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REDESIGN OF YOUNG COCONUT PEELER TOOL BASED ON THE JOB STRAIN INDEX METHOD

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ABSTRACT

The flesh of a direct coconut consumed, and water coconut can instantly drink and drink refreshing without through processing. So many people like this fresh beverages. But often a little regard for risks to be inflicted. When the process of cleavage, coconut workers use a sharp as the tools by the position of hands very close to the skin of young to be cut and likely the machete hit the hands of the sellers. Posture in the seller of this palm was also considered fewer ergonomics. Posture work with the shoulder and neck bent also drew the occurrence of injury musculoskeletal disorders (MSDs). The questionnaire nordic body map shows that 28 respondents experienced musculoskeletal complaints that means that the upper body. Then it will be the measurement of posture work on a job a strain of index by determining six parameters that next used as variable as a multiplier. The experimental work on this obtained the value of multiplier by 4.5 which means the working posture is on a scale 2. These activities were categorized as can pose an important ongoing risk. Revisions have been done is design an apparatus produced by based on Indonesian anthropometry. Anthropometry used of them is high the elbow up for the service of (D4): 95 cm, the hip-high (D5): 50 cm, long-range fore (D24)): 79 cm in size and wide the hands (D29: 16cm.

KEYWORDS: Job Strains Index, Posture Work, Anthropometry & Work Accident

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Original Article

INTRODUCTION

Small and Medium Enterprises are the engines driving the national economy because of this more large corporate units. They are widespread throughout rural areas and considerable potential for employment growth. Their development or growth can be included as an essential element of policies to create jobs and generate income. Although SMEs are absorbing employees and represent the economic bones in developing countries, they are still having a classic problem. 2016 World Bank Company Survey, which includes data from 119 developing countries to measure the biggest barriers to SMEs, showing that SMEs perceive Access to finance is the most significant challenge for their growth (Wang, 2016).

One of the businesses that are still busy is selling young coconut. Indonesia is one of the largest coconut producing countries in the world. The total production of plantation crops by province and plant type in Indonesia is 2,899.7 tonnes (BPS, 2018). Where the coconut can be processed into various kinds of products that can meet the needs of human life (Apriani and Nurusman, 2019). The components of young coconut flesh can be consumed directly, and coconut water can be drunk immediately and become a refreshing drink without going through processing. Coconut water contains various vitamins and minerals and sugars so that young coconut water is still one of the most sought after drinks by consumers.

Based on preliminary observations during interviews with young coconut water sellers, unnatural work

attitudes also trigger small-scale work accidents such as those experienced by the worker, one of which was a machete cut because his finger was not focused on peeling young coconuts. So that it can be said that the working conditions are not ergonomic.

Previous research with the title "*Design of Young Coconut Peelers on an Entrepreneurship Scale*"Designed a young coconut shell machine using electricity as an energy source. The location of this unprotected knife disc still needs to be considered because of the risk of endangering the user of this tool. So it still needs to improve the design of young coconut peeler tools to make it easier for coconut peelers and avoid the risk of work accidents (Yamin and Rahman, 2016).In recent years some workers, employers, producers and researchers have started giving pay attention to how workplace designs can improve worker health. Bad workstations designed to increase unnecessary productivity, which also increases efficiency and productivity (Jukariya and Singh, 2018

The research was conducted on young coconut water sellers in the city of Pekanbaru. In this study, 28 young coconut water sellers were taken in several sub-districts in Pekanbaru City with the most intense sales intensity. Small and Medium Enterprises (UKM) are open from morning to night. The number of sales ranges from 50-120 young coconuts a day. A large number of enthusiasts for this fresh drink, of course, makes this young coconut water seller have to aggressively make gradual changes to maximize sales so that they are not less competitive with other coconut water sellers. The development of an entrepreneurial model can be done by packaging something old into a new one, or making something that was previously less efficient become more efficient and economical (Yamin and Rahman, 2016). It also considers the risks posed by peeling young coconuts.

When peeling young coconuts, workers use a machete as a tool with their hands very close to the skin of the young coconuts to be cut so that it is likely that the direction of the machete will hit the seller's hand. This will certainly lead to work accidents. Apart from causing work accidents to workers, the working posture of this young coconut seller is considered less ergonomic. Work postures with shoulders and neck bent also cause injury *musculoskeletal disorders* (MSDs).

