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ASSESSMENT TOOLS OF ERGONOMICS FOR DIFFERENT WORKPLACES - A REVIEW

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Abstract-

This paper proposes a literature review effectively on various assessment tools for different workplaces. Designing a workspace is based on the principle that there are correlations between workplace and body dimensions that cause body posture to be adapted. The main aim is to provide the reader with an accurate overview on the main scientific approaches proposed by researchers working in this area. The paper passes through the description of several research works as they run through the literature. An ergonomically design workplaces improve production and ensure the safety of workers. The importance given to human beings rather than on technical considerations. There are different methods, principles and tools applied for improving the interaction between humans and their working environment. This article discusses several important assessment tools of ergonomics and focuses how it performs to achieve ultimate goal of research.

Keywords— Ergonomics, Ergonomic Workstation, Ergonomic Assessment Tools.

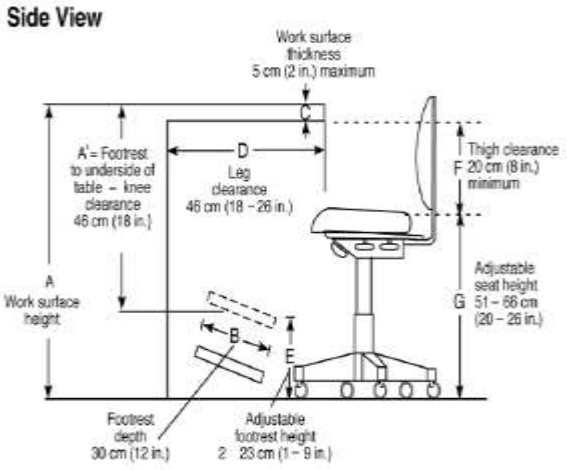
INTRODUCTION

The International Labour Organization (ILO) estimates that every day people die as a result of occupational accidents or work-related diseases – more than 2.78 million deaths per year. Additionally, there are some 374 million non-fatal work-related injuries each year. The human cost of daily adversity is vast and the economic burden of poor occupational safety and health practices is estimated at 3.94 per cent of global Gross Domestic Product each year. The reason behind that is an ergonomic problem at the workplace and bad design of work organization. It is always a wish to organize and implement a work that will result in less fatigue and consume low energy. Ergonomics is a term generally used in the area of working conditions improvement, whereas the term human factors is defined as "the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design, to optimize human well-being and overall system performance"[16].

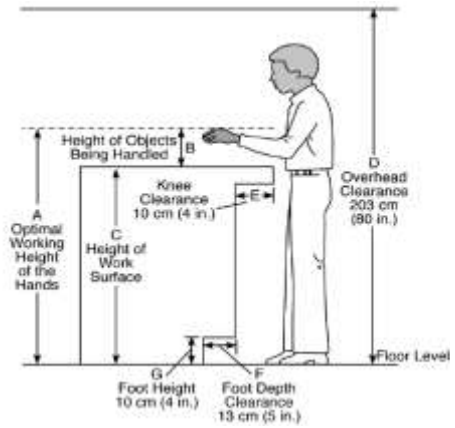
ILO defines ergonomics as, 'the application of human biological sciences, its conjunction with engineering science to the worker and his/her working environment to obtain maximum satisfaction and enhance productivity'. It is basically a man, machine and environment system [2]. There are different ergonomic standards which help to create effective workplace design such as, NISOH equations for lifting task (NIOSH stands for National Institute for Occupational Safety and Health), OWAS (OWAS stands for Ovako Working Analysis System), RULA (Rapid Upper Limb Assessment), REBA (The Rapid Entire Body Assessment) method, OCRA (Occupational Repetitive Action), Burandt Schultetus analysis, Garg Analysis [1].

There are different workplaces like sitting, standing and siting/standing [3]. For short-term task cycle, Sitting workplaces are used and those items do not need the hands to work at an average level of more than 15 cm above the work surface. In case of handle the Weights need to be less than 4.5 kg and also when workers are doing assembling or writing tasks for the majority of the shift they need to be in a sitting position. If there is no knee clearance for the seated operation then standing workplaces are used in that situations along objects that are being handled weight more than 4.5 kg. They are also used when reaches are frequent and high, low or extended such as those in front of the body, and when the operations, that have to be done, are physically separated and require frequent movement between workstations. Examples and measurements for sitting and standing workplace as shown in picture a and b.

