ISSN:1991-8178

Australian Journal of Basic and Applied Sciences

Journal home page: www.ajbasweb.com

Study of Ergonomic Risks in Wooden Furniture Production

[1]Butree Kaden, [2]Kritsada Wannapa and [3]Preecha Khansri

[1]*Department of Industrial Engineering, North-Chiangmai University, Chiangmai, Thailand*
[2]*Department of Industrial Engineering, North-Chiangmai University, Chiangmai, Thailand*
[3]*Department of Industrial Engineering, North-Chiangmai University, Chiangmai, Thailand*

ARTICLE INFO

Article history:
Received 12 March 2015
Accepted 28 April 2015
Available online 2 May 2015

Keywords: *Ergonomics, Rapid Upper Limb Assessment, Occupational Safety, Wooden furniture, International Labour Organization checkpoints.*

ABSTRACT

Background: This research aimed to study ergonomic risks factors in wooden furniture production processes. Researchers applied 2 methods using International Labour Office checkpoints and Rapid Upper Limp Assessment. **Objective:** To assess ergonomic risk factors in 10 wooden furniture factories. **Results:** From using International Labour Office checkpoints, materials storage and handling and workstation design were in high risk From RULA assessment, postures of lower arm, trunk and neck of operators were in high risk scores. **Conclusion:** Several working postures in producing wooden furniture were in high risks and should be approved for better environment and safety for workers.

To Cite This Article: Butree Kaden, Kritsada Wannapa and Preecha Khansri., Study of Ergonomic Risks in Wooden Furniture Production. ***Aust. J. Basic & Appl. Sci.,*** *9(17): 64-70, 2015*

INTRODUCTION

This research studied several ergonomic risk factors of operators in 10 wooden furniture factories in Bantawai, Chiangmai. Bantawai is the village of wood-carving handicrafts that has been known as an important and attractive cultural place of Chiangmai for Thai and foreign tourists. Several type of wooden products will be found in Bantawai for example: wood-carving furniture, wood texture-polishing furniture, crackle paint wood furniture and wood antique furniture.

Because of a high skill laborers within several years experience, wooden products in Bantawai becomes Economic value added products for village community. Mostly, the studied wooden furniture business were carried on from ancestors. Outstanding technical skill of production were also passed on knowledge. Similarly, there are also no alterations working conditions and procedures.

From a generally surveying, 10 of studied factories have an assembly processes as major production, that are processes occurred after several pre-assembly process such as polishing, cutting, etc. The number of assembly factories are more than other type of production, so researchers decided to study in this type of production because the results of studying will be abundantly useful and may becomes the beginning point of further ergonomics study in wooden production in Bantawai.

Several researchers studied extensively about laborer safety and ergonomics. There are sparsely studying of occupational accidents among workers in the wooden furniture industry (Jegatheswaran *et al*., 1012), it is necessary to reexamine several parameters in this type of industry persuade job attraction for workforce permanently. In Thailand, wooden furniture accident records from 2005 to 2009, work station of accident is Machine centre related with tasks of handling heavy and bulky wood stocks, mishandling machines and poor extraction of wastes. From the injury report rate for wood product manufacturing in Maine during 1987 to 2004 was almost twice the state-wide average for all manufacturing, associated variables related to job risks were high physical workload, machine incompetence, training deficiency, absence of a lockout and tagout schedule, low seniority status, and male gender (Christina and Laura, 2009). The American Furniture Manufacturers Association has developed a guideline for its members (Gary, 2005) including, the role-play characteristics of the partnership, the different motivative techniques for pursuing workers and some challenges confront during attempts, with a hope to be helpful for others in furniture industry. A study of participatory intervention in a furniture manufacturing company in Southern Brazil by replacing a cellular teamwork model instead of the former Tayloristic model (Guimarães *et al*.), results of the study indicates that it is possible to make balance between ergonomics

Corresponding Author: Butree Kaden, Department of Industrial Engineering, North-Chiangmai University, Chiangmai, Thailand.
Tel: +66-871786634; E-mail: budtree073@gmail.com

and production capacity that it is essential to make a clarify management. Moreover, making the balance and sustainability of the two former factors can increase both worker contentment and productivity efficiency. In the furniture manufacturing industry records (Gary *et al*., 2002) and survey data identified that workers are in high risk for work-related low back injuries because of during the loading and unloading furniture with high forces, performing static awkward postures during upholstering the furniture and repetitive bending and twisting posture all the day of working.

