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Design of a Hydraulic Trolley to Reduce Work Risks in Gram Transfer Activities at PT XYZ

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Abstract

Material Handling Equipment (MHE) is a tool used to facilitate worker activities when doing heavy work. Material Handling Equipment (MHE) is also very helpful for workers in reducing the workload caused by less ergonomic activities that can cause worker fatigue. At PT XYZ, there is the activity of transferring grams onto trucks with trolleys. In the activity of transferring gram ± 60 minutes for transferring gram onto the truck. The worker's posture when using the trolley has a REBA value of 12 which means Very High Risk. Therefore this study focuses on redesigning the trolley with consideration of REBA analysis using the Kansei Engineering approach. The redesign results get a REBA value of 3, and it can be concluded that the proposed trolley is better than the existing trolley.

1. INTRODUCTION

Material Handling Equipment (MHE) is used to move goods between the destination workstations.MHE serves to help speed up the work of the user as well as to reduce the workload caused by those activities that are less ergonomic, which can cause fatigue in workers. According to Sunyoto (2012), the workload is too much to cause tension in a person to cause stress. Matter This can be caused by the level of expertise required being too high, an increase in working speed may be too high, an increase in working volume maybe too much, and so on, whereas according to Tarwaka (2010), the workload can be defined as a difference between the capacity or ability of workers with the demands of the job at hand.

SPT XYZ is a company engaged in metal manufacturing or fabrication, with the main components being precision machining, laser cutting, and metal fabrication. The raw materials used by this company consist of three types: metal, plate, and steel. The first process is the return of the material to the storage rack, after which it will be processed into the CNC Lathe Machine; where this process is to shape the material according to the customer's request, after carrying out the next forming process is the CNC Milling Machine process, where this process is to cut and drill on the material part, then goes into the welding process where this process is used to combine materials and for the last process is an inspection where this process is to check whether the goods are defective or not and whether the goods are following customer orders.

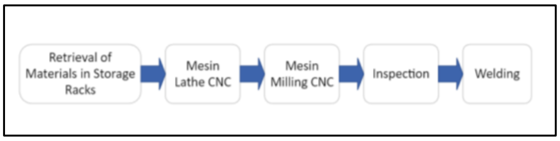

Figure 1.
Production Process Flow

In Figure 2, there is the activity of workers transferring grams onto a truck with a trolley that is not ergonomic. In the activity of transferring gram ± 60 minutes for transferring gram onto the truck. The trolley in PT XYZ still has an enormous workload because it does not have a handle that is used to push the trolley, has a reasonably small size with a size of 60x40x40 cm, cannot lift gram onto the truck, and the transfer distance of the grunt onto the truck is ± 25 meters. This makes workers injured and quickly tired at work.

Figure 2.
The Process of Transferring and Lifting Grams

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Based on the results of interviews with the operator, information was obtained regarding the complaints that were felt regarding the trolley used, namely: it did not have a handle, the material rusted easily, the size was not ergonomic because the trolley was too short, it was not multifunctional, and the trolley was easily damaged. Based on measurements of the operator's work posture, a REBA value of 12 was obtained for the current trolley. With this score, it can be concluded that employee posture is included in the category of needing action right now (Very High Risk, Implement Change).

Figure 3.
Measurement Of Work Posture

Therefore, this research focuses on redesigning the trolley to reduce work risks to the trolley operator. In the process of designing the proposed trolley, the Kansei engineering approach was taken, this approach was taken to produce assistive devices that match the expectations of the operator because, in Kansei engineering, the involvement of the operator or user is used as a consideration in the design.

2. LITERATUR REVIEW

2.1 REBA

Rapid whole body assessment (REBA) (Hignett and McAtamney, 2000) was developed to assess unpredictable work postures in health care and other service industries. Data about body posture, style used, type of movement or action, repetition, and coupling is collected. A final REBA score is generated to indicate the level of risk and the urgency of action to be taken.

