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Application of FMEA methods in Minh Duong furniture company in Vietnam

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ABSTRACT

This paper aims to apply FMEA (Failure Mode and Effect Analysis) tools in the wood production process of Minh Duong Wood Company. In this study, the process evaluation indicators according to FMEA were analyzed such as failure severity - S (Severity value), failure frequency - O (Occurrence number), error detection ability. failure - D (Detection number), risk priority factor - RPN (Risk Priority Number). The research results show that the failure modes of the process have been systematically and comprehensively identified. Fault types are ranked as priority for improvement and corresponding solutions have been proposed.

Keywords*: FMEA, failure severity (S), failure occurrence frequency (O), failure detection ability (D), risk priority factor (RPN)*

1. Introduction

Failure Modes and Effects Analysis (FMEA) was first introduced to the Apollo program in 1960 by the space industry. Then, in 1970, this tool was applied in the automotive industry and was included in the quality management standard QS-9000 in 1994 (Teng et al., 2006). Currently, FMEA is applied in many different fields from industrial production, design, to service. FMEA is a tool to help businesses improve quality and improve process viability by identifying potential failures early and prioritizing defects to be resolved. In addition, the application of FMEA will improve teamwork, reduce design changes and costs arising from such changes (McDermott, Mikulak & Beauregard, 2002; Cung, 2007).

In the world, there have been many studies on the application of FMEA in different industries (Chen, 2007; Wang et al., 2009). In Vietnam, this tool is increasingly being applied by many businesses in Vietnam, especially foreign businesses. Particularly in the field of research, this is also a topic that has received a lot of attention from researchers (Nguyen, 2007; Phan, 2012; Nguyen & Mai, 2013).

Today, with the integration of the World Economic Organization (WTO), Vietnamese enterprises must constantly improve the quality of products and services to be able to compete with foreign enterprises. One of the many tools and modern business and production methods that Vietnamese businesses should learn and apply is FMEA. Minh Duong Wood Company is a company specializing in the production of furniture from wood. The company soon realized the benefits as well as how to apply the FMEA tool in the products manufactured by the company to create a competitive advantage. Therefore, this study was conducted to identify the types of defects, advantages and disadvantages. Prioritize fault modes, deploy and evaluate the effectiveness of error improvement solutions. Thereby, helping Minh Duong Wood Company to have a deeper insight into the application of FMEA tools to its production and business activities.

2. Scientific research and research establishments

FMEA is a methodology that focuses on prioritizing critical failures to improve the safety, reliability, and quality of products and processes (Cung, 2007). FMEA ranks potential failures by determining a risk priority factor (RPN) to take appropriate corrective actions. The scale for the components of the RPN such as failure severity (S), frequency of failures (O), and detectability of failures (D) is usually given from 1 to 1. 10. The higher the S and O scores, the higher the severity and the greater the frequency of the error. Similarly, the higher the value of D, the more difficult it is to detect errors. Faults with a higher RPN index are ranked in a higher priority order. RPN is calculated as the product of component indices to determine the risk level of a process/design: RPN = S x O x D.

2.1.Classification FMEA*:* There are two types of FMEA, design FMEA and process FMEA (Cung, 2007). FMEA-Design (Design FMEA, D-FMEA or FMEA-D) is primarily concerned with optimizing product reliability. Because of the focus on the product to be manufactured, some call this type of FMEA the Product FMEA. When a product is made up of more than one ingredient, it is called an FMEA-Part FMEA for each base ingredient. Some people also call these types of FMEAs FMEA-Projects (Project FMEA), to emphasize the point that an FMEA must be conducted at the very beginning of a product design project. The purpose of FMEA-Design is to ensure that all potentially fatal errors and how they arise have been identified and investigated. FMEA-Process (Process FMEA, P-FMEA or FMEA-P) is mainly focused on improving productivity, especially in production facilities (machines, tools, production lines, etc.) and sequence of ways, accessing information, welcoming customers, etc. manually or automatically. Therefore,

people often call this method FMEA - Equipment (Machine FMEA) or FMEA - Organization (Organization FMEA). Especially, in enterprises that simply service, people also call this FMEA as Service FMEA. When conducting an FMEA project-The process for a service, one distinguishes between back office activities, performed outside of the customer's presence, and front office activities carried out by the customer. performed in the presence or participation of the client. In this paper, only the FMEA process for wood production enterprises in Vietnam is studied.