Picture a



Picture b



LITERATURE REVIEW

To design an ergonomic workplace there are lots of software for giving appropriate solution like the Jack Siemens is one of them. This software offers ergonomic aspects of manual operations during early stages of designing products and manufacturing processes by improving safety, efficiency and comfort of the workplace environment using digital human models [6]. Tajana LUŠETIĆ et al. (2018) , showed that an ergonomic principles and recommendations are important to reduce physical stress, illness, facilitate task execution, and enable rapid information exchange in the work environment. Authors claimed that time is reduced by redesigning the workplace in a more ergonomic way so that workers don't have to do some unnecessary actions and for this case it was taking parts from the cart, walking to every product, walking to the storage for some parts and putting the final product on the cart. Authors claimed two proposals having a conveyor on the table. Worker would then put the final product on it and wouldn't have to walk to the cart which would result in reducing the time of this operation. Second proposal is assembling products on the rotating and lifting table since for every operation the position of the worker is different, so are the strains and loads for the body. With this proposal, the work of the worker could be facilitated. By using software Jack, it can determine strains and loads on the body in a simulation with human models. Finally, by virtual analysis of workplace prior its physical design we can foresee possible shortcomings that are relevant for proper workplace design.

R. Breen et al. (2007) , investigated 4th class children's posture and discomfort during computer use by Rapid upper limb assessment (RULA) method. RULA is a subjective observation method of postural analysis[8]. It requires no special equipment or previous skills in observation techniques and is a simple technique to learn [7].

Analysis	Step	Description
Wrist and Arm Analysis	1	Locate upper arm position
	2	Locate Lower Arm Position
	3	Locate Wrist Position
	4	Locate Wrist Twist Position
	5	Determine Posture Score A
	6	Add Muscle Use Score
	7	Add Force/Load Score
	8	Find Row in Posture Score C
Neck, Trunk and Leg Analysis	9	Locate Neck Position
	10	Locate Trunk Position
	11	Determine legs condition
	12	Determine Posture Score B
	13	Add Muscle Use Score
	14	Add Force/Load Score
	15	Find Column in Posture Score C
	16	Determine final score (1-7)

Table 1. Steps of RULA Assessment [9]

The main consideration is type of muscle work utilized (sitting) and the external loads experienced by the body. Assessments can be completed in a confined space without disruption to those under observation. Table 1 shows the steps of RULA assessment. The posture of 9–10 year old schoolchildren was found to be unacceptably poor and tended to deteriorate over a 15–25-min computer session. While using a mouse 16% children observed

feeling discomfort when using a mouse. One probable conclusion proposed that poor posture was associated with discomfort and musculoskeletal symptoms find out during computer use for even short periods of time.

Andrzej M. Lasota [2014], proposed a study to assess the workload and the risk of MSD's (Musculoskeletal disorders) in the process of order fulfillment for the packer position and to conduct an analysis of risk factors using the REBA (The Rapid Entire Body Assessment) method. REBA scoring steps as shown in Figure1. REBA is designed to assess the risk exposure associated with MSD's based on the posture of the operator at work and considers the issue based on the observation of techniques used in performing the work activities. It takes into account the body postures taken by the employee during physical work, distinguishing the following segments: trunk, neck, legs, upper arms, lower arms and wrists. Also included are load/force required, hand-object coupling used and an activity score (static postures held repetition, large rapid changes in postures or unstable base)[10].

