International Journal of
INTELLIGENT SYSTEMS AND APPLICATIONS IN ENGINEERING
ISSN:2147-6799 www.ijisae.org Original Research Paper

Establishment Lockout Tagout (LOTO) Quality Manual at Sri Aman Fabrication and Industrial Trading SDN BHD

Zulhaimi Mohammad[1], Ahmed Mohamed Kadoura[2], M.F.M. Alkbir[3*], Shahrul Effendy Kosnan[4], Sairul Izwan Safie[5]

Submitted: 18/10/2023 **Revised:** 06/12/2023 **Accepted:** 15/12/2023

Abstract: Lockdown Tagout is a crucial aspect of occupational safety. In fact, it is essential to protect employees and workers near the machinery and equipment they use, maintain, and service. Still, there was information in this study regarding a LOTO system to create a LOTO quality manual at Sri Aman Fabrication and Industrial Trading Sdn Bhd. Observation and interviews have been done in order to collect data from all respective failures. The current study encompassed the entire framework development process, including variable identification, Failure Mode and Effect Analysis (FMEA), implementation of the LOTO quality manual, LOTO training programme, and procedure, and, at the end, the creation of an initial conceptual model for a sustainable maintenance framework.

Keywords: *Lockout Tagout, LOTO Quality Manual, Failure Mode and Effect Analysis (FMEA), Initial Conceptual Sustainable Maintenance Framework Model*

1. Introduction

Lockdown in order to prevent the reintroduction of hazardous energy while equipment is being maintained, tagout is an essential safety procedure that entails de-energizing electrical connections, closing valves, neutralising excessive temperatures, and securing moving parts. In this manner, your staff members can complete their work as securely as possible to maintain productivity [1][2].

Over the last few decades, hundreds of maintenance employees have died while doing their jobs. The majority of the deaths happened during scheduled preventative maintenance procedures. Workers in high-risk occupations such as construction, repair, and maintenance report an overall fatality rate of 9.4 per 100,000 workers, whereas manufacturing workers report 2.6 and all workers 3.6. The National Institute for Occupational Safety and Health (NIOSH) of the United States (US) concludes that exposure to dangerous electricity during maintenance results in substantial risk [3].

E. Aghenta et al [4] concentrated on reducing the hazards associated with hazardous energy lockouts and tagouts, as well as reporting the most frequent causes of these injuries: electrocution and becoming trapped in or between pieces of machinery.

Industries use lockout/tagout (LOTO) safety protocols to protect workers against the unintentional release of dangerous energy or energy from equipment during servicing or maintenance activities. The purpose of these processes is to confirm that hazardous energy has been managed and to make sure that dangerous machinery undergoing maintenance is appropriately marked and turned off until the job is finished [5][6].

The nonactivation methods are intended use case for the LOTO system. It is also intended to stop the flow of energy into machinery or equipment prior to the performance of any maintenance or repair procedures. To guarantee that energy has been properly isolated and to stop the release of harmful energy, certain individuals in this system are authorised to lock and tag symbols for the energy isolation procedure. Energy-insulating equipment that is locked into the "off" position is a safe operating condition. This device keeps the equipment and machine from receiving power and keeps them in a regulated position by requiring a key to be removed or a specific tool to be used in a unique unlocking process. The marking equipment serves as a conspicuous warning sign, alerting other workers not to operate the machine while it is being repaired or maintained. It also indicates that the gadget has been locked. It is anticipated that the installation of an appropriate and correct LOTO system will reduce the likelihood of mishaps, casualties, or injuries during maintenance [7].

Deaths from LOTO-related causes persist despite the regulations. In terms of top 10 violations in the industry in 2016, LOTO infractions came in second place for deliberate violations. There are several factors that contribute to LOTO-related deaths, such as personal traits, energy management state, and kind of exercise. LOTO programmers have several drawbacks, such as incomplete programmers, general procedure steps being omitted, users failing to read placards, a propensity to use other techniques without conducting a thorough risk assessment, a lack of subcontractor supervision and coordination, a lack of audit tools, and a lack of documentation of audit results. An LOTO programmer needs personnel training and particular plant equipment access controls in order to be successful. Equipment that is designed for simple lockout, in addition to training, can reduce injuries connected to LOTO. The importance of

