

Fundamental Study of Energy Control System: Lockout and Tagout (LOTO) Implementation in Malaysia Automotive Industry

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Abstract

Automotive is one of the main production industries that has a major impact on the Malaysian economy. A large selection of companies and organizations in the style, development, manufacture, marketing and mercantilism of cars may be involved in the car industry. The process, maintenance and maintenance of automotive production require a proper energy control system, which contains a great deal of dangerous energy that can harm workers. LOTO is the best choice of energy management system that ensures safe working conditions when operating, sustaining, purifying or repairing. In contact with the machine or tool, there is some lesion or accident but the remainder of the energy remains in the machine, which can result in an unexpected movement. This fact caused OSHA to regulate the LOTO to release residual energy into the machine or prevent energy from moving by doing certain isolation. This study concentrates on the application of LOTO systems in certain car industries in Malaysia. The study is conducted with surveys and questionnaires being distributed to the employees. The current LOTO practice in the industry should be assessed at the end of the study.

Keywords: LOTO, lock out tag out, automotive, critical success factors, safety, osha

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1. Introduction

Manufacturing trade means all sectors that are involved in the production and operation and the production of new products or in the introduction of costs. In the developed countries, the trade in production represents a major part of the economic sector. The final product will either work in a completed smart device, which can be ordered by consumers or as an interim product used in the assembly process. In the Western countries, manufacturing industries developed in the 18th-19th century with the prevalence of technological and socio-economic changes.

This was commonly called age. It starts in the UK and substituted for mechanization and fuel production for

work-intensive textile production. Development sectors are the AN economy's leading asset manufacturing industries. The companies use a range of techniques and methods known as process management of development. The sectors of the manufacturing sector are generally categorized in electronics, building, automobile, mechanical, chemical, energy, fibre, food-and nutrient-related, plastics and transportation industries, and telecommunications industries. One of Malaysia's largest manufacturing industries is the automotive industry. The automotive industry can be a large selection in the car style, development, manufacture, marketing and commercialism of companies and organizations involved.

It is one of the largest economic markets in the world in terms of revenue. The automotive industry does not include vehicle-based businesses such as car repair stores or fuel-filling stations until shipment to end-users. According to Malaysia Automotive, Robotics and IoT Institute (MARii), Malaysia automotive sector continued to be a sufficiently great benefactor to the economy in 2018, contributing 4.2 % to the country's gross domestic product (GDP).

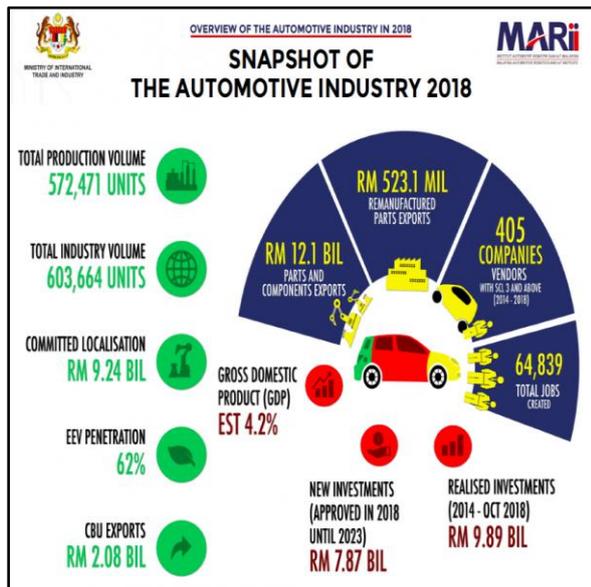


Figure 1.1: Overview of Automotive Industry in Malaysia

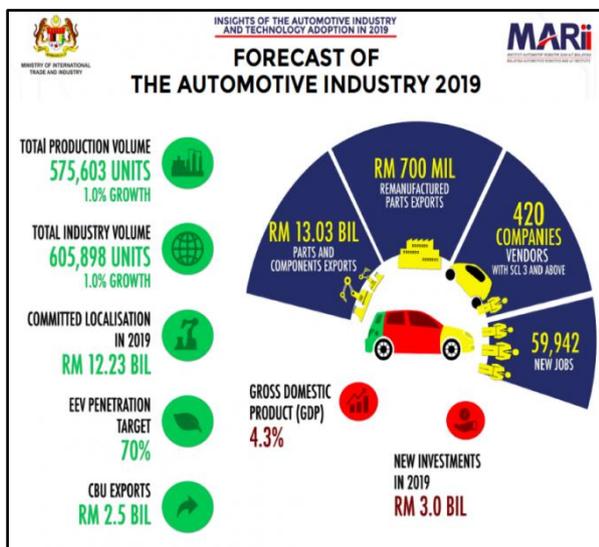


Figure 1.2: Insights of Automotive Industry in Malaysia

The automotive industry uses a variety of processes and mechanisms. The company also operates a large number of devices and appliances with a wide range of power. Since the automotive industry is a large and heavy-duty industry, power and labor is naturally commonly used. The fuel used should be regulated for the safety of all consumers of machinery and equipment.