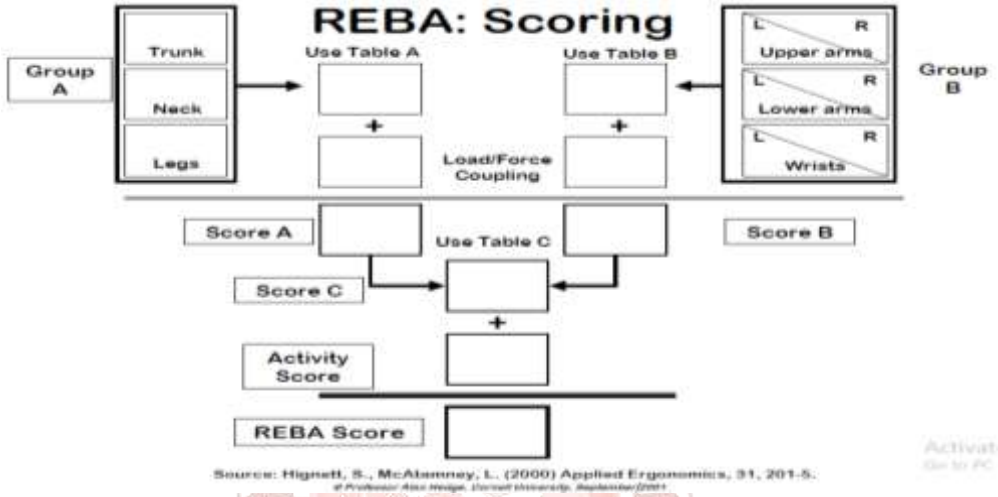


Figure 1. REBA SCORING

Figure 1. REBA Scoring

The authors singled out the five action categories such as AC 0 - negligible exposure for that corrective actions are not required, AC-1 low exposure levels for that corrective action may be required, AC - 2 medium level of exposure for that corrective actions are required, AC- 3 high level of exposure for that corrective action required soon, AC-4 very high exposure levels for that corrective action required immediately. The conclusion of this study to assess the level of exposure to MSD's in the process of order fulfillment using the REBA method and assign the activities to different action categories such as 5 activities for AC – 2, 7 activities for AC – 3, 1 activity for AC – 4. Author state the Ergonomic intervention related to − reorganization of workstations and redesign of working methods.

Ayodele Samuel Onawumi, (2012), makes an Ergonomic assessment of taxicabs using participatory ergonomic intervention approach among Southwestern Nigerian drivers. Author systematically used Participatory ergonomic intervention approach (PEIA) for work area analysis in the evaluation of ergonomic suitability of driver-vehicle system. By collecting data of driver like personal, musculoskeletal problems and evaluation of some selected in-vehicle components proposed a result of Percentage difference in the makes of the taxicabs in design and esthetics. Some facts regarding driving work and driver body was categorized in terms of Number of driving hours, work-related musculoskeletal problem over a period of time (at the head and neck body area, at the upper extremity link-system , at the thoracic extremity link-system, at the lower extremity link-system) on the body of drivers. Finally the result demonstrates general experience of low back and upper back pain, and other explainable musculoskeletal stress occurs at wrist pain, buttock right feet and neck of driver. The reason behind that the misfit between local driver body requirements and the imported technological system characteristics as a Occupational hazard. That can prevented by government should establish an Ergonomic Department in the ministry of Productivity/Works whose responsibility is to develop reliable database for different categories of user population in the Country [5].

Shahu R., (2016), The NIOSH Lifting Equation has its application in a variety of fields like at construction sites, casting firms, auto parts manufacturing, etc,. In each field study is concentrated to reduce the Low Back Pain (LBP) and calculate L.I. (Lifting Index) to assess risks due to various lifting tasks caused by manual lifting tasks at workplaces. The study based on these applications is being used to know effectiveness of lifting tasks in order to ensure safe working practices of workers at Technocrats India, Nagpur. The result shows increased L.I. for all the 8 operators working on the Cylinder Body part machining. Author give suggestions regarding ergonomically designed proper heighted tables and roller conveyers were made so that the working will be more protective in regards workers point of view.

