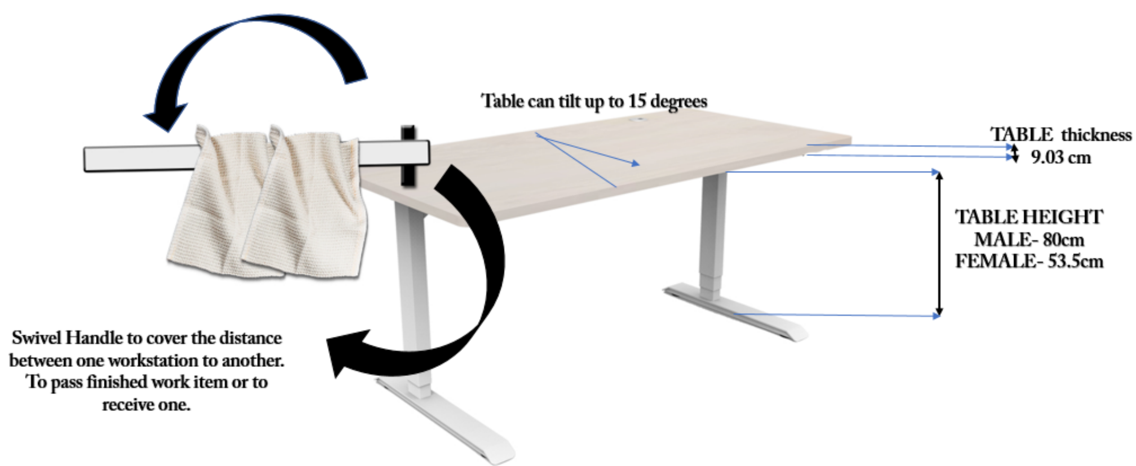

Figure 04: Proposed design for the adjustable table with swivel handle

5. Discussion

In actual practice in ready-made garments, the workstation is not ergonomic as it is not based on anthropometric measurements. As a result, not only production gets hampered but also lessens of human resources. We try to mitigate this. After implementing a similar design, the RULA score is measured again. And in this time the RULA score is reduced from 5 to 2 which also indicates that the design eliminates the bad posture of the worker. This design is capable of reducing pain and improving productivity and worker safety. Besides, some supporting tools can be added to improve the posture that is not provided due to some limitations.

6. Conclusion

This study mainly focuses on the sewing section of garments factory as the lion share of the workers work here and for this reason, it plays a vital role in factory. Increment of productivity and safety are the vital result of the study as after implementing the design the productivity and safety is increased. But due to lack of awareness of workers as well as management ignore it. As a result, they suffer from a huge monetary and human related loss. So the top management should consider it seriously and implement ergonomic workstation in full scale properly.