[1,3,4]*Advanced Facilities Engineering Technology Research Cluster (AFET), Plant Engineering Technology (PETech) Section, Universiti Kuala Lumpur Malaysian Institute of Industrial Technology, 81750 Masai, Johor, Malaysia.*
**Corresponding Author Email: munir@unikl.edu.my*
[2]*Department of Mechanical and Manufacturing Engineering, Faculty of Engineering,*
Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia.
[5]*Instrumention and Control Engineering Section, Technology, 81750 Masai, Johor, Malaysia.*

incorporating a safety committee for LOTO enhancements has been emphasised by writers. Manufacturing companies who want to evaluate and enhance their LOTO programmes have found that a self-audit checklist is helpful. Unfortunately, a human element approach is often absent from the LOTO implementation phase, which results in a mismatch between the users and the LOTO system. A long-term pragmatic intervention can also benefit from a human factor viewpoint; previous research has shown that this is necessary. This article describes the conditions surrounding these abnormalities, their underlying cognitive processes, and recommendations for improvement [8].

2. Research Objective

2.1 The objectives are as follows

RO1: To determine the establishment of Lockout Tagout (LOTO) quality manual at Sri Aman Fabrication and Industrial Trading Sdn Bhd

RO2: To analyze LOTO programs and procedures to minimize the potential hazards and Injuries from data taken using the FMEA method

RO3: To propose appropriate LOTO program training and procedure

Research Flowchart.

The flowchart below showsthe procedure of research.

