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Supplier Quality Risk Evaluation of Automotive Component Suppliers in PT.X Using FMEA

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Abstract

Supplier quality management is essential in the automotive industry because supplier-related failures can disrupt production processes, increase operational costs, and reduce customer satisfaction. This study aims to identify and evaluate supplier quality risks of automotive component suppliers in PT.X using the Failure Mode and Effects Analysis (FMEA) method. A quantitative descriptive approach was employed by collecting primary data through observations, interviews, questionnaires, and expert assessments involving quality control managers, supplier quality engineers, procurement staff, and production supervisors. Secondary data were obtained from supplier quality reports, defect records, audit documents, and corrective action reports. The identified failure modes included defective automotive components, inconsistent material specifications, delayed supplier corrective actions, poor packaging quality, and inadequate supplier inspection systems. Risk evaluation was conducted using Severity (S), Occurrence (O), and Detection (D) scores to calculate the Risk Priority Number (RPN). The results showed that defective automotive components had the highest RPN value of 432, indicating the most critical supplier quality risk affecting production continuity and operational efficiency. Inadequate supplier inspection systems and inconsistent material specifications also showed high RPN values of 336 and 280, respectively. The study concludes that the FMEA method effectively supports systematic identification, evaluation, and prioritization of supplier quality risks. Several improvement strategies are recommended, including strengthening supplier quality audits, improving incoming inspection systems, enhancing supplier training, and implementing continuous supplier performance evaluations to reduce supply chain risks and improve operational performance in the automotive industry.

Keywords: Failure Mode and Effects Analysis (FMEA); supplier quality risk; automotive industry; Risk Priority Number (RPN); supply chain management

1 Introduction

The automotive industry is one of the most competitive manufacturing sectors, requiring companies to maintain high product quality, delivery reliability, and operational efficiency [1]. In automotive supply chains, suppliers play a critical role in ensuring the continuity of production processes and maintaining final product quality [2]. Any failure in supplier performance, particularly related to product quality, can lead to production delays, increased operational costs, customer complaints, and reputational damage for manufacturing companies. Therefore, supplier quality risk management has become an essential aspect of supply chain management in automotive industries [3].

PT.X, as a company operating in the automotive sector, relies on multiple component suppliers to support its production activities. The quality consistency of supplied components directly affects the performance and reliability of the company's final products [4]. However, several risks may arise during supplier operations, such as defective materials, inconsistent specifications, delayed corrective actions, inadequate inspection systems, and poor process control. These issues may contribute to disruptions in production and reduce customer satisfaction. Consequently, companies need a systematic approach to identify, evaluate, and prioritize supplier-related quality risks.

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One of the widely used methods for risk identification and analysis is Failure Mode and Effects Analysis (FMEA). FMEA is a structured risk assessment method used to identify potential failure modes, analyze their causes and effects, and determine risk priority levels based on Severity (S), Occurrence (O), and Detection (D) [5]. The multiplication of these three factors generates the Risk Priority Number (RPN), which helps companies prioritize improvement actions on the most critical risks [6]. FMEA has been extensively applied in manufacturing industries because it enables organizations to proactively prevent failures before they occur [7].

In supplier quality management, FMEA can be utilized to evaluate risks associated with supplier processes and component quality performance. By applying FMEA, companies can identify the most critical supplier-related risks and formulate appropriate mitigation strategies to improve supply chain reliability and product quality [8]. Furthermore, the method supports decision-making in supplier evaluation and continuous improvement programs.

Several previous studies have discussed the implementation of FMEA in manufacturing and supply chain risk management [9, 6]. However, research specifically focusing on supplier quality risk evaluation in automotive component suppliers remains limited, particularly in the context of Indonesian automotive manufacturing companies. Most existing studies emphasize internal production risks rather than supplier-related quality risks. Therefore, this study aims to fill the research gap by analyzing supplier quality risks in PT.X using the FMEA approach.

This study aims to identify potential supplier quality failure modes, evaluate the level of risk associated with each failure, and determine priority improvement actions for automotive component suppliers in PT.X. The results of this study are expected to provide practical contributions for companies in improving supplier quality management systems, reducing supply chain disruptions, and enhancing overall operational performance. In addition, this research is expected to contribute academically to the development of supplier risk management studies using the FMEA method in the automotive industry.

2 Material and Methods

2.1 Research Design

This study employed a quantitative descriptive approach to evaluate supplier quality risks of automotive component suppliers in PT.X using the Failure Mode and Effects Analysis (FMEA) method. The research focused on identifying potential supplier-related quality failures, analyzing their impacts on production activities, and determining priority risks that require corrective actions. Flowchart research as shown in Figure 1 below.

2.2 Research Object

The object of this study was automotive component suppliers that supply raw materials and production components to PT.X. The evaluation focused on supplier quality performance, including product conformity, delivery consistency, inspection systems, corrective action responsiveness, and process capability.

2.3 Data Collection

The study used both primary and secondary data sources.

Primary Data

Primary data were collected through:

- Direct observations of supplier-related quality issues in PT.X production activities.
- Interviews with quality control managers, procurement staff, supplier quality engineers, and production supervisors.
- Questionnaires and expert assessments to determine the Severity (S), Occurrence (O), and Detection (D) scores in the FMEA analysis.

