Ergonomics Evaluation of Manual Material Handling Activities in the Section of Feeding Laying Hens at Poultry Farm

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Abstract. This study aimed to evaluate the activity of feeding laying hens at poultry farm. Observations were made of all workers in charge of providing animal feed totaling 13 workers. The work observed was the process of loading animal feed on baskets until the final distribution. The evaluation was based on the results of the Nordic Body Map questionnaire, physiological workload measurements, National Institute for Occupational Safety and Health (NIOSH) lifting calculations. The worker's physiological workload was taken into account, and it revealed that there has been an increase in work pulse rate obtained Cardiovascular Load (%CVL) is in the range of 58% -72% and the energy consumption of workers ranges from 4.10-6.59 Kcal/minute. Thus, physiologically the work activities carried out by the feeding workers are categorized as moderate work, and it is necessary to improve the work activities. Meanwhile, evaluation using the Recommended Weight Limit (RWL) and Lifting Index (LI) in the process of animal feed showed RWL values ranged from 8.61 kg-10.19 kg, and LI values ranged from 1.87 to 2.50. This number is beyond the limit for manual lifting.

1. Introduction

CV Nabila Farm is one of the Small and Medium Industries (IKM) laying hens in West Sumatra, which was established in 2000. CV Nabila Farm is located in Jorong Parumpuang, Nagari Koto Baru Simalanggang, Payakumbuh City, West Sumatra. CV Nabila Farm produces around 56,400 eggs every day with distribution areas covering Pekanbaru, Jambi, Bengkulu, and Jakarta. Given the number, the demand of retailers with an average demand of around 70,000-80,000 items per day--has not met. CV Nabila Farm must streamline the production flow to increase egg production.

One of the factors that resulted in inefficient production flow is the disorganization of the feeding process. Workers in the livestock maintenance division of the IKM generally still must carry out manual work activities using a simple sling. This method takes 65-75 minutes for a series of cages with a capacity of ± 3800 tails. Additionally, it often ends in waste. Every day, IKM distributes animal feed for a series of cages with a capacity of 3800-4000 chickens as much as 560 kg. Feed requirement for one chicken is known to be only around 125 gr/day; however, for one series of cages, it takes 475 kg. The discrepancy shows a waste of feed amounted to ± 85 kg/day/cage series.

Figure 1. Feeding in husbandry

Animal feeding activities still consider human labor to be an essential role. Based on the results of interviews with workers, found obstacles for workers in the process of animal feed is carried out using a sling made of cloth and baskets with weights ± 20 kg and distance of ± 400 meters with repetition 2x a day ie at 07.00 WIB and 13.00 WIB. This results in losses not only to the workers themselves but also to the owners of the company itself. These losses include complaints felt by workers, the feeding process that requires a long time, and the amount of chicken that is wasted. Staff feel discomfort in back, neck, and arm, Between productivity and safety and health are explained by four factors[1]: need for more innovative ways to reduce the high rates of workplace injury and illness, pressure to reduce socialand economic costs of injury and illness, need to improve labour productivity without workers needing to work longer hours and/or taking on more work, and need to offer good working conditions as an enticement to recruit and retain skilled workers in tight labour market.

Several studies have been carried out by previous researchers relating to the evaluation of material handling manuals such as providing NBM questionnaires, REBA analysis and RWL and LI calculations on brick making work and on contract workers at PT. JC [2]. Other studies use NIOSH Lifting Equation to determine the ideal RWL for jobs in Malaysia [3], and make improvements to the appointment of the distribution of printing materials [4]. Other studies conducted an ergonomic analysis of the scarfing process activities in the Slab Steel Plant's Division using the OWAS, NIOSH and Nordic Body Map methods. Following preceding researches, this study conducted posture analysis using the Nordic Body Map method, evaluation of physiological workload using measurements of the worker's pulse per minute, and evaluation of the lifting Equation based on the NIOSH removal equation. Other studies using the RULA method as a basis for the redesign of the engine thresher [5]. This purpose of this research is examine workers performance during the husbandry using nordic body map questionnaire, physiological burden of workers, calculating energy consumption and analyze the risks posed by manual material handling.