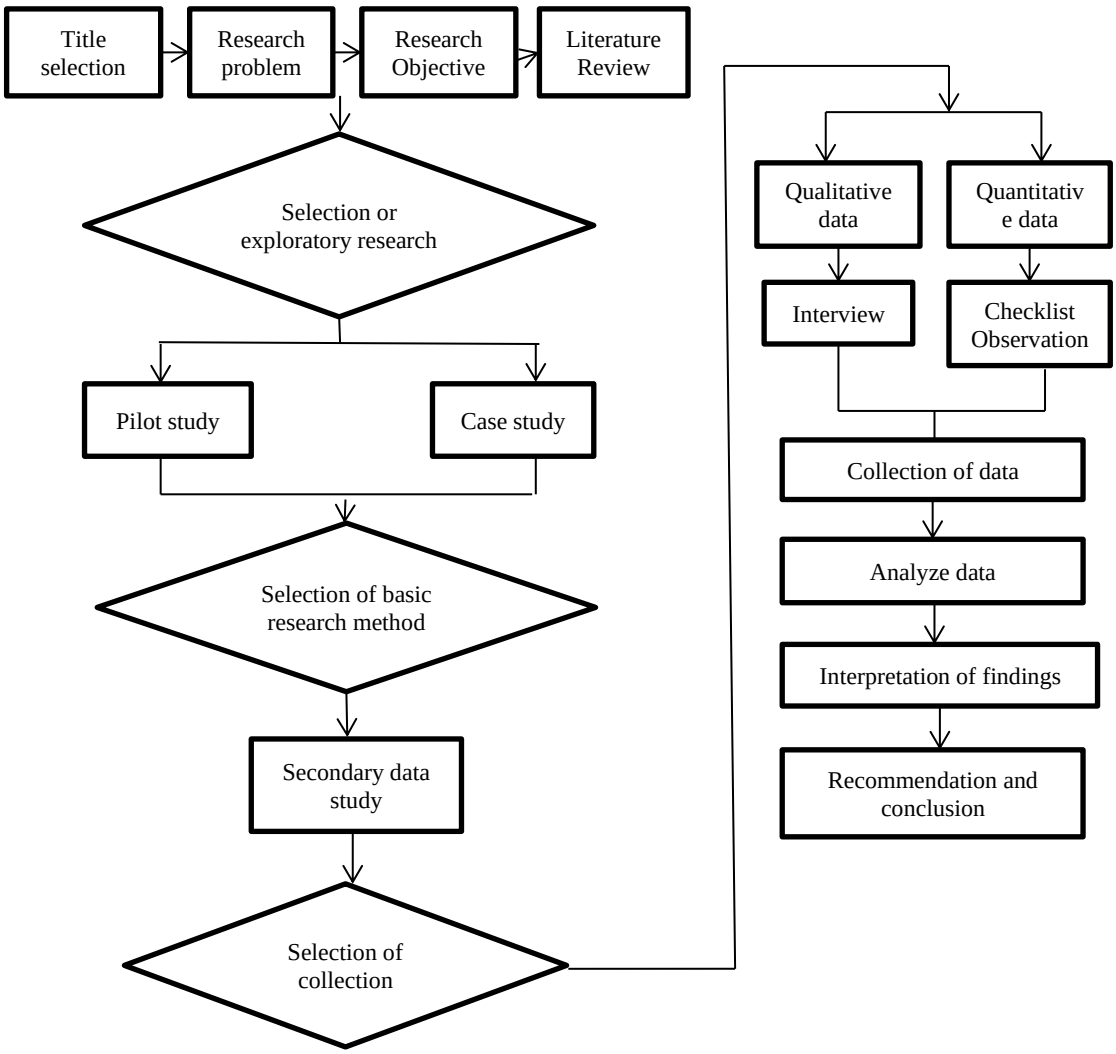

Fig. 1. Research Flowchart

Several Lockout and Tagout (LOTO) journals cover maintenance activities in identifying variables. In order to achieve the objective of creating Lockout Tagout (LOTO) quality manuals, a number of fundamental research techniques look for, record, and evaluate the information users require to complete their duties as well as how that knowledge is integrated to address a choice. Primary and secondary data were the two kinds of data collected for this investigation.

In the conduct of this research, structured interviews were conducted to gain an insight into the variables selected from journals and the validity of the journal. During this session, the survey questionnaire was also checked. After verification and validation of the survey questionnaire, the Sri Aman Fabrication and Industrial Trading Sdn Bhd questionnaire has been distributed to collect statistical information.

Results for data processing analysis are obtained to investigate a researcher moving from the qualitative data collected into some form of clarification, understanding, and interpretation of persons and situations. Analysis has been performed to verify information, variables, and relationships. Lastly, the sustainability

structure of the original proposal has been established based on statistical results.

Research Scope. The aim of this research is to establish Lockout Tagout (LOTO) practices at Sri Aman Fabrication and Industrial Trading Sdn Bhd, whereas the process is assigned, authorized, or carried out on equipment with an energy source to be activated or discharged through service or maintenance activity. The results of this research were identified and analyses from the company were gathered.

The effectiveness and current state of the Lockout Tagout (LOTO) system method were taken into consideration in this study. Sri Amman Fabrication and Industrial Trading Sdn Bhd, assessing and implementing energy control, system maintenance, and servicing as the best element of these philosophies and instruments.

2.2 LOTO under the safety system

LOTO is the logout and release of a condition, which is followed by:

- Line clearance ˆ
- Work permit system

Line clear (LC) was the process of releasing energy to external and internal sources (for instance, mechanical and electrical energy releases that involved isolation). The worker needed to maintain the corporate formats through process control, mechanic control, electrical control, and instrumentation control under the work permit system [9]. Lack of follow-up, ignorance of the potential for energy isolation, inadequate training to operate electrical equipment, overconfidence in work activities, and disregard for standard operating procedures when performing maintenance and shutdown work are all contributing factors to the potential for energy isolation. The LOTO system includes numerous components, like the previously described equipment and equipment with the ability to self-act during isolation. It was required to include these components in the security measures under the LC and work approval to guarantee safe isolation. Conveyors, pressure vessels, chemical storage tanks, electrical panels, idle machines, motors, and pumps are a few instances of equipment. A failure gap showed inadequate supervision, information, and instruction for security systems by completing the safe maintenance standard operating procedure in fig.2.

