TITLE PAGE

LEVERAGING DATA SCIENCE TO ENHANCE FMEA: A PROACTIVE APPROACH TO RISK MANAGEMENT IN PRODUCT DEVELOPMENT AND MANUFACTURING

THESIS

Submitted as one of the requirements to obtain

Magister Manajemen

By

Dina Mustikarini

023202405011

FACULTY OF BUSINESS

MASTER OF TECHNOLOGY MANAGEMENT STUDY PROGRAM

CIKARANG

AUGUST 2025

SIMILARITY INDEX REPORT

Turnitin_Dini

ORIGINALITY REPORT

12%	5%	11%	3%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	www-emerald-com-443.webvpn.sxu.edu.cn Internet Source	2%
2	Amine EN-NAAOUI, Maryam GALLAB, Mohammed KAICER. "Intelligent Model for Improving Risk Assessment in Sterilization Units Using Revised FMEA, Fuzzy Inference, k-Nearest Neighbors and Support Vector Machine.", Journal of Applied Research and Technology, 2023 Publication	1%
3	Marc-André Filz, Jonas Ernst Bernhard Langner, Christoph Herrmann, Sebastian Thiede. "Data-driven failure mode and effect analysis (FMEA) to enhance maintenance planning", Computers in Industry, 2021 Publication	1%
4	www.emeraldinsight.com Internet Source	1%
5	link.springer.com Internet Source	1%
6	Bianca Arcifa de Resende, Franco Giuseppe Dedini, Jony Javorsky Eckert, Tiago F.A.C. Sigahi et al. "Proposal of a facilitating methodology for fuzzy FMEA implementation	1%

	with application inprocess risk analysis in the aeronautical sector", International Journal of Quality & Reliability Management, 2023 Publication	
7	lup.lub.lu.se Internet Source	1 %
8	Orlando Durán, Fabián Orellana, Gabriel Lobos, Alexis Ibacache. "Integrating Fuzzy FMEA and RAM Analysis for Evaluating Modernization Strategies in an LNG Plant Pumping and Vaporization Facility", Applied Sciences, 2024 Publication	<1 %
9	Wang, Y.M.. "Consumer preference prediction by using a hybrid evidential reasoning and belief rule-based methodology", Expert Systems With Applications, 200905 Publication	<1 %
10	www.worldenergyconference.org Internet Source	<1 %
11	www.researchgate.net Internet Source	<1 %
12	Claudio Favi, Michele Germani, Marco Mandolini. "Design for Manufacturing and Assembly vs. Design to Cost: Toward a Multi-objective Approach for Decision-making Strategies During Conceptual Design of Complex Products", Procedia CIRP, 2016 Publication	<1 %

GPT ZERO REPORT

Dini Mustikarini

Turnitin_Dini

Quick Submit
Quick Submit
President University

Document Details

Submission ID
trn:oid:::1:3336963659

Submission Date
Sep 12, 2025, 4:22 PM GMT+7

Download Date
Sep 12, 2025, 4:26 PM GMT+7

File Name
Chapter.023102405311.pdf

File Size
1.1 MB

33 Pages
9,097 Words
47,801 Characters

turnitin Page 1 of 35 - Cover Page Submission ID trn:oid:::1:3336963659

turnitin Page 2 of 35 - AI Writing Overview Submission ID trn:oid:::1:3336963659

*% detected as AI

AI detection includes the possibility of false positives. Although some text in this submission is likely AI generated, scores below the 20% threshold are not surfaced because they have a higher likelihood of false positives.

Caution: Review required.

It is essential to understand the limitations of AI detection before making decisions about a student's work. We encourage you to learn more about Turnitin's AI detection capabilities before using the tool.

Disclaimer
Our AI writing assessment is designed to help educators identify text that might be prepared by a generative AI tool. Our AI writing assessment may not always be accurate (i.e., our AI models may produce either false positive results or false negative results), so it should not be used as the sole basis for adverse actions against a student. It takes further scrutiny and human judgment in conjunction with an organization's application of its specific academic policies to determine whether any academic misconduct has occurred.