2. Methodology

This study aimed to examine workers performance during husbandry. We employed the Nordic Body Map, measuring the physiological burden of workers by measuring the increase in work pulse compared to the maximum rice rate (% CVL) and calculating energy consumption, analyzing the risks posed by manual material handling activities using NIOSH Lifting Equation.

The study was conducted on workers giving layer chicken feed at CV Nabila Farm, Payakumbuh, Indonesia. Data collected were the layout of the feeding process, stages of the feeding process, the pulse of workers before and after the feeding process, vertical distance, horizontal distance, subjective perception of the operator, and time study for lifting process [6]. Data collection was carried out by distributing Nordic Body Map questionnaires, measuring the pulse of workers before and after feeding, measuring horizontal distances, vertical distances, and distance of load transfer during the feeding process. The results of the data processing will be used to find out whether the animal feeding work is

carried out according to the concept of ergonomics.

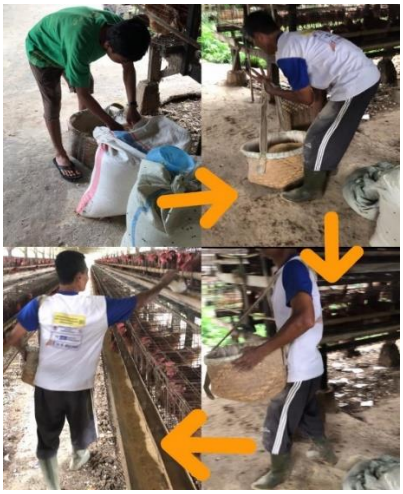


Figure 2. Feeding worker posture

Physical activity levels are measured by heart rate [7]. The Heart Rate Reserve (HR Reverse) considered in percentage formulated by equation [8]. Moreover, HR Reverse has 5 grades, fewer than 30% determine no fatigue. 30% -60% determine the need for improvement, between 60% to 80% describe work in no time; 80% -100% describe urgent action is required; more than 100 expresses that no activity allowed [9].

$$Maximum\ heart\ rate = 220 - age \quad (1)$$

$$Heart\ rate\ reserve = Maximum\ heart\ rate - resting\ heart\ rat \quad (2)$$

$$\%\ \text{HR Reserve} = \frac{\text{Work heart rate} - \text{resting heart rate}}{\text{Maximum heart rate resting heart rate}} \quad (3)$$

This research computed consumption energy of exercise. It was executed to fit the level of activity. There are five levels of activity which consist of as Unduly Heavy, Very Heavy, Heavy, Moderate, Light, and Very Light. The energy consumption formula is displayed in Equation and Equation mean energy consumption for certain activities. Equation shows Energy expenditure during working time (Kcal/s). Energy consumption defines Energy consumption for specific activities (Kcal/s). Et offer Energy expenditure during working time (Kcal/s). Et describes Energy expenditure during rest time (Kcal/s).

$$KE = Et - Ei \quad (4)$$

$$Et = 1.80411 - 0.0229038\ (x) + 4.71733 * 10^{-4}\ (x)^2 \quad (5)$$

NIOSH Lifting Equation is tool that complete manual lifting task or parts to reduce the overall possibility of lower back pain or injury. To aid in the prevention of lifting-related lower back injury, NIOSH advanced the Revised NIOSH Lifting Equation (RNLE), to measure a recommended weight limit (RWL), and lifting index (LI) used for estimating the physical demands of the activity[10] The Equation for determining the recommended load to lift a worker under certain conditions according to NIOSH is as follows [11]

$$RWL = LC\ x\ HM\ x\ VM\ x\ DM\ x\ AM\ x\ FM\ x\ CM \quad (6)$$

Where:
LC, Load Constant
HM, the Horizontal Multiplier factor

VM, the Vertical Multiplier factor
DM, the Distance Multiplier factor
FM, the Frequency Multiplier factor
AM, the Asymmetric Multiplier factor
CM, the Coupling Multiplier factor

