Re-Designed Work Station for Breeding Hens Based On Work Posture and Anthropometrics in Widodomartani

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Abstract. Animal husbandry is one of the agricultural sub-sectors that has an important role in contributing quite significantly to the country's economy and breeding hens are one of those. In setting up breeding hens that sufficiently adequate it does not require substantial capital. However, many breeding hens in designing the work station are less ergonomic, giving rise to the level risk of musculoskeletal disorder. The aim of this study is to assess the work posture of the operators and from the result of this study, it can be proposed improvement of the work station to improve work posture and to reduce the level of Musculoskeletal Disorder. The method that used in this research is Quick Entire Check, Nordic Body Map, and Anthropometrics. The result showed that the exposure level operator 1 got value 41.47%, the action that needs to be done is need more research to make it safe. While operator 2 got value 55.68%, the action that needs to be done is doing another research and change the activities. Also, it can be seen if the pain felt by the two operators is in the neck, buttock, shoulder, arm, calf, and knee. From the research results, the recommendation given is to redesign work stations that pay attention to work posture by implementing anthropometry and adding several innovations.

1. Introduction
Animal husbandry is one of the agricultural sub-sectors that has an important role in contributing quite significantly to the country's economy. The animal husbandry sub-sector contributed 146.1 trillion rupiahs or 1.85% of Indonesia's GDP in 2010 [1]. The animal husbandry sub-sector is part of the agricultural sector which is very potential to be developed providing animal food.

Although animal husbandry is a high economic contributor, there are still many farms that do not have an ergonomic layout. Besides, workers also do not pay attention to the position of his body when working. Based on the journal from Wang, Kong, & Jung, 2012, explains the examples of workers who do not pay attention to their work postures. The farmer required bending or twisting just 4 body portions (right upper arm, left upper arm, right hand, and left hand), yet the farmer when in delayed static stances for 100% of the working time when holding a water wand. The ranchers crouched without taking a break for more than 60% of the working time. Besides, farmer additionally consistently bowed their trunks for scooping and taking care of boxes more than 56% of the working time [2]. This is unfortunate because it can hamper workers to work optimally.

Poor work posture is often caused by the design of the work station that does not pay attention to the suitability of its users. This was explained in a journal from Purwaningsih, P, & Susanto, 2017, the study is on the work station in the laundry that is not good for the workers. When the operator does his/her work, they need to be in the long-standing and sitting work postures in the activity of ironing...
clothes. In practice, the operator or laundry worker in the ironing section (ironing clothes) must also carry out ironing activities for more than 8 hours, in a standing position, repetitive and monotonous work. The workers are in repetitive, monotonous, bend and twist posture that can cause injury to the workers. A desk that is too high is also one of the reasons workers do not feel comfortable doing their jobs [3]. It also can increase the level of risk of musculoskeletal disorders. Musculoskeletal injury is a major cause of occupational diseases in industrial sectors of developed and developing countries [4].

In setting up a breeding hen that is sufficiently adequate it does not require substantial capital. However, many breeding hens in designing the work station are less ergonomic, giving rise to the level risk of musculoskeletal disorder. Even in breeding hens in Indonesia still using a lot of manual work. Manual work that is done repeatedly (repetitive) with monotonous work movements and long work hours has the potential to cause work fatigue where there will be continuous muscle loading. Incorrect work postures make fatigue become faster. Usage of ergonomic will help improving the quality and profitability, yet more significantly, is to feel great and secure while carrying out the responsibility [5,6,7]. Implementation of ergonomics is expected to reduce the job-related risk.

In the work station namely egg structuring, egg collection, and poop removal, the operators are getting the work done with the posture of squatting on the floor and bending to take the egg and poop. Awkward work posture such as working with excessive standing, squatting, bending can lead to musculoskeletal complaints that can impact on declining work performance. Therefore, it is necessary to assess the work posture of the operators in all work stations to determine the risk level of musculoskeletal injury. Assessing the work posture methods used are Quick Exposure Check and Nordic Body Map as supporting tools. QEC was chosen because it can combine operator ratings and observer ratings [8]. The operators’ postures are recorded in video and at a standstill taking photographs and these images are used for postural examination. Thus, from the result of this study, it can be proposed improvement of the work station to improve work posture and to reduce the level of Musculoskeletal Disorder. Improvements will be made is to redesign the work station and add facilitation that is in accordance with anthropometric data. Musculoskeletal issues can be limited by improving the strategies, working techniques, and work station [9]. Based on the existing problem then the result of this study expected to be used as a reference to improve work posture and work station.