Frequently Asked Questions

How should I interpret Turnitin's AI writing percentage and false positives?
The percentage shown in the AI writing report is the amount of qualifying text within the submission that Turnitin's AI writing detection model determines was either likely AI-generated text from a large-language model or likely AI-generated text that was likely revised using an AI paraphrase tool or word spinner.

False positives (incorrectly flagging human-written text as AI-generated) are a possibility in AI models.

AI detection scores under 20%, which we do not surface in new reports, have a higher likelihood of false positives. To reduce the likelihood of misinterpretation, no score or highlights are attributed and are indicated with an asterisk in the report (*%).

The AI writing percentage should not be the sole basis to determine whether misconduct has occurred. The reviewer/instructor should use the percentage as a means to start a formative conversation with their student and/or use it to examine the submitted assignment in accordance with their school's policies.

What does 'qualifying text' mean?
Our model only processes qualifying text in the form of long-form writing. Long-form writing means individual sentences contained in paragraphs that make up a longer piece of written work, such as an essay, a dissertation, or an article, etc. Qualifying text that has been determined to be likely AI-generated will be highlighted in cyan in the submission, and likely AI-generated and then likely AI-paraphrased will be highlighted purple.

Non-qualifying text, such as bullet points, annotated bibliographies, etc., will not be processed and can create disparity between the submission highlights and the percentage shown.

turnitin Page 2 of 35 - AI Writing Overview Submission ID trn:oid:::1:3336963659

ABSTRACT

FMEA – Failure Mode Effect Analysis method is used as a critical tool for identifying and mitigating risks to ensure efficiency, cost-effectiveness, and high product reliability. FMEA is usually done with the traditional methods that are often manual, time-consuming, subjective, biased, and prone to inconsistencies due to non-standardized failure records. The purpose of this study is to develop and propose a data-driven FMEA framework to reduce manual effort, increase objectivity in risk assessment, and enable proactive quality improvement.

The study will use data science with the integration of K-Nearest neighbors (KNN) and fuzzy logic to enhance the identification, classification, and prioritization of failure modes. Collected real-world FMEA data from PT X, a screw manufacturing company in Indonesia, and gained expert insights into AI integration, which provides a foundation for developing adaptive FMEA models.

Traditional FMEA at PT X is reactive, manual, with non-standardized failure modes. The proposed enhanced FMEA framework will enable automated failure classification, objective Risk Priority Number, faster scoring, and manage more data without manual intervention, and it will be faster and efficient in the meantime. It will increase consistency and objectivity.

The integration of KNN and Fuzzy logic methods into the FMEA process can improve risk management practices in product development in manufacturing, making it more adaptive, data-driven, and proactive. For PT X, it can reduce the time to respond when addressing potential failure. The approach is scalable and can be applied across industries, aiming to modernize the FMEA process.

The proposed method will enable decision makers to use a new way for application of machine learning techniques in FMEA as align with industrial 4.0 to leverage digitalization.

Keywords: Data Science; FMEA; Product Development; Product Reliability; Risk Management.

ABSTRAK

FMEA – Methode Failure Mode Effect Analysis digunakan sebagai alat kritis untuk mengidentifikasi dan memitigasi resiko untuk memastikan effisiensi, efektivitas biaya dan produk dengan keandalan tinggi. FMEA traditional biasanya dilakukan secara manual, membutuhkan waktu lama, subyektif, bias dan rentan terhadap ketidakpastian akibat catatan kegagalan yang tidak standard. Studi ini bertujuan untuk mengembangkan dan mengusulkan kerangka FMEA berbasis data untuk mengurangi usaha manual, menambah objektivitas penilaian resiko dan mengaktifkan perbaikan kualitas.