Various energy control systems can be used to monitor the energy used in the industry. One of the energies which can be applied is the lock-out tagout (LOTO), usually used in the manufacturing field with a number of machines. Controls may be used in business and analytical settings to ensure that the hazardous machinery area unit is properly shut down and not restarted until maintenance or maintenance is completed. Lockout uses an energy management unit in the corresponding energy management system to physically protect a machine. The controlled instrumentality shall not be operated until the locking device has been removed. Tagout is a tag that indicates that the energy analysis system and the instrument command are only assisted by the deletion of the tag.

The car industry was one of the key pioneers of worldwide supply chains, and supply chains are still complicated only for men. It is a struggle to ensure a good supply chain, while secure, educated and healthy employees are retained. Once the supply chain is in difficulty, the square measure of individual individuals is in danger of being that of the consumer. We can see from here that the safety is important in this sector as the industry uses a large amount of machinery and workforce that involves people's lives. A new initiative has been set up to reduce the number of workplace accidents due to injury and changes in the general working environments in the sector by the Automotive Industry Action Group (AIAG). Again, this is evidence that the automotive industry is important in the field of safety, health and the environment and must be taken into account so that no incidents occur during the production process and production that can stop production. This will result in many more management problems, customers, the relevant authorities and many more related to industry and enterprises. The conveyor belt, painting robot, welding, overhead transfer conveyor, CNC, Jig solder, engine-machine work station, solder robot, are few robots used for automotive manufacturing purposes. In the automotive industry there are also many stamping machines. The stamping includes the spreading of sheet-metal shaping processes, including bouncing, blinking, embossing, bending, flanging and coining with a press or stamping press.

Mechanics may be different, as shown by higher rates of deaths, accidents and illnesses, than the employee's common position. Contact of objects and instrumentality, such as components, materials and vehicles, poses a major risk for each fatal and non-fatal injury. 147 mechanics were murdered in duty between 2003 and 2005. A death rate for all jobs overall was 5.3/100,000 in 2005, which surpassed the 4.0/100,000 average [1]. Mechanics with days off from the introduction in 2005, with 15,680 nonlethal injuries and illnesses, were similar to 2004 after a decrease of 9, 8% from 2003 to 2004. In terms of the number of injuries and diseases involving day aloof from 2005, mechanics stratified the fourteenth in all occupations, identical to 2004. Many of the majority of the incidents is due to work or strain; the

number one causes for regional mortalities are the threats and terrorism. [1].

This research will be done in view of the objective keeping in mind the end goal to dodge from any blunder in achieving the objective. This is vital to ensure this research will be on track a probability in committing any errors:

- i. To determine the implementation of Lockout and Tagout (LOTO) in automotive industries in Malaysia.
- ii. To analyse the status of Lockout and Tagout (LOTO) implementation

Research was conducted in Malaysia's automotive industries to define lockout and Tagout process (LOTO) procedure during automotive service and maintenance function. The state and performance of LOTO process procedures in cars were introduced into the car industry during this study. The best part of these philosophies and instruments were chosen and installed during the installation and repair of the energy control system.

The aim of the study is to increase the awareness of the role of energy control system such as the implementation of LOTO at work, especially in the automotive industry, with a variety of heavy machines, and to inform employers and employees about them. During maintenance, cleaning or repair activities LOTO can ensure a safe work environment. Therefore, LOTO implementation will mitigate the harm caused by the accidental energy generation of a machinery start-up or the release of stored energy which could cause a crash.

The LOTO protocols are used to prevent mistakes and the chances of unnecessary accidents and injuries, and to help workers avoid mistakes. This method or software of energy control may also minimize downtime and improve operating efficiency. This research on the car industries therefore benefits the company as well as helps to improve other industries' efficiency and productivity.

2. Research Elaborations

This study introduces a conceptual framework, research methods and data analysis techniques in this chapter. The principal purpose of the analysis is to determine how LOTO is applied in auto industry and, of course, whether or not LOTO is used. The structure of this study has been made in order to accomplish the goals and avoid any errors, which may result in undue costs and additional time to visit the industry and collect data. A number of lockout and Tagout (LOTO) papers covering repair practices in the detection of variables.

The sample questionnaire has been validated by the specialist to collect and verify their opinions on selected variables in articles. Following checking and verification of the survey questionnaire, an online survey questionnaire was sent to a number of automotive companies via e-mail and Whatsapp.

After all the questionnaire responses were collected, a statistical analysis was performed. A number of statistical analyses were conducted using the Social

Science Statistics Package (SPSS) software. This study identified cross-tabling of variables with other results. The data, variables and relationship have been checked with cross-tabulation analyses. Finally, on the basis of statistical results the sustainability framework for the original concept was developed.

The literature review item applied to this work, which was included in chapter 2 of that study. In the study, papers, books and the Web are the resources used to complete this analysis. For additional information, the literature review is an important part of the sources.

Quantitative is an analysis which uses statistical information and data to be converted into usable data for problem calculation. Quantitative data are surveys including online surveys, interviews, web surveys and systematic findings.

This study used the online survey approach in order to gain a broader insight into the LOTO process in maintenance activities and to gain a helpful overview of car industry research in Malaysia. The survey was designed to test the following assumption, to assess whether the based industries understood the importance of a LOTO in the automotive industry as an element. The questionnaire was used in the survey to collect primary data on automotive industries in Malaysia.