For wooden furniture production, it is necessary to pay attention to hand tool design. Since hand tools are devices that involve in almost every production sequences. The redesign of cutting non-powered hand tools for cutting wood has been approached by studying the difference of blade coating materials affect to the force demands, it was found that the force demands of cutting hand tool blades can be reduced by using Polytetrafluoroethylene coating substitute for lacquer or chromium coating and more ergonomic usability will be useful to improve consumer supply in the market (Minna and Tanja, 2003). Universal design methodology in hand tool design process is a methodology to convert user evaluation into crucial design factors by the universalized evaluation scale based on product attributes, this methodology will be useful for contribution user-centered universal design application (Kai-Chieh Lina and Chih-Fu Wub, 2015).

International Labour Office's (ILO) ergonomics checkpoints:

ILO Ergonomics Checkpoints is a list of the titles of the ergonomic checkpoints included 132 items in the list, user may use either the whole list or their own list containing only those items relevant to their workplace. The manual presents 132 realistic and flexible solutions to ergonomic problems that can apply to use in whole range of workplaces, subjects of checkpoints including 9 categories: materials storage and handling, hand tools, machine safety, workstation design, lighting, promises, control of hazardous substances and agents, welfare facilities and work organization (International Labour Office in collaboration with the International Ergonomics Association, 2010). Each of the checkpoints shows an action, the reason of improving requirements, and also recommends further mentions. Moreover, the template checklist is also included and can be easily adapted to uses in every workplace. Application of the International Labour Office's ergonomics checkpoints in the industries of industrially developing countries to assess ergonomic awareness in 3 companies. The subject of this study were to apply basic ergonomics through a participatory ergonomics intervention process that can support a continuous learning process and lead to an improvement in health and safety as well as in the work systems in the organization (Faramarz Helali,2009). The reason why ILO checkpoints are : typical good practices can be represented in multiple areas, how-to section of these checkpoints shows easy improvements principles and the illustrated checkpoints can be used as group work tools in short-term training courses to raise safety and ergonomics attitude in industry (Kazutaka, 2007)

RULA (Rapid Upper Limb Assessment):

RULA is a method developed for using in ergonomics investigations of workplaces where work-related upper limb disorders (Lynn McAtamney and E Nigel Corlett, 1993), this method was designed to provide a quick analysis of worker's upper limb. It provides an objective measure of the work-related upper limb disorders risks by performing tasks where the demands on the upper body are high but the whole body demands are relatively low. Body parts evaluated by RULA technique are includes: hand, wrist, elbow, shoulder, neck and low back . The uses of this ergonomics evaluation approach are in different risk score between 1-7, where higher score signify greater level of apparent risk. The RULA score was developed to detect work postures or risk factors that deserve further attention.

Many researchers used RULA assessment methods to evaluate job risks in several job type (Mao-Jiun J. *et al*., 2004), (Alireza *et al*., 2004), (M. Massaccesia *et al*., 2003). The assessment result can lead to the proper working posture solution that can reduce the working risk level.

Objectives:

This study aimed to study ergonomic job risks on wooden furniture assembly operations. Ten wooden furniture factories were participated in this research. Objective of this study is to find out ergonomic problem of working and solution; results of this study will be useful and can be implemented further improvement of wooden furniture production. That would be a beginning point of gravely concerning about working ergonomics and workers' life quality.

Methods:

Subjects:

Ten wooden furniture factories were participated in this study. All factories production process were in assembly operations

Methods:

Application of International Labour Office's (ILO) ergonomics checkpoints:

To achieve the aim of the study by using the ILO ergonomics checkpoints, the manual was used to collect data for 6 months of time. The checklists

were redesigned locally adapted to be easily handling. Then, researchers made ready-to-use information sheets; and organized training workshops for planning and implementing. Using the ILO ergonomics checkpoints is shown in Figure (1).

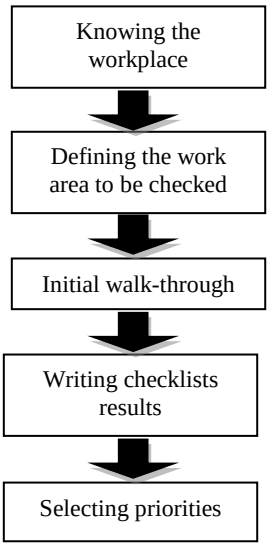

Fig. 1: ILO ergonomics checkpoints procedures.