Studi ini menggunakan ilmu data integrasi KNN atau K-Nearest neighbors dan logika fuzzy untuk meningkatkan identifikasi, klasifikasi dan prioritas dari mode kegagalan. Mengambil data actual FMEA dari PT X, Perusahaan manufacture sekrup di Indonesia dan mendapatkan wawasan ahli tentang integrasi Artificial Intelligence(AI) sebagai dasar untuk mengembangkan model FMEA yang adaptif.

FMEA tradisional di PT X reaktif, manual dengan mode kegagalan yang tidak standard. Proposal meningkatkan kerangka FMEA untuk membuat klasifikasi kegagalan otomatis, angka prioritas resiko yang obyektif dengan cepat, mengelola lebih banyak data tidak dengan manual, lebih cepat dan efisien, juga meningkatkan konsistensi dan objektivitas.

Integrasi dari methode KNN dan logika Fuzzy dalam FMEA dapat meningkatkan praktek manajemen resiko untuk pengembangan produk di pabrikasi, membuat lebih adaptif, berbasis data dan proaktif. Untuk PT X, dapat mengurangi respons waktu dalam mengatasi potensi kegagalan. Pendekatan ini dapat di skalakan dan di gunakan di seluruh industry yang bertujuan dalam memodernisasi proses FMEA.

Methode proposal dapat digunakan untuk pengambil keputusan untuk menggunakan teknik machine learning dalam FMEA yang sejalan dengan memanfaatkan penggunaaan digitalisasi dalam industry 4.0

Kata kunci: FMEA; Ilmu data; Keandalan Produk; Manajemen Resiko; Pengembangan Produk.

TABLE OF CONTENTS

TITLE PAGE i
APPROVAL PAGE ii
CERTIFICATE OF COMPLETION EXECUTIVE OVERSEAS IMMERSION PROGRAMME 2025 iii
PANEL OF EXAMINERS APPROVAL SHEET iv
ACKNOWLEDGMENTS v
STATEMENT OF ORIGINALITY vi
SIMILARITY INDEX REPORT vii
GPT ZERO REPORT ix
SCIENTIFIC PUBLICATION APPROVAL FOR ACADEMIC INTEREST x
ADVISOR APPROVAL FOR PUBLICATION xi
ABSTRACT xii
ABSTRAK xiii
TABLE OF CONTENTS xiv
LIST OF FIGURES xvi
LIST OF TABLES xvi
1. Introduction 1
1.1 Background 1
1.2 Problem Statement 5
1.3 Methodology 6
1.4 Research Question 6
1.5 Research objective: 7
2. Literature Review 7
2.1 Failure Mode Effect Analysis concept in Manufacturing 7
2.2 FMEA and its application 10

2.3 Data science application in Manufacturing and Product Development and FMEA 11
2.4 KNN – K Nearest Neighbour 12
2.5 Fuzzy FMEA 14
2.6 Digital Transformation and FMEA automation 15
3. **Research Method** 16
3.1 Data Collection 18
3.2 Preprocessing Data 19
3.3 KNN Application 19
3.4 Fuzzy Logic Calculation 19
3.5 Automated FMEA with KNN and Fuzzy Logic generation 23
3.6 Validation and evaluation 24
3.7 Ethical Consideration 24
4. Case Analysis 24
5. Lesson Learned 27
6. Managerial Implications **20**
7. Conclusion 31
REFERENCE 34

LIST OF FIGURES

Figure 1.1 Model of automated FMEA ……..... 9
Figure 1.2 Data driven FMEA methodology to enhance planning …….. 12
Figure 3.1 Model of automated FMEA …… 17
Figure 3.2 Conceptual frame work of Automated FMEA …….. 17
Figure 3.3 Examples of FMEA from PT X, screw manufacturing company ……. 18
Figure 3.4 Triangular Membership Function Diagram ……..…. 20
Figure 5.1 AI Enhance FMEA Lesson …… 28
Figure 6.1 Roadmap of FMEA implementation ……. 31

LIST OF TABLE

Table 3.1 Table of Rule Book ……..…. 22
Table 5.1 FMEA Comparison Before and After …….. 28