

**Unveiling the potential of FMEA in higher education:
Pathway to improved risk management and quality**

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Unveiling the potential of FMEA in higher education: Pathway to improved risk management and quality

Abstract

Design/Methodology/Approach: This research conducted a global survey to identify the critical success factors, benefits, and common challenges in using FMEA in the higher education sector.

Purpose: While educators impart FMEA instruction, its practical implementation within the educational sector remains limited. This study investigates the application of FMEA within higher education institutions. Implementing FMEA in these institutions is difficult due to statutory requirements, schedule restrictions, and stakeholder participation challenges. Moreover, higher education institutions struggle with preserving education quality, faculty training, and resource management, complicating organised methods such as FMEA.

Findings: The outcomes highlighted that lack of awareness regarding the tools' benefits is the primary barrier to FMEA implementation. However, respondents perceive that FMEA can improve process reliability and quality in higher education institutions. Further, the analyses found that knowledge about the FMEA tools is the prime critical success factor, and the lack of time due to other priorities in the organisation is a significant challenge in tapping the potential of FMEA.

Research Limitations/Implications: A limitation of the study is the relatively low number of HEIs surveyed globally. Further, the study provides a broad perspective rather than a focused study on one HEI.

Practical Implications: This study addresses this gap by exploring the potential benefits, challenges, and factors associated with the successful adoption of FMEA in academic settings. Using this information, HEIs can become more successful in applying FMEA.

Originality/Value: This study is unique in its exploration of the application of FMEA with higher education institutions for service quality improvement.

Keywords: *Failure Modes Effects Analysis, Higher Education, Critical Success Factors*

1. Introduction

Higher education institutions (HEIs) struggle with the factors associated with academic course costs and delivery, student recruitment, graduate job opportunities, research funding, social

environment, institutional culture, student accommodation, transportation proximity, and other factors in maintaining their student intake, operational costs and institutional reputations each academic year (Das and Mukherjee, 2017; Hoseiny *et al.*, 2023; Mbawuni & Nimako, 2015). In recent years, increased stakeholder awareness, technological advances, and rapid global competition have pressured HEIs to deliver enhanced service quality to their customers (Kinker *et al.*, 2020; Latif *et al.*, 2019). HEIs must provide reliable service quality and affordable student fees (Kinker *et al.*, 2020; Mbawuni & Nimako, 2015).

Failure mode and effect analysis (FMEA) is a widely utilised risk management tool commonly utilised in various sectors to ensure the reliability and safety of the process or system under study (Lin & Lo, 2023; De Oliveira *et al.*, 2018; Peeters *et al.*, 2018). FMEA aims to prevent process failures by understanding the potential failure modes and effects. Organisations develop and implement actions based on this knowledge to eliminate or reduce their likelihood and safety risk (Lin & Lo, 2023). Many methods explore potential failure modes in a process and thus mitigate against risk, such as fault tree analysis, root cause analysis, event tree analysis, and FMEA (Du *et al.*, 2017; Peeters *et al.*, 2018). Regulatory authorities mandate risk management in many industries, particularly highly regulated ones such as medical devices, automotive, and pharmaceutical. Therefore, FMEA is widely used as a risk management tool to demonstrate compliance with the relevant industry regulations (Huang *et al.*, 2020; Liu *et al.*, 2019).

FMEA is one of the most powerful tools in the quality improvement toolbox that contributes to the enhanced service quality and reliable education system (Anastasiadou & Zirinoglou, 2020; Hamid *et al.*, (2016). The value of the FMEA is as an inductive technique using the question “*What happens if ...?*”. Documenting the likelihood and impact of risks or process failure modes is a vital part of managing any organisational service delivery, and managers must have access to readily available risk information to make decisions (Curkovic *et al.*, 2013). FMEA is a tool used to collect information related to risk management decisions. The analysis starts at the process level and then breaks into sub-processes. Hence, FMEA is a bottom-up analysis method for understanding and ranking process failures (Elahi, 2021). Nevertheless, the utilisation of FMEA within the global higher education sector (HES) has been restricted due to the general absence of continuous improvement (CI) methods (Bartolomé & Benítez, 2022; Lin & Lo, 2023).

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The research conducted by Imeri *et al.* (2014) and Capolupo *et al.* (2023) offers a thorough insight into the critical ‘hard’ and ‘soft’ components of Total Quality Management (TQM) necessary for the effective adoption of CI approaches. Imeri *et al.* (2014) explain how both tangible and intangible components of TQM practices impact organisational performance in Southeast European companies, emphasising the significance of a well-rounded strategy that incorporates soft elements such as leadership, culture, and employee engagement in addition to the hard elements such as tools and techniques. Capolupo *et al.* (2023) examine the non-technical aspects of TQM within social care multiservice organisations. They highlight the importance of organisational culture, leadership, and stakeholder participation in creating a supportive environment for ongoing improvement. The HES can improve the adoption of FMEA and other CI methodologies by addressing both the technical and interpersonal aspects of quality management. HEIs can unlock the full potential of FMEA for service quality enhancement by developing a supportive culture, effective leadership, and active stakeholder participation to overcome implementation barriers.

Although FMEA has found its way into the literature concerning HEIs, its utilisation as a tool has been infrequent. Jüttner (2005) and Teng *et al.* (2006) stated that organisations are widely adopting all traditional risk assessment processes and tools with a trend towards using less formalised and 'softer' tools such as FMEA. Therefore, this study aims to investigate the current state of FMEA adoption in HEIs and identify critical success factors, critical failure factors, benefits, and challenges of FMEA application as a tool to improve the service quality of HEIs. Therefore, this study aims to address the following research questions.

- RQ1:** What is the present status of FMEA adoption in HEIs?
- RQ2:** What are the benefits, challenges, barriers, and limitations of using FMEA in HEIs?
- RQ3:** What factors help in successfully adopting FMEA in HEIs?

The remainder of the manuscript is structured as follows. The next section discusses the relevant literature on FMEA in the HEIs and the research methodology used in this study. The fourth section presents the key findings, while the fifth section discusses the findings and implications of the study. The final section presents the conclusions, limitations, and directions for future research.

2. Literature Review

2.1 Defining FMEA

There are various types of FMEA, each tailored to meet the specific needs of various industries and sectors. However, the same method is employed to understand, prevent, and minimise failure modes and their associated results (Stamatis, 2019). There are three types of FMEA recognised as most utilised in more regulated sectors, such as manufacturing, include the Design FMEA (DFMEA), Process FMEA (PFMEA) and User or Use FMEA (UFMEA) (Elahi, 2021).

The DFMEA focuses on product or service design and is best used early during the design development process to identify potential design flaws that could result in a product or process failure. Practitioners often integrate DFMEA into the Design for Lean Six Sigma (DLSS) methodology. For example, Eaton *et al.* (2023) utilised FMEA in designing an enhanced data management system, while Trubetskaya *et al.* (2023) applied FMEA to design a manufacturing facility's space management system. The PFMEA focuses on existing processes and services and is a powerful failure prevention technique due to its proactive nature in predicting and implementing risk mitigation measures (Stamatis, 2019). The third FMEA type, the User or Use FMEA (UFMEA), is often utilised to aid in human factor design and usability testing of products to predict user/customer failure or misuse. Formulating strategies with a systematic risk evaluation plan can be an effective solution for resolving HEI issues and improving the service quality of institutions (Brochado, 2009).

2.2 Use of FMEA in difference sectors and disciplines

FMEA, as a quality improvement tool, focuses on all possible causes of failure in a system or process. For example, FMEA is widely applied in supply chain risk management (SCRM) to establish potential failure modes across the entire supply chain, from the raw material supplier to service delivery, warranty and repair (Teng *et al.*, 2006; Jüttner, 2005). FMEA also supports the analysis of all possible ways to prevent failure mode recurrence through eliminating risk, mitigating risk, and implementing risk contingency plans (Curkovic *et al.*, 2013).