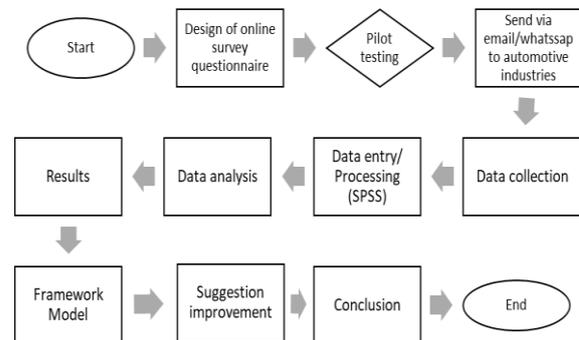


Figure 1.3: Flow Chart of Online Survey Questionnaire

This research focused on the repair practices selected by the automotive industry. Many automotive manufacturers have been listed by several sources based on early studies. Only 10 companies were selected for this research following the search and filtering of all data.

Due to the nature of this inquiry, the decision sample was selected which focused on LOTO activities. The decision sample model was used in cases where it was very important to gather specialized evidence in the field of research and the use of any other sample design would not require specific information to be collected.

The sample size was determined by the following factors. In terms of clarification, the roots of the survey are checked and confirmed by researchers and practitioners. With only 10 companies involved in this study, each company involved has received a collection of on-line questionnaires. There was a need for strong

feedback, so intense contact was conducted in two ways. The online questionnaires were distributed directly by email and WhatsApp, and telephone calls followed.

The original theoretical sustainable maintenance and operation model was built through a combination of administrators, engineers, technicians and other persons responsible for LOTO input knowledge.

The following were used in the design of the general information questionnaire. Demographic- Part A, LOTO General Knowledge- Part B and LOTO Implementation- Part C.

Table 1.1 Questionnaire Development

Parts	Explanation
Part A (Demographic)	<ul style="list-style-type: none"> • Focuses on respondent's demographic and background • To ensure questionnaire answered by selected respondent
Part B (General Knowledge)	<ul style="list-style-type: none"> • To collect feedback on the questionnaire in terms of structure, relevant questions, emphasis of the task, etc.
Part C (LOTO Implementation)	<ul style="list-style-type: none"> • The status of Lockout and Tagout in automotive industries. • To define the absolute, partial or under-pilot level of Lockout Tagout implementation.

Closed questions are used in this study. In order to get the respondent a high response rate, the closed format of questions was applied. The layout of the query will help ensure that all the parameters have been addressed and included in the questionnaires, which are of significance for the study. Close-ended questionnaires are a number of alternatives asking the respondent to take decisions. All questions in the questionnaires are classified as being closed with the nominal, ordinal or Likert scale. Closed questions help respondents to decide quickly on a number of options.

For the online questionnaire, Google Form was used to allow respondents to easily complete the survey.

The statistical analysis of data involves certain forms of statistical tools that cannot be performed without knowledge of them. The Social Science Statistical Package (SPSS) and Microsoft Excel were used to analyse the findings and to create a graph for statistical tools. Descriptive statistical analysis was used to determine the status of the Lockout Tagout (LOTO) system that is widely used by the automotive industry.

Cross-tabulation was performed in the SPSS analysis to propose the industry best practice LOTO guidelines.

The descriptive statistics of the variable of interest in a situation should be described in the analysis. In a coherent way, descriptive study presented data. The Results type can be organized in a table using data frequency and graphs

3. Results or Finding

In Chapter 1, the main objective of the research have been stated which is to determine the status of Lockout Tagout system implementation in automotive industry in Malaysia. This chapter presented detailed data collected from the respondent in the industry. The data were collected by survey process which includes many types of questionnaires. The analysis on the data from the questionnaire feedbacks were done by using Statistical Package for Social Science (SPSS) and Microsoft Excel.

Online questionnaire is a broad geographical area that can be included in the survey so that the questionnaire can be done at their convenience.

This segment focuses on describing three major parts of the survey questionnaire consisting of Part A for demographic, Part B for general knowledge about LOTO, and Part C for implementation of LOTO.

Descriptive statistical is used in any experiments to define the characteristics of the interest variable in a scenario. In a meaningful way, the descriptive analysis presented data. The data form can be organized in a table that used both data frequency and graphs. For the standard deviation value, for each answer, more than 1.0 indicates a huge difference. Several groups are analyzed by this approach in this study.

The descriptive analysis for Part A – demographic question is shown in the table above. For each variable, the mean level and standard deviation is shown as above.

Table 1.2: Descriptive Statistics for Demographic Question

	Descriptive Statistic				
	N	Minimum	Maximum	Mean	Std. Deviation
Company	42	1.00	2.00	1.5238	.50549
Department	42	1.00	5.00	2.7381	1.54698
Position	42	1.00	4.00	2.8571	.87154
Working Experience	42	1.00	3.00	2.1905	.59420
Valid N (listwise)	42				

For Part A-Demographic Question, Table 1.2 provides descriptive analysis. For each variable the average level and standard differences are shown as above. In the table above, we can see that the Department parameter standard deviation value is more than 1.0 meaning that

the majority from question is from the department of variations.