Ergonomic problems in the combined brick kiln system personal and environmental factors. The first to burn, physical fitness, age and later experience including organizational roles, schedules, work schedules, rest facilities, equipment up to assignments and psychological support (Ijaz, et.al., 2020). The removal of material can result in workers experiencing changes in the spinal structure especially if the workers are malnourished. Sometimes they are not aware of this danger, especially if the owner has no concern for the health of the workers. Work continuously and Improper posture increases the MSD risk factors in cash workers (Joshi and Dudani, 2008). Poverty and other disadvantages job opportunities set up and poor quality of life to workers who make most of the work unorganized sectors in rural areas. Unfortunately,

Some of the initial observation documentation that has been carried out shows that several workers' body postures are considered not ergonomic so that it can endanger the health and safety of operators in doing their work. Each time the young coconut peels it takes +4 minutes. Some of these work postures are shown in figure 1.

Figure 1: Working Position of Coconut Peeler Operator.

Figure 1.shows several work postures that carry out young coconut peeling activities. This activity shows the operator bending over with the fingers very close to the machete. Because the work posture is not ergonomic, it is necessary to assess the operator's work posture. In this case, the work posture measurement method is used, namely the Job Strain Index. Where the Job Strain Index is a method used to evaluate the level of risk of a job that can cause injury to the upper part, namely the hand, wrist, upper arm, or elbow. This method also considers the duration of the activity and the energy used during work.

Nordic Body Map is one of the methods used to determine the presence of physical pressure with the risk of muscle complaints that a person feels in doing his job. In this questionnaire, there are 4 categories of assessment of complaints that are felt and known directly from the worker. The four categories are not sick, rather sick (a little uncomfortable), sick, and very sick. Nordic Body Map is the simplest way of assessing muscle fatigue. Musculoskeletal disorders based on the Nordic Body Map (NBM), unnatural / forced labour postures that are mostly experienced by most respondents with complaints on Lower Extremities with a score of 20, this occurs in coconut workers who carry out daily activities with an unusual position natural or forced to cause musculoskeletal disorders (Sangaji, et.al., 2020).

An ergonomics is a form of solving problems found in the field, especially those related to ergonomics by utilizing technology and changing the function of these technologies in humans. thus enabling a new design that is better and more effective than the previous situation, for example, in a product that does not yet exist and of course, still does not abandon existing ergonomic principles. And this design is expected to help humans in doing their job.

Job Strain index(JSI) is a method for evaluating the level of risk from a job that can cause injury to the upper part of the hand, wrist, upper arm, or elbow. This method considers six variables including intensity of exertion, duration of exertion, energy usage per minute, the posture of the hand or wrist, speed of work and duration of work per day (Restuputri, 2018).

Strain Index (SI) is a job evaluation method for determining whether workers expose workers to an increased risk of developing musculoskeletal disorders from Distal Upper Extremity (DUE) (Moore and Garg, 1995 Quoted by Stanton, 2004). Anthropometry measurements have many uses in a variety of fields, such as product design, medicine, nutrition, and engineering. One of its applications is in ergonomics, which includes the design and layout of spaces where people live and work, with special reference to anthropometric data, such as the ability to hold and control controls (Dianat., Et.al., 2018). The constraints in designing anthropometry are the design of work stations, work facilities, and product design so

that they can adjust to the user's body size for users to do their work comfortably and meet ergonomic principles (Chairiani and Zulkarnain, 2019).

METHODS

Job Strain Index is a measurement of work posture by considering the energy expended by the operator and the duration of the operator doing his job. This is because the existing data is measured directly from the actual conditions observed. The stages in assessing work posture using the Job Strain Index method are as follows:

- Collect data from six parameters

  Six parameters that must be done in the first process, namely:

- *Intensity of* Exertion

  This parameter is used to determine the value of the intensity parameter of the use of energy from the work performed by the operator and to give weight to the value according to the effort the operator does.

- *Duration of Exertion*

  Duration of exertion is the percentage of the time and exertion lasts during a work cycle.

