DESIGNING AND DEVELOPMENT OF VEHICLE IDENTIFICATION NUMBER (VIN) PUNCHING MACHINE TROLLEY

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Abstract: Musculoskeletal Disorders is serious issue on manufacturing industries due to low awareness of the right working procedure. This study is to find ways to enhance the ergonomics awareness in manufacturing Industry. The project discuss about the technique for the worker to do their job in manufacturing. The project focuses to analyze working posture and low back pain by using working posture evaluation using Rapid Entire Body Assessment (REBA) and Rapid Upper Limb Assessment (RULA) method. This project will be evaluated, examine and recommend a new skill/technique of machine handling as solution to improve current working postures. A work position that not follow right procedure will instantly cause fatigue to the body and will lead to lower productivity and efficiency. At manufacturing company, a lot of work position not following ergonomic aspects at work area which the worker wrongly lift the heavy machine and put a burden on his body.

***Keywords**: Ergonomics Aspects, RULA and REBA Method*

1. Introduction

Ergonomics is important at at workplace and it is designed to enhance the relationship between work environment and workers. This project aims is to run an ergonomic assessment in manufacturing industry. Ergonomic assessment in this project more to enhance the work environment, tools/equipment, work posture while assuring the wellbeing, safety and health of the workers. The improvement that been considered by using the ergonomic evaluation to reduce the risk when doing work at the company. Figure 1 shows the vehicle identification number (VIN) machine is located at punching body work area. The machines is quite heavy and with wrong postures or procedure, it can lead to back pain injuries. There are some standard that have impact on the efficiency, productivity work environment, methods of production and body postures of worker. A work posture has a direct impact on worker's performance and productivity.

Figure 1. VIN machine not follow 5s and Ergonomic Concept (Ohnishi, et al., 2016)

This situation will give some risk to the workers which lead to lower performance than usual. It will leads to some bad effect such as back pain and tiredness to the workers. Besides that, the punching machine is heavy and with wrong postures, it can affect worker safety and performance which lead to serious problem for the company.

2. Methodology

In this design process, there are 3 stage involved as can be seen in Figure 2. Stage 1 involves problem identification and issues regarding heavy machine handling procedure/processes. Stage 2 will be focused based on designing and development of ergonomic trolley for Vin punching machine. Finally, in stage 3, effectiveness of the ergonomic trolley before and after the application will be carried out by the evaluation test.

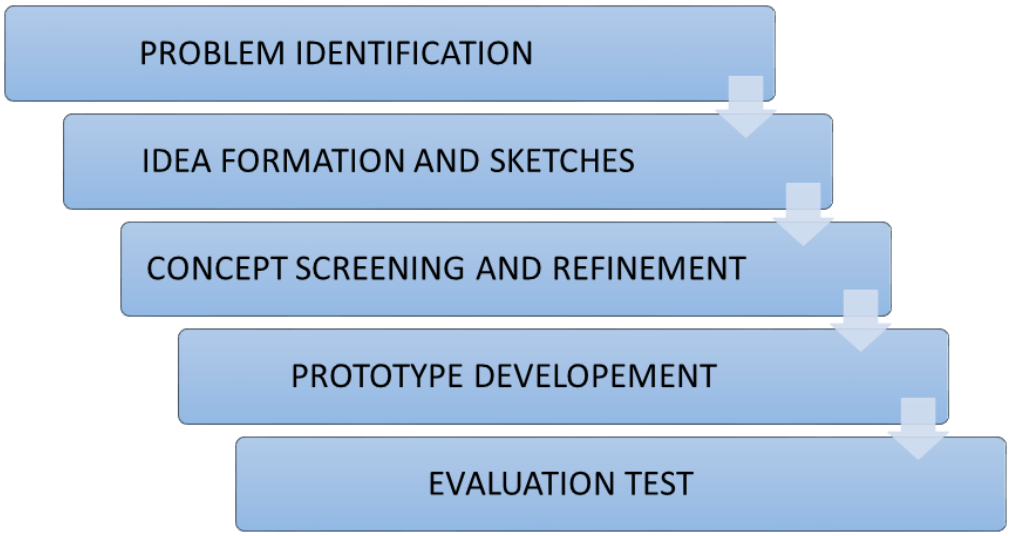

Figure 2. Design Process in this study

2.1. Stage 1: Identification Problems

The problem identification are correlated to the current process of machine handling and was managed through on interview, observation and work procedure at production line, involving the operator that responsible for the operation of punching number at car chassis. The operator has been told about the scope and aim of this project. They were informed that the trolley is about achieving ergonomic aspects at workplace which can improve work performance and safety every worker.