The concise analysis for Part B- General Knowledge of Lockout Tagout (LOTO) is shown in the table above.

Table 1.3: Descriptive Statistics for General Knowledge of LOTO

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
B01	42	1.00	1.00	1.0000	0.00000
B02	42	1.00	1.00	1.0000	0.00000
B04	42	1.00	2.00	1.2381	0.43108
B05	42	1.00	2.00	1.3810	0.49151
B06	42	1.00	2.00	1.6905	0.46790
B07	42	2.00	3.00	2.0238	0.15430
B09	42	1.00	4.00	2.5238	0.86216
Valid N (listwise)	42				

The descriptive analysis for Part B-General Lockout Knowledge Tagout (LOTO) is given in Table 1.3 above. From the above table, we can observe that the B09 default value is among the highest. For B09, this refers to LOTO's critical success so that most respondents have chosen different responses.

Table 1.4: Descriptive Statistics for LOTO Implementation

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
C01	42	1.00	1.00	1.0000	0.00000
C02	42	1.00	3.00	2.1667	0.90841
C03	42	1.00	1.00	1.0000	0.00000
C04	42	1.00	2.00	1.6667	0.47712
C05	42	1.00	1.00	1.0000	0.00000
C06	42	1.00	3.00	1.5952	0.58683
C07	42	1.00	2.00	1.0952	0.29710
C08	42	1.00	3.00	2.1667	0.65951
C09	42	1.00	1.00	1.0000	0.00000
Valid N (listwise)	42				

The descriptive analysis is presented in Table 1.4 on the implementation of Part C-Lockout Tagout (LOTO). The standard deviation value from this paragraph must be below 1.0, since this is the LOTO system implementation

which indicates whether it is safe to operate or not. All variables are acceptable, as they are below 1.0.

Part A: Demographic Questions

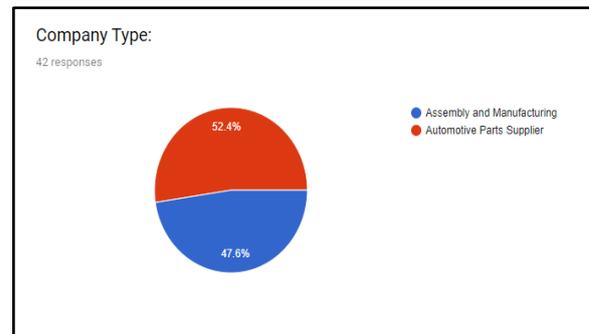


Figure 1.4: Respondent Company

The company form which responded in Malaysia in the automotive company was shown in Figure 1.4. Above, 47.6% of respondents are from Assembly and Manufacturing and 52.4% are from Automotive Parts Supplier.

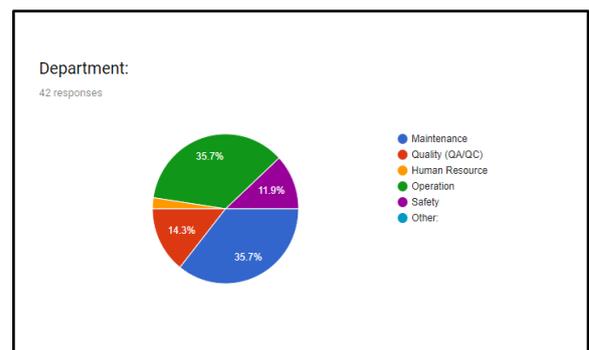


Figure 1.5: Respondent Department

The proportion of respondents in the car industry in Malaysia is shown in Figure 1.5 above. Maintenance and Operation were the highest respondents who contributed 35.7%, while Quality department (QA / QC) accounted for 14.3% and Safety department accounted for 11.9%.

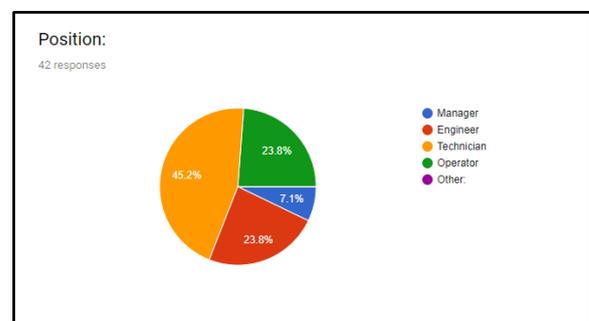


Figure 1.6: Respondent Position

The proportion of respondents in the automotive industry was shown in Figure 1.6 above. It was shown that 45.2% of respondents were technicians, followed by operators and engineers at 23.8% and managers at 7.1%.

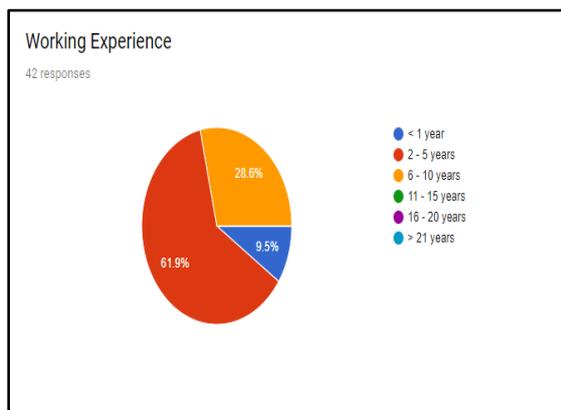


Figure 1.7: Respondent Working Experience

In Figure 1.7, majority of the respondents were 61.9 % which have been working around 2 to 5 years. The rest of respondents have been working for 6 to 10 years which contributes 28.6 % and 9.5 % for less than 1 year.