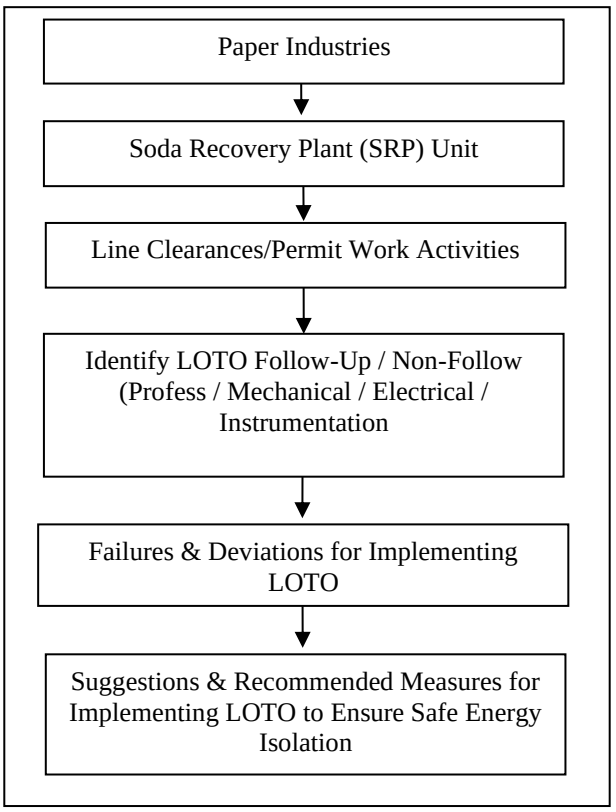

Fig. 2. Methodology

3. Result and Discussion

Analytical descriptive research was done by looking at the accident cases to identify the main reasons for failure and suggested fixes. The accident occurrence reports pertaining to the LOTO procedure's failure over the previous three years served as the main source of data. Using an in-depth interviewing technique on the informants engaged in each case, each incident was examined in greater detail. Supporting data, such as machine data, the LOTO practice's operating method, LOTO equipment, data on personal protective equipment, secure work permits, and supporting photo documentation, are used in this field of study [10].

Extensive data acquired directly from the company, including checklists used to collect data and information for this study. This study, on the other hand, used qualitative research methods and collected data through observation and interview. Minitab and Microsoft Excel were used to conduct the analysis.

Table 1. Descriptive Data

Types of Failures	Total
Failure to de-energize	0%
Failure to drain residual energy	0%
Failure to double-check the settings	25%
Lack of training	50%
Lack of equipment-Specific Lockout Procedures	25%
Use of Duplicates/Master keys/Shared Locks	0%

Table 2. Result of Descriptive Data

Session

Descriptive Statistics: Total of failures

Variable	Mean	StDev	Variance	Median	Mode	N for Mode
C1	0.1667	0.2041	0.0417	0.1250	0	3

Tables 1 and 2 depict a descriptive study of the overall number of failures by a services company. The variable has a mean level of 0.1667 and a standard deviation of 0.2041 as shown above. The variance for median would be 0.0417 and 0.1250, respectively.

Figure 3 shows the most common types of failures in service companies that occurred when maintaining and servicing the machines. It reveals that company Danamin (m) Sdn Bhd (Yard fabrication) and NAEC (Malaysia) Sdn Bhd have the same type of failures which re 25% at "Lack of training". While another 50% total of failures at company YEELIE SUPPORT SDN BHD which is "Failure to double-check the setting" and Steel Ally Engineering Sdn Bhd for "Lack of equipment – specific lockout procedures" respectively.