Each operators will be given task to do the work process and need to report if they experience pain on their body through the operation. During the examination, if anyone have any ideas, opinion or issues about the ergonomic, they are encouraged to share it with everyone else. If the ideas is good, it will make as a new solution

2.2. Stage 2: Development of Design

i. Idea Sketches and Formation

The conception of design were created through discussion, reviews of the ideas through brainstorming session. The design must be carefully considered so that the design can be produced and all parts functioning. There are several that should be considered in designing the trolley which is strength, ergonomic factor and suit to work environment. There are 3 design that have been draw by using AutoDesk Inventor.

ii. Conception Screening and Refinement

There are 3 design of the ergonomic trolley but only 1 will be chosen as a final product as refer to Figure 3. The conception screened concepts will be reviewed and evaluated, before choosing last design. The supervisor will provided correction or ideas before selected the final design

iii. Prototype Development

A prototype was built by using steel at body frame. This material is chosen because it has high tensile strength and low cost which meet the requirement for this project. It also use the polyurethane tyre so that the trolley can be used in any production line beside punching body work area.

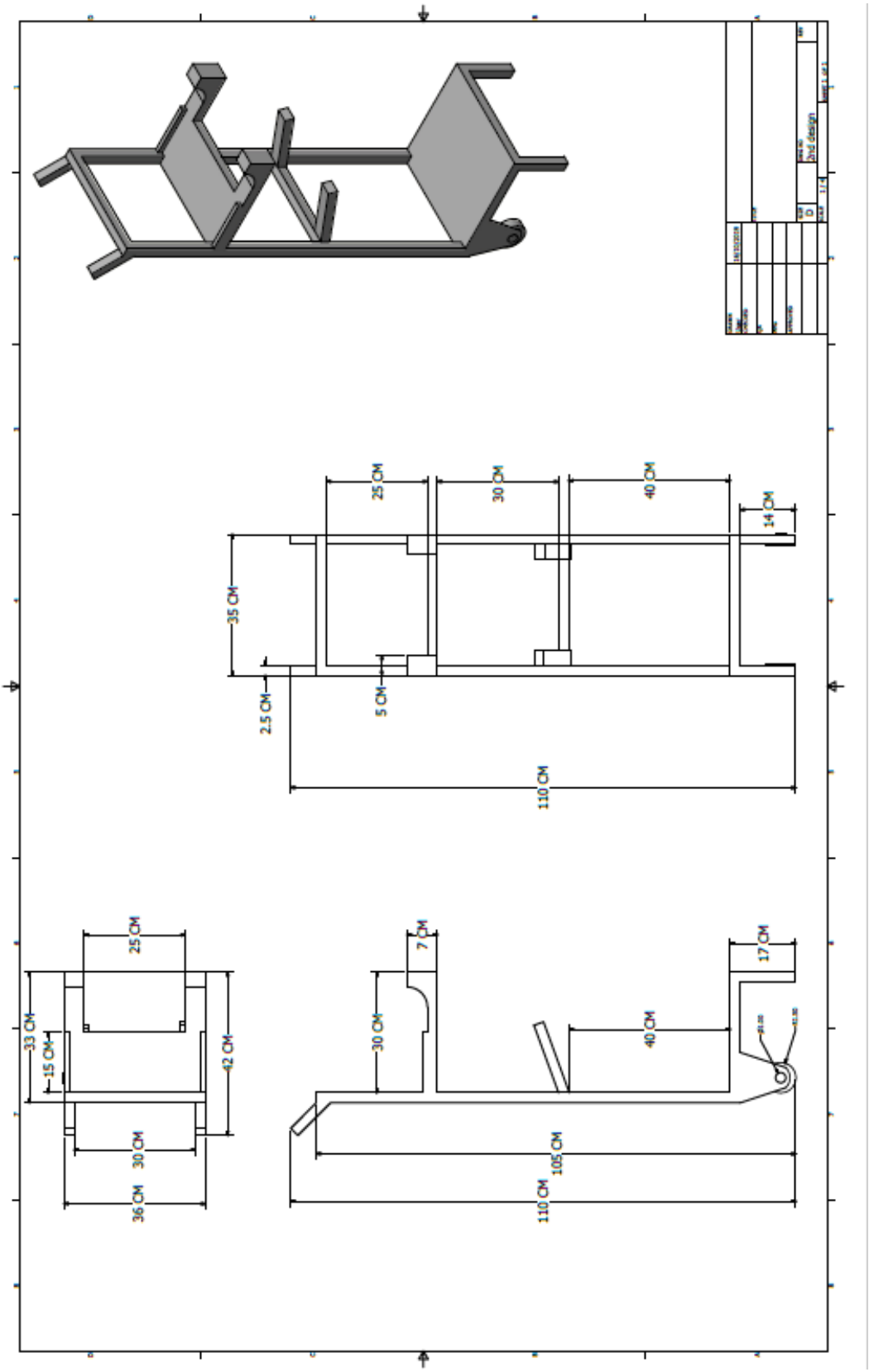

Figure 3. Selected Design

2.3. Stage 3: Evaluation Test

This design mostly focused on the ergonomic and safety of the worker on machine handling at work place. For the measurement of the design, the antropometric data need to be taken. Antropometry is important when something involved in industrial design and ergonomics where statitiscal data about the body dimensions will be taken. Ten Operator will be take their High Elbow Standing (cm) and their Hand Held Diameter (cm) to adjust the trolley according to the anthropometry graph (Dick et al., 2016).