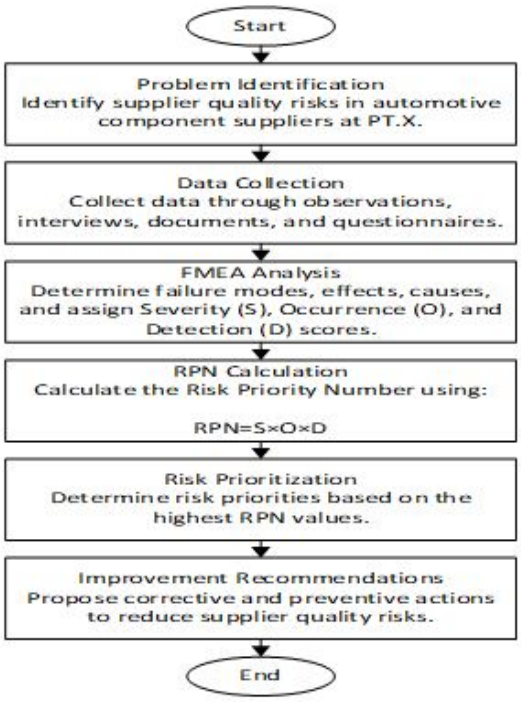

Figure 1. Flowchart Research

Secondary Data

Secondary data were obtained from:

- Supplier quality reports.
- Defect and rejection records.
- Supplier audit documents.
- Corrective action reports.
- Company operational documents and previous research related to supplier quality management.

Respondent Criteria

The respondents involved in this study were selected based on their experience and involvement in supplier quality management activities at PT.X as shown in Table 1.

Table 1. Respondent Criteria

No	Position	Number of Respondents	Role in Research
1	Quality Control Manager	1	Determine quality impact
2	Supplier Quality Engineer	2	Identify supplier risks
3	Procurement Staff	2	Evaluate supplier performance
4	Production Supervisor	2	Assess operational impact
5	Incoming Quality Control Staff	3	Assess detection capability

2.4 Failure Mode and Effects Analysis (FMEA)

The FMEA method was used to identify and evaluate supplier quality risks systematically [10]. The stages of the FMEA process in this study are described as follows:

1. Identification of Failure Modes

   Potential failure modes related to supplier quality were identified based on historical quality problems, supplier evaluations, and expert discussions. Examples of failure modes include: defective components from suppliers, inconsistent material specifications, delayed corrective actions, poor packaging quality, and inadequate inspection procedures.

2. Determination of Failure Effects

   The effects of each failure mode on PT.X production processes and product quality were analyzed. The impacts may include production stoppages, increased rework, customer complaints, and additional operational costs.

3. Determination of Failure Causes

   Possible causes of each failure mode were identified to understand the root causes of supplier quality problems. These causes may involve inadequate process control, insufficient operator training, poor communication, or lack of supplier quality assurance systems.

4. Risk Assessment

   Each failure mode was evaluated using three FMEA criteria [11, 12]:

   - Severity (S): the seriousness of the failure impact.
   - Occurrence (O): the frequency of failure occurrence.
   - Detection (D): the ability of the current system to detect failures before affecting production.

   The assessment used a scale from 1 to 10, where higher scores indicate greater risk levels.

5. Calculation of Risk Priority Number (RPN)

   The Risk Priority Number (RPN) was calculated using the following equation [13] :

   $$RPN = SxOxD \tag{1}$$

   Where:

   S = Severity score

   O = Occurrence score

   D = Detection score

   The RPN value was used to prioritize supplier quality risks requiring immediate corrective actions.

6. Risk Prioritization and Improvement Recommendations

   Failure modes with the highest RPN values were categorized as critical risks [12]. Improvement recommendations were then proposed to reduce supplier quality risks, such as: strengthening supplier quality audits, implementing stricter incoming quality inspections, enhancing supplier training and communication, developing supplier performance monitoring systems, and establishing corrective and preventive action programs.

2.5 Data Analysis

The collected data were analyzed descriptively using FMEA tables to rank supplier quality risks according to their RPN values [14]. The analysis results were used to identify dominant supplier quality issues and formulate appropriate mitigation strategies for PT.X.