Lifting Index calculation aims to find out the lifting index that does not contain the risk of spinal injury, with the Equation [12]

$$LI = \frac{Weight}{\text{RWL}} \tag{7}$$

If LI> 1, the weight of the load exceeds the recommended lifting limit, then the activity carries a risk of spinal injury.
If LI <1, the weight lifted does not exceed the recommended lifting limit then the activity does not contain a risk of spinal injury [13]

3. Results and Discussion

3.1. Nordic Body Map Questionnaire Results

The Nordic Body Map questionnaire was given to 13 feed workers to see complaints felt by the workers. The Nordic Body Map questionnaire results can be seen in Table 1; instructions for loading workers using the Nordic Body Map questionnaire can be seen in Table 2.

Table 1. Nordic result body map

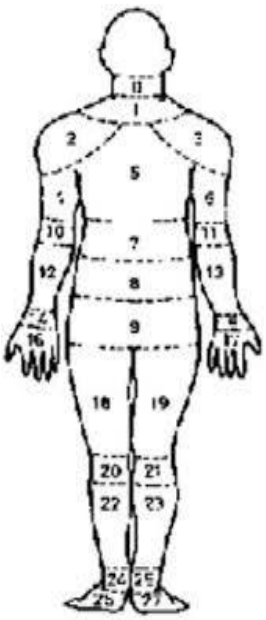
Muscoloskeletal	Scoring				NBM	Muscoloskeletal	Scoring			
	1	2	3	4			1	2	3	4
0. Upper Neck				√		1. Lower Neck				√
2. Left Shoulder				√		3. Right Shoulder				√
4. Upper Left Arm			√			5. Back			√	
6. Upper Right Arm		√				7. Waist				√
8. Hip		√				9. Bottom			√	
10. Left Elbow			√			11. Right Elbow			√	
12. Lower Left Arm	√					13. Lower Right Arm	√			
14. Left Wrist				√		15. Right Wrist				√
16. Left Hand			√			17. Right Hand		√		
18. Left Thight	√					19. Right Thight	√			
20. Left Knee		√				21. Right Knee		√		
22. Left Leg				√		23. Right Leg				√
24. Left Ankle		√				25. Right Ankle		√		
26. Left Foot		√				27. Right Foot		√		
Sum Score Right				37		Sum Score Right				39
Individual Sum Scores of MSDs										**76**

Table 2. Classification of Nordic body map

Degree of pain	Score	Degree of pain	Score
No pain	1	Pain	3
A Little Pain	2	Highly Pain	4

Table 3. Nordic body map total score

Score	Individual Sum Score	Degree of Risk	Improvement
1	28-49	Low	Doesn't urgent to upgrade
2	50-70	Medium	Maybe need to upgrade
3	71-91	High	Need to upgrade
4	92-112	Very High	Need upgrade as soon as Possible

Based on the results of the NBM questionnaire obtained, Upper neck, Shoulder and Wrist are the three biggest complaints among the other body parts, and a value of 76, which is based on Table 3, is categorized high, so it needs improvement in work posture. The number implies that the workers withstand too heavy stuff moreover in not fair distance. Under this situation, it is reasonable for them to complain on their neck, right and left shoulders, back, and waist.

3.2. Physiological Workload Measurement Results

The physiological workload is carried out by taking into account the raise in working pulse compared to the maximum pulse rate.

Table 4. Physiological workload classification based on energy consumption and issued energy

Workload Classification	Oxygen consumption (L/minute)	Energy expended (kcal/hour)	Heart Rate (bpm)
Very light	0.23-0.33	75-100	60-80
Light	0.33-0.5	100-150	70-90
Is	0.5-1.0	150-300	80-110
Weight	1.0-1.5	300-450	100-130
Very heavy	1.5-2.0	450-600	120-150

The calculation of energy consumption results indicated that the workload of workers is in the moderate category. Calculations show energy consumption while working in the range 211-374 kcal/hour as shown in Table 5.

