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Application of Novel Ergonomic Postural Assessment Method in Indonesia Creative Industry Centers

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Abstract— **An operator's productivity should be affected by the conditions of the work station where the operators are carrying out their activities. The conditions of the work station or good work environment for an operator are effective, comfortable, safe, healthy and efficient. This paper analyze the Novel Ergonomic Postural Assessment Method application in the Indonesia creative industry centers in Bandung. Bad operator work postures carried out every day cause a high risk of musculoskeletal disorders for the operators in the creative industry centers in Indonesia. Thus, the research problems can be formulated as: How is the application of the Novel Ergonomic Postural Assessment Method (NERPA) in the center of creative industries in Indonesia. Based on the constraints of the problem, each new design in four creative centers in Bandung was conducted. In the doll making, the first posture is designing doll pattern station which is a priority for improvement by designing a table to reduce the level of musculoskeletal risk for its workers. The fourth body posture in shoe-making is a priority to be improved by making a design tool to cut the footwear to reduce the level of musculoskeletal risk. Knitted clothing center having level of musculoskeletal risk are priority improvements, namely in the first posture because the operator works in long standing state. Tofu making center also has high level of musculoskeletal risk, namely in the molding tofu station in posture 5.**

I. Introduction

Small-Medium Industries (SMI) have strategic role in the national economy. This can be seen from the number of business units which is 3.4 million units and more than 90 percent of them are national industrial business units. That means that the absorption of these industry workforces are more than 9.7 million people in 2013 and 65.4 percent from the total employment of the non-oil and gas industry sector. In addition, SMI also has a lot varieties of product, it is able to fill wide market area, and is a source of income for the wider community and has resistance to various crises occured. Based on these characteristics, the growth and development of SMI will contribute greatly to realizing a strong, advanced and populist national economy [1].

Creative industries in Wikipedia are defined as industries focusing on the creation and exploitation of intellectual property work such as art, film and television, software, games, or fashion design, and creative services between companies such as advertising, publishing, and designing. According to the Ministry of Trade of Indonesia, the creative industry is an industry that comes from the use of creativity, skills and talents of individuals to create prosperity and jobs [2]. At conceptual stage, creativity and innovation are absolutely closed to improve people income through new creative economy strategy in a region [3].

The main capital needed in the creative industry is not large-scale physical capital or large machinery, but creative and resilient labor capital, a combination of creativity, expertise and individual talent. Based on the latest data, the creative industry is able to contribute to GDP (gross domestic product) of 7.29 percent in 2013 or worth 486.1 trillion rupiah [4]. Creative industry has huge potential to economic contribution in Indonesia. Indonesia, especially Bandung, starts to be seen as one of place where creativity developed [2].

Generally in developing countries, small scale industries employ high percentage of workers as a substitute of automation [5]. An operator's productivity should be affected by the conditions of the work station where the operators are carrying out their activities. The conditions of the work station or good work environment for an operator are effective, comfortable, safe, healthy and efficient. The bad condition of a work station will reduce the operator performance and can also pose a risk of work injury within a certain period. In general, an operator working with repetitive movements, poor body posture, and excessive strength can experience frame injury (musculoskeletal disorder) [6]. Workspace and is surrounding ambience play a decisive role on how people's level of productivity and creativity are influenced [7].

Non ergonomic workspace has emerged as a significant cause of musculoskeletal disorders among employees of health care organization [8]. The World Health Organization defines musculoskeletal disorders (MSDs) as health problem of the locomotor apparatus, including all forms of ill-health ranging from light, transitory disorders to irreversible, disabling injuries [9]. Occupational exposure to vibration and awkward posture are associated with shoulder and neck MSDs. Longitudinal studies are required to elucidate the mechanisms responsible for these associations, and intervention studies are warranted [10].

Musculoskeletal Disorders (MSDs) is the result of a design of work tools that are not ergonomic and are the cause of the highest complaints on the production floor causing cessation of a worker from a factory [11]. The ability of managers and supervisors to assign the right work to the right person at the right time is key [12]. Companies sometimes pay little attention to the work environment where the operators work, even though the performance of the operator will ultimately affect the company productivity, especially

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home industries which do not pay attention to occupational health and safety (K3) aspects [13].