Within the spectrum of postural analysis tools, REBA lies between detailed event-driven systems and time-driven tools. Examples of detailed event-driven tools include three-dimensional observing systems (Hsiao and Kesselring, 1990) or NIOSH (National Institute for Occupational Safety and Health) equations (Waters *et al*., 1993), which require information about specific parameters to provide high sensitivity. Time-driven field tools such as OWAS (Ovako's work posture analysis system) (Karhu *et al*., 1977) provide high generality but low sensitivity (Fransson-Hall *et al*., 1995). REBA can be used when an ergonomic workplace assessment identifies further postural analysis is needed and The whole body is used. Postures are static, dynamic, rapidly changing, or unstable. Live or dead loads are being handled either frequently or infrequently. Workplace modifications, equipment, training, or worker risk-taking behavior, are monitored before/after changes.

2.2. KANSEI ENGINEERING

Kansei Engineering is a type of technology that can translate customer feelings into design specifications (Lokman, 2010). So it can be concluded that the Kansei Engineering method is a method to help design a product according to user complaints or user needs in order to achieve a design that suits the user.

The Kansei Engineering Method has several types to solve problems in different ways. The following are the types of Kansei Engineering (Nagamachi & Lokman, 2016): Kansei Engineering Type-I Category Classification, Kansei Engineering Type-II Kansei Engineering System (KES), Kansei Engineering Type-III Hybrid Kansei Engineering System, Kansei Engineering Type-IV Kansei Engineering Modeling, Kansei Engineering Type-V Virtual Kansei Engineering, and Kansei Engineering Type-VI Collaborative Kansei Engineering Designing.

Kansei Engineering is a methodology that connects several methods for conducting research. Methods can be modified or changed based on their purpose. The following are the methods in Kansei Engineering (Nagamachi & Lokman, 2016): Choice of Participant Group, Collection of Kansei Word, and Data Reduction Method for Selection of Kansei Word, Rating Scale Types Used, Computerized Data Collection Connecting the Kansei Word to Product Properties.

3. RESEARCH METHODOLOGY

This study aims to reduce the operator's work risk by redesigning the trolley with the Kansei engineering approach. The selection of Kansei engineering is used with the hope that the products developed will be more oriented towards consumers and reflect the desires of consumers or users. The following are the stages of the research conducted.

a. In the early stages of the research, the writer formulated the problem by studying the existing object to be examined, which aims to determine the existing problem. At this stage, the author explains the background problems in which there are field studies and literature studies. Studies in the field are used to observe the existing trolley conditions directly. At the same time, the literature study was carried out on theories related to the problems that exist in research. After creating The background then, formulates the problem on the existing condition of the trolley for further research can be carried out. After that, make goal-setting research and problem definition. Determination of research objectives is carried out for shows the results of the research following what is desired. Whereas problem definition is to limit the scope of the problem that is too broad so that the author focuses on the problem to be studied.

b. At the data collection and processing stage to serve as the Trolley design concept. The first stage is knowing what the user wants and how to interview workers who use trolleys to see the desire for the existing trolley. After getting the data, the user's wishes will be used as the author as a data source research to get Kansei's word. Kansei word describes a product to be made and represents from user's feelings and desires. After getting the data, process data using validity and reliability tests previously obtained in the questionnaire. This test works to see the suitability of a Kansei word on the questionnaire given to the user, whether in accordance with the user's wishes or not. The next stage is semantic differential, where semantic differential measures a word's emotional content more objectively. Next is factor analysis, which aims to reduce and identify the relationship between variables into a few sets of indicators only. The next stage is the KJ method, and this KJ method is used for.

c. At the stage of analyzing and designing the concept, the first step trolley to do is to map the product concept. This study uses Kansei word type 1 by mapping the product concept using diagrams a tree containing Kansei words with several categories. Step The next step is to determine the product specifications obtained from Kansei Word. With product specifications, trolley products can be designed according to the desired specifications, such as size, material, and features, assisted by anthropometric data to obtain the appropriate size. After the product specifications have been obtained, the next step is to design a trolley according to the previously obtained specifications. The design of the trolley is a design 3D which can make it easier for users to see the product will be made in; designing the trolley assisted by benchmarking to get references on the product to be designed.

At the stage of conclusions and suggestions explaining the research conducted, namely applying the Kansei word obtained to the PT Azmindo Metal Indonesia design to meet workers' wishes and reduce the workload when moving grams by trolley.