2.2. Research methods: To implement the FMEA project in the company, an FMEA group of 5 people has been established, the members are department/stage managers. In addition to this FMEA group, the results are also monitored and evaluated by the Plant Manager. The implementation steps are applied according to the FMEA implementation process (Table 1). The company's secondary data is collected for pre-improvement process analysis. The indicators evaluate S, O, D, causes and propose solutions based on expert methods. Experts are people with experience in the process. They are managers, engineers, senior workers involved in the process.

TABLE 1: Steps to conduct FMEA

Steps		
1	Define process or product	FMEA team reviews product design drawings or process flowcharts.
2	Brainstorm to find potential mistakes	FMEA team members brainstorm together to find potential mistakes.
3	List Potential Impacts for Defects.	For each failure, the FMEA team determines the effects (if any) if these failures occur
4	Determination of Severity of Impacts	For each impact, the FMEA team determines their severity and rate (give points) them.
5	Determining the frequency of errors	Based on real data or on estimates, the FMEA team determines and ranks (scores) the frequency of errors.
6	Determine the detectability of defects or impacts	The FMEA team will determine and rate (scoring) the extent to which defects are discovered or their effects.
7	Calculate the risk priority factor (RPN) for errors	RPN = S x O x D
8	Prioritize failures to take preventive actions	Rank failures in the order of RPNs. Use Pareto's rule to select the most serious error to take preventive action
9	Action to reduce or eliminate errors	Reduce or eliminate D by stricter control, warning lights, work instructions, processes, etc… Reduce or eliminate O by eliminating or controlling potential causes Reduce or eliminate S (difficult to do) by adjusting process reordering
10	Recalculate the RPN	After the actions are taken, the S, O, and D scores of the errors are expected to decrease. The FMEA team needs to recalculate these values as well as the RPN values.

(Source: McDermott, Mikulak & Beauregard, 2002)

3. Results and discussions

The research team, after performing the steps in Table 1 correctly, the results obtained at each step are as follows:

Steps 1, 2: The FMEA team analyzed the wood production process and identified 23 types of defects occurring at 7 stages of this process (Table 2).

TABLE 2: Types of defects in wood production

Stage	**Types of failure**
Saw	Saw not the right size
Drying	Wood after drying is strewn and cracked
Pairing	Wrong size; Not the same color; Joints are open; Joint surface is not equal.
Drill	Incorrect location; Wrong size; Drill holes are dented, cracked; During the drilling process, the heart of wood was discovered, and the eyes were black
Sanding	Uneven sanding; The sand is wavy
Bounding	Bounding is not standard, not smooth, not even
Paint	Not the same color; Wrong color; Paint flow; To cling dust; Paint scratches

Steps 3, 4, 5, 6: The FMEA team developed the severity rating scale (Severity-S); Occurrence-O; The ability to detect (Detection-D) of failure types (Appendix 1 and 2). Based on that, the FMEA team determines the S, O, and D scores for each type of failure.

Steps 7, 8, 9: The FMEA team calculates the risk priority factor RPN1 (before improvement) for each failure type, the results of identifying 6 failure types with the highest RPN1 coefficient are shown in Table 3. The group then continues to discuss and analyze to find the cause of these failures in Step 9.