Part B: General Knowledge about Lockout Tagout (LOTO)

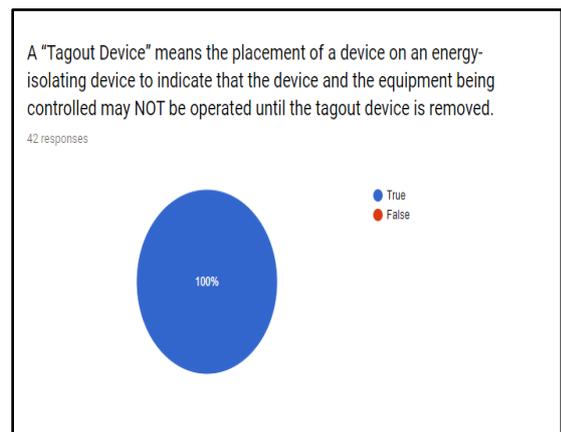
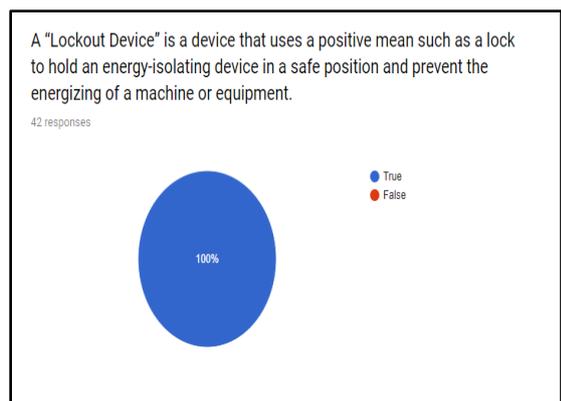


Figure 1.8: Definition of Lockout and Tagout Device

The answer to these two questions is true in Figure 1.8. For Lockout and Tagout device definition, all respondents responded correctly. The figure shows that 100% answered correctly.

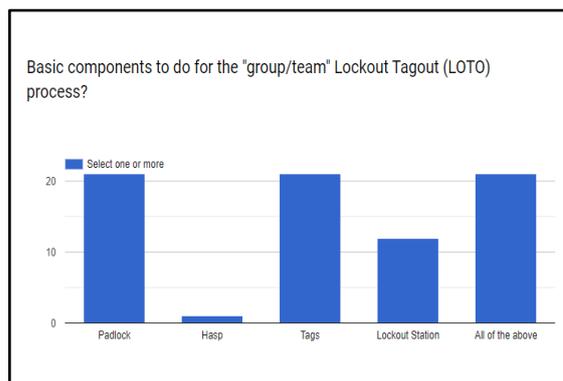


Figure 1.9: Basic Components of Lockout Tagout in Group

The core components of LOTO for group or team maintenance are identified in Figure 1.9 above. The LOTO system needs padlock, hap, tags and lock out stations in group or team operations, so the answer to this question is all of the above. The majority of respondents correctly responded and some incorrectly replied where LOTO's four main components were not included.

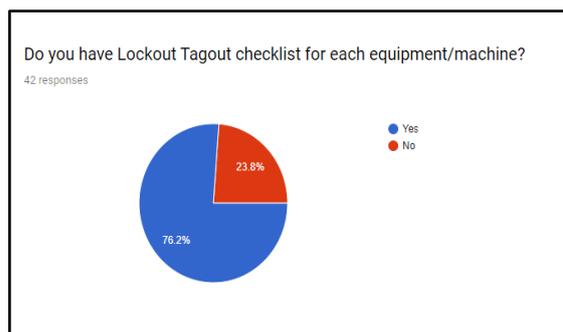


Figure 1.10: Lockout Tagout Checklist

In Figure 1.10, majority from automotive industries provided checklist for each equipment or machine which contributed 76.2 % and followed by 23.8 % which do not have checklist for their equipment and machine.

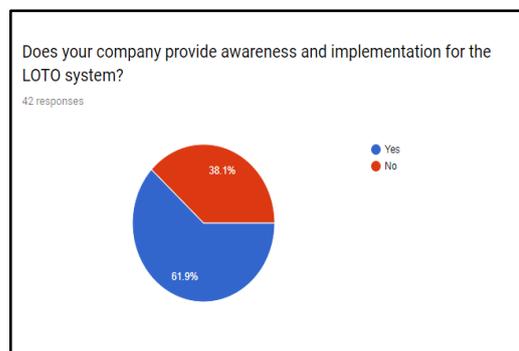


Figure 1.11: Implementation of LOTO in company

Figure 1.11 indicates that the car industry has a large percentage of the LOTO program which contributed 61.9% to knowledge and implementation and that the other that did not provide was 38.1%.