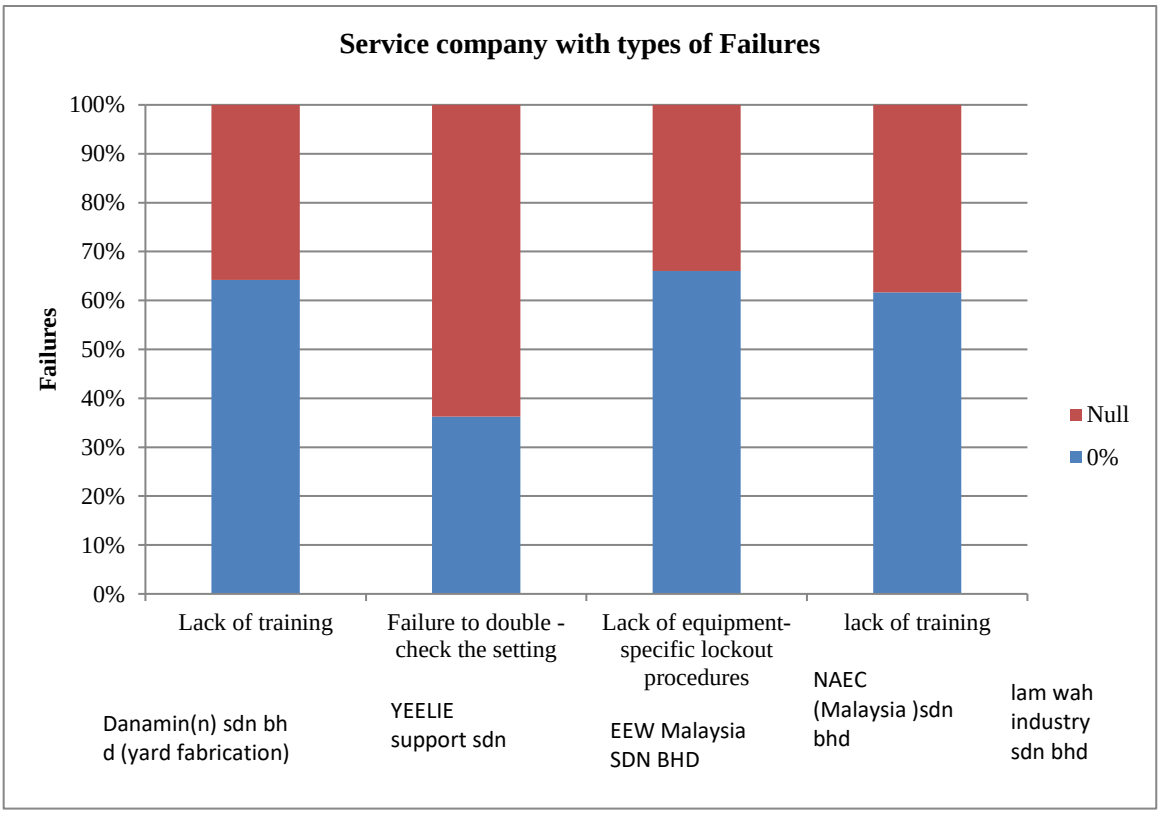

Fig. 3. Services Company with Types of Failures

Figure 4 represented the types of failures that occurred in each of the six services companies in total. According to the findings, "Lack of training" contributes to 50% of the most common failures, while "Failure to double-check the settings" and "Lack of equipment – Specific Lockout Procedures" contribute for 25% respectively. According to the chart, the most common failures are Failure to

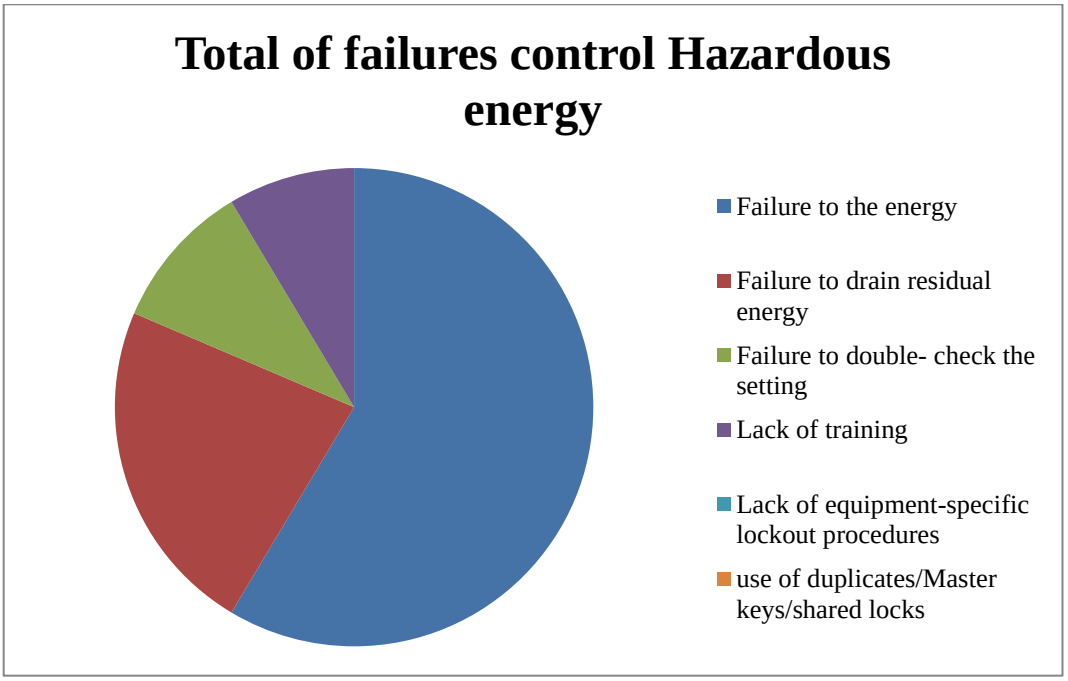

Fig. 4. Total of Failures Control Hazardous Energy

Double-check the configurations, lack of supplies, an absence of training, and certain lockout methods, all of which require additional action to protect the workplace, staff, and machinery from accidents that may occur during future maintenance or services. This is because malfunctions continue to occur, and the severity of these failures ranges from mild shocks and missing fingers to the loss of life.

