Implementing FMEA in the Slipper Shoes Manufacturing Process of a Case Company in Thailand

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This research implements the Failure Mode and Effects Analysis to identify the failure modes that cause defect and waste in the slipper shoes manufacturing process of a case company in Thailand. This research collects the data by questionnaire, interviews, and discusses with the experts at a case company in Thailand to review the process and list the potential effects that cause defects and wastes in the process. Then, each failure mode's degree of severity, occurrence, and detection are evaluated, and the risk priority number is calculated. Finally, the importance of each failure mode is ranked by the value of the risk priority number.

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Classification: FOR Code: 291899

Language: English

London Journals Press

LJP Copyright ID: 392896
Print ISSN: 2631-8474
Online ISSN: 2631-8482

London Journal of Engineering Research

Volume 19 | Issue 5 | Compilation 1.0

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The result of this study improves the reliability and quality of the manufacturing process by recommending preventive or corrective actions to solve the problems with a proactive and systematic method based on the concepts of Failure Mode and Effects Analysis.

Keywords: failure mode and effects analysis (FMEA), slipper shoes manufacturing process, thailand, risk priority number.

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I. INTRODUCTION

Slipper shoes are one kind of product that gets a high degree of sales value. Usually, people wear slipper shoes in warm climates or the warm period of the year to keep their feet cool and dry. Therefore, it is reasonable that slipper shoes have a very high volume of demand in Thailand and other countries in Southeast Asia

Thus, this research selects a case company of slipper shoes in Thailand as the studying object and tries to identify lists and causes of the failures in the manufacturing process of slipper shoes of the case company. This study then makes the recommendation to solve the problems by using a proactive and systematic method based on the concepts of Failure Modes and Effects Analysis (FMEA).

The objective of this research is to prevent the possible causes of the failure modes from occurring. Therefore, the quality of the product can be assured, and the wastes of the production processes can be eliminated for the case company in Thailand.

FMEA has been used as the research tool in this study. Failure modes are identified first. Then, these failure modes are evaluated based on their ranking of severity, occurrence, and detection. Finally, the potential causes and remedy actions of these failure modes are also investigated.

II. METHODOLOGY

This research investigated the sources of failure in the slipper shoes manufacturing process by using the FMEA process. There are four steps to process FMEA in this research.

2.1. Review the process and List potential failure modes that cause wastes in the manufacturing process.

There is 7 components to produce slipper shoes and 22 failure modes in this process.

2.2. Assign Severity, Occurrence and Detection ranking for each failure mode.

After list the potential failure mode and effects in the manufacturing process. Then, researcher send a questionnaire to 10 experts in the field that related to this topic. The scoring criteria base on Table 1, 2, and 3 respectively.

Table 1: Criteria for Ranking Severity (S) in FMEA

Effect	Severity Criteria	Ranking
Extremely serious	Failure mode causes the possibility of not meeting government regulation and might be fatal to product user.	10
	Failure mode causes the possibility of not meeting government regulation and might endanger product user but not fatal.	9
	Failure mode causes the possibility of not meeting government regulation but will not endanger product user.	8
Very serious	Failure mode may not meet buyer's (retailer's or distributor's) requirements. The buyer decides to cancel or return the order of the product and will not place any order to the company again.	7
	Failure mode may not meet buyer's (retailer's or distributor's) requirements. The buyer decides to cancel or return the order of the product but will place orders to the company in the future.	6
	Failure mode may not meet buyer's (retailer's or distributor's) requirements. However, the buyer only asks compensation from the company and will not return the order of the product and will place orders to the company in the future.	5
Serious	Failure mode may make end user think that the product has a bad quality.	4
	Failure mode may cause production interruption and/or defective parts.	3
	Failure mode will not cause production interruption but some defective parts. May occur.	2
Less serious	Failure mode will not cause noticeable negative effect.	1

Table 2: Criteria for Ranking Occurrence (O) in FMEA

Probability of Failure Occurrence	Possible Failure Rates Criteria	Ranking
Very high: Failure is almost unavoidable	Failure occurs once from 10 pairs of production workpieces.	10
	Failure occurs once from 20 pairs of production workpieces.	9