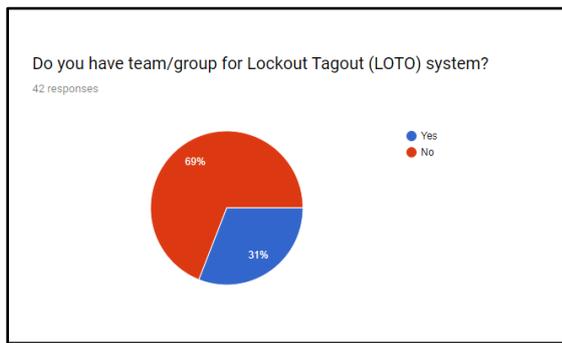


Figure 1.12: Team or Group for Lockout Tagout (LOTO) system

Figure 1.12 indicated the existence of team or group for Lockout Tagout (LOTO) system in automotive industries. 69 % shows that most of the respondent clarified they did not have team or group for LOTO and other 31 % answered their company have the team.

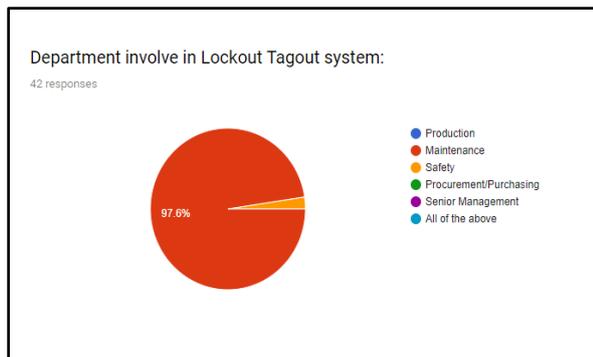


Figure 1.13: Department Involve in LOTO

Figure 1.13 shows the respondent mostly answer that the maintenance department involved in Lockout Tagout system by 97.6 % and 2.4 % of them it is applicable for safety department. The appropriate departments involved in LOTO system actually are all the above.

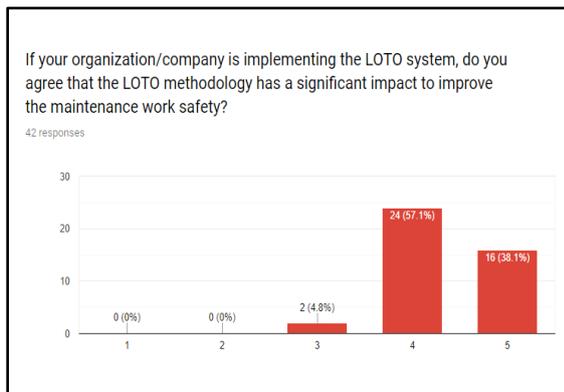


Figure 1.14: Impact of LOTO in Maintenance Work Safety

Figure 1.14 above shows that the Lockout Tagout System can be improved by 57.1 percent of respondents. 38.1% replied to the statement strongly and 4.8% agreed to the statement. We can concluded from these questions

that the LOTO system could improve maintenance activities for all organizations or respondents.

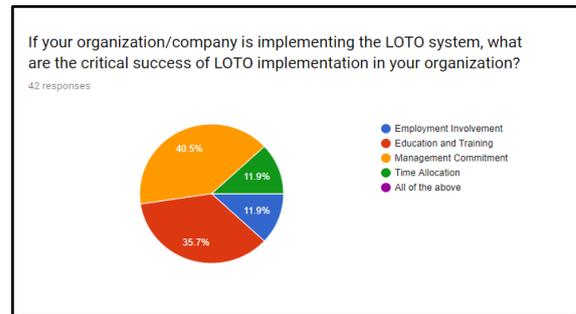


Figure 1.15: Critical Success of LOTO in Organization

Figure 1.15 shows critical success factors which be ranked by their individual factors. The highest critical success in organization has two factors which are management commitment with 40.5 % and education and training with 35.7 %. Next, both employment involvement and time allocation takes 11.9 %.

Part C: Lockout Tagout (LOTO) Implementation

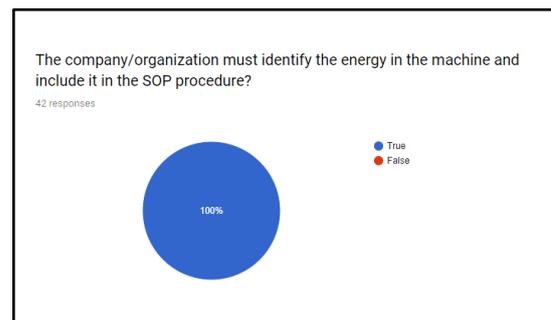


Figure 1.16: Identify Energy

1.16 illustrates that all respondents agree that the energy must be identified in the machine by all organizations and included in the SOP before the maintenance is performed.

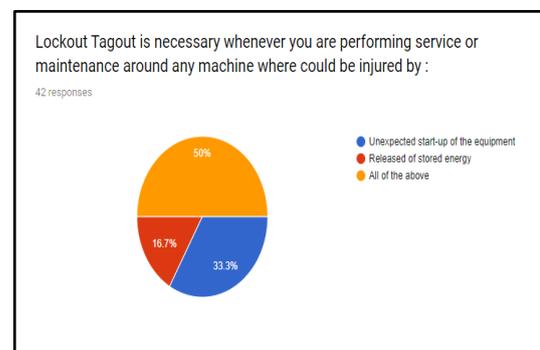


Figure 1.17: Lockout Tagout

In figure 1.17, the question refers to the purpose of Lockout Tagout in maintenance activity. The majority of the respondents were 50 % which answered that LOTO is for both situations which are unexpected start-up and

released of store energy. The rest of the respondents (33.3%) answered for unexpected start-up of equipment and the rest (16.7%) chose released of stored energy.

