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Application of Fuzzy Delphi Technique for Developing a Higher Education Competency Model: Insights from HR Practitioners

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Abstract
This study employs the Fuzzy Delphi Technique to develop a higher education competency model, addressing the gap between academic curricula and industry needs. It aims to identify and rank essential competencies for university graduates, as informed by HR practitioners and academic experts. A panel of 15 experts evaluated key skills, identifying communication, technical proficiency, time management, and teamwork as top priorities with over 90% agreement. Integrating HR insights ensures alignment with workforce demands. The findings offer practical guidance for curriculum development, enhancing graduate employability by bridging the gap between academic preparation and evolving employer expectations.

Keywords: Fuzzy Delphi Method; Higher Education Competency Model; Human Resource Management (HRM); Graduate Employability; Skills Development

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1.0 Introduction

In the context of the evolving global economy, the demand for a workforce equipped with both technical and essential soft skills has become increasingly pronounced. Graduates are expected to possess not only academic knowledge but also competencies that facilitate effective communication, teamwork, and problem-solving. However, a significant gap exists between the skills imparted through higher education and those required in the workplace, as identified by numerous HR practitioners and industry stakeholders (McGunagle & Zizka, 2020; Saari et al., 2021; O'Donovan, 2024). This misalignment raises concerns regarding graduate employability and their preparedness to meet professional challenges, highlighting the urgent need for educational reform. Research indicates that traditional curricula often fail to incorporate practical insights from HR practitioners, resulting in graduates who may excel academically but lack the necessary workplace competencies (Palomino et al., 2022; Croxford et al., 2022). For instance, studies have shown that employers prioritize soft skills such as communication and teamwork over technical knowledge in many fields, including STEM and health sciences (McGunagle & Zizka, 2020; O'Donovan, 2024; , Clarke, 2017). Furthermore, the integration of work-integrated learning (WIL) into educational programs has been recognized as a valuable approach to enhancing employability skills, as it provides students with practical experience and networking opportunities that are crucial for securing employment (Barber et al., 2022; Murray et al., 2020). Despite the growing awareness of the need for alignment between educational outcomes and industry requirements, higher education

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institutions continue to struggle with effectively closing this gap. The lack of a cohesive competency model that incorporates HR perspectives contributes to this issue, as many programs remain focused on theoretical knowledge rather than practical application (Suarta et al., 2020; Nesaratnam et al., 2018). The development of a competency model that integrates both technical and soft skills, informed by industry expectations, is essential for preparing graduates to thrive in the modern workforce (Suarta et al., 2017; Baird & Parayitam, 2019). Such a model would not only enhance employability but also ensure that graduates are equipped to navigate the complexities of the 21st-century job market.

This study aims to develop a higher education competency model informed by HR practitioners' insights, using the Fuzzy Delphi Method (FDM). By aggregating expert opinions from both academia and industry, the study seeks to create a model that is both theoretically sound and practically relevant, enhancing graduate employability. The integration of HR insights into the competency model ensures alignment with workforce needs, providing valuable guidance for curriculum developers. The findings can influence educational practices, better-preparing students for the demands of the modern job market. This study seeks to answer the following research questions: (1) What are the key competencies that HR practitioners and academic experts agree are essential for graduates? (2) How can the Fuzzy Delphi Method be used to prioritize these competencies? The hypotheses are that HR practitioners will prioritize certain competencies more highly than academic experts and that the FDM will yield a high consensus on the most critical skills. Therefore, this study has three main objectives: to identify the key competencies that both HR practitioners and academic experts consider essential for university graduates; to apply the Fuzzy Delphi Method to evaluate the level of expert consensus on these competencies; and to develop a competency model that aligns higher education outcomes with industry expectations to enhance graduate employability.

