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Analysis of a Quality Issues in a Security Access Control System Using the 8 D Method

Viktória Varsányiné Szeredi
Doctoral School on Safety and Security Sciences
Obuda University
Budapest, Hungary
szeredi.viktoria@phd.uni-obuda.hu
ORCID: 0009-0003-9398-3009

Monika Pogatsnik
Alba Regia Faculty
Obuda University
Szekesfehervar, Hungary
pogatsnik.monika@amk.uni-obuda.hu
ORCID: 0000-0002-2698-7291

***Abstract*— Consistent product and service quality is a crucial factor for optimizing organizational performance and maintaining a competitive market advantage. The literature on quality management systems and quality assurance practices offers a wide spectrum of solutions to achieve measurable and improvable quality parameters. Practical process analyses highlight the necessity of systematically applying proactive error prevention and reactive troubleshooting methods. This research investigates the significance of two widely adopted quality improvement techniques: the 8D (Eight Disciplines) and FMEA (Failure Mode and Effects Analysis) methodologies. Through a specific case study, it demonstrates the systematic, step-by-step implementation of the 8D technique, illustrating the structured process of fault discovery, root cause identification, and the introduction of lasting corrective actions.**

Keywords—8D Methodology, FMEA, Quality Management

I. Introduction

In today's industrial environment, maintaining high product and service quality is essential for companies that want to stay competitive and meet customer expectations. To support this, many quality improvement systems have been developed, including lean methods, Six Sigma, and various problem-solving techniques. These systems help organizations prevent errors, solve problems efficiently, and improve their processes over time. Among the many available tools, the FMEA (Failure Mode and Effects Analysis) and the 8D (Eight Disciplines) method are two widely used approaches. FMEA is mainly used to identify and assess risks before failures happen, making it a proactive tool. The 8D method, on the other hand, is a structured way to investigate and solve problems that have already occurred. It focuses on finding the root cause and implementing long-term corrective actions. These two methods are often used together, as they complement each other well: FMEA helps prevent issues, while 8D helps resolve them.

This paper presents a case study from the field of security access control systems, where recurring failures required a detailed investigation. The goal of the research is to show how the combined use of FMEA and the 8D method can help identify the causes of quality problems, reduce the cost of poor quality, and support continuous improvement. The methods were chosen because they are well-established in industry, easy to apply in practice, and effective in both risk management and problem-solving. By placing them within the broader framework of quality improvement systems, the study aims to highlight their role and usefulness in real-world applications.

II. Failure Mode and Effects Analysis (FMEA)

The Failure Mode and Effects Analysis (FMEA) is a quality management methodology that falls within the domain of failure analysis techniques. The fundamental principle of FMEA is a systematic, step-by-step approach to identifying potential weaknesses or bottlenecks before they manifest. The methodology can also be effectively applied to analyze existing processes or products [1].

An FMEA analysis is typically conducted by a cross-functional team comprised of individuals from different departments within an organization. The team's objective is to assess critical points and the probability of a failure occurring. They define specific criteria and score potential failure modes, from which they derive metrics suitable for risk prioritization. Two key metrics are commonly utilized. The first is the Criticality Number (CN), which is the product of a failure mode's probability, the proportion of defective units, and the operating time. This metric is generally applied to high-risk processes and products. The second metric, used for consumer goods, is the Risk Priority Number (RPN), a product of three distinct factors: Occurrence, Severity, and Detection [2].

The application of the FMEA method commences with the definition of process steps. The second step involves identifying potential failure modes, mapping the problem, and describing its form. The third step is to analyze the failure effects, examining the consequences of a problem's occurrence. This is where the first metric, Severity, is typically determined, assessing the criticality of the consequences. In the fourth step, the possible causes are analyzed using the Occurrence metric, which measures the frequency and likelihood of a given problem or defect. The fifth and final analysis stage is the Detection process, which investigates the presence of adequate preventive or control measures. The product of these three metrics, Severity, Occurrence, and Detection, which are typically scored on a 1-10 scale, yields the RPN. FMEA has several main types depending on the application area and objective, including design, process, service, or system FMEA [3].

While FMEA offers numerous advantages, such as its illustrative nature and broad applicability, it also presents certain limitations:

- The assessment is subjective, as the choice of the failure to be analyzed is determined by the person conducting the measurement.

- It can be superficial.
- Its function is often narrowly confined to meeting customer expectations.
- The individual metrics are typically not examined separately.
- It is time-consuming and may not be suitable for complex systems [2], [3].