- Efforts per minute

  The work per minute is obtained from the calculation of the exertion value during the study.

- Hand or wrist posture

  This parameter is done by observing the wrist at the time of the exertion and explaining it with one of the perceived positions.

- Working speed

  Work speed is done to find out how fast workers do their work.

- Duration of work per day
- The weighting of each work variable.
- Determine the multiplier for each variable.
- Multiplier to calculate the Strain Index score.
- Evaluate the strain index job score

RESULTS AND DISCUSSIONS

The Intensity of Exertion (IE)

This parameter is used to determine the parameter value of the intensity of energy use of the work performed by the worker and to give weight to the value according to the work done by the operator. Work intensity is obtained by measuring the work pulse which is shown in Table 1. Worker 1's pulse is 76 beats/minute. This means that the pulse ranges from 75-100 beats/minute so that it is categorized as low/light effort intensity. So that the business intensity is included in the Rating Value 3 and the Multiplier value is 1.

Table 1: Worker Intensity of Exertion (IE) 1

Category	Heart Rate (Pulse / Minute)	Rating Category	*Rating Value*	*Multiplier Value*
Light (Light)	75 - 100	Almost imperceptible/casual effort	1	1
Somewhat Hard	100 - 125	It takes effort	2	3
Hard	125 - 150	The effort was clear, the facial expression did not change	3	6
Very Hard	150 - 175	Requires excessive effort seen from a changed facial expression	4	9
Closer to the maximum	> 175	Requires your shoulders and back to exert energy	5	13

Duration of Exertion (DE)

Duration of exertions the percentage of the time and exertion last during a work cycle. The Work cycle is 4 minutes for one stripping. The total observation time was 9 hours / 540 minutes. After getting the DE value, then the value is converted into a rating value and *multiplier*. Based on the results of the calculation of the business duration value of 59.25 %, so that for the duration of the business, the Multiplier value is 2 as shown in table 2.

Table 2: Duration of Exertion (DE) Worker 1

Per cent Duration	*Rating*	*Multiplier Value*
<10%	1	0.5
10% - 30%	2	1.0
30% - 50%	3	1.5
50% - 80%	4	2
> 80%	5	3

Effort Per Minutes (EM)

The effort per minute is obtained from the calculation of the exertion value during the study, which is 6 times. Then divided by the total research time in minutes. EM <4, then this activity is included in Rating 1 with a Multiplier value of 0.5.

Hand / Wrist Posture (HWP)

The position of the hand/wrist when doing work activities, namely flexion to form an angle of 20˚ with the abnormal category, so the hand/wrist position is included in the Rating Value 3 and the Multiplier value 1.5 as in table 3.

Table 3: Worker's Wrist Position 1

Category	Wrist Extensions	Flexion on the Wrist	Deviation in Ulnar	Information	*Rating* Value	*Multiplier Value*
Very Good	00-100	00-50	00-10	Neutral Position	1	1
Good	110-250	60-150	110-150	Near neutral position	2	1
Fair	260-400	160-300	160-200	The position is not neutral	3	1.5
Bad	410-550	310-500	210-250	Not very neutral position	4	2
Very Bad	> 600	> 500	> 250	Position close to extreme	5	3

Working Speed

Work speed is done to find out how fast workers do their work the value is obtained from the comparison between the

observation speed and the standard speed. Worker 1 performs work activities for 3 minutes. When compared with the standard time, which is 4 minutes, so this activity is included in the very fast category and gets a Multiplier value of 2 as in table 4.

Table 4: Worker Speed of Work 1

Category	Information	*Rating*	*Multiplier Value*
Very slow	Very slow speed	1	1
Slow	Slow speed	2	1
Pretty fast	Normal speed	3	1
Fast	Fast speed but keep pace	4	1.5
Very Fast	The speed is very fast but the speed cannot be kept	5	2

Work Duration per Day

The value of this parameter is obtained from the observed conditions. From the observations that have been made, it is known that Worker1 works every day for 9 hours from 09.30 - 18.30. So based on the Work Duration table per day this activity is included in Rating 5 with the Multiplier Value obtained is 1.5.