Table 5. Physiological workload classification based on increased worker's pulse rate

% CVL	% CVL classification
<30%	No fatigue occurs
30% - 60%	Repair is needed
60% - 80%	Work in a short time
80% - 100%	Immediate action is required
> 100%	Not allowed to move

The result of% CVL by taking into account the increase in the pulse rate of work compared to the maximum pulse rate obtained was 72%. This level is in the range of 60 to <80%. As a matter of fact, when carrying out work livestock maintenance, workers may have fatigue. This arrangement must be repaired or limited by time.

Table 6. Calculation of physiological workload of feeding workers

	Age	Pulse rate / minute			% CVL	Information	E. Exp (Kcal/s)		Energy Consumption (Kcal / hour)	Information
		HR Work	HR Rest	HR Max			Early	End		
1	56	138	74	164	71.1%	Work in a short time	2.69	7.62	296.08	Lightweight
2	44	143	73	176	68.0%	Work in a short time	2.6	8.17	331.76	Medium
3	52	136	72	168	66.7%	Work in a short time	2.60	7.41	288.83	Lightweight
4	42	149	64	178	74.6%	Work in a short time	2.27	8.86	395.63	Medium
5	27	146	63	193	64%	Work in a short time	2.23	8.51	376.93	Medium
6	41	137	79	179	58%	Repair is needed	2.93	7.52	274.89	Lightweight
7	24	128	71	196	46%	Repair is needed	2.55	6.60	242.72	Lightweight
8	41	148	70	179	72%	Work in a short time	2.51	8.74	374.09	Medium
9	41	129	72	179	53%	Repair is needed	2.60	6.69	245.95	Lightweight
10	42	146	79	178	68%	Work in a short time	2.93	8.51	334.61	Medium
11	22	138	72	198	52%	Repair is needed	2.60	7.62	301.59	Medium
12	38	115	74	182	38%	Repair is needed	2.69	6.21	211.5	Lightweight
13	28	139	64	192	59%	Repair is needed	2.27	7.73	327.86	Medium

NIOSH

Figure 3 shows the manual lifting process during the animal feed process.

Figure 3. Process for appointing manuals for feeding livestock

Table 7. Summary for recommended weight limit and lifting index

Multiplier	Formula	Origin Parameter	RWL (kg)	LI	Value	Destination Parameter	Value	RWL (kg)	LI
Constant Load (LC)	21.9	21.9 kg			21.9 kg	21.9 kg	21.9 kg		
Horizontal (HM)	25 / H	H = 42 cm			0.6	H = 42 cm	1.09		
Vertical (VM)	1- (0.03 | V-75 |	V = 27 cm			.86	V = 27 cm	0.93		
Distance (DM)	.82 - (4.5 / D)	D = 71 cm	9.2 kg	2.36	.883	D = 71 cm	.87	8.6 kg	2.54
Asymmetry (AM)	1- (0.0032 x A)	A = 0º			1	A = 0º	1		
Frequency (FM)	Table Frequency Multiplier	1 lifts / min			.94	28 lifts / min	0.45		
Coupling (CM)	Good, Fair, Bad	Fair			0.95	Fair	0.95		

The results of the calculation of recommended weight limit and lifting index indicate that the work of transporting food storage equipment and the process of animal feed are at risk of causing spinal injury due to LI values> 1, which can increase the low back pain risk. RWL and LI calculations are theoretic calculations giving the result that the work is too heavy and dangerous because it exceeds the existing recommendations. Although the calculation of energy was included in the light workload, further research and analysis is highly suggested [14].

4. Conclusion

Nordic Body Map questionnaire was given to 13 feeding workers, and showed that there had been complaints about soreness in the upper neck, back, waist, and shoulders. Calculation of CVL and energy requirements measured to determine the physiological workload of workers showed that the feeding worker's task was categorized as moderate and need improvement as it causes fatigue for workers. Based on NIOSH manual lifting calculations, it was found that the work of animal feed is hazardous to cause injury to the spine, because the recommended load for lifting manually is only 8-10 kg while the average worker transports 18-20 kg of feed.

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