The automotive industry often utilises FMEAs in the design process for most part designs. Further, manufacturers require their suppliers to submit an FMEA as part of product approval documentation (AIAG, 2022; Chrysler Corporation *et al.*, 1998). In the medical technology (MedTech) industry, ISO 13485, the quality management system (QMS) standard for medical

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device manufacturers, states that there must be analysing, evaluating, controlling, and measuring of risk throughout the product lifecycle (McDermott *et al.*, 2022). The ISO 13485 QMS standard also references ISO 14971, the risk management standard for medical devices (ISO 13485, 2016). Therefore, FMEAs are also submitted to the regulators to demonstrate compliance with ISO 13485:2016 and ISO 14971: 2019. In the pharmaceutical industry, the International Conference of Harmonisation (ICH), the Food and Drug Administration (FDA), and the European Medicines Agency (EMA), as well as other global regulatory bodies, promote the Quality by Design (QbD) approach as a pharmaceutical quality management system that predicts, controls, and systematically responds to risks that may occur in the research stage and manufacturing process and utilises FMEA (FDA, 2004; Lee, 2005).

2.3 Use of FMEA in HEIs

The literature indicates that much of the application of FMEA is related to academics in HEIs, while sparse literature relates to disaster mitigation and contingency planning (Nouri *et al.*, 2010; Silva *et al.*, 2014) and identifying safety hazards or building infrastructure failures (Wahab & Basari, 2013). For example, Nouri *et al.* (2011) applied FMEA in the areas of HEI educational and administrative buildings that had laboratory hazards and held flammable chemicals in storage to identify vulnerabilities in people and infrastructure.

An FMEA approach aids HEI managers in improving service quality through failure factor severity (Karimi Takalo *et al.*, 2013). Wahab and Basari (2013) applied FMEA in a Malaysian university to resolve downtime and reliability issues with equipment and facilities in student accommodation buildings. The study implemented an appropriate maintenance schedule for those buildings (Wahab & Basari, 2013). The application of FMEA is not limited to educational institutions' infrastructural failure analysis. For example, Bartolomé and Benítez (2022) and Gorgani (2016) employed FMEA to gain insights into student dissatisfaction with teaching. The latter investigated the reasons for student dissatisfaction in an engineering drawing course using FMEA. Their study revealed that employing teachers with prior industrial experience and know-how of the subject, developing good relations with the students, providing interactive lectures with stimulating discussions and scheduling teachers' assessments could further improve the academic services of the institution in this course (Gorgani, 2016). Bartolome and Benitez (2022) utilised FMEA to assess the risk of student failures in a mechanical engineering course.

Similarly, a study in Greece explored the critical failure factors of student satisfaction with the university using FMEA to develop improvement actions within Greek higher education (Anastasiadou & Zirinoglou, 2020). Student retention at Wawasan Open University was studied using quality tools, FMEA, Deming's Plan-Do-Check-Act cycle (PDCA), and process mapping. Utilising FMEA aided the development of an action plan that the institution needed to implement to provide the students with clear and defined study pathways and milestones to complete their academic program on time (Chuah & Lim, 2018). Table 1 provides a summary of the application of the FMEA tool in HEIs from the literature.

<INSERT TABLE 1 APPROXIMATELY HERE>

2.4 Benefits and Limitations of FMEA

Despite FMEA being one of the most used risk analysis tools for many industries to enhance the safety of products, it has its limitations as a tool as well as benefits. The advantage of FMEA is that it allows for a structured and in-depth analysis and is adaptable across all industry types (Janss *et al.*, 2016). According to Elahi's (2021) findings, although organisations and practitioners use FMEA widely, it is essential to note its limitations. Specifically, FMEA is effective in identifying and addressing individual faults and failures. However, an FMEA cannot analyse risks arising from multiple failures co-occurring, failures during normal operating conditions, or failures caused by common causes. The subjectivity of the FMEA process when assigning ratings, coupled with its dependence on the perspectives and expertise of participants, can present a potential limitation (Speer, 2018). A study by Onofrio *et al.* (2015) examined a medical device already on the market. They pointed out the limitations in the FMEA process, specifically related to the reliability and subjectivity of the assigned ratings in the product design. When using FMEA, the severity, occurrence, and detection ratings are treated equally within the method (Liu *et al.*, 2013). In assessing and scoring various failure modes in an FMEA, the resulting composite of occurrence, severity, and detection ratings could yield a consistent overall risk priority number (RPN). However, it is essential to note that the severity and criticality of distinct risk consequences within the RPN might vary (Elahi, 2021; Liu *et al.*, 2013).

Several authors have investigated alternatives to the traditional FMEA method to improve its effectiveness for various industries (Huang *et al.*, 2020; Kirkire *et al.*, 2015; Spreafico *et al.*, 2017), including suggesting the integration of FMEA with other tools (Khorshidi *et al.*, 2015;

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Spreafico *et al.*, 2017). For example, some authors integrated FMEA with fuzzy linguistic modelling (FLM) (Sharma *et al.*, 2005). However, many regulated sectors dislike change if it invites regulators' attention and affects marketing authorisations (Onofrio *et al.*, 2015). The higher education sector is not mandated to utilise risk management methods (and by association, FMEA) as highly regulated industries are. Therefore, it has more scope to integrate FMEA into its quality systems in a manner deemed fit.

2.5 Integrating LSS and FMEA in HEIs

By applying LSS as a theoretical framework, we can better understand how FMEA helps HEIs improve the quality of their services. An excellent starting point for applying FMEA in the academic sector is LSS, which focuses on process improvement and waste reduction. By suggesting a way to combine FMEA for comparable outcomes, Li *et al.* (2019) demonstrate how LSS approaches can improve the efficiency of service operations in HEIs. To demonstrate the adaptability and usefulness of LSS principles in many organisational contexts, including HEIs, Ciasullo *et al.* (2024) take a gendered look at how LSS impacts quality performance in Italian hospitals. Thomas *et al.* (2017) give a practical example of LSS's use in the classroom by detailing its incorporation into lesson planning and delivery. Following the objective of FMEA to identify and resolve potential issues, Douglas *et al.* (2020) investigate the use of Lean Thinking to identify inefficiencies in HEIs. Results from this research lend credence to the idea that FMEA, one component of the LSS methodology, can significantly improve the quality of services provided by educational institutions when used systematically.

2.6 Conclusion and Gaps in the Literature

FMEA is a valuable tool for risk management and quality improvement. However, it has limitations in its method, use, and application. Despite its widespread popularity and use by many industries, the application of FMEA in HEIs is limited. HEIs have mainly applied FMEA in safety studies, assessment of student satisfaction with teaching, administrative process review, and infrastructure and environmental sustainability assessments in HEI facilities. Applying the FMEA approach in HEIs was observed to bring about process improvements and enhancements in customer experience.

Nevertheless, significant potential exists for broader implementation across HEIs. By doing so, HEIs can reap significant advantages such as increased profitability, student attraction and

retention, staff retention, greater funding appeal, enhanced employee and student satisfaction, and the establishment of streamlined processes.

This work contributes significantly to the literature by investigating the theoretical and practical consequences of FMEA adoption in HEIs. It addresses a significant vacuum in the current literature by presenting a thorough grasp of the benefits, limitations, and possibilities of FMEA in academic contexts. Researchers and practitioners in quality management and risk assessment can benefit significantly from this study's findings.

3. Research Methodology

3.1 Survey design and dissemination

In order to answer the research questions of the study, a survey method in the form of a questionnaire was adopted to elicit the respondent's opinions. A questionnaire-based survey approach was chosen as the research instrument in this study as it allows the researcher to have greater control over the research process (Saunders *et al.*, 2015) as well as provides more time for respondents to complete and verify their answers at their own convenience time (Dillman *et al.*, 2014).

The validity of the questionnaire explains how well the collected data covers the actual area of measurement (Fielding *et al.*, 2008). Face validity pertains to researchers' subjective evaluations regarding a measurement's clarity, relevance, and reasonableness, assessing whether its items appear relevant, understandable, unambiguous, and clear (Broder *et al.*, 2007). In order to improve the validity of the survey instrument, each question in the survey was designed based on the literature review.