High: Usually it involves processes that have failed frequently before	Failure occurs once from one 50 pairs of production workpieces.	8
	Failure occurs once from one 100 pairs of production workpieces.	7
Moderate: Occasional failures	Failure occurs once from 500 pairs of production workpieces.	6
	Failure occurs once from 2,000 pairs of production workpieces.	5
	Failure occurs once from 10,000 pairs of production workpieces.	4
Low: Relatively few failures	Failure occurs once from 100,000 pairs of production workpieces.	3
	Failure occurs once from 1,000,000 pairs of production workpieces.	2
Remote: Failure is unlikely	Failure is detected and eliminated by the quality inspection process	1

Table 3: Criteria for Ranking Detection (D) in FMEA

Detection	Likelihood of Detection by Process Controls	Ranking
Almost impossible	Cannot discover or identify the cause of failure mode even use the extra and advanced equipment.	10
Very remote	Occurrence of the failure mode is random and it is difficult to detect by using the extra and advanced equipment.	9
Remote	The failure mode can be detected by using the extra and advanced equipment carefully.	8
Very low	The failure mode can be detected by using the extra and advanced equipment easily.	7
Low	The failure mode can be detected by using the extra and generated equipment carefully.	6
Moderate	The failure mode can be detected by using the extra and generated equipment easily.	5
Moderately high	The failure mode can be detected by using the standard equipment carefully.	4
High	The failure mode can be detected by using the standard equipment easily.	3
Very high	The failure mode can be visually detected by the quality inspector.	2
Almost certain	The failure mode can be visually detected by the operator.	1

2.3. Calculate the Risk Priority Number (RPN) and Prioritize Failure mode.

The Risk Priority Number for each failure can be calculated by the following formula:

$$RPN = Severity(S) \times Occurrence\ (O) \times Detection\ (D)$$

Then, prioritize the RPN by ranking failure mode that contains the highest score to the lowest score to determine the most critical cause of failure modes to make a recommendation.

2.4. Make a recommendation.

After identified possible causal factors and the root causes of the problems in the production process by means of the FMEA method. It is necessary to make the process improvement. Base on the suggestion from expertise and researcher work experience, we can create control plans development to solve the problem. Table 4 shown top 5 of RPN scores in this process.

Table 4: Summary of Failure Modes

Rank	Failure Mode	Effect(s) of Failure	Potential Causes	Recommendation	RPN
1	F1.1 Produce EVA in wrong formula	E1.1.1 EVA cannot be used to produce shoes	C1.1.1.1 The process is an open system. Sometimes the formula needs to be adjusted according to the weather	Collaborate with R&D department to develop stable EVA formula.	36
			C1.1.1.2 Workers lack of work experience	Reduce staff turnover rate. Enhance job training program.	6
2	F2.5 Produce the rubber sole in wrong formula	E2.5.1 Rubber cannot be used to produce the out sole	C2.5.1.1 the process is an open system. Sometimes the formula needs to be adjusted according to the weather	Collaborate with R&D department to develop appropriate rubber formula.	30
2	F6.1 Use the wrong tag, box or bag in packing finished goods process	E6.1.1 Rejected by QC, waste time and cost for re-processing	C6.1.1.1 Work on multiple order at the same time but there is no effective order classification system	Improve the identification system of products.	30
4	F5.1 Scrub the workpiece too much causing the size of workpiece cannot meet the specification	E5.1.1 Wasted materials	C5.1.1.1 Workers lack of work experience	The factory needs to improve the working condition, e.g., ventilation system of working place.	24
5	F6.2 Quantity of the good is insufficient in the pack in the packing finish goods process	E6.2.1 Rejected by QC and waiting for re-packaging.	C6.2.1.1 Unbalanced workload and /or worker ignorance.	-Improve the identification system of products. -Re-calculate the workload and make new standard time.	20

IV. CONCLUSION

The essential contribution of this research is to identify the failure modes, and their associate potential causes and effects, and make the recommendations to reduce or eliminate the potential failure modes and their potential causes in the slipper shoes manufacturing process of the case company in Thailand by applying the FMEA as the research tool. Compare with other industries, the intensity of failure in the production of slipper shoes is low because workers do not operate on heavy-duty machinery. Refer to RPN level contained in this study, failure modes with high RPNs do not get a high level of the severity of the criteria but are likely to occur more frequently.