III. The 8D Technique

The Eight Disciplines (8D) problem-solving methodology is a structured approach designed to facilitate the identification of a problem's root cause. It comprises eight discrete steps aimed at addressing the fundamental etiology of an issue, moving beyond mere symptomatic treatment. The efficacy of the 8D method is often enhanced through synergistic application with the FMEA (Failure Mode and Effects Analysis) methodology, a practice well-supported in the literature [4].

Originating in military contexts, the 8D technique was subsequently adopted by the automotive industry, a developmental trajectory common to numerous technical innovations [5]. Empirical evidence from multiple researchers confirms its effectiveness, underscoring its value in leading to the implementation of corrective actions that demonstrably enhance product or service quality [6], [7], [8]. The systematic nature of the process necessitates meticulous documentation to provide a comprehensive record of the investigation's progression and its outcomes. This procedure is recognized for its comprehensive scope, integrating various analytical tools and management methods such as the Ishikawa diagram, the 5 Whys technique, Pareto analysis, and other graphical representations like histograms [9]. Researchers have delineated the following sequential process for the 8D technique, distinguishing it from other problem-solving methodologies [9], [10]:

1D Form the Team. Assemble a cross-functional team of individuals who are involved in various stages of the process or product and possess relevant information. The team is also responsible for preparing accurate documentation of the data. The team is led by a facilitator or moderator who is independent of the product, service, or system being investigated.

2D Describe the Problem. Clearly define and identify the problem, gathering all relevant information. This includes determining the nature and location of the fault, as well as its duration and whether it is a recurring issue.

3D Implement and Verify Interim Containment Actions. The objective of this initial intervention is to isolate the source of the error to minimize losses while the problem and its root cause are being investigated. Corrective actions may include holding and re-inspecting products at both the manufacturer's and customer's sites.

4D Identify and Verify Root Causes. Investigate the causes that led to the deficiency or problem. This step involves identifying the root cause of all potential failures, using tools such as measurement, testing, the Ishikawa diagram, and brainstorming.

5D Choose and Verify Permanent Corrective Actions (PCAs). Develop and recommend a corrective action plan to the team's leader. This step is essentially about creating an action plan.

6D Implement and Validate PCAs. Execute the recommended actions and measure their effectiveness. The goal is to eliminate or reduce the likelihood of similar problems occurring in the future.

7D Prevent Recurrence. This involves feedback and examining how the implemented actions have contributed to improving the quality of the process or product. It includes measuring and analyzing the success of the corrective actions.

8D Congratulate the Team. Conclude the process by drawing conclusions and acknowledging the team's work. This involves evaluating their performance and strengths to motivate them, as well as analyzing the efforts made.

Harazin's study [5] posits a conceptual linkage between the eight stages of the 8D process and the Deming Cycle's Plan-Do-Check-Act (PDCA) principle. Within this framework, the "Plan" stage encompasses the first three steps of the 8D process, preceded by a preparatory Step 0 for problem sensing and identification. The "Do" stage correlates with 8D Steps 4 through 6. The "Check" phase is represented by the 7th step, while the "Act" stage corresponds to the final 8th step, which involves formal closure, drawing conclusions, and acknowledging team achievements. It is notable that Harazin's analysis deviates from other scholarly works regarding the integration of quality assurance tools; for instance, he proposes the application of the FMEA methodology during the 7th step [5].

IV. The Relationship between FMEA and 8D

Research by Koncz [9] further explores the interrelationship between the two methodologies, suggesting that issues identified via the 8D method can be leveraged to enhance FMEA, thereby assisting in the determination of appropriate actions. Krajnc and Trata [11] similarly emphasize the necessity of analyzing, during Step 5, how a customer complaint mandates modifications to existing documentation. The 8D method's standardized steps are widely adopted within the automotive industry, and its application is initiated following the identification of a fault. The shared objective of both FMEA and 8D is the identification and elimination of a failure's root cause. The effective implementation of these methodologies can establish a robust foundation for a quality management system. FMEA serves to prioritize risks; while it does not mandate action for low-level risks, practical experience indicates that this is often considered unacceptable by customers. If an analysis determines a fault or problem to be a critical risk, the product or service must undergo alteration or modification [12].

Scholarly consensus consistently underscores the interdependence of these two methods. FMEA typically functions as a static document that reflects relevant corrective actions from the user's perspective, whereas 8D is primarily engineered to prevent the recurrence of a fault or problem. Following the completion of an 8D analysis, the FMEA is qualitatively supported and updated [13], [14].