Determining the Multiplier for Each Variable

SI = IE X DE X EM X HWP X SW X DD

Table 5: Multiplier for each Worker Variable 1

Variable	Measurement Results	Rating Value	Multiplier Value
Intensity of Exertion / IE (Pulse / Minute)	76	1	1
Duration of Exertion / DE (%)	59.25	4	2
Effort Per Minutes / EM	0.2	1	0.5
Hand / Wrist Posture / HWP (0)	20	3	1.5
Working speed	Very fast	5	2
Work Duration per Day	9 hours	5	1.5
Score Strain Index			**4.5**

Evaluating the Score Job Strain Index

After multiplying the six variables, the next step is to evaluate the value of the JSI. There are 3 categories in determining the level of job risk. The previous step obtained a Score Strain Index of 4.5.

Table 6: Levels of Risk

Scale of Risk	Information
Value ≤ 3	The work that is observed is quite safe
Value 3 - 7	The work being observed can pose a risk
Value ≥ 7	The work that is observed is dangerous

Based on Table 6, Worker 1's work activities are included in the category that may pose a risk. After calculating using the Job Strain Index method, 17 workers were found on a scale of 2, which means that this job is included in activities that pose a risk.

Based on the calculated Strain Index score, the work posture is on a scale of 2, which means that the work posture used needs to be improved. In this case, a design for a young coconut peeler was made. The design of the tools that will be made is in the form of a simple tool by combining more than one young coconut stripping activity. This concept not only makes it easier for workers to carry out stripping activities but also minimizes the time used so that it is considered more efficient when compared to the manual method. And reduce the risk of work accidents for its users. This tool is also

equipped with a work table so that it can help the workers to move around in stripping young coconut activities.

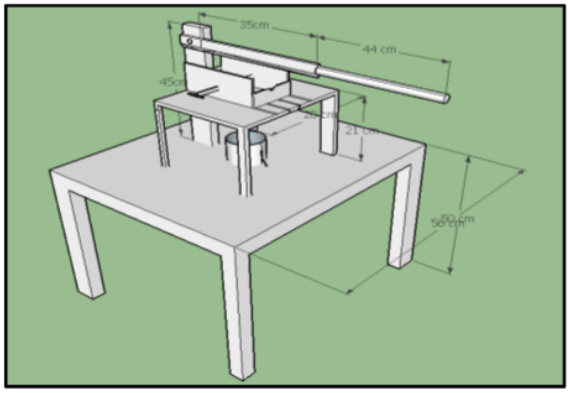

Figure 2: Young Coconut Stripping Tool Design.

Besides, this tool is equipped with a sharp knife which also holds the handle lever when splitting the coconut. This tool is also equipped with vice as a young coconut presser and clamp that can be adjusted to the size of a young coconut fruit that is different for each type, thereby reducing the risk of hands getting hit by a knife. After the coconut is split, then the coconut water flows by itself until it is accommodated in the container that has been prepared. The anthropometry used in the design of young coconut stripping tools can be seen in table 7.

Table 7: Anthropometric Data for the Design of Young Coconut Peeling Tool

No.	Body Dimensions	Anthropometric Data	5th Percentile	50th Percentile	95th Percentile
1	D4	Elbow height standing	95.75	104.2	112.65
2	D5	Hip Height	32.35	42.22	50.09
2	D24	The length of the reach of the hand forward	60.96	67.39	73.83
4	D29	Hand width up to the palate	9.44	12.98	16.52

CONCLUSIONS

The design of the tool is made in the form of a simple tool by combining more than one young coconut peeling activity. This concept not only makes it easier for workers to carry out stripping activities but also minimizes the time used so that it is considered more efficient when compared to the manual method. And reduce the risk of work accidents for its users. This tool is also equipped with a work table so that it can help the workers to move around in stripping young coconut activities.

After designing, testing was carried out by distributing a Nordic Body Map questionnaire and calculating the parameters to obtain a Strain Index score. After comparing initial testing using a manual system after using aids, it was found that workers did not experience significant musculoskeletal complaints. Whereas in the initial test Strain Index score, some workers are on a scale of 2 level scores where on this scale, the activities carried out can pose a risk. After testing when using the tool, the Strain Index score obtained drops to 1.5 so that this tool is considered safe and comfortable to use by the user.

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