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Failure Mode and Effect Analysis (FMEA) Analysis in Convection Msmes in Pekalongan Regency

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A B S T R A C T

FMEA is an engineering technique used to determine, identify, and eliminate known failures, problems, errors, and the like from a system, design, process, and service before it reaches consumers. From the definition of FMEA above, which refers more to quality, it can be concluded that FMEA is a method used to identify and analyze a failure and its consequences to avoid this failure. Konveksi is a micro, small, and medium business, or people too often call it a cottage industry. In general, convection entrepreneurs only get orders and large quantities at certain moments, such as before Eid and the turn of the new school year. Small and medium enterprises (SMEs) in various countries, including Indonesia, are drivers of a strong people's economy. With this research, it is hoped that we can find out the effects of failure in a convection/shirt industry process on convection MSMEs in Pekalongan Regency. The type of research is qualitative research with a case study design observation method. In the FMEA Analysis of Convection MSMEs, the failure referred to is a danger/loss that arises from a production process in Convection MSMEs in Pekalongan Regency

INTRODUCTION

Convection is a micro, small, and medium business or what people often call a home industry. Small and medium enterprises (SMEs) in various countries, including Indonesia, are drivers of a strong people's economy (Jamaludin, 2020). The convection business is a business that will never end because the products produced, namely clothing, will always be needed by the community (Rilahudin & Rukmi, 2021). This condition is one of the attractions for many business actors to open convection businesses so that the number of convection businesses increases from year to year. The increase in convection businesses causes competition to become tighter so to survive, a convection business must have a competitive advantage. One of the competitive advantage factors that convection business actors must pay attention to is the quality of the products produced. Consumers will feel disappointed if convection companies provide them with defective products.

This condition is detrimental to the company because apart from causing delays in the delivery of orders to consumers, this condition can reduce the company's profits. Therefore, efforts must be made to minimize defects in clothing products made at the Cipta Mandiri MSME convection. These types of defects include the process of cutting the fabric which does not match the size of the pattern, the stitching is not neat, the fabric having holes, the fabric has oil spots or is dirty, the buttonholes are not the correct size, and so on.

Efforts to reduce defects have been made, such as checking each workstation, starting from checking needles, knives, machine conditions, and so on, then visually inspecting products by operators and repairing existing defective products. However, the efforts to reduce defects that have been carried out have not yielded significant results. Therefore, efforts need to be made to identify the root causes of product defects at Konveksi Cipta Mandiri MSMEs so that appropriate improvements can be made to reduce the number of defects. Therefore, employers are very concerned about issues related to Occupational Safety and Health (K3). Efforts to control work accidents and work-related diseases require identifying factors or sources of danger in the workplace, evaluating risks, and implementing adequate control efforts (Jaya Maulana et al., 2023).

The method that will be used to solve this problem is the Failure Mode And Effect Analysis (FMEA) method. The Failure Mode Effects Analysis (FMEA) method is used by weighting severity, occurrence, and detection for each cause of failure, then finding the RPN value by multiplying the severity, occurrence, and detection factors and then ranking them according to the largest RPN value. The first ranking is the most critical cause of the problem and must be addressed immediately.

FMEA is an engineering technique used to determine, identify, and eliminate known failures, problems, errors, and the like from a system, design, process, and/or service before it reaches consumers. From the definition of FMEA above, which refers more to quality, it can be concluded that FMEA is a method used to identify and analyze a failure and its consequences to avoid this failure. In the context of occupational health and safety (K3), the failure referred to in the definition above is a danger that arises from a process (Hanif et al., 2015). Failure Mode Effects Analysis (FMEA) is a method that makes it possible to obtain a relationship between the causes and effects of a defect to find a solution by describing the best decision regarding the implementation of appropriate actions. The Failure Mode Effects Analysis method used is process because the data used is data for the production process section.

LITERATURE REVIEW

The Failure Mode Effects Analysis (FMEA) method is used by weighting severity, occurrence, and detection for each cause of failure, then finding the RPN value by multiplying the severity, occurrence, and detection factors and then ranking them according to the largest RPN value. The first ranking is the most critical cause of the problem and must be addressed immediately.

FMEA is a method of evaluating the possibility of a failure occurring in a system, design, process, or service to create steps to handle it (Andiyanto et al., 2017). FMEA is an engineering technique used to determine, identify, and eliminate known failures, problems, errors, and the like from a system, design, process, and/or service before it reaches consumers. From the definition of FMEA above, which refers more to quality, it can be concluded that FMEA is a method used to identify and analyze a failure and its consequences to avoid this failure. In the context of occupational health and safety (K3), the failure referred to in the definition above is a danger that arises from a process.