References

1. https://ergo-plus.com/rula-assessment-tool-guide/
2. Molenbroek, J.F.M., Kroon-Ramaekers, Y.M.T., and Snijders, C.J. 2003. *Revision of the design of a standard for the dimensions of school furniture.* Ergonomics 46, 681-694.
3. Milanese, S., Grimmer, K., 2004. School furniture and the user population: an anthropometric perspective. Ergonomics 47, 416–426.
4. M. M Kabir and M. Ahmed (2003)*Design of Working Chair and Table for Bangladeshi Garments Workers to Reduce Fatigue and Discomfort* ICME03-AM-53
5. A Step-by-Step Guide Rapid Upper Limb Assessment (RULA), Ergonomics Plus Inc
6. R. S. Bridger, *Introduction to Ergonomics,*1993,1st edition, October, McGRAW-Hill
7. Mark S. Sanders & Ernest J. McCormic, 1993, *Human Factors an Engineering and Design* 7th ed., McGraw-Hill
8. A. Shikdar, (2004), Identification of Ergonomic Issues That Affect Workers in Oilrigs in Desert Environments, *International Journal of Occupational Safety and Ergonomics (JOSE)*, vol. 10, no. 2, pp. 169-177.
9. M. Macias, M. G. Ramirez, J. L. Garcia, J. J. Diaz, S. Noriega, (2009), Ergonomic Evaluation of Work Stations Related With the Operation of Advanced Manufacturing Technology Equipment: Two cases of study, *XV Congreso internacional de ergonomia semac.*
10. Shikdar, O. I. Garbie, M. R. Khan Khadem, (2011), Development of a Smart Workstation for an Assembly Task, *Proceedings of the 2011 International Conference on Industrial Engineering and Operations Management Kuala Lumpur.*
11. Mahatme, S. Mahakalkar, V.Pradhan, S. Sonwane, (2014), A path for horizing your innovative work ergonomic analysis and workstation design for automation in steel industry, *International journal of pure and applied research in engineering and technology*, vol. 2, no. 9, pp. 390-401.
12. Tiwari, S. S. Banwait, R. K. Upadhyay, (2014), An ergonomic study of casting industry using fuzzy dominance and analytical hierarchy process, *International Journal of Advanced Technology in Engineering and Science*, vol. 2, no. 7, pp. 288-302.
13. Fang, C.C. Robert, H. Fang, (2007), An ergonomic approach to an investigation into the risk factors leading to work-related musculoskeletal disorders for taiwanese hairdressers, *International Association of Societies of design research.*
14. G. Trentin, G. A. Oliveira, D. Setti, (2012), Thermography: an a assessment tool in the Ergonomic Analysis of a Work Station in the Foundry Industry, *International conference on industrial engineering and operations management.*
15. L. Rahman, (2014), Study and analysis of work postures of workers working in a ceramic industry through rapid upper limb assessment (RULA), *International Journal of Engineering and Applied Sciences*, vol. 5, no. 3, pp. 14-20.
16. Myhre, (2012), The Other 21st Century HealthCare Issue: An Ergonomic Approach to Addressing Workplace Injuries, *Symposium on Human Factors and Ergonomics in Health Care*, pp.79-82.
17. Mohammad Iqbal, Salma A. Iqbal, A.N. Mustafizur Rahman and A.H.M. Samsuzzoha, (2011), Ergonomics and design, *Proceedings of the 2011 International Conference on Industrial Engineering and Operations Management Kuala Lumpur, Malaysia*, pp. 845-851.
18. D. Vaidya, K.G. Sontakke, N. A. Ansari, (2014), Ergonomics Evaluation of Body Posture of Worker In SSI, *Journal of Emerging Technologies and Innovative Research*, vol. 1, no. 6, pp. 430-434.
19. S. Mujumdar, V. Karandikar, S. M. Sane, (2013), Industrial Work Station design: An Ergonomic Approach to Number Punching Machine, *International Journal of Current Engineering and Technology*, vol. 3, no.4, pp. 1463-1466.

20. B. Wanave and M. K. Bhadke, (2013), An Ergonomic Evaluation & Assessment of the Workstation to Improve the Productivity for an Enterprise:-A Review, *Int. Journal of Engineering Research and Applications*, vol.3, no.6, pp. 1598-1602.
21. K. Swain, J. P. Gupta, S.K. Mohanty, P. K. Sahoo, (2009), Ergonomic evaluation of a pedal operated cashew nut sheller, Ergonomics for Everyone, *International Ergonomics Conference Humanizing Work and Work Environment*.
22. S. Ulin, T. J. Armstrong, R. G. Radwin, (1990), Use of computer aided drafting for analysis and control of posture in manual work, *Applied Ergonomics*, vol. 21, no. 2, pp. 143-151.
23. Bossomaier, A. Bruzzone, A. Cimino, F. Longo, G. Mirabelli, Scientific approaches for the industrial workstations ergonomic design: a review, *Proceedings 24th European Conference on Modelling and Simulation ©ECMS Andrzej Bargiela, Sayed Azam Ali David Crowley, Eugène J.H. Kerckhoffs (Editors)*.
24. https://www.ergocenter.ncsu.edu/resources_tools/workstation-design/ (Accessedon 15th September, 2019)
25. https://www.sciencedirect.com/topics/medicine-and-dentistry/workstation-design(Access on 15th September, 2019)
26. http://changingminds.org/disciplines/workplace_design/workstation_design.htm (Access on 15th September,2019)
27. Ibrahim H Garbie, An Experimental Study On Assembly Workstation Considering Ergonomically Issues, *Proceedings of the 41st International Conference on Computers & Industrial Engineering*, 2011, 275-282.
28. A. Ansari, P. N. Shende, M. J. Sheikh, R. D. Vaidya, (2013), Study and Justification of Body Postures of Workers Working In SSI by Using Reba, *International Journal of Engineering and Advanced Technology (IJEAT)*, vol.2, no.3, pp. 505-509.
29. K. Sengupta, B. Das, (1997), Human: An Autocad based three dimensional anthropometric human model for workstation design, *International Journal of Industrial Ergonomics*, 19, pp. 345-352.

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