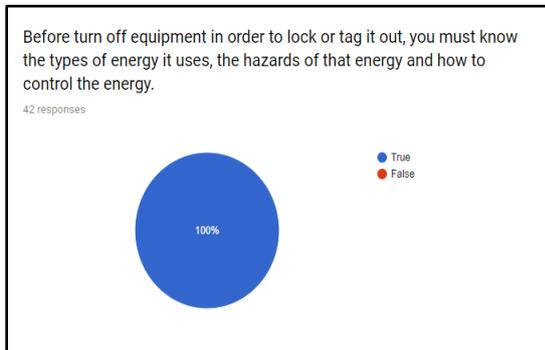


Figure 1.18: Identify Types of Energy

Figure 1.18 above shows that 100% of respondents answered correctly to the statement where before turning off equipment, we need to know the types of energy involved, the hazard from that energy and how to control the energy.

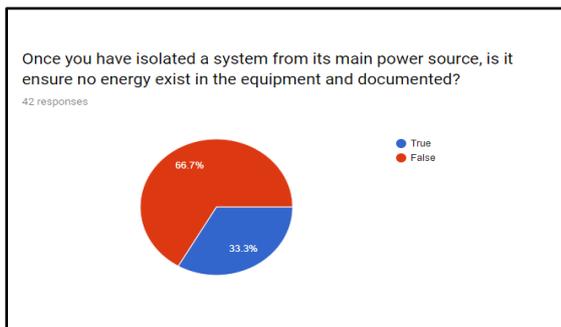


Figure 1.19: Isolated System

The above shows that there are very difficult to determine the energy after the system isolation. Some people ignored the situation and could lead to accidents. 33.3% of respondents reported the statement indicating 'True' wrongly and 66.7% of respondents replied correctly for it indicating 'False.'

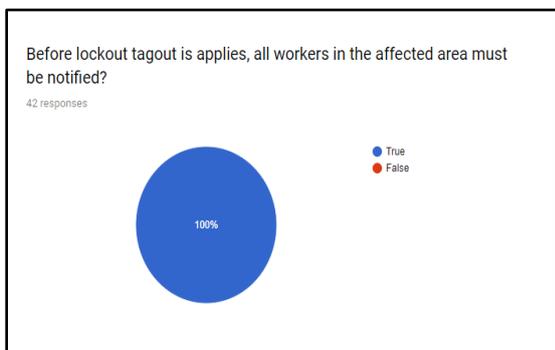


Figure 1.20: Affected Area

The person who works in the area or nearly to where equipment is being maintained or serviced under lockout and tagout is called as Affected Area. Figure 1.20 indicated that 100 % of respondent answered correctly.

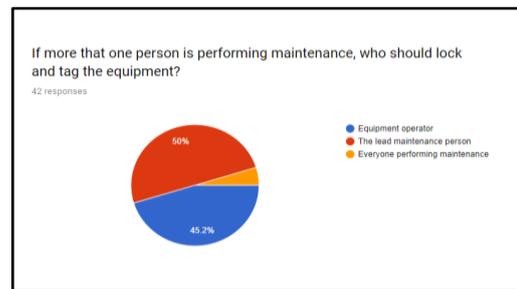


Figure 1.21: Person in Charge for LOTO Installation

From Figure 1.21, the survey question is to determine who should lock and tag the equipment if more than one person is performing maintenance. From figure above, it indicated that only 4.8 % answered correctly which is everyone who perform the maintenance should be the one who lock and tag the equipment. The rest of respondent may get confused and answered wrongly where 50 % said only lead maintenance person should lock and tag the equipment as well as for equipment operator for 45.2 %.

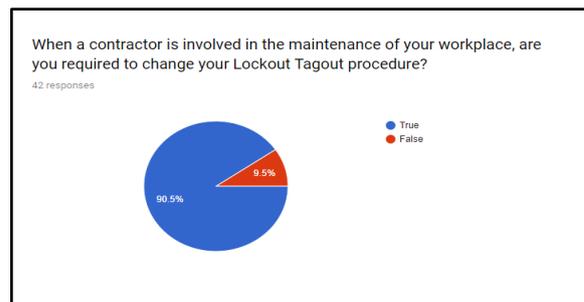


Figure 1.22: Contractor Involvement

Figure 1.22 determined whether or not a contract should change the Lockout Tagout procedure of the organization or following the current procedure provided. Only 9.5 percent replied correctly where the contractor had to follow each of the organization or company's procedures when carrying out maintenance activities without any changes.