FMEA is, in fact, frequently regarded as the most significant management method integrated within the 8D problem-solving process itself [9]. A fundamental requirement for the effective implementation of both methodologies is the formation of a heterogeneous, multidisciplinary, and cross-functional team. Such a team, comprising employees from various departments and functions, ensures a multifaceted and comprehensive analysis, thereby enhancing the probability of acquiring relevant and accurate information [15].

Feature	FMEA	8D
Primary Goal	Proactive Identification & Risk Assessment	Reactive Analysis & Root Cause Elimination
Application Phase	Proactive (Design/Process Phase)	Reactive (After Failure Occurs)
Core Process	Identifies Failure Modes, Effects, Causes; RPN Calculation	8Disciplines: Containment (D3), Root Cause Analysis (D4), Corrective Actions (D5)
Primary Tools	RPN Calculation, Risk Matrix	Ishikawa, 5 Whys, Pareto Analysis
Key Advantage	Proactive Risk Reduction, System Robustness	Root Cause Discovery, Sustainable Solutions
Limitation	Subjective Rating, Time-Consuming	Retroactive Use Only, Documentation Intensive
Interrelation	Updated based on 8D Results	Guides Preventive Actions in 8D (D7)

Fig. 1. *FMEA and 8D Method Comparison*

V. THE CASE STUDY: APPLYING THE 8D METHOD TO A PRACTICAL EXAMPLE

The subsequent section details a case study demonstrating the practical application of the 8D methodology within a company that manufactures and distributes security access control systems. This project, designated as A3, involves the analysis and corrective investigation of a problem that occurred within a security access control system using the 8D technique. The investigation was conducted collaboratively with the manufacturer, as both parties had a vested interest in both short-term issue resolution and the initiation of long-term corrective actions. Given that continuous product defects were causing persistent problems, the investigation was executed with the full involvement of all stakeholders and various corporate departments.

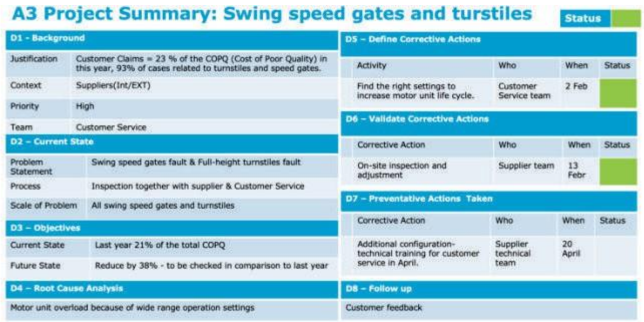

Fig. 2. *Project summary*

This figure provides a summary of the analysis process. Subsequently, the documented steps of the A3 project are presented in detail, and their effectiveness is summarized. The background analysis clearly demonstrated an increase in the Cost of Poor Quality (COPQ). This represents the additional costs incurred due to quality problems. Some of these costs are easily quantifiable, such as the cost of repairs, scrap, potential accidents, extra labor hours, energy consumption, or penalties. Other costs are not fully quantifiable and are of a non-monetary nature, such as time expenditures or damage to the company's reputation. The concept of quality is often paired with meeting customer expectations in the literature, which is why it is essential to prevent a drop in quality, as it can lead to customer disappointment and a potential decrease in sales [16], [17].

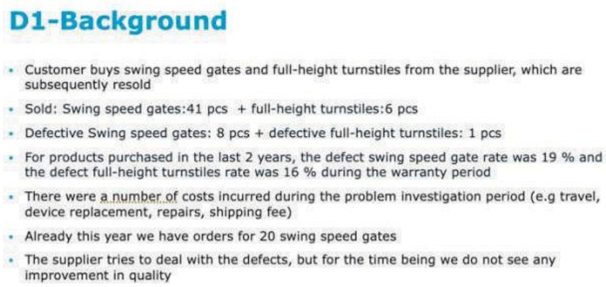

Fig. 3. *D1*

D1 - Define the Background and Team

In this case, the failure rate for the security access control systems purchased for resale by the company was 19% for the first product type and 16% for the second type during the warranty period. During the problematic period, various costs were incurred, including travel, equipment replacement, repairs, and shipping fees. The supplier promised to address the defects, but initially, no improvement in quality was observed. As mentioned earlier, this is the "0-step" identified in some research, which involves identifying the problem or defect. Considering the complexity, the team was composed of experts from customer service, design, and software development departments.

D2 - Describe the Problem

In this step, the company conducted a brainstorming session to assess the situation. The summary of this assessment can be illustrated by answering the following questions see in Fig.4.