Working posture assessment by using Rapid Upper Limb Assessment (RULA) and Rapid Entire Body Assessment (REBA) was also conducted to access workers subjection to ergonomic risk factors while perfoming punching body process (Van et al., 2010). Table 1 shows the RULA and REBA are the two easiest methods for risk assessment in the workplace. Both of this method is to examine and evaluate the loads that can be taken on musculoskeletal systems when the workers work with risk such as awkward postures, excessive force and static muscle works. The scoring through this method is needed so that the injuries can be reduce on the future.

Table 1. RULA scoring (Dempsey and Hashemi, 1999)

Score	Level of MSD Risk
1-2	neglibible risk, no action required
3-4	low risk, change may be needed
5-6	medium risk, further investigation, change soon
6+	very high risk, implement change now

3. Results

Ergonomic trolley design research to increase productivity is carried out with anthropometric measurement methods on punching body operators. The variables used in this research are trolley operator anthropometric data measurement, measurement of trolley operator process time and measuring productivity levels. The stages of the research that will be carried out are as follows:

a) Data collection
Anthropometric data (elbow standing and hand-held diameter), punching body time data before and after the application of ergonomic trolley, peformance rating before and after applied the ergonomic trolley, allowance before and after applied the ergonomic trolley.

b) Data test
Normaly distribution anthropometric data test, Uniform punching body time before and after the application of ergonomic trolley data test, and machine movement in production line before and after the application of ergonomic trolley data test.

c) Data processing
Anthropometric data used to determine percentile values. If the percentile value has been obtained, then the size of the ergonomic trolley can be design.

3.1. Anthropometric Data for Trolley Operator

The trolley operator Anthropometric data are necessary for trolley design such as hand held diameter and high elbows standing. Table 2 shows anthropometric data from this study.

Table 2. Anthropometric Data

OPERATOR	HIGH ELBOWS STANDING (CM)	HAND HELD DIAMETER (CM)
1	102	5
2	103	5
3	105	6
4	108	7
5	109	9
6	108	9
7	107	8
8	106	5
9	104	4
10	103	4