4. RESULT AND DISCUSSION

4.1 Data Collection and Processing

The data used in this study were obtained based on domain identification. The domain is PT XYZ workers with an age range of 19 years to 56 years. Then Identify the trolley currently used by the company.

a. Principal Components Analysis

Data is obtained by collecting Kansei words. When using the product, Kansei words must be based on function, material, and mechanism. These words can be in the form of adjectives, verbs, or nouns. In the Kansei approach, user responses can be used as information that can explain the product according to the user's wishes. In this study, 60 Kansei words were obtained. The 60 Kansei words are reduced using Principal Components Analysis to become 17 Kansei words.

Table 1.
Kansei Word

No	Kansei Word	No	Kansei Word
1	Comfortable	10	User size
2	Safe	11	Big capacity
3	Effective	12	Stable
4	Hold Load	13	Easy to Clean
5	Resilient	14	Unique
6	Durable	15	Good maneuver
7	Light	16	Efficient
8	Multifunction	17	Productive
9	Easy to push		

b. Validity and Reliability Test

To test the level of importance of eating, a questionnaire was distributed. From the results of the questionnaire, the following results were obtained. The results of the normality test above use the normality test using the Shapro-Wilk approach because the number of respondents is less than 50 people. Based on the results of the normality test, the sig. of 0.000 so that it can be said that the data is not normally distributed. The next step is to test the validity and reliability. The validity test used was the Spearman method because the data were not normally distributed and the number of respondents was less than 50 people. According to Azwar (2011), "data can be considered valid if sig ≥ 0.30". The following are the results of the validity test obtained.

Table 2.
Validity Test

Kansei Word	CC	Sig	Result	Kansei Word	CC	Sig	Result
Comportable	0,44	0,3	Valid	User size	0,433	0,30	Valid
Safe	0,53	0,3	Valid	Big Capacity	0,45	0,30	Valid
Effective	0,50	0,3	Valid	Stabil	0.66	0,30	Valid
Hold on The Load	0,46	0,3	Valid	Easy to clean	0.42	0,30	Valid
Resilient	0,44	0,3	Valid	Unique	0,49	0,30	Valid
Durable	0,50	0,3	Valid	Good manuever	0,60	0,30	Valid
Light	0,43	0,3	Valid	Efficient	0,55	0,30	Valid
Multifunction	0,44	0,30	Valid	Productive	0,69	0,3	Valid
Easy to drive	0,449	0,3	Valid				

Based on the reliability test results above, the Cronbach Alpha coefficient value was 0.809, so it can be said that the results of the coefficient values are reliable or consistent.

c. Semantic Differentials

After conducting validity and reliability tests and having been declared valid and reliable, the next step is to perform a Semantic Differential. Articles of Aros (2014) state that the Semantic Differential is a tool for measuring the connotative value of an object or image made by Osgood and his colleagues (1957), which aims to provide a quantitative basis that allows both objective measures of psychological meaning Analisis Faktor.

The result of the Kaiser-Meyer-Olkin value is 0.515 or greater than 0.5, so these results can be predicted and analyzed further. While the significance value is 0.000 or less than 0.05, indicating that the indicators used are correlated.

The Extraction value for each variable is > 0.50, so all variables can be used to explain factors or represent characteristics of the proposed trolley design. In the initial column, each variable has a value of 1 because there is no unique variance. After getting the results from the Communalities, it is obtained that the Kansei word that meets the requirements can be continued by grouping the variables into components, factoring the process by looking at the eigenvalues of each component. There are six components in the factoring process table with eigenvalues > 1, so the 17 questions above can be grouped into 6.

Table 3.
Kansei word grouping

No	Kansei word	Component	No	Kansei word	Component
1	strong	1	10	Effective	3
2	Easy to push	1	11	Hold the load	4
3	Stable	1	12	Durable	4
4	Easy to clean	1	13	Light	4
5	Unique	2	14	Large payload capacity	5
6	Comfortable	2	15	Good maneuver	5
7	Safe	2	16	Efficient	5
8	Multifunction	2	17	User size	6
9	Productive	2			

Above are six groups for all Kansei words based on the results of the factoring process, which have eigenvalues > 1. Then from the six groups, the group again according to the component in each variable with the highest value. After getting the group, the next stage is concept mapping to get the zero level in the KJ Method. The following are the characteristics and specifications of the trolley product. This KJ method uses affinity diagrams as a tool to group Kansei words into more specific categories called affinity clusters. The cluster has two levels or levels where the more significant the level, the more detailed it is.