2. Literature Review

2.1. Anthropometrics

Anthropometrics is derived from the Latin word *anthropos* which means human and *metron* which means measurement, thus anthropometry has a meaning as a measurement of the human body [10]. Here are some definitions of anthropometry from various sources:

- Anthropometry is a collection of numerical data that associated with characteristics of human body such as size, shape, and strength and the application of these data for handling design problems [11].
- Anthropometry is predominantly identified with the elements of the work station an and the arrangement of tools, equipment, and materials [12].
- Anthropometry does not only focus on the appropriateness of work environment statures yet additionally how operators can easily access controls and input devices [13].

2.2. Nordic Body Map

Nordic Body Map is a subjective measurement tool to determine the parts of muscle which feel symptoms ranging from distress (mildly ill) to very sick [14]. Through a subjective approach, skeletal muscle complaints can be measured and analyzed properly. The use of subjective value has included
some of the phenomena that occur in the psychological, biomechanical, and measurement techniques, as well as being the easiest way to assess and is interpreted [15].

2.3. Quick Exposure Check
Quick Exposure Check (QEC) is a method of measuring posture loads introduced by Dr. Guanyang Li and Peter Buckle. QEC assesses in four areas of the body exposed to the work musculoskeletal disorders (WMSDs) to a person or operator. QEC was developed for [16]:

- Assess changes in exposure to the body at risk of musculoskeletal before and after ergonomics intervention.
- Involving observers and workers in conducting assessments and identifying possibilities for changes to the work system.
- Comparing exposure to the risk of injury between two or more people who do the same job, or between people who do different jobs.
- Increase awareness among managers, engineers, designers, occupational safety, and health practitioners and operators regarding musculoskeletal risk factors at work stations.

3. Method
To study and analyze work posture and anthropometrics for improving work station related activities, a systematic methodology consisting of several steps that will be explained down below.

3.1. Step-1: Selection of the study site
The study site is at the small animal husbandry of breeding hens in Widodomartani, Ngemplak, Sleman. Where in this breeding hens the workers do their job namely egg structuring, egg collection, and poop removal, the operators are getting the work done with the posture of squatting on the floor and bending to take the egg and poop. Awkward work posture such as working with excessive standing, squatting, bending can lead to musculoskeletal complaints that can impact on declining work performance. This site is selected for this study because it offers in studying the situation in animal husbandry that involves work station to improve work posture and to reduce the level of Musculoskeletal Disorder.

3.2. Step-2: Preliminary Survey
As a systematic procedure is needed for the collection of relevant data on several aspects of the jobs and activities, a phase-wise plan has been made for data collection (mainly for primary data) for the understanding of the work systems that involve physical activities that are carried out by workers. This preliminary study was conducted to determine the problems experienced by the workers of breeding hens when namely egg structuring, egg collection, and poop removal, it was known that the workers have awkward work posture such as working with excessive standing, squatting. So, this business is needed ergonomic intervention.

3.3. Step-3: Identification of issues to be surveyed
Based on the preliminary survey, several ergonomic problems on the workers of breeding hens are studied. These research issues are as follows:

- Issues-1: Types of recommended work stations, tools, and equipment.
- Issues-2: Types of occupational health problems and work posture.
- Issues-3: Characteristics of the jobs.

3.4. Steps-4: Data Collection
The researcher collects the data needed for research like QEC data, NBM data, and anthropometry data. These data are needed to complete this research. Anthropometry data is secondary data collected
from bank data that already provided by DSKE UII Laboratory but other data are primary data. The anthropometry data that need to be collected are:

- Popliteal Height (TPO)
- Standing Elbow Height (TSB)
- Hand Reach (JT)
- Standing Eyes Height (TMB)
- The Range of Hand Elbow (RS)

3.5. Step-5: Data Processing
Processing the data in here means assess the work posture, assess the pain on the body, testing the normal test on anthropometry data, calculating the percentile of anthropometry to design the recommended work station based on data that already obtained.