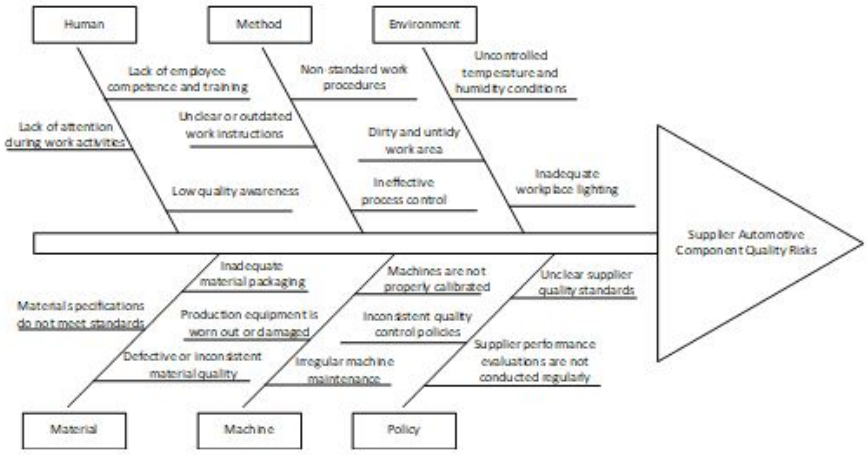

Figure 2. Fishbone Diagram

3 Results and Discussion

3.1 Identification of Supplier Quality Risks

Based on observations, interviews, and analysis of supplier quality records in PT.X, several potential failure modes related to automotive component suppliers were identified. The identified risks mainly affected product quality, production continuity, and operational efficiency. The dominant supplier quality problems included defective components, inconsistent material specifications, delayed corrective actions, poor packaging quality, and inaccurate inspection processes. Table 2 presents the identified supplier quality failure modes and their potential effects on PT.X production activities.

Table 2. Identified Supplier Quality Failure Modes

No	Failure Mode	Potential Effect
1	Defective automotive components	Production disruption and product rejection
2	Inconsistent material specifications	Product quality variation
3	Delayed supplier corrective action	Repeated quality problems
4	Poor packaging quality	Component damage during transportation
5	Inadequate supplier inspection system	Undetected defective materials

The results indicate that supplier quality issues can significantly impact production performance and customer satisfaction. Defective components and inconsistent specifications were identified as the most frequently occurring problems affecting PT.X operations.

3.2 FMEA Risk Assessment

After identifying the failure modes, each risk was evaluated using the Failure Mode and Effects Analysis (FMEA) method. The assessment was conducted by assigning Severity (S), Occurrence (O), and Detection (D) scores based on expert evaluations from the quality control and procurement departments.

The Risk Priority Number (RPN) was calculated using:

$$RPN = SxOxD \tag{2}$$

The FMEA calculation results are shown in Table 3.

The analysis results show that defective automotive components had the highest RPN value of 432, indicating that this failure mode represented the most critical supplier quality risk in PT.X. This

Table 3. FMEA Analysis Results

No	Failure Mode	S	O	D	RPN
1	Defective automotive components	9	8	6	432
2	Inconsistent material specifications	8	7	5	280
3	Delayed supplier corrective action	7	6	6	252
4	Poor packaging quality	6	5	4	120
5	Inadequate supplier inspection system	8	6	7	336

condition demonstrates that defective components have severe impacts on production continuity and are relatively difficult to detect before entering the production process. The second highest risk was related to inadequate supplier inspection systems with an RPN value of 336. Weak supplier inspection processes increased the possibility of defective materials being delivered to PT.X. Meanwhile, inconsistent material specifications also showed a relatively high RPN value of 280, indicating the importance of maintaining material quality consistency among suppliers.

3.3 Discussion

The findings demonstrate that supplier quality risks significantly influence operational performance in automotive manufacturing companies. The high RPN values indicate that supplier-related quality failures may lead to production downtime, increased rework costs, and customer dissatisfaction if not properly controlled. The dominant risk identified in this study was defective automotive components. This problem may occur due to insufficient process control, lack of quality monitoring, or inadequate supplier capability. In automotive industries, component defects are critical because even small quality deviations can affect product safety and reliability. Therefore, supplier quality assurance systems must be strengthened to minimize defect occurrences.

Another important finding was the high risk associated with inadequate supplier inspection systems. Suppliers with weak inspection procedures may fail to identify defective products before shipment. This condition increases the burden on incoming quality control activities in PT.X and may reduce production efficiency. Implementing standardized inspection procedures and regular supplier audits can help reduce this risk. Inconsistent material specifications were also identified as a significant issue. Variations in material quality can affect product performance and manufacturing precision. This finding highlights the importance of establishing clear technical specifications and conducting periodic supplier evaluations to ensure compliance with company standards.

Based on the FMEA analysis, several improvement strategies are recommended for PT.X, including strengthening supplier quality audits and performance evaluations, implementing stricter incoming material inspections, enhancing supplier training programs on quality management, improving communication and corrective action systems with suppliers and developing long-term partnerships with high-performing suppliers.

4 Conclusion

This study evaluated supplier quality risks of automotive component suppliers in PT.X using the Failure Mode and Effects Analysis (FMEA) method. The results showed that supplier-related quality problems, such as defective components, inconsistent material specifications, inadequate inspection systems, delayed corrective actions, and poor packaging quality, significantly affected production performance and operational efficiency. Among the identified risks, defective automotive components had the highest Risk Priority Number (RPN), indicating the most critical issue requiring immediate improvement actions. The implementation of FMEA successfully helped identify, analyze, and prioritize supplier quality risks systematically, enabling PT.X to focus on high-priority corrective and preventive actions. Several recommendations were proposed, including strengthening supplier audits, improving inspection procedures, enhancing supplier training, and conducting continuous supplier performance evaluations. Overall, this study demonstrates

that FMEA is an effective method for improving supplier quality management and reducing supply chain risks in the automotive industry.

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