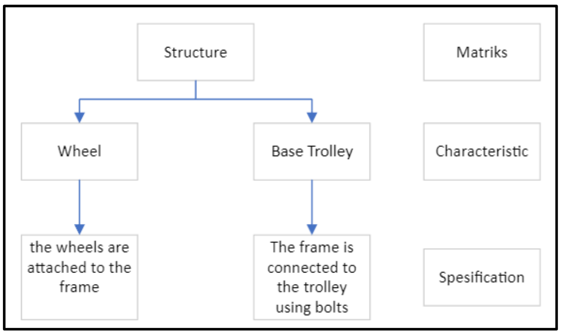


Figure 5.
Product Concept mapping

4.2 Discussion

After obtaining the characteristics and technical specifications of Grouping Using the KJ Method, the next step is to make a visual design. Before visualizing using CAD, it is necessary to design a trolley first. Designing is done by benchmarking or using existing products as a reference to find references or ideas that match the design being made. This study uses three techniques to be used as a reference in benchmarking. The selection of the three reference products is based on the compatibility between the Kansei word and the technical specifications for the designed product.

The following is a benchmarking for making a trolley concept design.

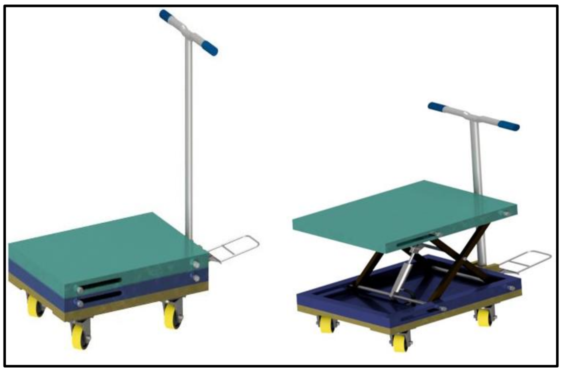
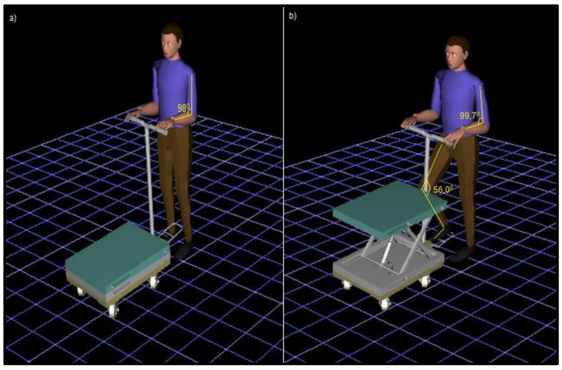


Figure 6.
Proposed Hydraulic Trolley Design

Rapid Entire Body Assessment (REBA) is used to help analyze work posture, which consists of assessing the posture of a worker's neck, back, arms, wrists, and legs; the following results from the work posture analysis using the REBA Score for the proposed Trolley.

Based on the REBA score measurement results it has shown a reduction in the risk value between the existing trolley and the proposed trolley. On the existing trolley, a REBA score of 12 was obtained; with the REBA value, it was found that the worker's posture was included in the category that needed action right now (Very High Risk. Implementation Change). Whereas for the proposed trolley REBA score, the REBA score when pushing the trolley is 3. From this score, it is included in the low-risk level (Action may be needed), and for the REBA score when raising the trolley base, it gets a score of 4, which is included in the level of moderate risk (requires action). From the REBA score measurement results, it can be concluded that the proposed trolley is better than the existing trolley.



(a) Pushing the Proposed Trolley (b) Raise the trolley base

Figure 7.
Measurement of work posture

5. CONCLUSION

Based on the REBA score measurement results it has shown a reduction in the risk value between the existing trolley and the proposed trolley. On the existing trolley, a REBA score of 12 was obtained; with the REBA value, it was found that the worker's posture was included in the category that needed action right now (Very High Risk. Implementation Change). Whereas for the proposed trolley REBA score, the REBA score when pushing the trolley is 3; from this score, it is included in the low-risk level (Action may be needed), and for the REBA score when raising the trolley base, it gets a score of 4 so that the score is included in the level moderate risk (requires action). From the REBA score measurement results, it can be concluded that the proposed trolley is better than the existing trolley.

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