3.6. Step-6: Data Analysis
Based on the data collection that already obtained through the QEC data, NBM data, and Anthropometry methods, the detailed analysis is done to fulfil these purposes, namely (i) to assess work posture of the worker, (ii) measure the pain complaints on the body of the worker, (iii) to know the problems that faced by the workers and (iv) to make the recommended work station that will help the workers do the work comfortably. The operators also are interviewed to provide their opinions about the problem they are facing to investigate whether there is a problem related to work posture and injury or pain on the workers caused by poor work station.

3.7. Step-7: Visualizing the Re-designed Concept of Breeding Hens
The researcher produced a design concept based on the identified needs or issues of the recommended re-design work station. The researchers a low-fidelity prototype in this study, in the form of a three-dimensional image of the work station for workers.

4. Result and Discussion
After the data comes out and the results, a detailed analysis is required. The detailed analysis of the research results is as follows.

4.1. Quick Exposure Check
Based on the calculation of Exposure Score and Level in Quick Exposure Check, the activities having moderate risk in the back, operator 1 got 18 scores and operator 2 got 24 scores from 8 to 56 score. For the shoulder/arm, operator 1 got 22 scores and operator 2 got 28 scores from 10 to 56 scores, it means the activities having moderate risk for shoulder/arm the operator. The wrist/hand having moderate risk too for the operator, from 10 to 46 scores operator 1 got 20 scores and operator 2 got 26 scores. For the risk of neck, operator 1 got 6 scores it is categorized as low risk for the neck, while operator 2 got 10 scores that categorized as moderate risk, the interpretation for neck itself is 4 to 18 scores.
The activities are less vibration, which is shown from the result of QEC that the scores for vibration are only 1 or low risk for both operators. For the driving situation, both of the operators got 1 score, it means having low risk ergonomic. In the work pace, operator 1 and operator 2 have different scores and risk, for operator 1 got 1 score (low risk) while operator 2 got 4 scores (moderate risk). The risk of stress for both operators is moderate, they got the same score that is 4 scores.

For the exposure level operator 1 got value 41.47%, from that result, the action that to do for operator 1 needs more research to make it safe for the operator. While the operator 2 got value 55.68%, the action to do for operator 2 is doing an other research and change the activities. Changes made can be in the form of improvements to work facilities to reduce fatigue and complaints due to work.

In determining the position of the body at work is largely determined by the type of work performed. The differences in exposure levels of operator 1 and 2 are caused by different job description. Operator 2 has to clean the poop under the cage, so he needs to bend his body in an awkward position. That is caused by the exposure score on back, shoulder, and hand is high. According to Irdiastadi & Yassierli., 2014, a work station that requires the operator to stand is not very desirable but is often needed [17]. Especially for work with the following conditions:

- Work requires frequent handling of material, especially if the material is heavy
- Work requires reaching out activities
- Work requires fairly high mobility, for example, be beautiful around the work station.
4.2. Nordic Body Map

Here is the NBM questionnaire result from the two operators that work in breeding hens in Widodomartani, Sleman.