The face validity of the questionnaire was done in two phases (Broder *et al.*, 2007). In Phase 1, each author reviewed the questionnaire for face validity, and wherever there was disagreement, an amicable solution was arrived at through discussion. In phase 2, the questionnaire was sent to five academicians and five educational administrators who evaluated the questionnaire and wherever the suggested improvement was made. We also calculated the content validity. Content validity refers to the extent to which a measuring instrument accurately captures and represents the entire range of the construct being measured. It assesses whether the items in the instrument comprehensively cover the content domain of interest, ensuring that the instrument adequately reflects the intended concept or construct (Privette and

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Bundrick, 1987). To measure this, we sent the questionnaire to five academicians and five educational administrators; we asked them to rate each question using a three-point scale: not necessary and useful but not essential and essential.

Further, we calculated the content validity ratio using Lawshe’s Method (Lawshe, 1975). This method is a linear transformation of a proportional level of agreement on how many “experts” within a panel rate an item “essential”. We used the equation
$$CVR = \frac{n_e - \frac{N}{2}}{\frac{N}{2}}$$
. n_e is the total number of members indicating essential, and N is the total number of raters. The minimum acceptable value for 10 raters was suggested by Lawshe and its subsequent revisit (Ayre and Scally, 2014) to be 0.8 (Lawshe, 1975). Therefore, all the questions that had a value above this were accepted, and those below were discarded. The survey instrument is attached in Appendix A. This study used Google Forms (Majid *et al.*, 2017; Malmqvist *et al.*, 2019). Participants for the survey were chosen and reached out to through LinkedIn's messaging feature, a widely used platform for professional networking (Power, 2015). The researchers primarily directed the outreach focus on LinkedIn toward academics and staff members within HEIs. The questionnaire consisted of two main parts. The first part of the survey consists of the demographic information of participants. The second part investigates the respondents' understanding and experiences with the FMEA method in the HEIs. The questionnaire requested that participants indicate their level of agreement or disagreement concerning the obstacles and difficulties related to FMEA usage, factors contributing to success, and advantages associated with implementing FMEA within HEIs (Dillman *et al.*, 2014). The questionnaire also communicated the study's ethics, aims, and objectives as part of the survey. Further, all respondents were promised anonymity and confidentiality in their responses to the survey questions (Israel & Hay, 2006).

Initially, 350 potential participants received the questionnaires. However, the number of responses received was 104, and from these, only 86 were deemed suitable for the subsequent data analysis due to their familiarity with the FMEA tool. This result yielded a response rate of 25%, which aligns with the guideline proposed by Easterby-Smith et al. (2012). They stipulate that quantitative research surveys consider a response rate exceeding 20% satisfactory. Table 2 represents the sample selection criteria for the survey.

<INSERT TABLE 2 APPROXIMATELY HERE>

3.2 Reliability

Cronbach's alpha is a statistical measure used to assess the internal consistency reliability of a scale or a set of items in a questionnaire. It quantifies the extent to which all the items in the scale or questionnaire are correlated with one another, indicating how well they measure the same underlying construct (Hair *et al.*, 2014). A higher Cronbach's alpha value typically suggests greater internal consistency among the items. This test assesses whether the research instrument can produce consistent results when used repeatedly. The generally accepted lower limit for Cronbach's alpha is 0.70 (Nunnally, 1994). However, it may be lower in exploratory research, such as this study. The Cronbach alpha for this study was 0.812 and, therefore, is an acceptable and strong indicator of the validity and reliability of the survey instrument.

4. Results

Table 3 summarises the preliminary classification of survey results. The data indicates that 68% of the respondents were faculty members in HEIs, and 60% were from Asia and Europe. Also, the majority of respondents are male (70%), and 60% are from the public sector. In addition, 44% of them are from a HEI with more than 1500 employees. Further, 69% of the respondents stated they had formal training on FMEA tools, with 58% stating they were extremely familiar and very familiar with FMEA. Even though 78% of the respondents teach FMEA, only 38% use FMEA in practice in their HEI. In addition, 79% of respondents reported that less than 10% of their HEI peers had formal training in FMEA, and of those respondents trained in FMEA, 80% used the traditional 10-level scale rating method of FMEA (Mikulak *et al.*, 2017).

<INSERT TABLE 3 APPROXIMATELY HERE>

This study critically evaluated the data from the survey instrument to identify barriers to FMEA implementation. Table 4 shows that all the other identified barriers significantly affected FMEA implementation in HEIs, except for the lack of financial resources. Data analysis revealed that a lack of awareness regarding the benefits of the FMEA, lack of training in the use and a lack of motivation to use FMEA were the top three barriers to the successful and frequent application of the FMEA tool in HEIs.

<INSERT TABLE 4 APPROXIMATELY HERE>

Further, correlation analysis between the barriers (Figure 1) indicates that there exists a high correlation ($r > 0.60$) between lack of employee involvement and empowerment (H) and lack of communication (I). In addition, lack of motivation to use the tool (D) and lack of awareness regarding the benefits of the tool (E) are highly correlated. These findings show that creating awareness and establishing clear communication is essential to ensure employee adoption of FMEA and involvement within HEIs.

<INSERT FIGURE 1 APPROXIMATELY HERE>

Interestingly, respondents believe HEIs can use FMEA to improve more than 50% of the university's administrative and IT services processes (Figure 2). Further, Figure 2 demonstrates that 41-50% of academic (teaching and research) problems can be tackled by FMEA, followed by marketing, recruitment, and finance (process) issues (41-50%). Less than 10% perceive FMEA as a valuable tool for improving research work and processes in HEIs.

<INSERT FIGURE 2 APPROXIMATELY HERE>

As shown in Figure 3, respondents stated benefits to their HEIs due to the application of the FMEA tool in assessing the failure factors of their respective operations. Improved process reliability and quality were among the most cited benefits of FMEA (9%). Also, other benefits of the FMEA tool, specifically within the HEI, included early identification and prevention of the failure at its initial stage (8%), error prevention (8%), reduced cost of poor quality (7%), and aid in problem-solving (7%). Respondents rated providing a structured road map for problem-solving (17%) and support in identifying areas of improvement (17%) as the least rated benefits.

<INSERT FIGURE 3 APPROXIMATELY HERE>

The top critical success factors for FMEA use in HEIs (Table 5) were knowledge about the FMEA tool (28%), management support and commitment (24%), and having a continuous improvement program in place (19%). The top challenge in applying FMEA (20%) was the lack of time since FMEA was not on the organisation's priority list. The second most prevalent

hurdle in FMEA utilisation was defining failure modes, their causes, and corresponding effects (14%).

<INSERT TABLE 5 APPROXIMATELY HERE>

The questionnaire also asked respondents which part of the PDCA cycle the FMEA most applied in HEIs (Figure 4). The respondents noted that FMEA was most applied in the plan (41%) and check (26%) phases. Within the different types of calculation methods and techniques used for FMEA, root cause analysis is a highly used tool and technique with FMEA, followed by Pareto analysis and Ishikawa diagrams, also known as cause and effect diagrams (Table 6). Further, among fuzzy logic expressions, respondents effectively used intuitionistic fuzzy sets (17%), centroid trapezoid fuzzy quantisation (13%) and interval type-2 fuzzy sets (13%) during analysis.

<INSERT FIGURE 4 APPROXIMATELY HERE>

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Moreover, time-consuming and tedious to trace failure was the top limitation of FMEA adoption in HEIs (Table 7). Finally, a Chi-squared test demonstrated no association between teaching and applying FMEA (Table 8). This finding was not surprising since a previous question highlighted that although 78% of the respondents are teaching FMEA, only 38% have utilised FMEA within their practice in HEI.

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5. Discussion

An FMEA aims to systematically and methodically identify potential failures or issues systematically and methodically in a process, product, or system, evaluate their potential effect, and thus implement a corrective, preventative, mitigation or contingency action. Although manufacturing, engineering, and healthcare organisations most often utilise FMEA, its academic applications are restricted (RQ1). Even though HEI academics and faculty members

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teach FMEA in HEI, they are not applying the same in the education system or other HEI processes. This finding may be because more than 69% of respondents indicated that less than 10% of their organisational peers in HEIs have FMEA training. This finding was similar to a study by Mathur *et al.* (2022), who found that 68% of HEI respondents stated that less than 10% of their HEI employees had training in essential quality management tools.