The use of FMEA is carried out through a discussion process from different divisions in the company to analyze the causes of failure of components and subsystems in a process or product. FMEA uses criteria for the probability of occurrence, detection, and severity of damage to determine risk priority numbers (RPN) and risk score value (RSV) so that they can later be used to determine actions for prioritized risks (Suherman & Cahyana, 2019).

Failures are grouped based on the impact they have on the success of a system's mission. In general, FMEA is defined as a technique that identifies three things, namely:

1. Potential causes of failure of systems, designs, products, and processes during their life cycles.
2.The effects of the failure.
3.The level of criticality of the failure affects system function, design, products, and processes (Hanif et al., 2015).

METHODOLOGY

The problem that occurs in companies is that defective products are often produced that exceed the product defect tolerance standards set by the UMKM Konveksi Cipta Mandiri. Various efforts have been made but have not been effective. It is necessary to identify problems with defective products so that repairs can be carried out. The data needed to solve the problems that occur is production data to determine the stages of the initial process of making a product up to the stage of becoming a finished product, data on the number of production results to find out the number of products produced each period to meet consumer demand and data on the number of defective products needed to find out how many defects are caused in the company each period.

Based on the identification of product defect problems that occur, the Failure Mode and Effect Analysis (FMEA) method is a solution to solve problems that occur in the company. There are steps in the problem-solving process using the FMEA method, namely as follows:

1. Identify the product manufacturing work process
2. Identify failure mode (type of defect)
3. Identify failure effects
4. Identify the cause of failure (result of failure)
5. Identification of current control (detection mode)
6. Determine the severity rating value

RESULTS

1. Identify the Product Manufacturing Work Process

This stage is the first step in the problem-solving stage, namely describing the initial process of making a product until it becomes a finished product.

2. Identify Failure Mode (Type of Defect)

This failure mode identification stage is used to determine the types of defects produced during the production process and when the product is finished. The failure mode table can be seen in Table 1.

Table 1. Identification of Failure Modes

No	Process	Failure Mode
1	Choose fabric	The type of fabric does not match the client's request
		The amount of fabric purchased is excess or insufficient
2	Cutting fabric	Some of the fabric that was cut did not match the pattern size
3	Sewing	The stitching is not neat
		Skipping thread stitch
		The cloth is stained with oil or dirty
		The installation of the pocket on the front of the shirt is not appropriate
		Hollow cloth
4	Scramble	The fabric is folded so that the fabric is cut
		The fabric resulting from tearing becomes wrinkled
5	Holethe button	The buttonhole size is not correct
		Buttonhole thread tangles or bunches up

3. Identify Failure Effects

This failure effect identification stage is used to determine the defect effects produced by each type of defect. The failure effect identification table can be seen in Table 2.

Table 2. Identification of Failure Effect

No	**Process**	**Failure Mode**	**Failure Effect**
1	Choose fabric	The type of fabric does not match the client's request	The client was dissatisfied with the results
		The amount of fabric purchased is excess or insufficient	Excess fabric cannot be processed so it will reduce production efficiency, while insufficient fabric will also hamper the production process
2	Cutting fabric	Some of the fabric that was cut did not match the pattern size	The fabric cannot be processed further. Unless there is a mismatch in the larger pieces, it can be re-cut into small pieces
3	Sew	The stitching is not neat	Stitching that is not neat will delay the processing time because you have to repeat the stitching
		Skipping thread stitch	The thread stitch will skip
		The cloth is stained with oil or dirty	slows down the processing time due to having to repeat the stitching
		The installation of the pocket on the front of the shirt is not appropriate	the
		Hollow cloth	Fabrics that have oil spots or are dirty cannot be processed further
4	Scramble	The fabric is folded so that the fabric is cut	Installing the pocket at an angle will delay the processing time because you have to re-sew it
		The fabric resulting from tearing becomes wrinkled	Fabric that contains holes cannot be processed further
5	Hole the button	The buttonhole size is not correct	Fabric that is cut during the overlock process will delay the processing time
		Buttonhole thread tangles or bunches up	work due to having to rework

4. Identify The Cause of Failure

This cause-of-failure identification stage is used to determine the causes of failure for each type of defect that occurs. The cause of the failure identification table can be seen in Table 3.