The study began from forming a research team. Then, training the team for more understanding and evaluating skill. The factories were observed by our team using the checkpoints thoroughly. In this research, writing checklists results were, if the measure has already been taken properly or is not needed any action the score is 0 (mark NO). If there were some problems that need further action, the score is -1(mark YES). Finally, checked a few items where the benefits seem likely to be the most important, the score is -2 (mark PRIORITY). Moreover, we can use the space under "Remarks" to put a description as shown in Figure (2). After measurement finished, researchers calculated total score for further decision to take action for improvement.

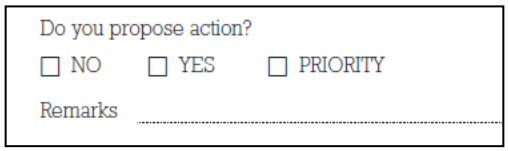

Fig. 2: Checking Example.

Application of Rapid Upper Limb Assessment:

To apply RULA technique in this research, researchers started with taking pictures of operators with digital camera. Four positions (left, right, front and back side) of working postures were taken. The score were given step by step. The first step is scoring the position of the upper arm, lower arm and wrist. The second is to decide if the worker works mostly with their hand/forearm in neutral or the palm of the hand facing up/down. The third step is determining the combined posture, muscle use and force/load score by considering RULA table and total up the scores. Next, scoring the posture of the neck, trunk and legs. Afterwards, determine the combined score for the neck, trunk and legs. The last step is to find the final score. Final score of 1-2 means posture is acceptable if it is not maintained or repeated for long periods. Final score of 3-4 means further investigation is needed, changes may be required. Final score of 5-6 means investigation and changes required soon and final score of 7 means investigation and changes are required immediately (Lynn McAtamney and E Nigel Corlett, 1993). RULA method scoring is shown in figure (3).

RESULTS AND DISCUSSIONS

Results of Application of ILO ergonomics checkpoints:

As shown in Figure (4), results from applying ILO ergonomics checkpoints to evaluate 10 wooden furniture factories. Researchers found that the average materials storage and handling is the highest risk factor at -0.55(±0.27), the next below is average workstation design score is at -0.50(±0.23) and average hand tools score is at -0.40(±0.19).

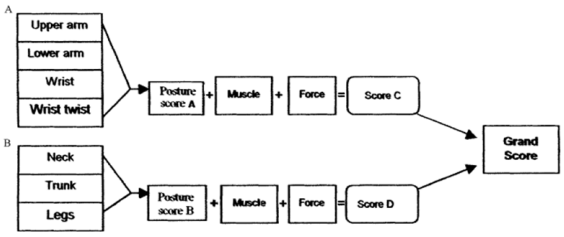

Fig. 3: RULA method scoring (Lynn McAtamney and E Nigel Corlett, 1993).

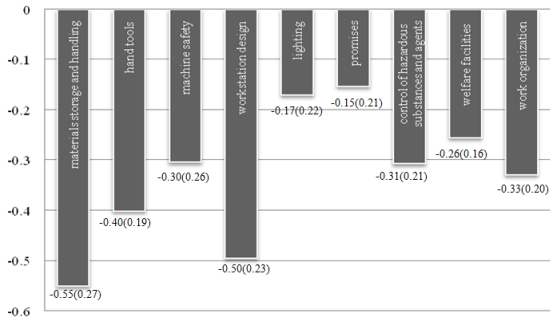

Fig. 4: Checking results of ILO ergonomics checkpoints.

The highest risk score in materials storage and handling category due to various defiency of transportation in working area, factory layout, handling equipments, hand tool for handling and material handling work station design. Figure (5) show problems of materials storage and handling in studied factories. And in figure (6) show improper workstation design that operators were accustomed to.

Fig. 5: Problems of materials storage and handling.

Fig. 6: Improper workstation designs.