This study also highlighted the benefits, challenges, barriers and limitations of using FMEA in HEIs (RQ2). Awareness and training are the top prominent barriers to adopting the FMEA in the HEI. FMEA is a manufacturing sector's established risk management and quality assurance technique. However, in smaller manufacturing units or those new to quality management methods, there may be a lack of awareness of the entire scope of FMEA's advantages (Stamatis, 2014). In HEIs, the lack of awareness may arise from the belief that FMEA is better suited to companies with tangible goods than service-oriented sectors such as education. This lack of awareness may result in lost chances to enhance service quality and risk management in academic contexts.

Moreover, training is necessary to guarantee that FMEA is implemented correctly and efficiently in the manufacturing sector (Stamatis, 2014; Stamatis, 2019). A lack of training can lead to insufficient or inaccurate risk assessments, which might result in product faults or safety hazards. Due to the lack of training, FMEA may be applied superficially or incorrectly in academic contexts, resulting in inefficient risk management or quality improvement programmes.

Even though respondents perceive that FMEA improves the process reliability/ quality and early identification and elimination of failure modes, HEIs are not applying FMEA in critical areas such as financial and IT services and HR processes. Interestingly, most people believe its application is limited in academic research. However, respondents believe that HEI organisations and processes can continually be improved through FMEA, as it promotes a preventative approach to identifying and fixing possible problems and risk mitigation. To mitigate possible adverse outcomes, universities can use FMEA to systematically evaluate academic course delivery, content, teaching, student services, facilities, and administration risks (De Oliveira *et al.*, 2018). Also, FMEA helps identify potential sources of mistakes and errors in complex processes, including admissions, enrollment, course registration, and grading, and gain insight into how to improve such processes (Sinthavalai & Memongkol,

2008). To further ensure the institution's continued compliance with accrediting and regulating organisations, FMEA can help determine problem areas and provide solutions to enhance quality management in HEI. Interestingly, Blaško *et al.* (2023) effectively used FMEA for the regulatory requirements in a university laboratory.

Nevertheless, to ensure the effective deployment of FMEA, providing sufficient time for the faculty members is essential (RQ3). Successful deployment can be achieved by establishing necessary training in educational institutions and persuading management and staff to use FMEA in process improvement projects (Sreedas & Emmatty, 2022). Further, the research indicated that HEIs can effectively use an FMEA in the planning stage and other phases of continual improvement projects. Knowledge about the usage of tools and top management support is a crucial success factor for the deployment of the FMEA. This outcome aligns with the findings of other research on the operational excellence (OPEX) approach (Bhat *et al.*, 2023; McDermott *et al.*, 2022).

The research demonstrates that fuzzy logic expression methods can benefit FMEA due to their ability to address ambiguity and uncertainty during the assessment stage. Recent studies support these findings, effectively using fuzzy-integrated FMEA for process improvement (Qin *et al.*, 2020; Zandi *et al.*, 2020). HEIs can use FMEA along with root cause analysis and Pareto analysis during quality improvement projects in the higher education sector. The respondents perceived that the major drawback of the FMEA is that it is time-consuming and tedious to trace failures, which limits its application in the education ecosystem. Thornton *et al.* (2011) mention that conducting an FMEA takes a significant amount of time, with 10 hours on average, not including meetings. According to Alruqi *et al.* (2021), FMEA deployment takes considerable time because of the workforce and materials needed to carry it out. Based on the above discussions, academicians should further investigate FMEA to develop an improved and integrated approach that includes Industry 4.0 technology or software to ensure FMEA completion is less tedious and time-consuming.

5.1 Theoretical Implications

Examining FMEA implementation in HEI contexts encompasses a range of theoretical implications concerning its adoption, benefits, challenges, obstacles, success factors, limitations, tools, and techniques. First, this research helps to spread innovation theories by investigating how to use FMEA in HEIs. Secondly, it contributes to quality management and

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risk assessment theories by investigating how FMEA might be used to serve students, educators, and support functions better. Third, studies of causes and challenges enrich theoretical frameworks for change management, organisational behaviour, and ongoing improvement. Researching the shortcomings and potential of FMEA in the academic setting opens the door to conceptual debates over its adaptability, personalisation, and biases. Finally, studies of FMEA methods and tools might add to theoretical frameworks for quality management and process improvement. Overall, the theoretical implications of the current research on FMEA in HEI improve the body of knowledge and practitioners' understanding of the function of FMEA in boosting quality and controlling risks in educational settings.

5.2 Managerial Implications

Academic administrators may evaluate the institution's preparedness for implementation and design strategies to encourage FMEA adoption using insights gained from this research into the variables affecting FMEA acceptance. Managers may optimise the beneficial effects of FMEA by understanding and prioritising its advantages, such as increased quality, risk management, and operational efficiency. HEIs can successfully implement FMEAs by developing mitigation techniques, providing essential training, and handling resistance to change. Managers may make the most of FMEA by focusing their efforts on the CSFs, increasing the likelihood of its success. Managers in the higher education sector need to be aware of the limitations of FMEA to establish reasonable expectations, examine other methodologies, and address any biases to achieve accurate and relevant outcomes. The present research on FMEA tools and techniques enables academic managers to choose the best methods for their institution's unique requirements, increasing the efficacy and efficiency of the FMEA process. Based on the research findings, the authors propose the following ten commandments in applying FMEA at HEI (Figure 5).

<INSERT FIGURE 5 APPROXIMATELY HERE>

6. Conclusions, Limitations and Future Research Perspectives

While FMEA is a valuable tool for risk management and quality improvement in various sectors, its application in HEIs is limited. This study addresses this gap by exploring the potential benefits, challenges, and factors associated with the successful adoption of FMEA in academic settings. Lack of awareness regarding the tool's benefits is a significant barrier to the successful adoption of FMEA. Further, respondents perceived that improved process reliability

and quality were among the most eminent benefits of FMEA. Interestingly, the lack of time due to FMEA not being on an organisation's priority list is the major challenge for the FMEA's success in the HEIs. Further, knowledge about the FMEA tools in the critical success factors and the time-consuming and tedious process of tracing failure were the top limitations of FMEA adoption in the HEIs.

Respondents indicated that using fuzzy logic expression calculation methods with FMEA would yield better results. In addition, they mention that HEIs can effectively utilise FMEA in different phases of the PDCA cycle of quality improvement projects in the higher education sector. Further, respondents noted that HEIs can use FMEA along with root cause analysis and Pareto analysis techniques during a project. Finally, the study shows no association between teaching and applying FMEA in HEIs.

A limitation of the study would be the relatively low number of HEIs surveyed globally. Future research can extend this study to include a more significant number of respondents from different countries. One particular HEI can also be considered a case study for a focused domain in the higher education sector to obtain more insight into the FMEA barriers, critical success factors, and challenges.

When applied to production, the FMEA is effective. PFMEA developed from DFMEA. In the service industry, both forms of FMEA have proven useful. However, its application in HEIs is limited. Ironically, academicians are at the forefront in extolling the virtue of FMEA to their students, but not by demonstrating its applications in their organisation. FMEA can be effectively taught and efficiently implemented in the HEIs, especially when evaluating educational services. Further, administrators of HEIs can use FMEA in decision-making and risk analysis.

Moreover, it can be integrated effectively with other tools and techniques, such as fuzzy methods, to complement the tool's strengths. In addition, FMEA can aid in effectively deploying OPEX strategies such as kaizen, theory of constraints, Lean, Six Sigma, Lean Six Sigma, and Design for Six Sigma in HEIs. Finally, in the era of start-ups, policymakers can ensure that FMEA is an open elective for all the disciplines in HEIs to boost innovation activities and strengthen the incubation centres of HEIs.

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Appendix A

Survey Instrument

1. Your current position:
 - a) Director/Dean/HOD
 - b) Faculty members
 - c) Registrar
 - d) Administrator
 - e) Librarian
 - f) IT officer/Manager
 - g) Finance Officer
 - h) Registrar
 - i) Administration officer
 - j) Other (please specify)
2. How many years of experience have you had in your present organisation?
 - a) < 1 year
 - b) Between 1 year and <5 years
 - c) =5 years and <10 years
 - d) =10 years and <15 years
 - e) =15 years and <20 years
 - f) =20 years or 20 + years
3. Where is your University/College/Institute/Research Centre based?*
4. For which processes of the university are you working? Please choose your response from the following list.

