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ORIGINAL ARTICLE

A Comparison of RULA, REBA Assessment on Work Activity of Installing Safety Tape on Floor Surface Using Assistive Tools

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Abstract: Safety tape used to mark hazardous, high risk machine and low hanging object in factories, hospital and so on. With the tape, it can warn people to be careful and not play around the area. Additionaly, nowadays the tape is used at all pemises as warning to people to keep social distancing at least 1 meter. Currently, people are installing the safety tape on the floor manually, without any proper assistive tools to apply, measure and cut the safety tape. Unfortunately, this method is time-consuming, and the worker faces body aches such as in the waist, knees, and arms as they need to bend over and be in an uncomfortable posture while laying the tape. The main objective of this research is to evaluate the RULA and REBA assessment of the current method of safety tape installation. The data will contribute to the design and development of assistive tools to install the tape. The tool is assessed using Theory and Innovative Problem Solving and Universal Design Principles (TRIZ-UDP) intervention tools. This tool will contribute towards design features which are deemed suitable to improve the element of universal design. From the UDP-TRIZ, UDP1a has suggested that the product be designed with TRIZ inventive principle "6 Universality". This tool is equitable for Malaysians by making the tools fit the users' height and size. The improvement toward UDP3b and UDP6a contribute towards ergonomic performance. Further after the development, the prototype is later tested, and another set of RULA and REBA assessments is executed to evaluate the improvement. Results of the RULA and REBA assessment onto the task with using the assistive tool has managed to lower the risk, and it can save working time to 34.5%

Keywords: RULA, REBA, Safety Tape Installation

1.0 INTRODUCTION

Occupational Safety and Health Administration (OSHA) is responsible for protecting worker health and safety. OSHA regulations require that permanent aisles and passageways must be marked appriopriately and in a consistent manner plant wide [1]. Figure 1 shows a basic color code recommendation that is widely accepted which complies with any interpretation of OSHA codes.

Figure 1. Safety color code [2].

The worker will manually install this safety tape and cut it using a scissor or knife. The work is difficult for the staff to bend down to paste the safety tape on the floor, and they will be in bad posture. In an ergonomics term, when the body takes a load with body bend posture, it will also affect lumbar vertebrae [3]. Based on survey among worker who involve in safety tape installation, 93.3% of them faced body pain problem especially at knee and leg. Figure 2 shows the installation work done manually by the worker. It is well-known that restraining the back and putting the load on the knee comes with it a risk of injury, may not be immediately affected but will affect long-term lives.

Figure 2. A worker is installing safety tape on the floor.

In addition, this manual method is time-consuming, whereas they need a ruler or measuring tape to measure between each line. By taping manually without any tools for reference, the distance between line by line is inaccurate as recommended dimension. In order to maintain the hazardous area, it requires regular maintenance. The tape needs to be removed, and reinstall the new tape when the tape is discoloured or damaged. This activity will be part of the worker routine to enforce and maintain. Therefore, assistive tools are required to improve the working condition that could overcome or reduce these drawbacks, which is highly desired.

2.0 METHODS

The area of research was set to the hazardous area for instance laboratories of educational institute. To involve the issue of warning to people to keep social distancing, the area of research also focus on public area that crowded with people such as government service counters, convenience stores, and other public access premises. The data was collected through a questionnaire survey, and it was distributed among the worker at the area. This survey aims to identify the current method they used to install the safety tape on the floor.

2.1 QUESTIONNAIRE SURVEY RESULT

By referring to the questionnaire survey result, most of the respondents used measuring tape to measure the distance between each line, and they used a blade to cut the tape as visualized in Figure 3.

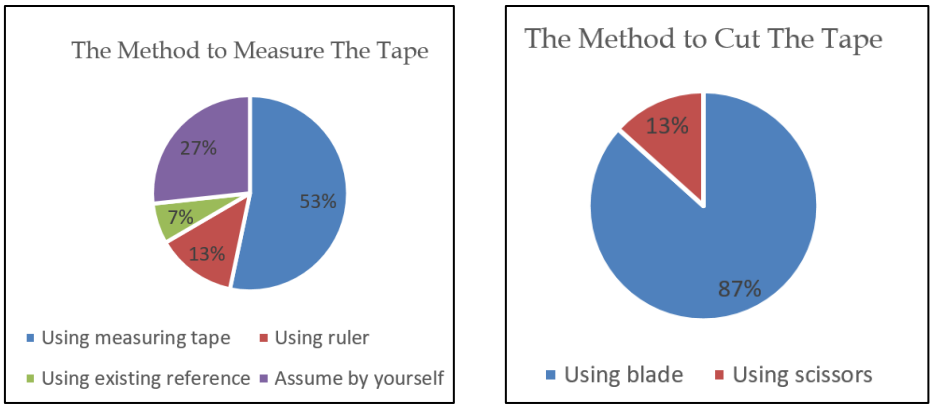

Figure 3. Method to measure and cut the safety tape.