3.2. Anthropometric Graph

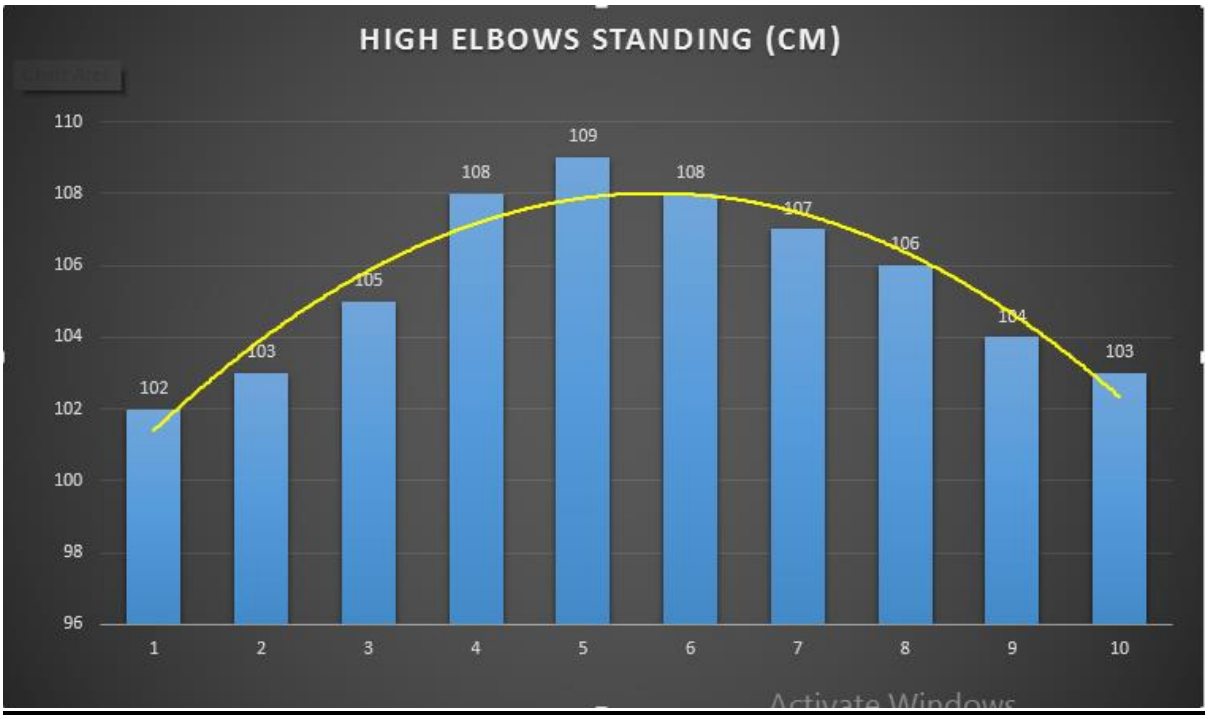

Figure 4. Anthropometric Graph for High Elbows Standing (cm)

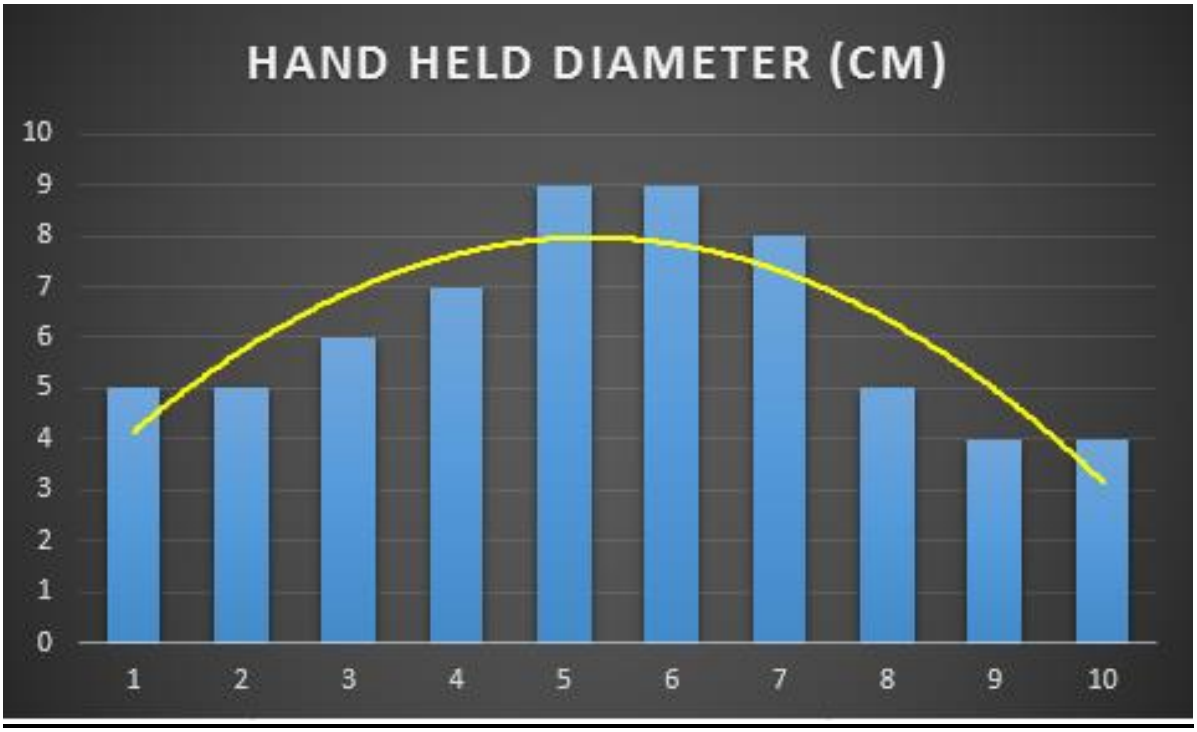

Figure 5. Anthropometric Graph for Hand Held Diameter

Figure 4 and Figure 5 show the Ergonomics of trolleys are designed based on percentile values for high size the trolley is taken from the 5th percentile to 95th percentile value of the standing elbow which is 108 cm. . The height range of a cart handle from the floor should be about 94 cm (37 in) to 117 cm (46 in). While for the diameter size the trolley handle is taken from the 5-th percentile value of the hand grip diameter from 2.5 – 4 cm.