ID	V	VM	H	HM	D	DM	A	AM	C	CM	L	DUR	F	FM	RWL	LI
1	39.37	0.93	3.97	1	4.17	1	83	0.71	POOR	0.9	17.63	8	0.3	0.81	11.07	1.59
2	11.85	0.85	7.91	1	3.97	1	87	0.71	POOR	0.9	17.63	8	0.32	0.81	10.11	1.74
3	39.37	0.93	4.17	1	4.13	1	79	0.76	POOR	0.9	17.63	8	0.33	0.81	11.85	1.49
4	16.37	0.89	7.99	1	8.18	1	84	0.71	POOR	0.9	17.63	8	0.27	0.81	10.59	1.66
5	12.16	0.85	15.35	0.67	4.13	1	88	0.71	POOR	0.9	17.63	8	0.3	0.81	6.77	2.6
6	39.37	0.93	8.07	1	4.09	1	86	0.71	POOR	0.9	17.63	8	0.33	0.81	11.07	1.59
7	16.6	0.89	12.02	0.83	4.17	1	87	0.71	POOR	0.9	17.63	8	0.3	0.81	8.79	2.01
8	16.18	0.89	4.56	1	4.96	1	84	0.71	POOR	0.9	17.63	8	0.3	0.81	10.59	1.66

Table 2: LI calculations for cylinder body part (Origin)

ID	V	VM	H	HM	D	DM	A	AM	C	CM	L	DUR	F	FM	RWL	LI
1	8.18	0.85	4.09	1	4.33	1	88	0.71	POOR	0.9	17.63	8	0.3	0.81	10.118	1.74
2	9.05	0.85	7.99	1	7.95	1	83	0.71	POOR	0.9	17.63	8	0.28	0.81	10.118	1.74
3	8.18	0.85	4.09	1	4.33	1	82	0.76	POOR	0.9	17.63	8	0.27	0.81	10.831	1.63
4	11.92	0.85	8.18	1	7.95	1	89	0.71	POOR	0.9	17.63	8	0.3	0.81	10.118	1.74
5	8.03	0.85	8.03	1	3.97	1	76	0.76	POOR	0.9	17.63	8	0.3	0.81	10.831	1.63
6	8.42	0.85	3.97	1	4.33	1	78	0.76	POOR	0.9	17.63	8	0.27	0.81	10.831	1.63
7	8.97	0.85	4.05	1	7.91	1	82	0.76	POOR	0.9	17.63	8	0.3	0.81	10.831	1.63
8	12.16	0.85	7.91	1	7.67	1	85	0.71	POOR	0.9	17.63	12	0.28	0.81	10.118	1.74

Table 3: LI calculations for cylinder body part (Destination).

There are 8 workers for the cylinder body part machining. Measurements for the variables for Cylinder body part are observed and based on these the RWL (Recommended Weight Limit) and LI were calculated and tabulated in table 2 and 3. The result after using the equation shows that for the Cylinder body part for all 8 operators, the LI came out to be greater than 1. This concluded there was a risk of LBP (Low Back Pain) and other injuries to the workers associated with the lifting tasks (both at the origin and the destination) [11].

Lene Bjerg SØRENSEN et al. (2011), describing the view while design of a Sterile Processing Plant on ergonomic basis. First time the project manager has to involve an ergonomist in one of his projects. The case study focused on to make the sterile processing plant to the shell of the new building. After the survey it became clear that the there is a need of ergonomic guideline in relation to integrating ergonomics in the engineering design of the sterile processing plant. The project manager circulated the document to actors in his own organization as well as in the hospital organization.