Because of manual method application in safety tape installation work, the worker has body pain, especially leg and knee and the result can be seen in Figure 4. They always have pain at the knee and leg because the manual method requires the worker to sit in an awkward posture for a certain period of time.

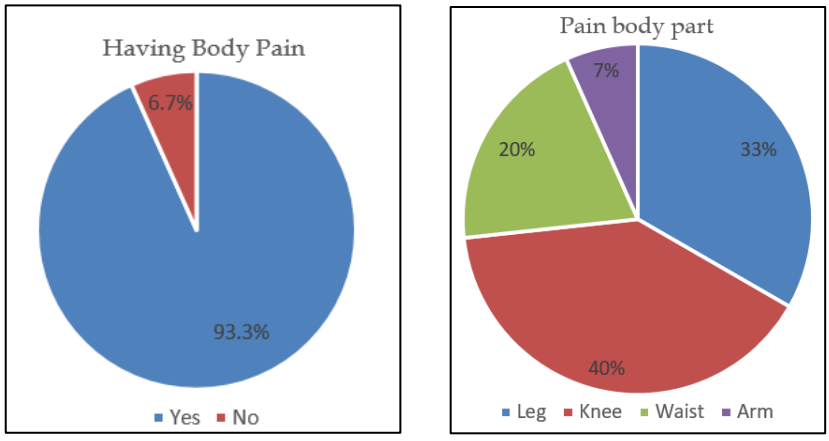

Figure 4. Respondents' experience about body pain.

2.2 DESIGN CONCEPT DEVELOPMENT

To ensure the product fulfils universal design, the product is assessed using Theory and Innovative Problem Solving and Universal Design Principles (TRIZ-UDP) intervention tools as shown in Table 1 [4]. This tool will contribute towards design features which are deemed suitable to improve the element of universal design. Corresponding Universal Design Principle (UDP) toward the problem highlighted in result from questionnaire firstly identified as shown below.

Table 1. Corresponding UDP and UDP guideline with a design issue.

Universal Design Principle (UDP)	UDP Guidelines
UDP1: Equitable Use	**UDP1a:** All potential users could use this product in essentially the same way, regardless of differences in their abilities
UDP3: Simple and Intuitive Use	**UDP3b:** An untrained person could use this product without instructions.
UDP6: Low Physical Effort	**UDP6a:** This product can be used comfortably (e.g., without awkward movements or postures).

From the identified corresponding UDP guideline, suitable TRIZ inventive principles correlated to the UDP guideline is chosen to generate the design concept. The design concept will be applied to the development of assistive tools in the design process.

Table 2. Generating design concept from UDP-TRIZ intervention tools.

Universal Design Principle	TRIZ 40 Inventive Principles	Design Concept
UDP1a: All potential users could use this product in essentially the same way, regardless of differences in their abilities	6. Universality	Product height and handle size will be equitable for Malaysian users' body and hand size
UDP3b: An untrained person could use this product without instructions.	6. Universality	The product mechanism will use a brake lever system to improve users' intuitive understanding of the basic function.
UDP6a: This product can be used comfortably (e.g., without awkward movements or postures).	12. Equipotentiality	To reduce the awkward postures of users to bend their knee and back, selecting a brake lever system will be used to operate the cutter mechanism to cut the tape.

3.0 RESULT AND DISCUSSION

3.1 PRODUCT PERFORMANCE TEST

In order to evaluate the performance of the assistive tape application tools function and ergonomic evaluation, a simulation of installing a safety tape for specific area is done. The assistive tape application tool was tested on different floor types (cement, tile, and carpet), a typical surface similar to the actual environment.

The assistive tape application tool will apply a safety tape in straight lines on different surfaces to evaluate the tool's performance. A visual inspection will be executed to evaluate the performance to stick the safety tape. Table 3 below shows the results of the tools' functional performance. From the result, this product required improvement to stick the safety tape properly onto the tile's surface. Minor improvement is required for the final product.

Table 3. Product performance on different surface.

Surface	Observation Data
Carpet	Safety tape is properly stick to the surface
Cement	Safety tape is properly stick to the surface
Tiles	Safety tape is not properly stick to the surface. To overcome this issue, the position of blade should be lower instead of current position.