Tsm: Lockout Tagout (LOTO) Michl: Machines Core team:						Responsibility: Engineer Prepared by:					FMEA number: LT-011232021 Page of: 1 FMEA Osn(Orig): 28th October 2021				
											Action Results				
Item /Function	Potential Failure Mode (s)	Potential Effect(s) of failure	Sov	Potential causes(s) Mechanism(s) of failure	Occ	Current Design/ Process controls	Dot	RPN	Recommended Action(s)	Responsibility and target completion date	Actions Taken	Now-Sov	Now-Ooc	Now-Dot	Now-RPN
	Failure to do energize	Pro or explosion where electricity could be the source of ignition in a potentially flammable or explosive atmosphere	5	Accidently or elaborately to shut down the machine and disconnect the power source before putting it to work	2	When trip shutdown is required, the loop will be co-energize	3	30	Do-energize the SDVs solenoid to make the mail valve does	Electrician/ Maintenance (IMMEDIATELY)	Lockout all switches and controls with assigned locks and tags	4	2	3	24
	Failure to drain residual energy	The machinery does unintentionally	5	Turning a machine off without disconnect	2	Reclosary Residual or stored energy and lockout	3	30	Always make sure to test the system to verify that	Electrician/ Maintenance (IMMEDIATELY)	Inspect the equipment to ensured/ energy sources are disconnected	4	1	3	12

		become active		ing it from a power source		sources of energy			no energy is present						
	Failure to double check the settings	Internal wiring on a piece of factory equipment electrically short, shocking worker who is repairing the equipment	5	Missing of any process control usually prove fatal	3	Making sure that the power sources are disconnected, movable machine parts firmly locked in place, residues emptied and equipment locked out is a must before commanding repairs	4	60	Important to check if tools and floors are cleared and all connections restored before unlocking and restarting the machines to open up the space for the regular use	Electrician/ Maintenance (IMMEDIATELY)	Completing sets of specific work instructions that outlines what controls and practices are needed to lock and tag out a system before performing any activity	4	2	4	32
Lookout Tagout	Lack of training	Put the technicians into risk and compromises on the satity of others in the shop floor	4	Improper training creates improper results	3	Each employee addressed with maintenance or repair jobs must be trained on safety and lockout procedures for systems and equipment under their control	4	48	It is important to recognize the different types of employees defined in the lock out/tag out standard and to ensure that each employees receives the appropriate training	Electrician/ Maintenance (IMMEDIATELY)	Retraining of all employees to maintain proficiency or introduce new or changed control methods	3	2	4	24
	Lack of equipment-specific Lock out procedures	Specific lock out procedures for each part and identification tags for each employee on the job are a must, without which the maintenance process could prove a challenge	5	If an energy isolating is not capable of being locked out, the device will be modified when possible	3	Specific requirement for testing a machine or equipment	4	60	Verify the effectiveness of lockout devices, tag out devices, and other energy control measures	Electrician/ Maintenance (IMMEDIATELY)	Use manufacturer instructions or in-house instructions	4	2	4	32
	Use of Duplicate Master	Sharing locks are a	5	Overconfidence, experienc	2	Each technician hold his	3	30	Lock makers have made	Electrician/ Maintenance	Ask for identification of the person	4	1	3	12

	Keys/ Shared Locks	potential problem with equally dangerous consequences		e, and familiarity with the facilities or procedure that influences people to overlook those lockout basics		own set of tagged lockout devices with a singularity (to facilitate the task) for accountability, responsibility and traceability purposes			restricted keys which are harder to copy because the process requires special equipment	(IMMEDIATELY)	requesting it and proof that this person has obtained permission from the original owner				

Validation and verification check:

Name:	Mr Sam
Company/Institution	Sri Aman Fabrication and Industrial Trading Scln Bhd
Signature/Position/Company Stamp:	
Expertise:	Maintenance & Services
Day and date:	19/11/2021

The FMEA worksheet above was utilized in this study, and the FMEA analysis was explained. Lockout Tagout (LOTO) was chosen to analyze and assess the item's functions as well as all operational modes or phases. By analyzing the LOTO's previous failure records, appropriate criteria for ranking severity, occurrence, and detection are determined. To begin, the failure modes of LOTO were identified, and it was determined if any failure of the item under consideration in each mode may have an undesirable potential effect. All failure modes that have been identified are documented. Rather than delving into the causes, the researcher focused on the potential effects. The failure mode's possible impacts are then indicated, along with their severity value.