Table 3. Identification of Cause of Failure

No	Process	Failure Mode	Failure Effect	Cause Of Failure Effect
1	Choose fabric	The type of fabric does not match the client's request	The client was dissatisfied with the results	There was miscommunication between the employee who bought the fabric and the client
		The amount of fabric purchased is excess or insufficient	Excess fabric cannot be processed soit will reduce producti on efficiency, while insufficient fabric will also hamper the production process	Cloth-buying employees lack concentration
2	Cutting fabric	Some of the fabric that was cut did not match the pattern size	The fabric cannot be processed further. Unless there is a mismatch in the larger pieces, it can be re-cut into small pieces	Fewer operators
3	Sew	The stitching is not neat	Stitching that is not neat will delay the processing time because you have to repeat the stitching	concentration. Cutting knife
		Skipping thread stitch	The thread stitch will skip	less sharp
		The cloth is stained with oil or dirty	slows down the processing time due to having to repeat the stitching	Fewer operators
		The installation of the pocket on the front of the shirt is not appropriate	the	concentration,
		Hollow cloth	Fabrics that have oil spots or are dirty cannot be processed further	new operator

4	Scramble	The fabric is folded so that the fabric is cut	Installing the pocket at an angle will delay the processing time because you have to re-sew it	less trained,
		The fabric resulting from tearing becomes wrinkled	Fabric that contains holes cannot be processed further	skip stitching...
5	Hole the button	The buttonhole size is not correct	Fabric that is cut during the overlock process will delay the processing time	Operators don't
		Buttonhole thread tangles or bunches up	work due to having to rework	change the needle

5. Identify Current Control

This failure effect identification stage is used to determine the defect effects produced by each type of defect. The current control identification table can be seen in Table 4.

Table 4. Identification of Current Control

No	Proses	Failure Mode	Cause of Failure
1	Choose fabric	The type of fabric does not match the client's request	Check the type of fabric before buying
		The amount of fabric purchased is excess or insufficient	Direct communication and keeping records with employees who buy cloth
2	Cutting fabric	Some of the fabric that was cut did not match the pattern size	Inspection is carried out visually by the cutting machine workstation operator, the blade is not replaced regularly
3	Sew	The stitching is not neat	The inspection is carried out visually by the sewing machine workstation operator
		Skipping thread stitch	The inspection is carried out visually by the sewing machine workstation operator, the sewing machine lacks regular maintenance and checking
		The cloth is stained with oil or dirty	Inspection of the engine oil cap and lack of cleanliness and regular checking
		The installation of the pocket on the front body of the shirt is not appropriate	periodically
		Hollow cloth	The inspection is carried out visually by the sewing machine workstation operator

4	Scramble	The fabric is folded so that the fabric is cut	Inspections are carried out visually by sewing machine workstation operators and operators who smoke while working are only reprimanded by the company owner
		The fabric resulting from tearing becomes wrinkled	The inspection is carried out visually by the serger workstation operator
5	Hole the button	The buttonhole size is not correct	The inspection was carried out visually by the overlock machine workstation operator, the overlock machine lacked regular maintenance and checking
		Bubuttonhole thread tangles or bunches up	Inspections are carried out visually by the hole machine workstation operator, the hole machine lacks regular maintenance and checks

6. Determine the Severity Rating Value

The process of determining severity rating values, occurrence ratings, detection ratings, and risk priority number (RPN) calculations can be seen in Table 5.

Table 5. Determining Saverity Rating Values

No	Process	Failure Mode	Failure Effect	Severity	Occurrence	Detection	RPN
1	Choose fabric	The type of fabric does not match the client's request	The client was dissatisfied with the results	5	2	3	30
		The amount of fabric purchased is excess or insufficient	Excess fabric cannot be processed so it will reduce production efficiency, while insufficient fabric will also hamper the production process	7	1	3	21
2	Cutting fabric	Some of the fabric that was cut did not match the pattern size	The fabric cannot be processed further. Unless there	7	2	2	28

			are discrepancies in larger pieces, it can be re-cut into small pieces				
3	Sew	The stitching is not neat	Stitching that is not neat will delay the processing time because you have to repeat the stitching	3	3	3	27
		Skipping thread stitch	The thread stitch will skip	3	3	3	27
		The cloth is stained with oil or dirty	slows down the processing time due to having to repeat the stitching	7	3	3	63
		The installation of the pocket on the front of the shirt is not appropriate	the	3	3	3	27
		Hollow cloth	Fabrics that have oil spots or are dirty cannot be processed further	7	3	3	63
4	Scramble	The fabric is folded so that the fabric is cut	Installing the pocket at an angle will delay the processing time because you have to re-sew it	6	2	3	36
		The fabric resulting from tearing becomes wrinkled	Fabric that contains holes cannot be processed further	5	2	3	30