| No. | Body Segment       | Level of Pain | Score |
|-----|--------------------|---------------|-------|
|     |                    | A  | %  | B  | %  | C  | %  | D  | %  |       |
| 0.  | Upper neck         | 1  | 50 | 1  | 50 | 3   |     |
| 1.  | Lower neck         | 2  | 100| 2   | 100| 4   |     |
| 2.  | Left shoulder      | 2  | 100| 2   | 100| 6   |     |
| 3.  | Right shoulder     | 2  | 100| 2   | 100| 2   |     |
| 4.  | Left upper arm     | 2  | 100| 2   | 100| 2   |     |
| 5.  | Back               | 2  | 100| 2   | 100| 2   |     |
| 6.  | Right upper arm    | 2  | 100| 2   | 100| 2   |     |
| 7.  | Waist              | 2  | 100| 2   | 100| 2   |     |
| 8.  | Buttock            | 2  | 100| 2   | 100| 2   |     |
| 9.  | Bottom             | 2  | 100| 2   | 100| 2   |     |
| 10. | Left elbow         | 2  | 100| 2   | 100| 2   |     |
| 11. | Right elbow        | 2  | 100| 2   | 100| 2   |     |
| 12. | Left lower arm     | 2  | 100| 2   | 100| 2   |     |
| 13. | Right lower arm    | 2  | 100| 2   | 100| 2   |     |
| 14. | Left wrist         | 2  | 100| 2   | 100| 2   |     |
| 15. | Right wrist        | 2  | 100| 2   | 100| 2   |     |
| 16. | Left hand          | 2  | 100| 2   | 100| 2   |     |
| 17. | Right hand         | 2  | 100| 2   | 100| 2   |     |
| 18. | Left thigh         | 2  | 100| 2   | 100| 2   |     |
| 19. | Right thigh        | 2  | 100| 2   | 100| 2   |     |
| 20. | Left knee          | 2  | 100| 2   | 100| 2   |     |
| 21. | Right knee         | 2  | 100| 2   | 100| 2   |     |
| 22. | Left calf          | 2  | 100| 2   | 100| 2   |     |
| 23. | Right calf         | 2  | 100| 2   | 100| 2   |     |
| 24. | Left ankle         | 2  | 100| 2   | 100| 2   |     |
| 25. | Right ankle        | 2  | 100| 2   | 100| 2   |     |
| 26. | Left foot          | 2  | 100| 2   | 100| 2   |     |
| 27. | Right foot         | 2  | 100| 2   | 100| 2   |     |

Based on the results of the Nordic Body Map questionnaire as shown in the table, the results of the questionnaire show that operator 1 felt moderate pain when working on the lower neck, buttock, left calf, and right calf. Besides, operator 1 feels painful only on the right shoulder. While the pain felt in operator 2 (moderate pain) in the upper neck and lower neck. While the pain (painful) when working is felt on the right shoulder, right upper arm, buttock, left knee, and right knee.

From these results, it can be seen if the pain felt by the two operators is in the neck, buttock, shoulder, arm, calf, and knee. The complaint was mainly caused by the activities of the two operators being repetitive and in quite a long time, which is around 2 hours. The pain in the neck is caused by the work of the operator where the operator works with the neck sometimes looking to take something or do something. Besides, the pain in the buttock is caused by the operator having to squat down for a long time where it can cause the buttocks muscle to be depressed. The cause of pain in the shoulder is because the operator often bends for a long period. While the cause of pain in the arms due to improper arm position (above the chest) and also make repetitive movements. The cause of pain in the
knee is because the condition of the knee is bent for a long time will cause fatigue. While the cause of pain in the calf is because the operator must do the foot work repeatedly.

Worker’s activity when the spine is bent causes the body to lean forward, the abdominal muscle, and the front side disc of the spine in the lumbar will be compressed [18]. This condition can cause back pain. Additionally, the shoulder has unsafe position if the position while lifting at the shoulders structure an edge of ≥45º from the vertical hub of the body, either horizontally of the body and towards the front of the body [19].

From data processing using the Nordic Body map, it can be said that there is a need for changes or improvements in work or work environment, especially those related to the parts of the body that get the most moderate pain and painful complaints, namely the neck, buttock, shoulder, arm, calf, and knee. Improvements that can be made to this problem are being able to evaluate the design of work tools and also the position of the worker when doing their work.

4.3. Normality Test
The normality test is carried out using SPSS software to find out whether the data used is representative of all existing samples. The data used for the normality test are body dimension data consisting of. By using a 95% confidence level, it is known that alpha = 0.05. The results of the Kolmogorov-Smirnov synergy are obtained which determine whether the data used is normal or not.

| Table 2. Normality Test |
|-------------------------|
| Kolmogorov-Smirnov*   |
| Statistic          | df | Sig. |
|------------------|----|------|
| TPO              | .143 | 30 | .122 |
| TSB              | .083 | 30 | .200* |
| JT               | .112 | 30 | .200* |
| TMB              | .106 | 30 | .200* |
| RS               | .127 | 30 | .200* |

The TPO gets a significance value of 0.122 which is greater than 0.05. Then on the TSB gets a significance value of 0.2 which is greater than 0.05. In the JT gets a significance value of 0.2 which is greater than 0.05. Then on the TMB gets a significance value of 0.2 which is greater than 0.05. Last on the RS gets a significance value of 0.2 which is greater than 0.05. Normality test results show that the significance value of each dimension is more than 0.05, which means that Ho is accepted and the population is normally distributed, the sample taken already represents the existing population.