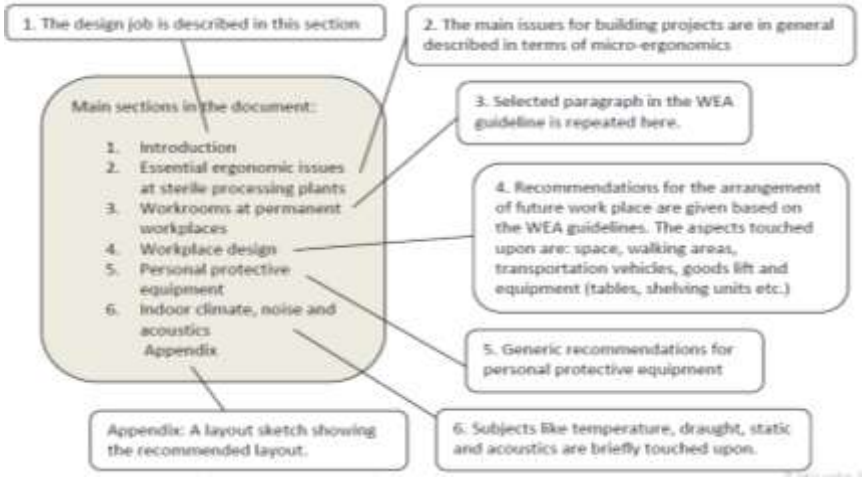


Figure 2. Content of the ergonomic guideline document

The study make an ergonomic guideline document became an important object and helps to integrate ergonomic knowledge into design processes [12].

Anuradha S. Patil et al. (2018), proposed a study regarding working condition of a urban woman in the kitchen and effects of a faulty kitchen counter on body of women as shown in table 4,

S.N	Working posture	Effects on body	Overall effect on Body
1	Working with hands too high and/or too far away	compensatory load on the curvature of the back	Lower Back Pain, Neck Pain, Feet Joint Pain, Shoulder Pain
2	Work surface too low	trunk flexion and back muscle strain	
3	Lack of clearance (standing too far away)	Constrained foot	
4	Working at the corner of counter	constrained foot position, toes turned out very much	
5	Standing in uncomfortable posture for a long time	twisted spine	
6	Tall person has to worked at sink and short person has to work above the counter	Tall person has to lean a lot and short person stretch shoulders and elbows above the counter.	

Table 4: Effects of a Faulty Kitchen Counter

The reduction of postural stresses is fundamental to workspace design in ergonomics. A many-sided approach is needed to arrive at appropriate workspace designs for different workers. To determine an optimal height for kitchen counter

then consider both the anthropometric diversity of the users and the diversity of tasks to be performed. Reason behind that kitchen counter is used by everyone in various age groups with variable body type, it is needed to be designed according to everyone's needs and convenience. If the user working at the counter gives a thought to the working parameters before starting the work rapidly, a lot of pain in the future can be saved. Design of kitchen platform cannot be generalized but it is to be customized by means of anthropometric parameters and ergonomic considerations [13].