TABLE 3: The six highest ranked failure modes according to the RPN1 coefficient in the wood manufacturing process

Stage	**Fault type**	**Fault effect**	**Cause of failure**	**Current control action**	**S1**	**O1**	**D1**	**RPN1**
Drill	In the process of drilling to detect the heart of wood, black eye	The next stage cannot be used.	Checking the workpiece is not good at the previous stage	Check with naked eyes	8	6	7	**336**
	Incorrect position	The next stage cannot be used.	Drill bit is misaligned. Wrong drawing or workers adjust the machine wrongly	Check with naked eyes and ruler	8	6	6	**288**
	Incorrect size	The next stage cannot be used.	Drill bit worn out. The skills of workers are still weak.	Check with ruler	8	6	6	**288**

	The drill hole is dented, cracked	The next stage cannot be used.	The machine runs at high speed. Workers do not know how to adjust.	Check with naked eyes	8	6	6	**288**
Grafting	Not the same color	A bad grafting surface will affect the product.	Poor workmanship	Check with naked eyes	8	8	5	**320**
	Joint is open	The next stage cannot be used.	The input workpiece is not close to the couplers. Insufficient coupling force	Check with naked eyes	8	8	5	**320**

Step 10: The FMEA team discusses how to come up with solutions for the above 6 types of defects that need to be prioritized for improvement. The proposed solution groups focus on the following four issues:

- People: The company should organize training sessions to improve skills for workers, train, transfer experience and mentor workers on standard operations to work and communicate clearly and understand the process. The company's standard process so that workers do it right from the beginning and don't let mistakes go to the next stages. Instruct workers on how to recognize errors, how to check for errors carefully at their own stage. Management levels must always monitor and observe to guide workers and train workers on how to work voluntarily, eliminating laziness and irresponsibility.

- Machinery: The company must build a team of technical, maintenance and professional staff to check machines and periodically maintain them. At the end of each working day, maintenance staff must check the machine parts and lubricate when necessary, check the power line to always be in a safe state. Develop weekly and monthly machine maintenance schedules and overhaul and overhaul to make the machine work efficiently and minimize downtime while in operation.

- Information: Build a more efficient information system like the Kanban system. Teach everyone how to write, read, and use Kanban so that information always comes down correctly.

- Environment: The working environment is a factor that greatly affects the morale of public employees and employees. Therefore, the company needs to quickly improve the working environment. The company should upgrade the dust collection system in the air because the company's system is quite old and not working effectively, causing too much dust in the air. Arrange local industrial vacuum cleaners to vacuum the floor of the workshop. If the working environment is not bright enough and well ventilated, it will adversely affect the quality of work. Therefore, in order to have enough brightness, the

factory should install the necessary electric lights and install light panels on the roof of the factory to get natural light to save electricity. Equip more exhaust fans on the roofs of workshops, arrange ventilation windows to increase air circulation in the factory to reduce the temperature in the working environment for workers.

- To improve the working environment in the most optimal way, the company should apply the 5S Method. The 5S method is a useful method of arranging workers' work areas and optimizing work efficiency.

After 2 months of applying some solutions, the FMEA team recalculated the coefficients S2, O2, D2 and RPN2 (after improvement) to evaluate the initial effectiveness of the solutions (Table 4).

TABLE 4. The coefficients S, O, D and RPN of the six failure modes prioritized for improvement in the wood production process.

Stage	**Fault type**	**S2**	**O2**	**D2**	**RPN2**
Drill	In the process of drilling to detect the heart of wood, black eye	6	5	4	**120**
	Incorrect position	6	5	5	**150**
	Incorrect size	5	5	5	**125**
	The drill hole is dented, cracked	6	7	4	**168**
Grafting	Not the same color	5	6	3	**90**
	Joint is open	5	5	4	**100**

4. Conclusion and Future research

This study presented how to apply FMEA tools to the wood production process of Minh Duong Wood Company. The results of the study have shown that this tool has helped businesses identify important types of defects that need to be prioritized to be resolved and from there propose solutions to overcome or eliminate failures in a timely manner. In addition, this study will also be a useful case for other businesses who want to apply for FMEA as a reference. In addition to the obtained results, this study also has some limitations, such as not applying the corrected FMEA tool (with the addition of RAV coefficient to support the ranking of improvement priorities instead of just being based on RPN) and has not yet built the most detailed and complete S, O, D rating scale. Therefore, future studies can apply the calibrated FMEA tool and continue to perfect the S, O, D rating scale.

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