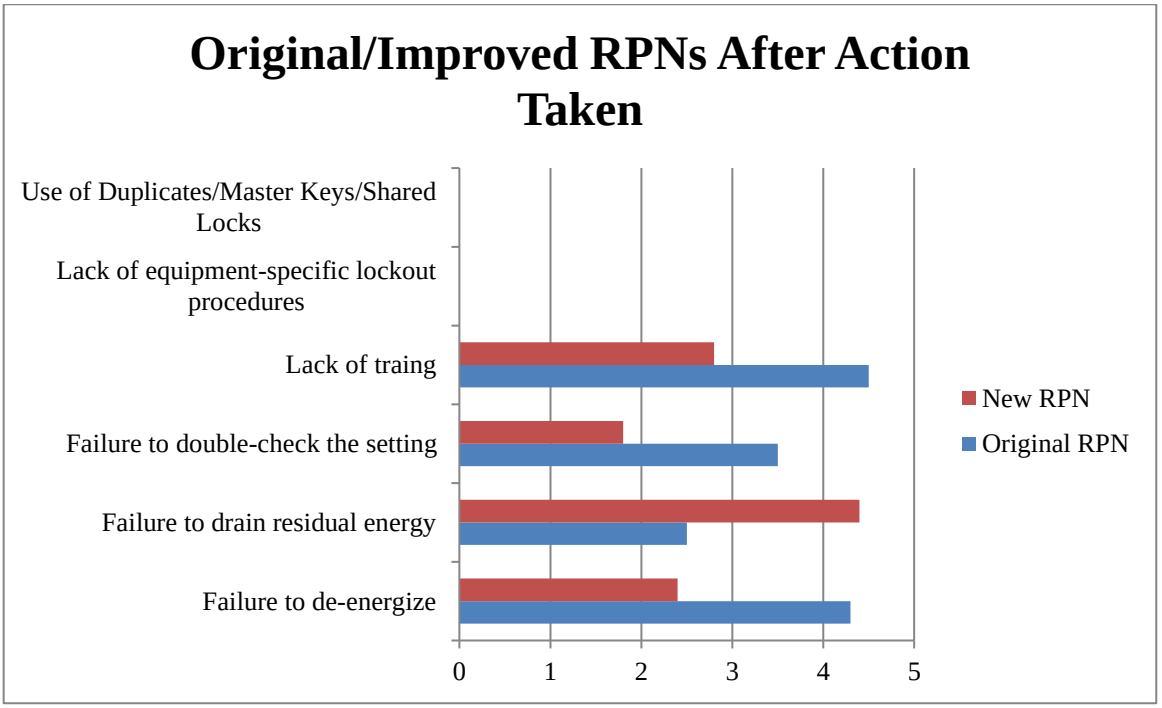

Fig. 5. Original / Improved RPN's After Action Taken

In an FMEA, a bar graph depicting the before and after RPN's seems to be very informative since it demonstrates the significant impact of the improvements achieved as a result of the FMEA process. The graph shows that the failure to double-check settings and the lack of equipment-specific lockout protocols had the highest initial RPNs, both at sixty. In the meantime, the new RPN for drafting action plans has been reduced from 60 to 32. In addition, the graph indicates that the current acceptable risk (RPN) cut-off is 40 since 1~64 is only acceptable FMEA ratings.