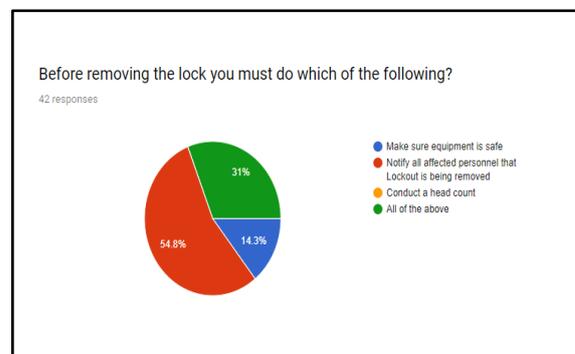


Figure 1.23: Person in charge for LOTO Release

The action to be taken before the lock-out is removed after maintenance is complete is identified in Figure 1..23. The answer to these questions is, 'All of the above' where action must be taken to secure the equipment,

notify all employees and perform a management account before the lockout is removed. The majority of respondents answered incorrectly by choosing notifies all affected personnel and make sure equipment is safe for both 54.8 % and 14.3 % consecutively. Only 31 % answered correctly.

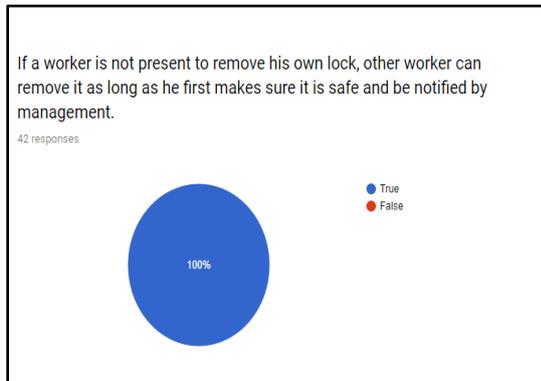


Figure 1.24: Decision for LOTO Release

The above figure is to determine how the person who puts the lock cannot remove his / her own lock is to remove the lock. All respondents correctly answered who the lock is, so long as it is safe and managed to notify.

4. Conclusion

This work has shown that it is important to introduce a LOTO program in the automotive industry based on evaluation results from data gathered from respondents. The application of LOTO was defined on the basis of the study. Several tools for statistical analysis were used for the research, including descriptive statistics and crosstab analysis.

The first prototype is a correlation of information management with the business type. Three versions were built for study. The role of the models is to determine the level of knowledge about LOTO in the company, to identify the company that provides awareness, structure and the critical LOTO implementation success factor. Based on the response provided by the respondent, the findings show that both companies are similarly familiar with LOTO and the simple LOTO feature. The knowledge level on LOTO for both companies is similar. By the presentation of awareness and LOTO system structure, the difference between both companies can be achieved. Similar with business –the organization is less open to the LOTO program or less qualified to workers.

The second prototype to be contrasted between the business form and the application of a LOTO process protocol has been developed throughout the study. This showed that the majority of respondents –companies with a major error in two LOTO processes –contribute a slightly serious error in four procedures, which contributed to the wrong answer while respondents from the company did. The best LOTO guidelines for the automotive industry were proposed in order to improve LOTO practices. It can therefore help to increase the

efficiency of LOTO Structure and the efficiency of industrial maintenance services.

Finally, the third design, by combining them with their Critical Success Factor (CSF) similarities, was developed. An early theoretical LOTO system model was introduced in order to improve LOTO activities. The design will add to LOTO's quality and production.

The research focuses on creating a LOTO checklist for best practice for the automotive industry. At the beginning of the study, three goals were established. The first is to determine the introduction of LOTO in Malaysia's automotive industry. Next to evaluate the application status and eventually to give automotive companies the best practice of LOTO. The implementation of research methodologies has achieved these three objectives. To achieve and benefit sustainability maintenance in Malaysia, a framework model could be tested for further improvement and global use for the automotive industries.

Appendix

- Table 1.1 Questionnaire Development
- Table 1.2: Descriptive Statistics for Demographic Question
- Table 1.3: Descriptive Statistics for General Knowledge of LOTO
- Table 1.4: Descriptive Statistics for LOTO Implementation
- Figure 1.1: Overview of Automotive Industry in Malaysia
- Figure 1.2: Insights of Automotive Industry in Malaysia
- Figure 1.3: Flow Chart of Online Survey Questionnaire
- Figure 1.4: Respondent Company
- Figure 1.5: Respondent Department
- Figure 1.6: Respondent Position
- Figure 1.7: Respondent Working Experience
- Figure 1.8: Definition of Lockout and Tagout Device
- Figure 1.9: Basic Components of Lockout Tagout in Group
- Figure 1.10: Lockout Tagout Checklist
- Figure 1.11: Implementation of LOTO in company
- Figure 1.12: Team or Group for Lockout Tagout (LOTO) system
- Figure 1.13: Department Involve in LOTO
- Figure 1.14: Impact of LOTO in Maintenance Work Safety
- Figure 1.15: Critical Success of LOTO in Organization
- Figure 1.16: Identify Energy
- Figure 1.17: Lockout Tagout
- Figure 1.18: Identify Types of Energy
- Figure 1.19: Isolated System
- Figure 1.20: Affected Area
- Figure 1.21: Person in Charge for LOTO Installation
- Figure 1.22: Contractor Involvement
- Figure 1.23: Person in charge for LOTO Release
- Figure 1.24: Decision for LOTO Release

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