- a) Academic
- b) Administrative
- c) HR Processes
- d) Marketing Processes
- e) Procurement Processes
- f) Other (please specify)

5. Your gender:

- a) Male
- b) Female
- c) I prefer not to say

6. What is the type of your University/College/Institute/Research Centre

- a) Public
- b) Private

7. What is the total number of employees (including faculty and staff) in your institute/university? Please choose one response from the following list.

- a) < 500
- b) Between 501 and 1000
- c) Between 1001 and 1500
- d) >1501

8. Are you familiar with the FMEA tool?

- a) Yes
- b) No

If NO, please do not continue.

9. If you are familiar with the FMEA, have you been trained?

- a) Yes
- b) No

10. What is the level of your understanding of the use of the FMEA method? Please choose one response from the following list.

- a) Not at all familiar
- b) Slightly familiar
- c) Familiar
- d) Very familiar
- e) Extremely Familiar

11. Do you teach the FMEA at the University/College/Institute/Research Centre?

- a) Yes
- b) No

12. Do you apply for the FMEA in your University/College/Institute/Research Centre?

- a) Yes
- b) No

13. What type of assistance has been used or employed in your FMEA project? Tick as many as apply.

- a) External consultants
- b) External trainers
- c) Industry assistance
- d) Experts from university
- e) Internal resources
- f) Other:

14. Rate the following barriers to applying the FMEA method in your university.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
Lack of top management commitment, involvement, leadership, and support					
Lack of financial resources					
Lack of training in the FMEA					
Lack of motivation to use the tool					

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
Lack of awareness regarding the benefits of the tool					
Lack of understanding of the tools as to when and where they should be used					
Lack of organisational culture					
Lack of employee involvement and empowerment					
Lack of communication					
Lack of availability of data					
Lack of availability of expertise, experience and good team skills					

Other (please specify)

15. What percentage of people in your organisation have been trained in the FMEA?

- a) Less than 10%
- b) Between 11-20%
- c) Between 21-30%
- d) Between 31-40%
- e) Between 41-50%
- f) More than 50%

16. What percentage of quality problems in your university can be tackled using the FMEA?

Please highlight or choose one response from the following list.

	Less than 10%	Between 11-20%	Between 21-30%	Between 31-40%	Between 41-50%	More than 50%
Academic (Teaching and Research)						
Administrative						
Finance Processes						
HR Processes						
Marketing and Recruitment Processes						
Professional Services Processes						
IT Services Processes						

17. How frequently are FMEA used in your University/College/Institute/Research Centre?

Please choose one response from the following list.

- a) Never
- b) Almost Never
- c) Sometimes
- d) Almost every time
- e) Every time

18. What are the fundamental benefits of FMEA in your experience? Please tick the top 10 that apply in your opinion.

- a) Improve process reliability and quality
- b) Increase customer satisfaction
- c) Early identification and elimination of potential process failure modes.
- d) Prioritise process deficiencies.

- e) Capture organisation knowledge.
- f) Emphasises problem prevention.
- g) Provides a uniform approach to identifying problems
- h) Provides information and tools for improving SOPs
- i) Forms the foundation for planning future evaluations.
- j) Cost and time for system development are reduced.
- k) Provides the opportunity for effective collaboration.
- l) Aid problem solving
- m) Provide structure to problem-solving
- n) Aids in continuous improvement
- o) Encourages teamwork and collaboration
- p) Help to identify areas of improvement
- q) Reduces cost of poor quality
- r) Aids implementation of Lean/Six Sigma
- s) Suitable for individuals with little formal statistical training
- t) Other (please specify)

19. What are the challenges in using FMEA in The Higher Education Institute (University/College/Research Centre in your experience)? Please pick the top 5 that apply in your opinion.

- a) Difficulties in representing the process
- b) Defining the failure modes, causes and effects
- c) Developing the rating scales for criticality
- d) Rating the criticality of the failure modes
- e) Lack of time due to other priorities in the organisation.
- f) Complex systems that have multiple functions consisting of several departments
- g) Difficulty in incorporating all possible factors influencing the product/process
- h) Team formation
- i) Other (please specify)

20. What are the success factors in implementing and using the FMEA in Higher Education Institute (University/College/Research Centre)? Please tick the top 3 factors that apply in your opinion.

- a) Knowledge about the FMEA tools

- b) Management support
- c) Widespread training
- d) Opportunity to use the tools
- e) Opportunity to participate in problem-solving sessions or events
- f) Having a continuous improvement program
- g) Sharing success stories and benefits
- h) Other (please specify)

21. At which phase of the Continuous Process Improvement project are you using FMEA more frequently?

- a) Plan
- b) Do
- c) Check
- d) Act

22. Which expression of risk factor opinions are used in FMEA (Reprioritization of the RPN)?

- a) Traditional 10-level scale
- b) Fuzzy logic

23. If it is a Fuzzy logic expression calculation method, which of the following classifications are used?

- a) Triangular fuzzy quantisation
- b) Trapezoidal fuzzy quantization
- c) Generalised trapezoidal fuzzy numbers
- d) Trapezoidal fuzzy numbers and fuzzy triangular numbers
- e) Centroid trapezoid fuzzy quantization
- f) Interval-valued intuitionistic fuzzy sets (IVIFS)
- g) Intuitionistic fuzzy sets(IFS)
- h) Intuitionistic fuzzy hybrid weighted Euclidean distance (IFHWED)
- i) Hesitant fuzzy linguistic term sets
- j) Double hierarchy hesitant fuzzy linguistic term sets (DHHFLTSS)
- k) Hesitant 2-tuple linguistic term sets
- l) Probabilistic linguistic term sets
- m) Interval 2-tuple

- n) Interval type-2 fuzzy sets
- o) Interval 2-tuple linguistic variables
- p) 2-dimensional uncertain linguistic variables (2DULVs)
- q) Cloud model
- r) Fuzzy belief structure
- s) Dempster–Shafer evidence theory (DSET)
- t) D numbers
- u) Basic probability assignments (BPAs)
- v) Weighted averaging operator of linguistic distribution (DAWA)
- w) BWM
- x) Fuzzy ordered weighted averaging (OWA)
- y) Fuzzy evidential reasoning

24. Which of the other tools/techniques have you combined with FMEA?

- a) Grey relational analysis (GRA)
- b) Technique for order preference by similarity to ideal solution (TOPSIS)
- c) Decision-making trial and evaluation laboratory (DEMATEL)
- d) Evidence theory
- e) Petri nets
- f) VIKOR
- g) Multi-attributive border approximation area comparison (MABAC)
- h) Quality Function Deployment (QFD)
- i) Fault Tree Analysis (FTA)
- j) Statistical Process Control
- k) Design Of Experiments
- l) Hazard Analysis Critical Control Point (HACCP)
- m) Kano Method
- n) Project Management
- o) TRIZ Method
- p) HAZOP (Hazard and Operability Study)
- q) Service Blue Printing
- r) Cost basis
- s) Analytical Hierarchy Priority (AHP)
- t) Multi-Expert Multi-Criteria Decision Making

- u) Graph Theory
- v) Poisson Distribution
- w) Taguchi Loss Function
- x) Error Commonality Index
- y) Group Oriented Decision Making
- z) Izonote Concept
- aa) ANOVA (Analysis of Variance)
- bb) Data Envelopment Analysis (DEA)
- cc) Ishikawa diagram
- dd) Pareto analysis
- ee) Root Cause Analysis (RCA)
- ff) Activity-based costing (ABC)
- gg) Non-homogeneous Poisson point process (NHPPP)

25. What are the significant limitations of FMEA in your experience in HEIs? Please tick the top 5 that apply in your opinion.