WHO reports that global risk factors for a number of morbidity and mortality include 37% back pain, 16% hearing loss, 13% chronic lung disease, 11% asthma, 10% injury, 9% lung cancer, and 2% leukemia. Musculoskeletal system disorders are major cause of chronic pain and physical disorders [14].

Bandung is one of the cities having some creative industry center in Indonesia. In the development of the industrial sector in Bandung, several industrial centers determined by Bandung Mayor decree No. 530 / Kep.295 DISKUKM.PERINDAG / 2009. Stated that there are 10 centers of micro, small and medium enterprises (UMKM) in Bandung, namely: 1) c 2) Binong Jati Knit Center, 3) Cihampelas Jeans Center, 4) Center for Textiles and Textile Products Cigondewah , 5) T-Shirt and Screen Printing Center, 6) Tofu Center in Cibuntu, 7) Kiaracondong Automotive Spare Parts Center, 8) Sukamulya Dolls Center, 9) Warung Muncang Dolls Center, and 10) Leuwipanjang Bag Center [15]. This research was conducted on the problems that were carried out with MSDs in creative endeavors in Bandung namely Dolls Center, Shoe Center, Knitting Center, and Tofu Center.

Novel Ergonomic Postural Assessment (NERPA) is a method used to analyze work postures that are at risk for the operator by using posture bodies classified as low, medium and high risk of injury depending on the ergonomic standards used[8]. Usually, the method used in analyzing the upper body work posture is *Rappid Upper Limb Assessment (RULA).* The NERPA method is an improvement of the RULA method, aimed to minimize the risk of musculoskeletal disorders by making changes to some degree of worker's body position, and also making changes to the assessment score [11].

There are various methods such as QEC, OWAS, SI, OCRA, HAMA, and PLIBEL to assess the load/stress on body parts. However, Rapid Entire Body Assessment (REBA) and Rapid Upper Limb Assessment (RULA) are two other commonly used techniques to assess postures at work regards to economic reasons and ease of use. Also, Novel Ergonomic Postural Assessment (NERPA) method is one of the newest methods of postural assessment [16].

Based on the background above, this study will analyze the *Novel Ergonomic Postural Assessment Method* application in the Indonesia creative industry centers in Bandung since Bandung is one of the cities having creative centers that are widely included in the network of the world creative city of UNESCO (United Nations Educational, Scientific and Cultural Organization) or UNESCO Creative Cities Network (UCCN) along with 47 other cities from 33 countries.

Bad operator work postures carried out every day cause a high risk of musculoskeletal disorders for the operators in the creative industry centers in Indonesia. Thus, the research problems can be formulated as; How is the application of the Novel *Ergonomic Postural Assessment Method (NERPA)* in the center of creative industries in Indonesia.

The objectives of this study are knowing the level of risk of musculoskeletal disorders in the operator's posture using the NERPA Assessment Worksheet, measuring worker anthropometric data in work stations who have a risk of musculoskeletal disorders in the operator's posture and redesigning work stations that have a risk of musculoskeletal disorders using anthropometric data.

II. Methods

A. Collecting Data

Data collection is done to collect data in accordance with the data needed. In this study the data needed are primary data and secondary data. Primary data is observational data taken directly in the creative industry centers in Bandung, while the primary data needed in this study are interview, documentation data of operator work posture in the form of images that support this research and data from the Nordic Musculoskeletal Quistionaire. Secondary data needed in this study are company profile, number of operators, and company organization hierarchy.

B. Processing Data

NERPA was presented for the first time in 2013 as one of the last working posture assessment methods, which does a better assessment of the physical condition. In fact, NERPA is a modified version of RULA and has the same structure; however, NERPA had major changes than RULA. This method is similar to many observational posture assessment methods that use a form of scoring system based on individual physical conditions for reporting the final score; and, finally, based on posture score, this method determines four action levels [17]. Action levels in this method are similar to RULA.