Results drawn from this research can be provided to the management of the case company so they can reduce or eliminate the quality problems or wastes of the production process accordingly.

Suggestions

Since the failure modes and their corresponding possible causes and effects have been identified, the remedy actions should be conducted by the case company to complete the improvement process. Consequently, the FMEA should be applied to the other production processes in the case company to further improve its quality and productivity.

REFERENCE

1. Abdullah, K. A., Rohani, J. M., Ngadiman M. S. (2005). "The Development of FMEA Information System for Manufacturing Industry", Paper presented at 3rd International Conference on Modeling and Analysis of Semiconductor Manufacturing, Singapore.
2. Carlson, C. S. (2012). Effective FMEAs: Achieving Safe, Reliable, and Economical Products and Processes Using Failure Mode and Effects Analysis, John Wiley & Sons, Hoboken, New Jersey.
3. Carlson, C. S. (2012). Failure Mode and Effects Analysis (FMEA), John Wiley & Sons, Hoboken, New Jersey.
4. Dubale, S., Suleman, S., & Gurmesa, A. (2017). "Failure Mode and Effect Analysis (FMEA) of IV-Medication Process in Mettu Karl hospital, Mettu Town, Oromiya Regional State, South West Ethiopia". Clinical Research: Open Access (CLROA) journal, 3(1), pp. 1-7.
5. Fadlovich, E. (2007). Performing Failure Mode and Effect Analysis, Retrieved from https://1th.me/L78t, Retrieved Date: December 31, 2007.
6. Gollomp, B. (2008). "Alookback-Quality and reliability facilitator-FMEA", IEEE Instrumentation & Measurement Magazine, 11(2), pp. 58-59.
7. ItalianSole (2016). 5 Kind of Comfortable Slippers & Flip Flops for Men & Women, Retrieved from https://blog.theitaliansole.com/2016/10/25/5-kind-comfortable-slippers-men-women-online/, Retrieved Date: October 25, 2016.
8. Liu, H. C. (2016). "FMEA Using Uncertainty Theories and MCDM Methods", FMEA Using Uncertainty Theories and MCDM Methods, pp. 13-27.
9. Meriem, A., & Abdelaziz, M. (2019). "A Methodology to Do Model-Based Testing Using FMEA", Proceedings of the 2nd International Conference on Networking, Information Systems & Security, 19, pp. 16-27.
10. Mhetre, R. S., & Dhake, R. J. (2012). "Using Failure Mode Effect Analysis in Precision Sheet Metal Parts Manufacturing Company", International Journal of Applied Sciences and Engineering Research, 1(2), pp. 302-311.
11. Ng, W. C., Teh, S. Y., Low, H. C., & Teoh, P. C. (2017). "The Integration of FMEA with Other Problem Solving Tools: A Review of Enhancement Opportunities", Journal of Physics: Conference Series, 890(1): 012139.
12. Shoe guide. (2019). Anatomy of the Shoe, Retrieved from https://www.shoeguide.org/shoe_anatomy/, Retrieved Date: February 20, 2019.
13. Stamatis, D. H. (2003). Failure Mode and Effect Analysis: FMEA from Theory to Execution, ASQ Quality Press, Milwaukee, Wisconsin.

14. Statista (2019). Footwear, Retrieved from https://www.statista.com/outlook/11000000/126/footwear/thailand, Retrieved Date: June, 2019.
15. Tague, N. R. (2005). The Quality Toolbox, ASQ Quality Press, Milwaukee, Wisconsin.

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