Design and Development of Tape Applicator For Managing Wire Purposes

Mohamad Syafiq A.K1,2*, Nur Amirah Adila H1, Muhammad Ikman Ishak1, C.Y. Khor1, M.U. Rosli1, Mohd Riduan Jamalludin1, M.A.M. Nawi1

1 Faculty of Mechanical Engineering Technology, Universiti Malaysia Perlis, 02100 Sungai Chuchuh, Padang Besar, Perlis, Malaysia
2 Centre of Excellence for Unmanned Aerial Systems (COEUAS), UniMAP, Kangar, Perlis

E-mail: msyafiq@unimap.edu.my

Abstract. The project titled Design and Development of Tape Applicator for Managing Wire Purpose is a project that needs to be achieved by evaluate the users’ performance while using manual method when taping wires and design and developing a tape applicator. This project is focused on to make it easier for the workers to tape wires on the floor without have to bend their bodies. Primary and Secondary data is gathered for completing this project. Interview is done to determine the usual method applied by users in taping wires on the floor and the difficulties that users faced when using manual method. After data is collected, idea generation of concept and sketches are made manually by sketching. Several aspects are being considered to choose the final design which is the most suitable. The final design chosen for the tape applicator is designed by Computer Aided Drawing (CAD) using Solidwork Software. At the end of the project, fabrication process is done before the product is testing. As for the result, time consumed for taping wire cables by using product is shorter than the time consumed when manual method is applied. All of the objectives are achieved.

1. Introduction

In 2006, based on Bureau of Labor Statistics, United States Department of Labor, 250 workers involved in deaths caused by too exposed with the electric current. Half of the employees were injured in fires and explosions and from this information, it is well known that electricity can be conducted through the body. In a condition when the body is in contacted directly towards the surface of equipment or any tools, and at the same time the equipment is also in contacted with any surface that is electrically conducted under, current flow will occur and enters the body at the point that is in contact and traverse through the body then exits at contact point at the other side which is usually the ground [1].

From here, it can be concluded that electrical accidents that commonly happened due to conditions that is not safe can be in term of no rubber insulator around the wire, how the cord is placed while not in use and managing the scattered cord when the main plug is plugged in to the main power. The maintenance that is insufficient causes the tools, equipment and installations that at first is considered as secure and harmless, to decrease the performance and results for unsafe condition [2].

Thus, based on Occupational Safety and Health Act of 1970, it is the responsibility of the workers to provide more secure and workplace with safety features to the workers. OSHA’s main function is to ensure the safety and health of America's working men and women by outlining and implementing
specification which includes providing training, outreach, and education. They introducing the partnerships and encouraging the continual process of improvement in workplace safety and health [3].

2. Methodology

2.1. Interview

In approaching the first objective, method of interviews is used. This method is used to identify closely towards the respondent’s feelings, emotion and opinions in respect to this research study. In using this method, it gives benefit to researcher as the respondent includes their personal and direct contact to the researcher. It results for the process of gathering information can be done more smoothly. Researcher needs to have some skills in order to carry the interview successfully. An interview is made around Perlis towards the individuals that involve in managing wires in their job scope and also to identify the method that they applied in the process of taping wire cables. The target place at first is the hall where events are usually held. Due to the hall that is not in operation for a few months, researchers focused on the second target place which is cybercafés. Some questions are prepared before interview session to get the details of the workers and gain information from them.

2.2. Questionnaire

Questionnaires are contributed to 20 people including the employees in the scope of wedding planning service, and individual that involves in photography career, and business site such as the night market. The female participated in this questionnaires were 9 people while the male respondents were 11 people. Most of the respondents were among the age range from 29 to 39 years old. Most of the respondents involves in night market seller which is 8 respondents, 6 respondents in scope of wedding planning service and 5 respondents from photography career.

![Figure 1. The questionnaire result for the important aspect for tape applicator.](image-url)

The questionnaire also investigated the time consume when they tape the wires manually on the floor. It is also to identify level of importance in the aspects from the users’ perspective in order to apply it in designing tape applicator. The aspects that has been listed are lightweight, type of tape used, save users’ energy, save users’ time, must be affordable, aesthetic value, easy to handle, easy to handle, and high durability. The range of importance rate from strongly disagree, disagree, moderate, agree, and strongly
agree. It was also used to help generate the customer needs and help in designing the final design of tape applicator.

Figure 1 shows the aspect level of importance based on user needs. These aspect level of importance helps in determining the customer needs for the tape applicator. The most important aspect that needs to be considered is the ergonomic of the product which it strongly agreed by 12 respondents. It is followed by the product that is durability and easy to handle which means it can be carried easily.