4.4. Percentile and Body Dimension
The following is the body dimension result after calculating with the percentile:

| Table 3. Analysis of Anthropometrics Dimension |
|---------------------------------------------|
| No. | Dimens | Product dimension | Measurement calculation | Allowance | Result (cm) |
|-----|--------|------------------|------------------------|-----------|-------------|
| 1.  | TPO    | The height for the first row of the cage | 46.3617 | - | 46.3617 |
| 2.  | TSB    | The height for the second row of the cage | 92.9833 | - | 92.9833 |
| 3.  | JT     | The maximum width from the first row to the third row | 63.2514036 | - | 63.2514036 |
| 4.  | TMB    | The height of the third row of the cage | 137.87 | - | 137.87 |
| 5.  | RS     | The width of the alley | 89.6548 | - | 89.6548 |

The explanation of the table above:
- Popliteal Height (TPO)
Percentile 95 is used in this dimension as a benchmark to measure or design the height of the first row of the cage. It is using percentile 95 so the people with big size not very bent when giving foods to the hens on the first row. So, the big size person still can access it comfortably no in very bent work posture.

- **Standing Elbow Height (TSB)**
  Percentile 50 is used in this dimension as a benchmark to measure or design the height of the second row of the cage. So, petite people and the big person still can use it comfortably.

- **Hand Reach (JT)**
  Percentile 5 is used to accommodate a petite person. It is as a benchmark for the maximum width from the first row to the third row. So, the petite person does not need to exceed his/her hand reach in giving the foods to the hens.

- **Standing Eyes Height (TMB)**
  Percentile 50 is used in this dimension or measure or design the height of the third row of the cage. It is using percentile 50 so it can accommodate the petite and big person. It also causes the third row is in the eye range.

- **The Range of Hand Elbow (RS)**
  Percentile 95 is used to design the alley in between the cage. So, it can be accessed by people easily. Especially by the person who carries trolley to get the egg.

Here is the visualization of the design using anthropometrics to make it fits or suits the person:

![Figure 3. The Implementation of Anthropometrics](image)

### 4.5. Product
The basic concept of anthropometry is used in the re-designing process and is suitable for people in Indonesia.

![Figure 4. Re-designed Breeding Hens](image)  ![Figure 5. Inside of the Breeding Hens](image)
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The basic concept of anthropometrics is used in re-design the work station process to make it fits or suits the person. The size of the work station has been adjusted to the dimension of the human body especially Indonesian within the age of 41-59 years old. With a design that emphasizes the 5 segments of the body, it will provide comfort and health and minimize the discomfort due to its size which is not ergonomic. These 5 segments of the human body's size are used in the re-designing of the work station. The advantages of the product are:

- Sufficient space and access for workers between two pens or in other words easy mobilization of workers.
- Three cages are made stacking up which is useful to maximize space but still pay attention to easy reach.
- At the bottom of the work, the station is equipped with chicken manure so that workers do not need to bend extreme just enough to scoop it through the channels that have been provided.
- The distance between the roof and the cage is large enough so that there are sufficient lighting and air circulation.
- Workers can work with appropriate posture due to anthropometry based design.
- There few facilities that added to the work station like a cupboard.
- The air circulation is good because it is using open breeding hens.
- Re-arranging the layout to improves material flow, reduce travelled distance, and increase productivity.

5. Conclusion

The result showed that the exposure level operator 1 got value 41.47%, the action that needs to be done is need more research to make it safe. While operator 2 got value 55.68%, the action that needs to be done is doing another research and change the activities. Also, it can be seen if the pain felt by the two operators is in the neck, buttock, shoulder, arm, calf, and knee. From data processing using the Nordic Body map, it can be said that there is a need for changes or improvements in work or work environment. The basic concept of anthropometry is used in re-design the work station process to make it fits or suits the person. This is the result of our redesign size, popliteal height is 46.3617 cm, standing elbow height is 92.9833 cm, hand reach is 63.2514036 cm, standing eyes height is 137.87 cm, and the range of hand. By re-designing the work station that based on the anthropometry, it can reduce the risk of musculoskeletal injury and increasing the productivity.

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