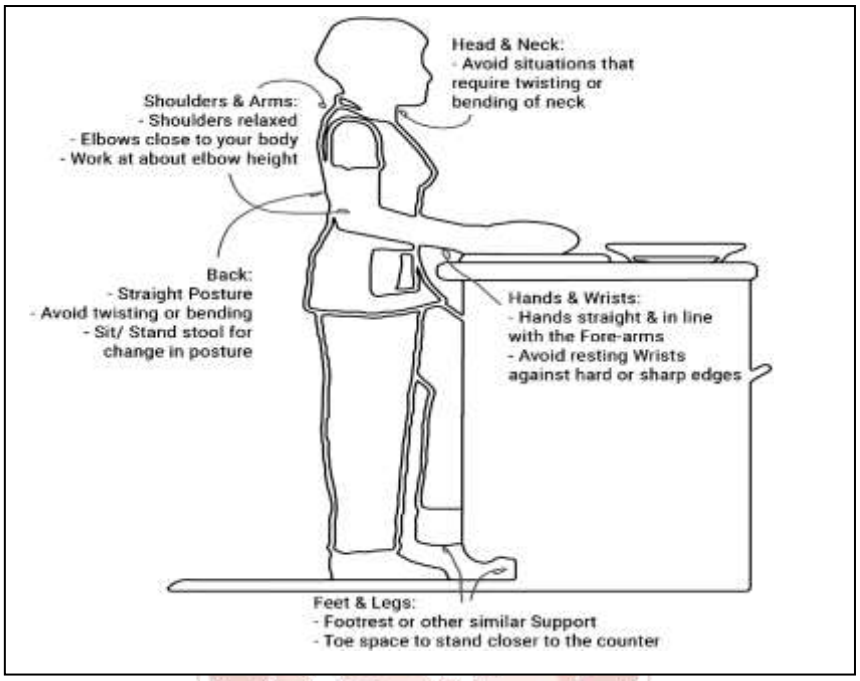


Figure 3: An indicative sketch of ideal posture for working at Kitchen Counter

An indicative sketch of ideal posture for working at Kitchen Counter as shown in fig3. The kitchen is one of the most obviously be treated as a functional workspace and hence, the human factors play key role in designing kitchen workspace. Researchers proposed some suggestions while designing a kitchen counter like Customizing counter heights, installing two or more counters at varying heights, enough space provided below the kitchen counter to accommodate the feet of the operator and for existing kitchen like check the height of the counter before you slice and dice such that arms at your sides and bend your elbows to 90 degrees, surface should be no more than a few inches below your hands and stand with your feet shoulder width apart to shoulders back and knees soft[14] [15].

The Thermography is use as a tool for ergonomic evaluation [4]. Brioschi et al., 2007, It is a technique that captures radiation in the long infrared band (7.5 to 13 µm) emitted by the human body, thus providing an image of the thermal distribution of the skin surface. The temperature of the skin, under carefully controlled environmental conditions, is mainly influenced by its microcirculatory activity and by the production of heat conducted to the surface which has been generated in deeper tissues. Thermography has more recently been called Infrared imaging (II), due to the new ultra-sensitive infrared detectors [17]. The equipment used for obtaining thermograms is a FLIR portable device, model InfraCamtm[4]
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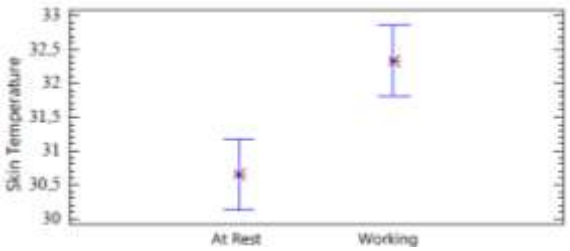

Figure 4: Skin temperature before and after 1.5 hrs.

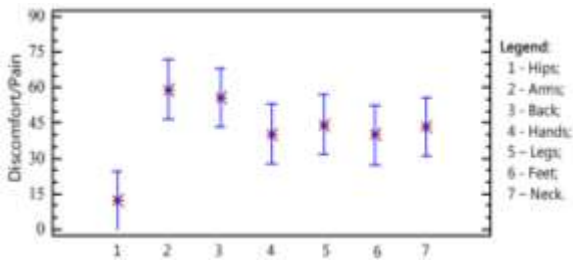

Figure 5: Perception of discomfort and (or) pain.

Figure 4 clearly shows the increase of the average skin temperature that thermograms were collected from a volunteer of the regions analyzed before and after 1.5 hours of activity. The average difference is 1.8^0 C. A question to be interpreted is how much this difference represents in terms of physical exertion. For this case, it is understood that the difference represents great exertion demanded from the employee due to two reasons, first is the An analysis of perceived pain and discomfort from the finishing sector (Figure 5) shows that the regions analyzed are in great demand and second is

the article by Guimarães, Fischer and Bittencourt (2004) made an analysis of an activity that requires great physical exertion and the biggest difference presented was 1.4° C, before and after the activity [18]. The results shown by the thermograms collected were consistent with the subjective analysis of discomfort and (or) pain made in the sectors of molding and finishing [4].

DISCUSSION AND CONCLUSION

From the literature it mentions that ergonomically design workplace is very important to reduce fatigue, provide more working comfort, lowered different musculoskeletal disorder, productivity and workers safety increased. When workers or any person works in a workplace which is ergonomically design then there will be less chances of bad effect on human body. But in some condition like work from home, part time job, computer operating job, etc. where work has to be done anytime and anywhere at that time there is no favorable working conditions. Each assessment tool has its own constraints and should be applied to appropriate tasks. The author's research has shown that a task evaluated most effectively when a certain type of tool is used appropriately. Workers who are using laptop/computer in home at that time they are using a generalized furniture/sitting place which is comfortable to them. Meanwhile after some time lapse the instant posture change, neck pain, back pain, eye straining such types of problems occurs. Literature reviews gives clear idea about how different assessment tools are use while designing different workplace, which parameters are consider and how to assess the workplace ergonomically.