The three main results of the study will be discussed in this section. They can be summarized as the NERPA assessment worksheet, NERPA performance, and NERPA benefit analysis. The NERPA assessment worksheet is shown in Figure 1.This worksheet attempts to explain the NERPA method in great detail by showing every step to complete an ergonomic task assessment. The approach of the new method begins with the premise of maintaining the original A, B, and C tables of the RULA method [11]. The NERPA method does not use modifications to assess the legs but presents changes for the arms, neck, trunk, and wrists. Following this reasoning, the performance in every part of the body with modified scores is shown in Figure 1.

New upper arm assessment with the NERPA method. Four positions are considered for bending the arm in the RULA method. Standard ISO 11226:2000. Establishes three ranges of scores instead four. These three ranges were used in the new method for this segment. The range of movement is expanded in this manner and does not penalize those common work positions that do not constitute, apriori, any risk for the worker [11].

After collecting data, the next step is processing data, processing data as for what was done in this study, namely:

1. Giving scores on each operator's work posture

Based on the data that has been obtained in data collection, the score can be determined for each of each respectively.

a. Assessment of the position of the upper arm.
b. Assessment of the position of the forearm.
c. Assessment of Hand Movement Position.
d. Hand transition calculation
e. Calculation of total scores in table A (upper arm, forearm, hand rotation, and round of hand movements).
f. Summing up the total score in table A with the level of muscle use and load carried.
g. Calculation of neck position.
h. Calculation of body position.
I. Calculation of foot position.
j. Calculation of total score in table B (neck, body and legs).
k. Summing up the total score in table B with the level of muscle use and load carried.
l. Determination of total score from table A and table B using table C.

C. Designing a Proposed Work Posture

After knowing the total score of each operator's work posture seen, then it is to determine the improvements that must be made with the aim of minimizing musculoskeletal disorders in the operator, namely by designing working methods using appropriate anthropometric data.

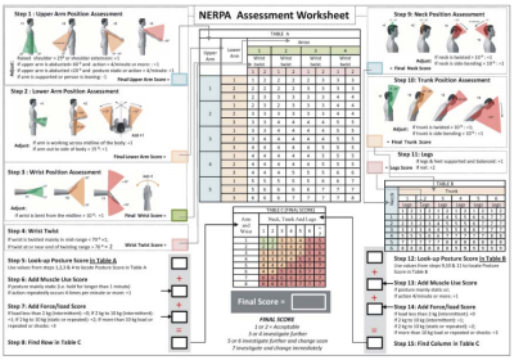

Figure 1. NERPA Worksheet

III. RESULTS

The tool designing in 4 UKM in Bandung was designed based on data processing on operator work posture, according to the NERPA assessment method categories and the dimensions of the worker anthropometry. Therefore, it was necessary to assess work posture and some dimensions of anthropometric measures which will be used for designing. The use of anthropometric dimensions was associated with the user subject and the selection of the appropriate dimensions.

A. Analysis of Body Posture of UKM for Doll Making

Analysis of NERPA data processing of doll making was carried out to find out how the state of posture of small and medium enterprises (UKM) operators when they did their work. Based on Figure 2, the assessment score of group A on the upper arm assessment was 2 because the operator's upper arm slope was 40º to create a puppet pattern. The score on the forearm assessment was 3 because the operator raises the forearm by 49º to create a puppet pattern. Wrist scoring score was 2 because the operator's wrist was bent by 15º and its position was in a distance away from the side of the body in making puppet patterns, the wrist rotation assessment score was 1 because the rotation was still in the middle position of the wrist. Moreover, the overall posture assessment score in group A was 5

Neck assessment score was 2 because the operator worked by looking downward, then the operator's neck formed at 15º. Body scoring score was 2 because the tilt angle of the operator's torso was at an angle of 15º. Foot assessment score was 1 because the foot was in a balanced state. The score of the overall body posture assessment of group B is 3. The final score obtained was 4, it required investigate further, so that the operators did not experience the effects of musculoskeletal risk in the future.