D2-Current State

- Swing speed gates fault & Full-height turnstiles fault

Who is effected?	Customers with delivered speed gates & turnstiles productions Every gate that has been installed so far is potentially affected.
What type of problem is this?	Operating problem (all access types are affected, i.e. security and safety level)
Why is it a problem?	Powerless motor unit - >Difficult to turn the arms
Where was it observed?	Project site
When was it noticed?	Observation spread 2-3 weeks after installation
How did problem occur?	Frequent passage errors, traffic jam
How Often ? YTD	9 pcs claim gates/year

Fig. 4. *D2*

D3 - Setting Objectives and Corrective Actions

In this phase, the task was to implement initial actions necessary until the source of the problem could be fully identified and resolved. The responsible parties for each task were also defined, along with the costs incurred due to the defective performance and the overall objective.

D3-Objectives

Description	Owner	Status
Containment action – WIP and Stocked finished goods settings correction	Customer	Done
Solving customer issues – adjust the critical settings and parameters	Supplier	Done
Find the right settings to increase motor unit life cycle	Supplier	Done
Optimalization the dynamic properties of motor unit:	Supplier	Done
• Opening speed parameter define • Motor unit sensitivity parameter define	Supplier	Done
Reduction of COPQ cost related to Gates and turnties reduction by 38%	Supplier	Ongoing

Fig. 5. *D3*

Following the introduction of these initial corrective actions, the goals were achieved by modifying settings and parameters and optimizing the system. The Cost of Poor Quality (COPQ) value is currently being reduced, with further reduction being a continuous objective.

D4 - Root Cause Analysis

The failures occurred during product use, regardless of the operating temperature (inside or outside). In both cases, the motor was found to lose power within 1-2 days. An analysis of the gate's activity by the manufacturer was deemed necessary. The log analysis determined that excessively high parameter values were negatively impacting the motor's performance. Due to the issue, the supplier committed to testing the system, subsequently verified the parameter values, and confirmed that the problem was attributable to the software's operation.

D4-Root Cause Analysis

- The malfunction occurs during use of products
- Independent of the operating temperature (inside or outside) – experienced both cases
- Within 1-2 days the engine lost power
- Manufacturer analysis of logs collected by the gates (supplier action)
- Log analysis found that too high parameter values negatively affect engine performance
- The supplier tests - checked parameter value and confirmed the cause of problem

Observed wrong usage of parameters:

Swing speed gates		
Dynamic properties of motor unit	**Value ranges**	**Value failure**
Opening speed	1-9	9
Full-hight turnstiles		
Dynamic properties of motor unit	**Choice values**	**Value failure**
Braking distance angle	1-120 [degree]	90
Go-call	0-50 [degree]	40
Motor unit sensitivity	1-100	80

Fig. 6. *D4*

D5 - Defined Corrective Actions

The implementation of corrective actions followed the root cause analysis, which involved a software redesign of the device. These corrective steps were initiated immediately after the root cause was identified.

D5-Defined corrective actions

- Upload new configuration in the application – anytime during turnstile operation
  - New configuration details:

Swing speed gates		
Dynamic properties of motor unit	**Value ranges**	**Value failure**
Opening speed	1-9	3
Full-hight turnstiles		
Dynamic properties of motor unit	**Choice values**	**Value failure**
Braking distance angle	1-120 [degree]	15
Go-call	0-50 [degree]	0
Motor unit sensitivity	1-100	5

- Upload new firmware in the application – anytime during turnstile operation
  The details of the new firmware are known only to the manufacturer

Fig. 7. *D5*

D6 - Validated Corrective Actions

Following the determination of the corrective actions, a checklist was created, jointly compiled and audited by the 8D team members. The table below illustrates the review and implementation of these actions.

D6-Validated corrective actions:

#	Corrective actions	Done

1	*On-site inspection and adjustment*
	• Inspection of correct position of end stops is performed by manual turning of wings to their end positions
	• Function reset – initialization
	  • reset of internal registers
	  • reset of error register
	  • activation of device initialization
	  • detection of faults
		Y

2	Upload new configuration in the application – anytime during turnstile operation	Y
3	Upload new firmware in the application – anytime during turnstile operation	Y
4	Last year 2 inspections at customer sites with 0 issues found after corrective actions implemented	Y
5	Monitoring trend in the Customer claims database (in TST)	Y

Fig. 8. *D6*

D7 - Review and Verification of Preventive Actions

After implementing the immediate corrective actions, the team set long-term goals and created a list of preventive processes and measures to be introduced. These were outlined in the following three points.