5	Hole the button	The buttonhole size is not correct	Fabric that is cut during the overlock process will delay the processing time	9	2	3	54
		Buttonhole thread tangles or bunches up	work due to having to rework	9	2	3	54

DISCUSSION

1. Choose Fabric

Choosing fabric is the first step in the production process at Mandiri Copyright Convection MSMEs. Based on the results of observations at MSME Konveksi Cipta Mandiri in 2024, there are two failure modes in the step of choosing fabric with RPN 30 (choosing the type of fabric) and 31 (less or more when purchasing fabric). This can happen because of miscommunication between the Client/Designer and the employee who buys the fabric. This condition will certainly be detrimental to both parties. Therefore, Entrepreneurs/Employees must carry out the Cause of Failure (checking and recording) when manufacturing fabric.

2. Cutting the Fabric

Cutting fabric is the second step in the production process at Mandiri Copyright Convection MSMEs. Based on the results of observations at the UMKM Konveksi Cipta Mandiri in 2024, there was one failure mode in the step of cutting fabric with RPN 28 (wrong size and pattern). This can happen because of miscommunication between the designer and the employees in the fabric-cutting process. This condition will certainly be detrimental to MSMEs because they have to buy and readjust to the specified design. Therefore, entrepreneurs/employees must carry out a Cause of Failure (check is carried out visually by the cutting machine workstation operator, the blade is not replaced regularly) when cutting fabric.

3. Sewing

Sewing is the third step in the production process at Mandiri Copyright Convection MSMEs. Based on the results of observations at the UMKM Konveksi Cipta Mandiri in 2024, there were 5 failure modes in the process of cutting fabric with RPN 27 (stitches not neat), 27 (thread skipped stitches), 63 (fabric exposed to oil), 27 (pocket installation not in the correct position), and 63 (perforated fabric). This can occur due to an error in the machine/damage to the machine which results in a defect in a product. This condition will certainly be detrimental to MSMEs because they have to make more products than targeted to cover the defective products. Therefore, entrepreneurs/employees must carry out the Cause of Failure (inspection carried out visually by the sewing machine workstation operator, the sewing machine lacks maintenance and regular checks) when sewing materials.

4. Scramble

Turning over is the fourth step in the production process at Mandiri Copyright Convection MSMEs. Based on the results of observations at MSME Konveksi Cipta Mandiri in 2024, there are two failure modes in the step of selecting fabric with RPN 36 (folded and cut fabric) and 30 (creased fabric). This can occur due to a system error or worker negligence when cutting the fabric. This condition will certainly be detrimental to both parties. Therefore, Employers/Employees must carry out the Cause of Failure (inspection carried out visually by the overlock machine workstation operator) when overlocking fabric.

5. Hole the Button

Punching holes in buttons is the final step in the production process at Mandiri Copyright Convection MSMEs. Based on the results of observations at the UMKM Konveksi Cipta Mandiri in 2024, there are two failure modes in selecting fabric with RPN 54 (buttonhole size is not appropriate) and 54 (buttonhole thread is tangled or piled up). This can happen because workers are not focused on work or are tired so there are errors in completing their work. This condition will certainly be detrimental to workers because they have to justify the wrong results of their work. Therefore, Employers/Employees must carry out the Cause of Failure (inspection carried out visually by the hole machine workstation operator, the hole machine lacks maintenance and regular checks) when tearing fabric.

The results of this observation are in line with research conducted by Iqbal & Hendang (2021), based on the risk priority number (RPN) value obtained in the Sewing Failure mode with the effect of the cloth being exposed to oil or being dirty and the holey cloth with the highest value which needs to be a top priority in repair. The result of this Failure Mode is that products that are dirty and have holes cannot be continued in production and fall into the category of defective products. Furthermore, entrepreneurs must immediately carry out control to reduce defective products, which can be done from the highest RPN order first.

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of Failure Mode and Effect Analysis (FMEA) observations on independent creative convection MSMEs in Pekalongan Regency in 2024, it can be concluded that from the many Failure Modes that occur in each step or production process, 2 Failure Modes have the highest RPN number with a value of 63. The highest RPN value is found in the sewing process with Failure Mode, dirty cloth exposed to oil and holes in the cloth.

Suggestions for MSME Owners to follow up on Failure Modes that occur in the production process to reduce defective products. Follow-up can be carried out according to the highest RPN value using the Cause of Failure as a control to reduce defective products that are detrimental to entrepreneurs, workers, or clients who collaborate with MSMEs.

FURTHER STUDY

The results of this observation are only limited to analysis using the FMEA method which can show the highest failure mode in the production process. The hope is that entrepreneurs can control using causes of failure to reduce failure modes that can occur.

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