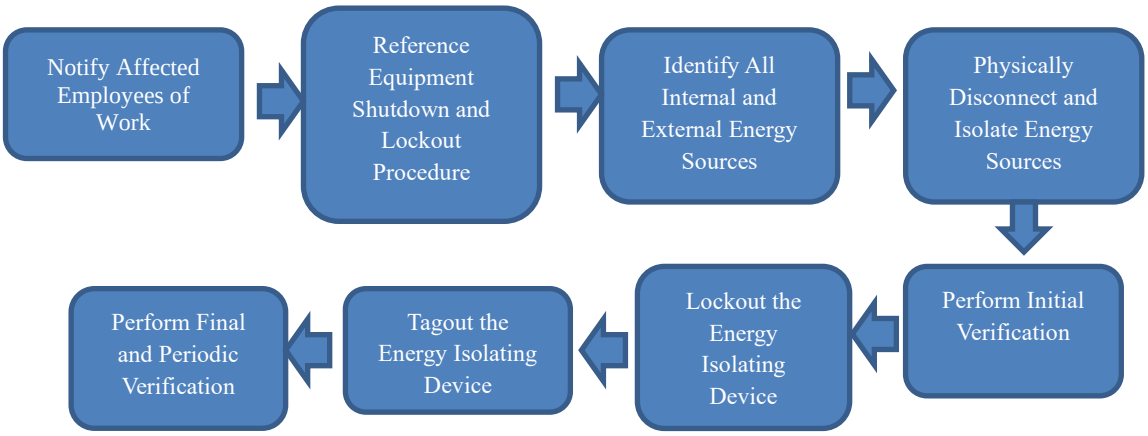

Fig. 6. Framework Model of Lockout Tagout

The results of the data analysis were used to create the first Lockout Tagout architecture design. According to Kumar and Tauseef, the LOTO system has eight framework models. As a result of the findings, the framework has been suggested in order to improve LOTO procedure as shown in Figure 6.

4. Conclusion

The focus of this research is on the establishment of the quality manual at Sri Aman Fabrication and Industrial Trading Sdn Bhd. Three goals have already been established. Finding out how Lockout Tagout is established is the first goal (LOTO quality manual at Sri Aman Fabrication and Industrial Trading Sdn Bhd, second is to analyze LOTO programs and procedures to minimize the potential hazards and injuries from data taken using observation and the third is to propose appropriate LOTO program training and procedure. The use of methodologies in this study was able to accomplish these three objectives. The LOTO training program's quality traditional and process may be put to the test in Malaysia as it grows for even greater improvement, as well as throughout the world for industries looking to maintain and advance their viability and make safety a core value to lower the risk of accidents and injuries.

Acknowledgement

I would like to thank the Universiti Kuala Lumpur - Malaysian Institute of Industrial Technology (UniKL MITEC) (Universiti Kuala Lumpur Kampus Cawangan Malaysian Institute of Industrial Technology (UniKL MITEC) for supporting this study.

Competing interest and funding statement

I would like to inform you that neither relevant financial nor non-financial competing interests need to be reported, nor competing interests need to be declared.

References

[1] T. Live and A. Training, "LA-UR-17-21059 Title : Author (s): Intended for : Issued :," 2017.

[2] A. Lockout, "WHY LOCKOUT / TAGOUT ? SIX STEPS PROCESS OF LOCKOUT / TAGOUT : LOCKOUT / TAGOUT LOCKOUT / TAGOUT."

[3] J. Furman, "Work Safety Improvement Within Autonomous Maintenance," *Multidiscip. Asp. Prod. Eng.*, vol. 3, no. 1, pp. 161–171, 2020, doi: 10.2478/mape-2020-0014.

[4] E. Aghenta, "Mitigating risks associated with Lockout / Tagout (LOTO) of Hazardous Energy in Nigeria - A tracker approach," no. October, 2012.

[5] O. O. Ogungbe, "The Implementation of Hazardous Energy Control (Lockout/Tagout) Program at XYZ Inc.,Plymouth, Minnesota," pp. 1–85, 2013.

[6] Y. Chinniah and D. Burlet-Vienney, "Study on lockout procedures for the safety of workers intervening on equipment in the municipal sector in Québec," *Int. J. Occup. Saf. Ergon.*, vol. 19, no. 4, pp. 495–511, 2013, doi: 10.1080/10803548.2013.11077007.

[7] Dewi, L. T. (2018). Investigation of Lockout/Tagout procedure failure in machine maintenance process. *Jurnal Teknik Industri*, *20*(2), 135-140.

[8] Illankoon, P., Manathunge, Y., Tretten, P., Abeysekara, J., & Singh, S. (2019). Lockout and tagout in a manufacturing setting from a situation awareness perspective. *Safety*, *5*(2), 25.

[9] Dźwiarek, M. (2022). Application of lockout/tagout procedures in production systems of Industry 4.0. *Journal of KONBiN*, *52*(3), 137-148.

[10] Ravi, M., Sridharan, P., & Senthilkumar, V. K. (2018). Implementation strategy of lock out and tag out (LOTO) electrical systems for paper industry. *International Journal of Applied Science and Engineering*, *6*(1), 1.