3.1 COMPARISON MANUAL METHOD AND TOOL APPLICATION

Rapid Upper Limb Assessment (RULA) is a reliable technique to assess the level of risk in an activity, especially those involving upper limbs like hands, arms, shoulder, neck, and trunk [5]. RULA is the most frequent use by international ergonomic experts because its procedure is appropriate [6]. Rapid Entire Body Assessment (REBA) is a technique created for ergonomics analysis of body activities that are reported to be hazardous. In REBA assessment, observations are made of limb and body posture most frequent used and give close attention to extreme joint angles, duration and forces [7]. In order to evaluate the ergonomic performance of assistive tape application tools, a comparison

between manual methods usually practised by the premise owner with the assistive tool is required. Ergonomic assessment will use RULA and REBA assessment sheets and the result of score can be referred in Table 4 and 5 [8][9].

Table 4. The result of score value from RULA assessment [8].

Score	RULA
1-2	Acceptable posture.
3-4	Further investigation, change may be needed.
5-6	Further investigation, change soon.
7	Investigate and implement change.

Table 5. The result of score value from REBA assessment [9].

Score	REBA
1	Negligible risk.
2-3	Low risk. Change may be needed.
4-7	Medium risk. Further investigate. Change soon.
8-10	High risk. Investigate and implement change.
11+	Very high risk. Implement change.

For subject A uses a manual method to install the tape, he needs to bend his trunk, waist and knee in bad posture. As a result, he suffers from body pain and cannot complete his job. Meanwhile, subject B the position of the tool handle is the same level as the worker's chest, and the angle of his arm is in a comfortable position to push the tool forward. Additionally, his back is straight, and the waist and knee are also in good posture. The posture of subject B can protect his trunk and reduce the risk of pain. Both postures are shown in Figure 5 below. Table 6 depicts the two methods compared in RULA and REBA assessment.

Figure 5. The subjects used different methods to install the safety tape.

Table 6. Result of RULA and REBA assessment for manual method and tool application.

		RULA	**REBA**
Manual Method	Sitting Posture	7	11
Tool Application	Standing Posture	4	3
Tool Application	Sitting Posture	5	5

The manual method was involved in sitting posture only to install the tape. The manual method has a high RULA and REBA assessment value, which means the job is very high risk and needs further investigation to implement change. The main reason contributing to the results is that the worker's posture is awkward. Subject A was in the same posture during the installation for a long time. Furthermore, subject A has no major posture changes compared to tool application.

Contrasting with subject B working posture, when using the assistive tool, the worker will change his posture from standing to sitting several times, resulting in more muscle relief. The tool application was asses in standing posture, which is while pushing the tool to make a line and pressing the brake lever to cut the safety tape. Then, it also was asses in sitting posture, whereas the worker needed to pull the tape to the tape applicator, which was done in less than ten seconds only. The RULA and REBA assessment for assistive tool application in standing posture shows the posture has a low risk. Although the tool load is 7.5 kg, it can still be handled well because it has wheels to increase mobility and appropriate handle size. Next, the RULA and REBA assessment result for tool

application in sitting posture is considered medium risk, but it is still acceptable because sitting posture is required in a very short period of time.

3.2 RESULT OF TOOL TESTING

The tool's performance was also evaluated in reducing working time instead of using the manual method. The time was taken of both methods to make ten lines, and the result is tabulated in Table 7.

Table 7. The average time is taken to make ten lines by using manual method and tool.

Line	Time Taken for Manual Method (seconds)	Time is Taken for Tool Application (seconds)
1	13	8
2	26	16
3	28	19
4	25	15
5	30	18
6	23	15
7	28	17
8	29	17
9	27	22
10	26	20
Average	**25.5**	**16.7**

Making ten lines using a manual method is time-consuming, whereas the average time is 25.5 s. On the other hand, when applying the tool, the average time to make ten lines is 16.7 s, and this shows that the working time can be saved to 34.5%. Moreover, the tool enables the worker to install the safety tape on the floor without measuring one line to the next because it includes an extender pole that acts as a measurement indicator.

4.0 CONCLUSION

Using RULA and REBA assessment, this study compared the manual method and applied tool when installing the safety tape on the floor. From the UDP-TRIZ, UDP1a has suggested that the product be designed with TRIZ inventive principle "*6 Universality*". The tool is designed considering the anthropometry of Malaysian size. Therefore, this tool is equitable for Malaysians by making the tools fit the users' height and size. Improvement toward UDP3b and UDP6a contribute towards ergonomic performance. The tool can overcome the work hazard issues in the manual method. This statement is backed by the data collected in RULA and REBA assessments. The tool application has proven to lower risk through the assessment and can save working time. The tool is convenient and easy to use, even minimal or without training. The tools select brake level mechanisms to improve intuitiveness. The worker only needs to press the brake lever to cut the safety tape, thus reducing the excessive bending impact toward the knee and back. The usage of assistive tool can save working time until 34.5%. When the scale of safety tape application is large, it also increase work quality and productivity.

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