2.3 Prototyping Fabrication
All the obtained aspects were analysed and being transformed into the product prototyping. The aspect with the highest score became the major reference and consideration in designing a prototyping. The design process started with several sketches by using hand drawing. After the evaluation, only the best design was chosen to proceed with CAD drawing. For this product, the CAD software used is Solidworks.

All the detail drawing was designed including the joint components and for assembly process. The joint components must be considered thoroughly since to easy the assemble and disassemble process. If the assemble process takes the longer time, time saving aspect was not achieved. Apart from that, for the stick or handle, which acts as a guide to push during taping process, the suitable height was evaluated based on ergonomics charts[4]. By considering average height of male and female Malaysians, the suitable height, 100 cm of stick was chosen. This is important to avoid the users need to bend their body during using this tape applicator. By using the suitable height, the user did not need to bend their body during taping process and the risk of back pain can be reduced [5].

The chosen material for the product is 1 kg ABS filament. This is because of abs plastic has good mechanical properties and can withstand high force [6]. All the CAD drawing data was converted and imported to 3D Printing Flashforge. The printing process takes 48 hours, for 4 parts before being assembled as final product.

Figure 2. The drawing and the actual product of tape applicator.
3. Results and Discussions

3.1. Product Testing
For product testing, an experiment for the product testing has been done for user that works with wires. Three of them is chosen for the user testing. Based on the questionnaire result, they usually worked with wires that is 3 to 5 meters length. For the experiment, 1 meter of wire is chosen for the user testing to make the process of experiment easier.

The experiment is done using masking tape because of the same properties as the actual product, Gaffer tape that it does not left residue behind on the wire cables and it can be easily tear after taping process to make the process easier. Table 2 shows the results of the product testing.

RCO% is calculated from the oxirane oxygen content (OOC) that can be obtained from the direct titration of hydrogen bromide. The RCO% is calculated for the reaction process with different temperature and presence of catalyst. The percentage RCO calculated for epoxidation without presence of catalyst with different reaction temperature shown in table 1.

Table 1. Result of the Product Testing

| User | Time taken when using manual method (s) | Time taken when using the product (s) |
|------|----------------------------------------|---------------------------------------|
| A    | 103.3                                  | 31.4                                  |
| B    | 110.2                                  | 32.6                                  |
| C    | 104.8                                  | 35.2                                  |

Based on the results of testing, it shows that the difference of the users’ height proves the length of the handle is suitable with any height of user. The aspect has been considered during research to ensure it can be used by users in any job scope including household usage.

From this experiment, average time taken for both manual method and using prototype is taken. The average time taken when product is used is 33.1 seconds while the average time taken when manual method is applied is 106.1 seconds. Graph for both of the time taken by users is shown in figure 3.

![Time taken for taping wire for various users.](image)

Based on the graph in figure 3, it is proven that the average time taken consumed when the tape is laid manually is longer than the time taken when product is used. Based on survey that has been done
during interview session, the time that usually consumed by users when taping 4 meter wires is in range 5 to 10 minutes. By means, it is equivalent to the time taken for 1 meter of wire during experiment is done.

One of the aspect that incorporate in wire taping process is the roller that act as the suppressor of the product. Manual method is a process that required more force to be applied on which it required user to press the tape harder while bending their body [6]. Product testing process required less force since the process is more user-friendly and the wire cables can be tape easily by the roller. Thus, the less force required for the wire cables to be laid on the floor, the less time taken is consumed to complete the process [7]. Based on the graph of Figure 2, the efficiency of the product is 73%, which means the time consuming for taping process for 1 meter of wire can be reduced up to 73%. Therefore, the productivity of the process can be enhanced besides the risk of back pain for the user can be improved.

4. Conclusions
The purpose of this project is to evaluate the user’s performance in applying manual method in taping wire and to design and develop a tape applicator of wire cables. It can be concluded that the first objective was successfully done and achieved. All the methods done such as the interviews, questionnaires, watching You Tube videos, and doing experiment towards user helps researcher to analyze the accidents that usually happened among the employees in the job scope involving wire cables. Other than that, the questionnaires that has been distributed towards 20 respondents succeed to evaluate the users’ performance in taping wire cables by using manual method. The common side effects towards the users’ body has been identified due to the non-ergonomic method that they applied while doing their job.

References
[1] Bures M 2015 Procedia - Soc. Behav. Sci. 174 3204.
[2] Elena M et al 2015 Procedia Econ. Financ 23 54.
[3] Reese C D et al 2006 Handbook of OSHA Construction Safety and Health 2.
[4] Shahriman A B et al 2017 J. Phy Con. Ser 908 501.
[5] Ishak M K et al 2017 MATEC Web Conf 97 01040.
[6] Abdullah A H et al 2015 Adv. Mater. Res. 1102 139.
[7] Shahriman A B et al 2017 AIP Conf Proc 20120.