REFERENCES

Antonio Cimino, Duilio Curcio, Francesco Longo, Giovanni Mirabelli,(2008), Workplaces Effective Ergonomic Design: A Literature Review, EMSS Proceedings 2008.

Maja Trstenjak,(2018), ERGONOMIC DESIGN OF WORKPLACE, Conference: MOTSP2018, At Primošten, Croatia.

Kodak's Ergonomic Design for People at Work, Second Edition, The Eastman Kodak Company, 2004.

Marcelo Gonçalves Trentin , Gilson Adamczuk Oliveira, Dalmarino Setti , '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, July 9-11 2012.

Ayodele Samuel Onawumi* and Emmanuel Babajide Lucas, 2012, Ergonomic assessment of taxicabs using participatory ergonomic intervention approach among Southwestern Nigerian drivers, Article in International Journal of Manufacturing Technology and Management , Vol. 25, Nos. 1/2/3, 2012

Jack User Manual, Version 8.2, 2014 Siemens Product Lifecycle Management Software Inc., 2014.

MCATAMNEY, L. and CORLETT, E.N., 1993, RULA: A survey method for the investigation of work-related upper limb disorders. Applied Ergonomics, 24, 91–99.

R. Breen , S. Pyper , Y. Rusk & S. Dockrell (2007) An investigation of children's posture and discomfort during computer use, Ergonomics, 50:10, 1582-1592, DOI: 10.1080/00140130701584944.

Kian Sek Tee, Eugene Low, Hashim Saim, Wan Nurshazwani Wan Zakaria, Safinaz Binti Mohd Khialdin, Hazlita Isa, M. I. Awad, and Chin Fhong Soon, A study on the ergonomic assessment in the workplace, AIP Conference Proceedings 1883, 020034 (2017).

Andrzej M. Lasota,2014, A REBA-BASED ANALYSIS OF PACKERS WORKLOAD: A CASE STUDY, LogForum Scientific Journal of Logistics , 2014, 10 (1), 87-95, p-ISSN 1895-2038, e-ISSN 1734-459X.

Shahu R., (2016), The NIOSH Lifting Equation for Manual Lifting and Its Applications. Journal of Ergonomics 6:15, ISSN:2165-7556 JER, an open access journal,doi: 10.4172/2165-7556.1000159.

Lene Bjerg SØRENSEN1,2 and Ole BROBERG1,(2011) , Integrating ergonomics into the engineering design of a hospital sterile processing plant: The role of an intermediary object, Conference: 10th International Symposium on Human Factors in Organizational Design and Management (ODAM), Volume: 1 (235-240).

Anuradha S. Patil1 (&) and Neela R. Rajhans2, (2018) , Human Factors in Designing Workspace: Customizing Kitchen Counter Design Conference Paper (PDF Available) in Advances in Intelligent Systems and Computing .

Singleton, W.T.: Introduction to Ergonomics. World Health Organization, Geneva (1972).

Kanawaty, G.: Introduction to Work Study, p. 542. International Labor Office, Geneva (1992).

Boatca, M., Elena, C.B.: A proposed approach for an efficient ergonomics intervention in organizations. Procedia Econ. Finance 23, 54–62 (2014).

BRIOSCHI, M. L.; YENG, L.T.; PASTOR, E.M.H.; TEIXEIRA, M.J. Utilização da imagem infravermelha em reumatologia. Rev. Brasileira Reumatologia, São Paulo, v.47, n.1, 2007. Available at: <http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0482-50042007000100008&lng=en&nrm=iso>. Accessed on: 02 Oct. 2007.

GUIMARÃES, L. B. M.; FISCHER, D; BITTENCOURT, P.I.H. Avaliação da Carga de Trabalho de Eletricistas Sistemas para Subida em Poste. XIII Congresso Brasileiro de Ergonomia, Fortaleza, 2004.