- a) Time-consuming and tedious to trace failure
- b) A late application does not affect the decision-making of design and process.
- c) It depends on subjective analysis and engineers' experience
- d) The relationship between different failure components is disregarded.
- e) Demands continuous brainstorming activity
- f) A lengthy consensus-building process
- g) It may not capture all possible issues
- h) Works in a team-dependent environment only
- i) Only the high-risk failure modes are addressed
- j) Compound failure effects cannot be analysed

Table 1. Summary of the applications of FMEA within HEIs from the literature

Function/ Area of Application	Objective	Location	Authors
Administrative/ Academic Processes	Establish how the university could be more sustainable	Taiwan	Lin and Lo, 2023
Teaching	Improve the teaching of a module and student satisfaction ratings	Iran	Gorgani, 2016
Research fund management	Internal control of scientific research funds to ensure the effectiveness and sustainability of the risk management of scientific research funds	China	Sun and Deng, 2017
Environmental management function	Assessment of environmental risks	Iran	Nouri et al., 2010
Library function	Diagnosing and routing electronic service quality improvement of academic libraries	Iran	Mirghafoori et al., 2020
Cybersecurity/ information management in a research lab	Information security risk management enhancement in a research lab	Brazil	Silva et al., 2014
Research/teaching laboratory	Risk assessment and quality improvement of liquid waste management in Taiwan University chemical laboratories	Taiwan	Ho and Chen, 2018
Teaching	Assess the risk of failures in a mechanical engineering course on theory of machines and mechanisms	Spain	Bartolomé and Benítez, 2022

Table 2. Target samples and unit of analysis of the survey

Description	Participants
Target sample	Academics and practitioners who teach the FMEA subject or consultants of the FMEA method
Target respondents	Director, Dean, Head of Department, Faculty members, Registrar, Administrator, Librarian, IT Officer/Manager, Finance Officer and Administration Officer
Unit of analysis	HEIs in different countries

Table 3. Survey outcomes

Demographics		No. of Respondents (%)
Current position	Administrator	5 (6%)
	Director/Dean/HOD	8 (9%)
	Faculty members	59 (68%)
	PhD Candidate	4 (5%)
	Visiting Professors	10 (12%)
Experience in the present organisation	< 1 year	5 (6%)
	=10 years and <15 years	13 (15%)
	=15 years and <20 years	17 (20%)
	=20 years or 20 + years	14 (16%)
	=5 years and <10 years	19 (22%)
	Between 1 year and <5 years	18 (21%)
Continent	Asia	25 (29%)
	Europe	35 (41%)
	North America	12 (14%)
	Others	14 (16%)
Gender	Female	26 (30%)
	Male	60 (70%)
Type of University	Private	26 (30%)
	Public	60 (70%)
Total number of full-time employees	< 500	20 (23%)
	Between 501 and 1000	23 (27%)
	Between 1001 and 1500	5 (6%)
	>1501	38 (44%)
Formal training in FMEA	No	27 (31%)
	Yes	59 (69%)
Familiarity with FMEA	Extremely familiar	19 (22%)
	Very familiar	31 (36%)
	Familiar	28 (33%)

Demographics		No. of Respondents (%)
	Slightly familiar	8 (9%)
Teaching FMEA at the university	No	19 (22%)
	Yes	49 (78%)
Application of FMEA at the university	No	53 (62%)
	Yes	33 (38%)
Percentage of people trained in the university on FMEA	Less than 10%	67 (79%)
	Between 11-20%	9 (10%)
	Between 21-30%	7 (8%)
	Between 31-40%	1 (1%)
	More than 50%	2 (2%)
Frequency of FMEA usage	Almost every time	3 (4%)
	Almost never	32 (37%)
	Never	20 (23%)
	Sometimes	31 (36%)
Type risk factor usage in FMEA	Traditional 10-level scale	69 (80%)
	Fuzzy logic	13 (15%)
	Both	4 (5%)

Table 4. FMEA barriers to implementation

Barriers	Average
Lack of awareness regarding the benefits of the tool (A)	3.22
Lack of training on FMEA (B)	3.11
Lack of motivation to use the tool (C)	3.09
Lack of understanding of the tool as to when and where to use (D)	2.97
Lack of organisational culture (E)	2.86
Lack of top management commitment, involvement, leadership, and support (F)	2.70
Lack of communication (G)	2.69
Lack of availability of expertise, experience, and good team skills (H)	2.60
Lack of employee involvement and empowerment (I)	2.55
Lack of availability of data (J)	2.54
Lack of financial resources (K)	2.46

Table 5. Top five challenges and critical success factors of using FMEA

Challenges	Frequency	Critical Success Factors	Frequency
Lack of time due to other priorities in the organisation	64 (20%)	Knowledge about the FMEA tools	65 (28%)
Defining the failure modes, causes, and effects	44 (14%)	Management support	56 (24%)
Difficulties in representing the process	42 (13%)	Having a continuous improvement program	44 (19%)
Complex systems that have multiple functions consisting of several departments	40 (13%)	Widespread training	29 (13%)
Difficulty in incorporating all possible factors influencing the product/process	39 (12%)	Opportunity to use the tools	22 (10%)

Table 6. Top ten fuzzy logic expression calculation methods and techniques used for FMEA

Fuzzy logic expression	Frequency	Techniques	Frequency
Intuitionistic fuzzy sets (IFS)	4 (17%)	Root cause analysis (RCA)	39 (12%)
Centroid trapezoid fuzzy quantization	3 (13%)	Pareto analysis	31 (10%)
Interval type-2 fuzzy sets	3 (13%)	Ishikawa diagram	30 (9%)
BWM (Best Worst Method)	2 (8%)	Quality function deployment (QFD)	29 (9%)
Interval-valued intuitionistic fuzzy sets (IVIFS)	2 (8%)	Fault tree analysis (FTA)	27 (8%)
Probabilistic linguistic term sets	2 (8%)	Statistical process control	21 (7%)
Trapezoidal fuzzy numbers and fuzzy triangular numbers	2 (8%)	Project management	19 (6%)
Fuzzy belief structure	1 (4%)	Analysis of variance (ANOVA)	15 (5%)
Fuzzy evidential reasoning	1 (4%)	Kano method	14 (4%)
Fuzzy ordered weighted averaging (OWA)	1 (4%)	Design of experiments	13 (4%)

Table 7. Top five limitations of FMEA

Limitations	Frequency
Time-consuming and tedious to trace failure	42 (20%)
It may not capture all possible issues	31 (14%)
A lengthy consensus-building process	25 (12%)
Disregarding the relationship between different failure components	21 (10%)
Demands continuous brainstorming activity	21 (10%)

Table 8. Chi-square test for association between teaching and applying FMEA

	Value	df	Asymptotic significance (2-sided)	Exact sig. (2-sided)	Exact sig. (1-sided)
Pearson Chi-square	2.900 ^a	1	0.089		
Continuity Correction ^b	2.187	1	0.139		
Likelihood Ratio	2.897	1	0.089		
Fisher's Exact Test				0.118	0.070
No. of Valid Cases	86				
a. 0 cells (0.0%) have an expected count of less than 5. The minimum expected count is 14.20.					
b. Computed only for a 2x2 table					