D7-Preventive actions taken

#	Preventive Actions	Done
1	Additional configuration-technical training for customer service and installers, for better initial configuration of the gates	within 6 months
2	Quality control procedure creation	within 6 months
3	Preventive maintenance done by company – every year revision	within 7 months

Fig. 9. *D7*

D8 - Monitoring and Team Recognition

As the project concluded, the team members agreed that continuous monitoring of customer feedback was expected. They also scheduled an annual review of the system settings. The final step was to acknowledge the team's work, summarizing their successful collaboration and the project's key outcomes.

Fig. 10. *D8*

VI. CONCLUSION

The objective of this research was to provide a relevant, comprehensive, and illustrative analysis of the practical application of the 8D problem-solving technique. In accordance with the company's request to preserve confidentiality, all sensitive corporate information has been omitted. The study emphasizes the critical importance of addressing quality issues and investigates the relationships between two widely used quality management techniques: FMEA and 8D. As demonstrated throughout this analysis, these two methods are closely interconnected in practical application. For a complete analysis, the use of other quality management techniques is also recommended and constitutes standard corporate practice.

The project documentation, provided with the support of the distributor, serves to illustrate the utility of the 8D method. The case study successfully demonstrates the method's effectiveness in identifying faults and deficiencies. It also highlights the efficacy of the investigative process, which culminated in the successful implementation of corrective actions.

REFERENCES

[1] R. J. Mikulak, R. McDermott, M. Beauregard "The Basics of FMEA", 2nd Edition, 2 edition. New York: Productivity Press, 2008.

[2] L. Juhász "A Hibamód és hatáselemzés irodalmi áttekintése" Repüléstudományi Közlemények XXVIII. évfolyam, 2016/3, pp 95-98.

[3] M. K. Könyves, N. Kalló, "A kockázatelemzés változásai: Az új FMEA megközelítés", Polgári Szemle 18. évfolyam 1-3. szám, 2022, pp. 250-261.

[4] S. U. Divanog˘lu, Ü. Tas¸ "Application of 8D methodology: An approach to reduce failures in automotive industry Engineering Failure Analysis", Volume 134, April 2022.

[5] T. Harazin, "Minőségügyi eszközök a problémamegoldási folyamat során", Cikksorozat bevezető, Magyar Minőség, 2021.

[6] Y. T. Prasetyo, S. F. Persada, A. M. A. Cagubcob, and A. A. N. P. Redi, "Application of 8D Methodology for Minimizing Test Mixing Event in Semiconductor Test Manufacturing" *IEEE 8th International Conference on Industrial Engineering and Applications, 2021*, pp. 360–367.

[7] R. Rathi, M. C. G. Reddy, A. L. Narayana, U. L. Narayana, and M. S. Rahman, "Investigation and implementation of 8D methodology in a manufacturing system" Materials Today: Proceedings, 2021.

[8] A. B. E Aichouni, F. Ramlie, and H. Abdullah, "Process improvement methodology selection in manufacturing: A literature review perspective", International Journal of Advanced and Applied Sciences, vol. 8, no. 3, pp. 12-20, 2021.

[9] A. Koncz, "A 8D problémamegoldó technika", Repüléstudományi közlemények 2015/3, pp. 7-16.

[10] C-F. Banica, N. Belu, "Application of 8D Methodology-An Effective Problem Solving Tool In Automotive Industry", Scientific Bulletin Automotive Series, XXV 29 (1) (2019) pp.1–7.

[11] M. Krajnc, D. Trata, "With 8D method to excellent quality", Journal of Universal Excellence, October 2012, Year 1, No. 3, pp. 118–129.

[12] A. Koncz, L. Pokorádi, "8D Usage in Automotive Industry", INTI 2018, 8th IEEE International Symposium on Computational Intelligence and Informatics, Nov. 21-22, 2018, Budapest.

[13] N. Ionescu, L. M. Ionescu, N. Rachieru, A. G. Mazare, "A model fo monitoring of the 8D and FMEA tools interdependence in the era of industry 4.0", International Journal of Modern Manufacturing Technologies ISSN 2067–3604, Vol. XIV, No. 3 / pp. 1-2, 2022.

[14] M. K. Könyves, N. Kalló, "A kockázatelemzés változásai: Az új FMEA megközelítés", Polgári Szemle 18. évfolyam 1-3. szám, 2022, pp. 250-261.

[15] A. Koncz, "A Hibamód és Hatáselemzés alkalmazása napjaink autóiparában", Bánki Közlemények, I. évfolyam 3. szám, 2018, pp 15-20.

[16] Ian R. Lazarus, "Cost of Poor Quality", Quality Magazine, 2021 március, 60. kötet/ 3. szám

[17] E. Christensen, "The Cost of Poor Quality", Cost Management, Boston 31. kötet. 1. kiadás, 2017. 01-02. pp 11-14.