Figure 2. Body Position A when Making a Doll Pattern

TABLE I. GROUP A SCORE ASSESSMENT FOR DOLL PATTERN

Upper Arm	*Lower Arm*	***Wrist***							
		1		2		3		4	
		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	2	3	3	3	4	4
	2	3	3	3	3	3	3	4	4
	3	3	3	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	4	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	6	6	6	6	6	7	7	7
	3	6	6	6	7	7	7	7	8

B. *Analysis of Body Posture of UKM for Doll Making*

Based on Figure 3, the assessment score of group A on the upper arm assessment was 2 because the operator's upper arm slope was 38º to create a shoe pattern. The score on the forearm assessment was 3 because the operator raises the forearm by 121º to create a shoe pattern. Wrist scoring score was 1 because the operator's wrist was bent by 15º and its position was in a distance away from the side of the body in making shoe patterns, the wrist rotation assessment score was 1 because the rotation was still in the middle position of the wrist. Moreover, the overall posture assessment score in group A was 3.

Neck assessment score was 2 because the operator worked by looking downward, then the operator's neck formed at 15º. Body scoring score was 3 because the tilt angle of the operator's torso was at an angle of 42º. Foot assessment score was 1 because the foot was in a balanced state. The score of the overall body posture assessment of group B is 5. The final score obtained was 5, it required investigate further and change soon, so that the operators did not experience the effects of musculoskeletal risk in the future.

Figure 3. Body Position A when Making a Shoe Pattern

C. *Analysis of Body Posture of UKM for Knit Making*

Based on Figure 4, the assessment score of group A on the upper arm assessment was 1 because the operator's upper arm slope was 0-20º to create a knit making. The score on the forearm assessment was 3 because the operator raises the forearm by 112º to create a puppet pattern. Wrist scoring score was 1 because the operator's wrist was bent by 15º and its position was in a distance away from the side of the body in making knit, the wrist rotation assessment score was 1 because the rotation was still in the middle position of the wrist. Moreover, the overall posture assessments score in group A was 3.

Neck assessment score was 2 because the operator worked by looking downward, then the operator's neck formed at 10º. Body scoring score was 1 because the tilt angle of the operator's torso was at an angle of 10º. Foot assessment score was 1 because the foot was in a balanced state. The score of the overall body posture assessment of group B is 3. The final score obtained was 7, it required investigate and change immediately, so that the operators did not experience the effects of musculoskeletal risk in the future.

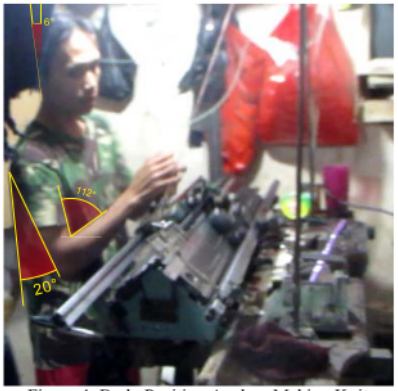

Figure 4. Body Position A when Making Knit

D. *Analysis of Body Posture of UKM for Tofu Making*

Based on Figure 5, the assessment score of group A on the upper arm assessment was 2 because the operator's upper arm slope was 33º to create a tofu making. The score on the forearm assessment was 2 because the operator raises the forearm by 30º to create a tofu making. Wrist scoring score was 2 because the operator's wrist was bent by 30º and its position was in a distance away from the side of the body in making puppet patterns, the wrist rotation assessment score was 1 because the rotation was still in the middle position of the wrist. Moreover, the overall posture assessment score in group A was 5.

Neck assessment score was 2 because the operator worked by looking downward, then the operator's neck formed at 53º. Body scoring score was 2 because the tilt angle of the operator's torso was at an angle of 25º. Foot assessment score was 2 because the foot was in a balanced state. The score of the overall body posture assessment of group B is 6. The final score obtained was 7, it required investigate and change immediately.