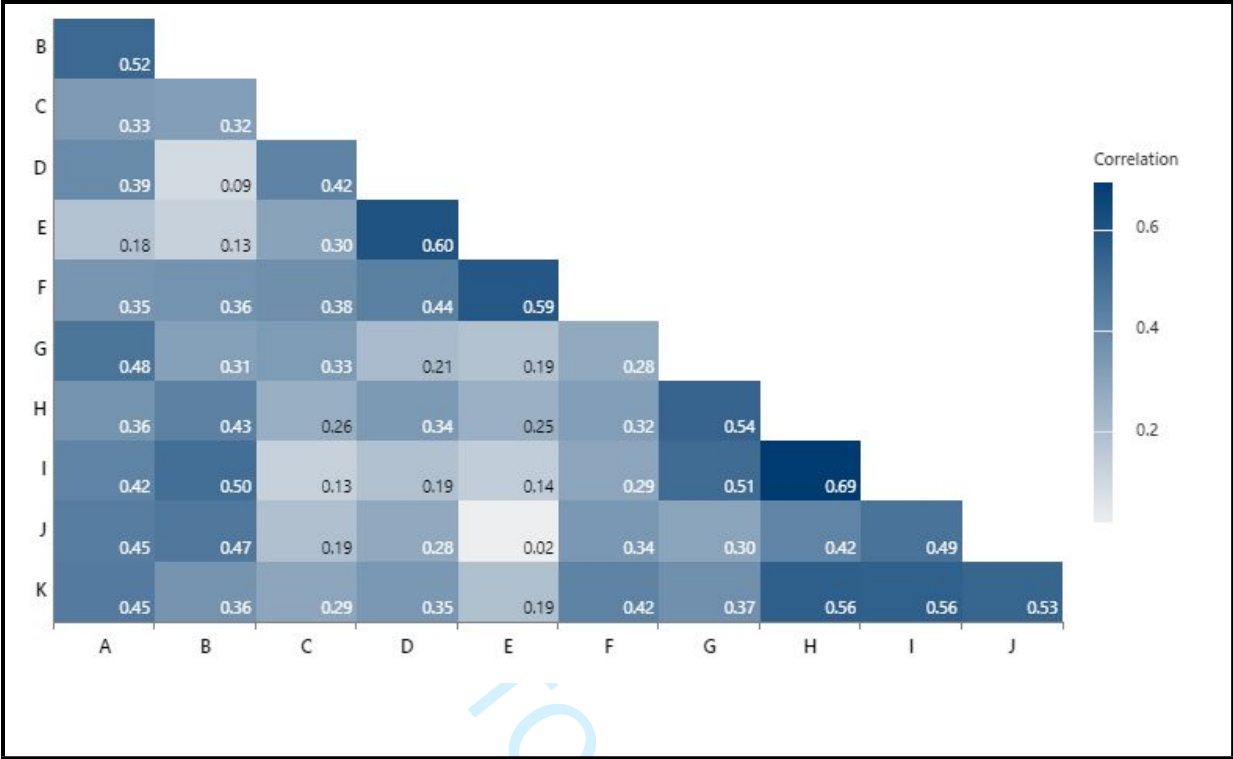


Figure 1. Correlation between the barriers

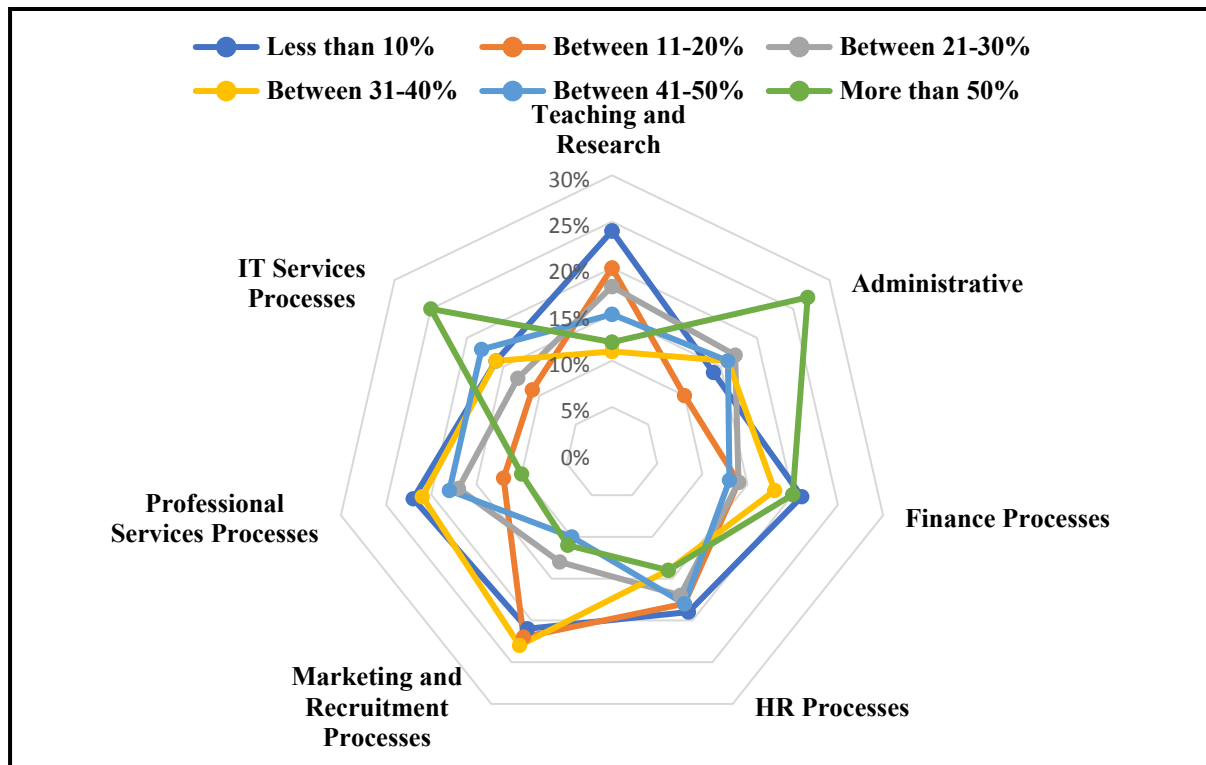


Figure 2. Percentage of quality problems with HEIs that using FMEA can address

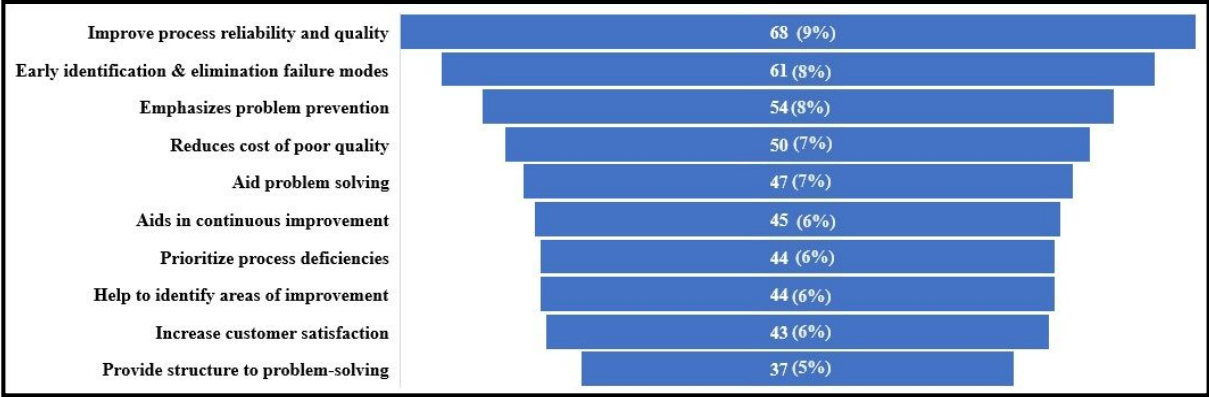


Figure 3. Top 10 benefits of FMEA

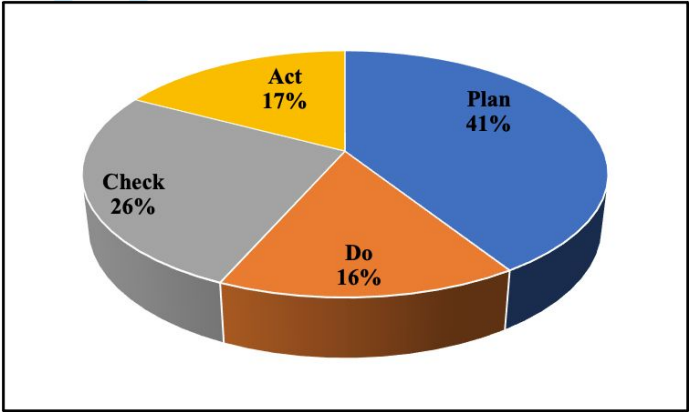


Figure 4. Frequency of usage of FMEA in continuous improvement phases

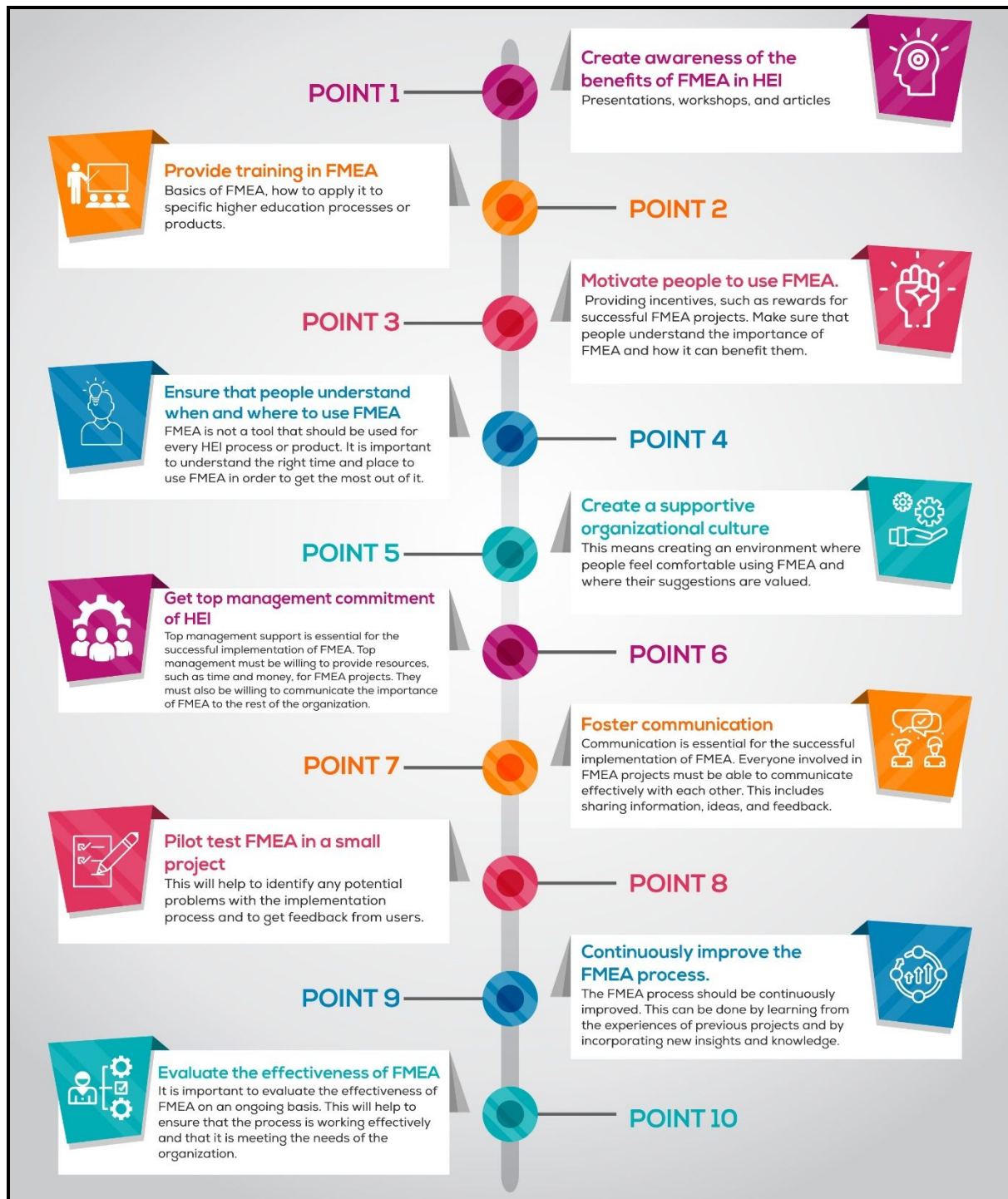


Figure 5. Ten commandments for FMEA deployment in the higher education sector

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Response to Reviewer comments

We have addressed all the reviewers' comments, and the manuscript has been revised accordingly. These suggestions helped us to improve the quality of the article further. The authors thank the reviewer for the positive and constructive feedback.

Reviewer: 1

Recommendation: Minor Revision

Comments:

However, any notes in part of the references. Please check one by one and revise again as part of the references. There are still some mistakes. Once revised, please process for the next phase.

Response: Thank you for the feedback. We have reviewed and corrected all of the references.

Additional Questions:

1. Originality: Does the paper contain new and significant information adequate to justify publication?: The paper contains new and significant information adequate to justify publication.

Response: Thank you for the feedback.

2. Relationship to Literature: Does the paper demonstrate an adequate understanding of the relevant literature in the field and cite an appropriate range of literature sources? Is any significant work ignored?: The paper demonstrates an adequate understanding of the relevant literature in the field and cites an appropriate range of literature sources.

However, any notes. Please check one by one and revise again in part of the references. There are still some mistakes. Once revised, please process for the next phase.

Response: Thank you for the feedback. We have corrected the references.

3. Methodology: Is the paper's argument built on an appropriate base of theory, concepts, or other ideas? Has the research or equivalent intellectual work on which the paper is based been well designed? Are the methods employed appropriate?: Methodology is appropriate.

Response: Thank you for the feedback.

4. Results: Are results presented clearly and analysed appropriately? Do the conclusions adequately tie together the other elements of the paper?: The conclusions adequately tie together the other elements of the paper.

Response: Thank you for the feedback.

5. Implications for research, practice and/or society: Does the paper identify clearly any implications for research, practice and/or society? Does the paper bridge the gap between theory and practice? How can the research be used in practice (economic and commercial impact), in teaching, to influence public policy, in research (contributing to the body of knowledge)? What is the impact upon society (influencing public attitudes, affecting quality of life)? Are these implications consistent with the findings and conclusions of the paper?: The implications for research, practice and/or society are good and okay.

Response: Thank you for the feedback.

6. Quality of Communication: Does the paper clearly express its case, measured against the technical language of the field and the expected knowledge of the journal's readership? Has attention been paid to the clarity of expression and readability, such as sentence structure, jargon use, acronyms, etc.: The Quality of Communication is good, no problem.