Results of Application Rapid Upper Limb Assessment:

In each factory, researchers carefully gathered data of working operations by camera and apply RULA method to evaluate jobs that workers possible to get risk from ankward postures. Ten high risk postures were assessed by RULA method including, factory1: wood polishing, factory2: wooden parts fastening, factory3: wooden parts fastening, factory4: wood cutting, factory5: wood polishing, factory6: wood polishing, factory7: wood cutting, factory8: wood cutting, factory9: wooden parts fastening and factory10: color spraying. Results of average RULA score assessment categorized by body compartments is shown in table (1). The highest score percent compared with the highest scoring is the left lower arm, the next below is the trunk and neck respectively, since most of wooden furniture

production use lower arms especially hands for working and abundantly work stations were not ergonomic designed.

Table. 1: RULA score assessment categorized by body compartments.

Body Compartments	Max. Scoring	Average RULA Score		Percent to Max. Scoring	
		Left	Right	Left	Right
Upper Arm	6	2.2(±0.79)	1.9(±0.57)	37	32
Lower Arm	3	1.8(±0.42)	2.0(±0.00)	60	40
Wrist Score	4	1.3(±0.48)	1.5(±0.71)	33	30
Neck	5	2.1(±0.32)		42	
Trunk	5	2.2(±0.42)		44	

Figure (7) represents differences of posture score A, posture score B, score C, score D and grand score. The highest grand score is from wood polishing process. Figure (8) shows working postures of finishing operation, operator's neck bent down over 20^{o} and was side-bending, his trunk bent down over 60^{o}, twisting and also side-bending. Figure (9) represents example of using upper and lower arm in high risk, operator's shoulder is raised and his lower arm was working across the midline of his body. For a long duration of working with high posture risk jobs may cause the work-related musculoskeletal disorders (WMSDs) that are a group of painful disorders of muscles, tendons, and nerves. Work which are frequent and repetitive, or with awkward postures cause these disorders which may be painful during work or at rest. Results of these scores would be advantageous for further work station design.

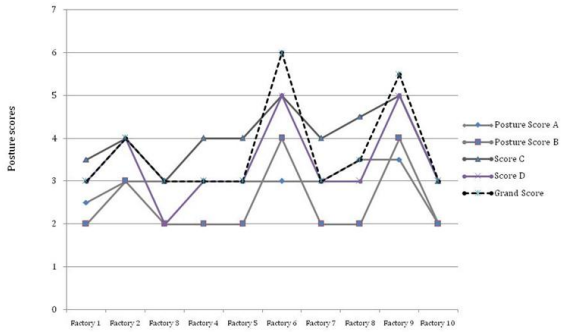

Fig. 7: Posture score A, Posture score B, score C and score D by RULA method of 10 production processes.

Fig. 8: Improper polishing postures with the highest grand score.

Fig. 9: Improper fastening postures.

Discussions:

Results of application ILO ergonomics checkpoints to evaluate 10 wooden furniture factories. Researchers found that the average materials storage and handling is the highest risk factor at -0.55(±0.27). Researchers had advised

several recommendations to involved factories including, the transport routes should be clear and marked, keeping aisles and corridors should be wide enough to allow two-way transportation, making the surface of transport routes even, not slippery, and without obstacles are necessary, factories should provide ramps with a small inclination instead of small stairways or sudden height differences within the workplace, the layout of some the work area should be improved, they may use carts, hand-trucks and other wheeled devices or rollers when moving materials. Moreover, using mobile storage racks, the multi-level shelves or racks or mechanical devices to avoid unnecessary movements. Handling of materials, they should use conveyers or dividing them into smaller lightweight packages, containers or trays hoists instead of carrying heavy weights. For handling improvement, providing handholds, grips or good holding points for all packages and containers, moving materials horizontally at the same working height, reducing tasks that require bending or twisting while handling materials, keeping objects close to the body when manually handling materials and combining heavy lifting with physically lighter tasks would be able to help operators avoid injury and fatigue and to increase working efficiency.

The next below is problems of workstation design, the score is at -0.50(±0.23). Researchers also gave some advices to studied wooden furniture factories s follows, industries should adjust the working height for each worker at elbow level or slightly below it and make sure that the workplace accommodates the needs of smaller and taller workers. Placing frequently used materials, tools and controls should be within easy reach and should provide a stable multi-purpose work surface at each workstation. Make sure that workers can stand naturally, with weight on both feet, and perform work close to and in front of the body. Workers must be able to alternate standing and sitting at work as much as possible. Standing workers should have chairs or stools for occasional sitting and sitting workers should have adjustable chairs with a backrest.