3.3.REBA and RULA

While performing the punching body process from key in data to lift the machine and punching the vin, the REBA and RULA methods were used to examine and evaluated the posture body when operate the machine. As for handling process, there are four section of REBA and RULA analysis. Table 3, 4, 5 and 6 shows the average REBA and RULA scores. As for the current method, REBA and RULA scores will be conducted through the process that involved in the punching body process.

Table 3. RULA scores of current method

OPERATOR	RULA SCORES BY OPERATORS		
	POSTURE SEGMENT		
	Key in Data	Lifting the machine	Transfer to production line 1
1	4	5	7
2	5	6	7
3	5	6	6
4	6	6	6

Rula score of 1 or 2 = allowable, 3 or 4 = look into further, 5 or 6 = look into further and adjust soon, 7 = will be analyzed and resolve immediately

Table 4. REBA scores of current handling method.

OPERATOR	REBA SCORES BY OPERATORS		
	POSTURE SEGMENT		
	Key in Data	Lifting the machine	Transfer to production line 1
1	7	10	11
2	6	11	11
3	6	9	10
4	8	8	10

REBA final score of 1 = lowest risk ; 2–3 = change may be needed; 4–7 = need to do investigation, will change soon; 8–10 = high risk for the body ; 11+ = very high risk, changes will be carried out immediately.

Table 5. RULA scores of the new handling method

OPERATOR	RULA SCORES BY OPERATORS		
	POSTURE SEGMENT		
	Key in Data	Lifting the machine	Transfer to production line 1
1	2	3	2
2	3	3	3
3	3	4	4
4	2	4	2

Rula Final score of 1 or 2 = allowable, 3 or 4 = look into further, 5 or 6 = look into further and adjust soon, 7 = will be analyzed and resolve immediately

Table 6. REBA scores of the new handling method

OPERATOR	REBA SCORES BY OPERATORS		
	POSTURE SEGMENT		
	Key in Data	Lifting the machine	Transfer to production line 1
1	4	5	3
2	3	7	4
3	5	5	4
4	4	6	5

REBA final score of 1 = lowest risk; 2–3 = change may be needed; 4–7 = need to do investigation, will change soon; 8–10 = high risk for the body; 11+ = very high risk, changes will be carried out immediately.

As for evaluation test, RULA scores has been reduced from 4–7 to 2–4 levels across all four posture segments after the used of ergonomic trolley. Scores of 3–4 said that it will be looked and investigate further, whereas scores of 5–6 will investigate further and changes need to be made. As for the highest scores which is 7, it will be analysed and need to resolve immediately. As for the REBA scores, it decreases significantly from score 6-11 to 3-6 after the application of ergonomic trolley.

3.4. Final Product

Figure 6. Front View

Figure 7. Behind View

4. Discussion

From the findings, the final product has contributing a lot of improvement at workplace, equipment and environment. The inputs from the operator by doing brainstorming session have led to the successful final design and product. Each of the ideas that been considered while brainstorming session has led to this final product. In the evaluation test of this ergonomic trolley, it has achieved its goal which is to follow the ergonomic concept at work place and to lower the risk of lower back pain. As for the productivity and efficiency terms, the final product can reduce the time taken when doing punching body job compared to time taken before the application of ergonomic trolley. In terms of safety and health, the ergonomic trolley provides a better work postures compared to the old ones. Besides that, operator also can push the trolley and bring the machine to any production line compared to the old method that need to lift the heavy machine which lead to serious back pain.

Although the final product is fully functional, it still need a lot of need a lot of improvement. For example, we can see that from RULA scores of new handling method is 2-4 which still need to improve. As for REBA scores of new handling method also need a lot of improvement since the score is 3-6 which is good but still need an improvement.

5. Conclusion

An ergonomic trolley has been design firtsly and developed in this study. The working operation for punching body has been successfully tested in manual handling of heavy machine and it can be seen that the safety and health and work efficiency has improved tremendously. Beside that, safety of manual handling also has been improved a lot as we can seen that it give minimal low back pain and excessive force at workplace. Finally, the developed ergonomic trolley gives the the worker a better working and can be seen in reduction of REBA and RULA scores after the application of the ergonomic trolley. Besides that, it also eliminates the manual handling while to bring the machine anywhere.

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