Response: Thank you for the feedback.

Reviewer: 2

Recommendation: Accept

Comments:

This study investigates the obstacles hindering the effective use of Failure Mode and Effect Analysis (FMEA) as a quality management tool in Higher Education Institutions (HEIs). Overall, the paper seems to be original, is quite well-written and the methodology employed is suitable to meet the research aim. Therefore, thanks to the accomplishment of the minor

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revisions suggested, the study seems to meet the standards of TQM Journal and can be recommended for publication.

Response: Thank you for the feedback.

Additional Questions:

1. Originality: Does the paper contain new and significant information adequate to justify publication?: This study investigates the obstacles hindering the effective use of Failure Mode and Effect Analysis (FMEA) as a quality management tool in Higher Education Institutions (HEIs). Overall, the paper seems to be original, is quite well-written and the methodology employed is suitable to meet the research aim.

Response: Thank you for the feedback.

2. Relationship to Literature: Does the paper demonstrate an adequate understanding of the relevant literature in the field and cite an appropriate range of literature sources? Is any significant work ignored?: The authors improved in the current version of the paper the section regarding the literature. The authors added additional bibliographic references in the entire section. The concept of continuous improvement has been clarified.

Response: Thank you for the feedback.

3. Methodology: Is the paper's argument built on an appropriate base of theory, concepts, or other ideas? Has the research or equivalent intellectual work on which the paper is based been well designed? Are the methods employed appropriate?: The procedure of data analysis and interpretation employed by the researchers has been clarified.

Response: Thank you for the feedback.

4. Results: Are results presented clearly and analysed appropriately? Do the conclusions adequately tie together the other elements of the paper?: The results section is well structured and clearly presented and it seems to be consistent with the research objectives previously stated.

Response: Thank you for the feedback.

5. Implications for research, practice and/or society: Does the paper identify clearly any implications for research, practice and/or society? Does the paper bridge the gap between

theory and practice? How can the research be used in practice (economic and commercial impact), in teaching, to influence public policy, in research (contributing to the body of knowledge)? What is the impact upon society (influencing public attitudes, affecting quality of life)? Are these implications consistent with the findings and conclusions of the paper?: The discussion of the results obtained is connected with the research aims. The implications of the study are debated adequately and are consistent with the findings obtained.

Response: Thank you for the feedback.

6. Quality of Communication: Does the paper clearly express its case, measured against the technical language of the field and the expected knowledge of the journal's readership? Has attention been paid to the clarity of expression and readability, such as sentence structure, jargon use, acronyms, etc.: The document is well written and the language employed is suitable.

Response: Thank you for the feedback.