About RULA method, several production processes were in high risks. Because of improper work stations and process designs. Some advices were given to workers and job leaders and they were all welcomed and delighted with suggestions. Researchers found that the RULA method is useful and can be used easily and also brief enough to be administered quickly as an initial screening tool. Results from RULA method will need more details to discuss, since it can assess just workers' postures not over all risks factors. Therefore, researchers applied ILO checkpoints together to get more balanced of details and conferred with some other ergonomists and occupational therapist.

Conclusions:

Application of ILO ergonomics checkpoints to evaluate 10 wooden furniture factories. materials storage and handling is the highest risk factor, the next below is average workstation design and hand tools. From RULA assessment, the highest risk score of body parts evaluated is the left lower arm, the next below is the trunk and neck respectively. Finishing operation has the highest risk score, because of the ankward postures of the neck and trunk. Working in wooden furniture production, we cannot refused that the most important parts of body for workers are hands. Nowadays, there are sparsely studying of occupational accidents among workers in the wooden furniture industry, it is necessary to improve several parameters in this type of industry to rectify ergonomics work design that will be benefit to workers to persuade job attraction in workplace, safety working conditions and quality of work life . Furthermore, the production effectiveness will increase permanently.

ACKNOWLEDGMENT

This research was financially supported by North-Chiangmai University.

REFERENCES

Alireza, C., T. Reza, A. Zahra and D. Mohammadhassan, 2004. Ergonomics intervention in carpet mending operation. Applied Ergonomics, (35): 493-496.

Christina, A., Holcroft, Laura Punnett, 2009. Work environment risk factors for injuries in wood processing. Journal of Safety Research, (40): 247–255.

Faramarz Helali, 2009. Using Ergonomics Checkpoints to Support a Participatory Ergonomics Intervention in an Industrially Developing Country (IDC): A Case Study. International Journal of Occupational Safety and Ergonomics, (15): 325–337.

Gary, A., Mirka, Christy Smith, Carrie Shivers, James Taylor, 2002. Ergonomic interventions for the furniture manufacturing industry. Part I-lift assist devices. International Journal of Industrial Ergonomics, (29): 263–273.

Gary, A., Mirka, 2005. Development of an ergonomics guideline for the furniture manufacturing industry. Applied Ergonomics, (36): 241–247.

International Labour Office in collaboration with the International Ergonomics Association, 2010. Ergonomic checkpoints: Practical and easy-to-implement solutions for improving safety, health and working conditions. International Labour Office,Geneva.

Jegatheswaran Ratnasingam, Florin Ioras, Ioan Vasile Abrudan, 2012. An evaluation of occupational accidents in the wooden furniture industry – A regional study in South East Asia. Safety Science,

(50): 1190–1195.

Kai-Chieh Lina and Chih-Fu Wub, 2015. Practicing universal design to actual hand tool design process. Applied Ergonomics, (50): 8–18.

Kazutaka Kogi, 2007. Action-oriented Use of Ergonomic Checkpoints for Healthy Work Design in Different Settings. J. Human Ergol, 36: 37-43.

Lia Buarque de Macedo Guimarães, Michel Jose Anzanello, Jose Luis Duarte Ribeiro,Tarcisio Abreu Saurin, 2015. Participatory ergonomics intervention for improving human and production outcomes of a Brazilian furniture company, International Journal of Industrial Ergonomics, 1-11.

Lynn McAtamney and E. Nigel Corlett, 1993. RULA: a survey method for the irwestigation of world-related upper limb disorders. Applied Ergonomics, (19): 91-99.

Massaccesia, M., A. Pagnottaa, A. Soccettia, M. Masalib, C. Masieroc and F. Grecoa, 2003. Investigation of work-related disorders in truck drivers using RULA method. Applied Ergonomics, (34): 303-307.

Minna, P., Aivinen, Tanja Heinimaa, 2003. The effects of different hand tool blade coatings on force demands when cutting wood. International Journal of Industrial Ergonomics, (32): 139–146.

Mao-Jiun, J., Wanga, Hsiu-Chen Chung and Hsin-Chieh Wu, 2004. Evaluating the 300 mm wafer-handling task in semiconductor industry. Industrial Ergonomics, (34): 459-466.