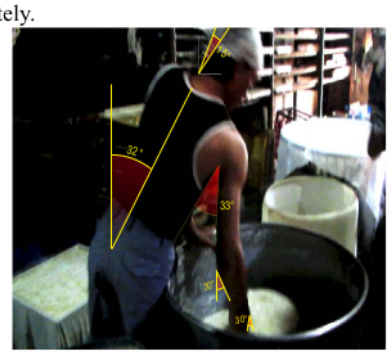

Figure 5 Body Position A when Making Tofu

IV. Conclusion

Based on the constraints of the problem, each design in four creative centers in Bandung was conducted. In the doll making, the first posture is designing doll pattern station

which is a priority for improvement by designing a table to reduce the level of musculoskeletal risk for its workers (Figure 6). The fourth body posture in shoe-making is a priority to be improved by making a design tool to cut the footwear to reduce the level of musculoskeletal risk (Figure 7).

Knitted clothing center having level of musculoskeletal risk are priority improvements, namely in the first posture because the operator works in long standing state (Figure 8). Tofu making center also has high level of musculoskeletal risk, namely in the molding tofu station in posture 5. Since the work is quite heavy and the risk level of musculoskeletal is high, it is a priority to design a work station that can reduce the risk of musculoskeletal (Figure 9) .

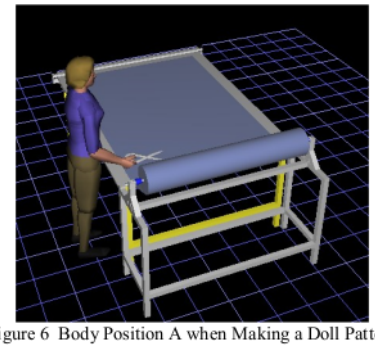

Figure 6 Body Position A when Making a Doll Pattern

Based on Figure 6, after the design was done, the operator could more easily work without having to bend his body to reach his work and not make the stomach and waist hurt due to uncomfortable working conditions.

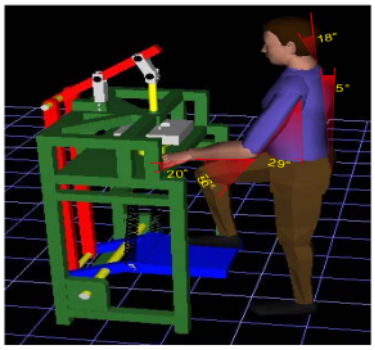

Figure 7 Body Position A when Making a Shoe Pattern

Based on Figure 7, before designing, the operator worked with squatting conditions and was not in a comfortable condition. After designing the tool, the operator could more easily work and worked with more comfortable and ergonomic conditions.

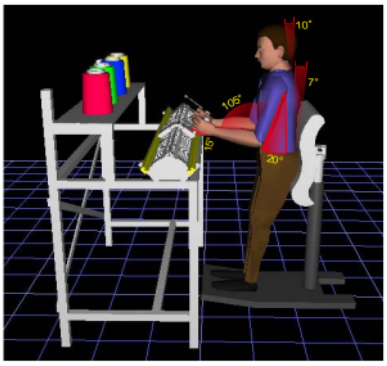

Figure 8 Body Position A when Making a Knit

Based on Figure 8, before designing, the operator worked in standing position for long time period; thus, it was affected his or her feet. The condition after designing could reduce the anxiety in feet area since the operator did not only rest on both feet but also lean on chair designed for standing. Therefore, the operator could work comfortably.

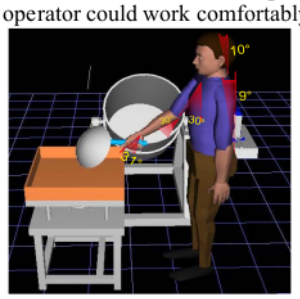

Figure 9 Body Position A when Making Tofu

In Figure 9, before designing at the molding tofu station, the operator bent when picking up the blobs of tofu to mould. This uncomfortable working condition had high level of musculoskeletal risk. The operator could work more comfortably, and did not bend in doing their work because the moulding tofu station was designed according to the anthropometry dimention. The design tool could also be set to its height so as to facilitate the operator in working.

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