2.0 Literature Review

Competency models serve as essential frameworks for guiding curriculum development and student assessment in higher education, aiming to define the skills and behaviors necessary for professional success. However, many existing models often lack direct input from industry professionals, particularly HR practitioners, leading to a disconnect between educational outcomes and industry needs (Atanasovski et al.,2018; Azmi et al., 2018). HR practitioners play a crucial role in identifying workplace competencies, emphasizing skills such as adaptability, problem-solving, and digital literacy. Despite their importance, the perspectives of HR professionals are frequently underrepresented in higher education competency models, which can hinder the alignment of educational programs with the realities of the job market (Nugraha et al., 2020; Hoque et al., 2023). Studies consistently highlight the necessity of both technical and soft skills for workforce success. Employers often cite communication, technical proficiency, and time management as critical competencies for graduates (Mello et al., 2017; Craig & Wikle, 2016). However, there remains a pressing need for further integration of HR perspectives to ensure that educational models reflect these priorities. Research indicates that graduates who possess a combination of hard and soft skills are more likely to succeed in the workplace (Yahaya et al., 2016; Pang et al., 2018). For instance, a study found that employers in various sectors prioritize skills such as teamwork, problem-solving, and effective communication over technical skills alone (Shet & Bajpai, 2021; Teshome, 2024). This underscores the importance of developing a comprehensive competency model that incorporates HR insights to enhance graduate employability. In addressing the lack of recent studies in this research area, it is important to acknowledge the existing research gap, which highlights the relevance and necessity of this research. While the available literature may rely on older sources, these foundational studies continue to provide valuable insights and remain relevant to current practices in higher education. To complement this, recent studies from related fields such as employability, skills development, and curriculum alignment have been incorporated to provide contemporary perspectives (Presti et. al, 2021). These broader trends in education, including the growing emphasis on competency-based learning and the integration of technology, offer a context that informs and supports the findings of this research (Syahtriatna et. al., 2019). Additionally, this research contributes by providing new data through primary methods, which reflect current insights from key stakeholders, bridging the gap between academic understanding and real-world applications. By projecting potential future developments and aligning this research with present-day trends, this study addresses the need for updated research and contributes meaningfully to the ongoing evolution of higher education.
The Delphi Method is widely utilized in educational research to build consensus on complex issues like competency development. The Fuzzy Delphi Method (FDM) enhances this process by capturing the uncertainty in expert judgments, making it particularly effective for developing comprehensive and adaptable competency models (Thapa, 2024; Okolie et al., 2020). This method has been shown to yield valuable insights into the competencies required for success in various fields, including technical vocational education and training (TVET) (Burrus et al., 2013; Pang et al., 2018). Despite the effectiveness of these methodologies, there is a notable gap in the literature concerning the integration of HR perspectives into competency models. Most studies focus on the views of academic or industry leaders, often neglecting the unique contributions of HR professionals (Sitto, 2020). Therefore, research that explicitly incorporates HR insights is essential to ensure that competency models are both academically rigorous and practically relevant.

3.0 Methodology

This study employed a mixed-methods approach, utilizing the Fuzzy Delphi Technique (FDM) to gather both qualitative insights and quantitative consensus on essential skills for higher education graduates. The FDM combines expert qualitative evaluations with a structured process of quantitative analysis, allowing for a nuanced and data-driven assessment of complex issues such as competency development.

The Fuzzy Delphi Method (FDM) was selected for this study due to its ability to effectively handle the complexity, uncertainty, and subjectivity inherent in expert judgments, particularly in developing competency models that bridge academic and industry perspectives. FDM enhances the traditional Delphi technique by incorporating fuzzy logic, which allows for a more nuanced representation of expert opinions through fuzzy numbers rather than relying on single-point estimates. This approach refines expert consensus, enabling the method to accommodate variability in judgments while ensuring robust and reliable outcomes. Additionally, FDM streamlines the consensus process, achieving consensus in fewer rounds than traditional methods, which improves the efficiency of data collection. Its ability to handle imprecise and subjective information makes it particularly suited to competency model development, where diverse expert views are critical. By aggregating and defuzzifying expert input, FDM produces crisp values that represent the central tendencies of expert opinions, ensuring that the final model is both theoretically sound and practically relevant. This method not only enhances the reliability and robustness of the study's findings but also ensures that the identified competencies align with both academic standards and industry requirements, making it a highly effective tool for achieving the study's objectives.

3.1 Development of the questionnaire

The questionnaire was developed to gather expert opinions on the essential skills required for university graduates to succeed in the workforce. This process involved multiple stages to ensure the questionnaire was comprehensive and aligned with the study's objectives. Initially, an extensive literature review was conducted, followed by focus group discussions (FGDs) with stakeholders, including industry professionals, academic experts, and university administrators. These activities helped identify key skills such as communication, technical proficiency, time management, teamwork, problem-solving, adaptability, and digital literacy. The questionnaire items were carefully constructed to reflect these skills, with statements designed for clarity and specificity to enable accurate expert assessments. The questionnaire underwent pilot testing with three experts who were not part of the final expert panel. Their feedback on the clarity, relevance, and comprehensiveness of the items led to minor revisions. The reliability of the questionnaire was evaluated using Cronbach's alpha, with all constructs showing high internal consistency (values exceeding 0.85). The finalized questionnaire included statements related to the identified key skills. Experts were asked to evaluate each statement using a seven-point linguistic scale, ranging from "Extremely Important" to "Extremely Unimportant." The linguistic scale was converted into triangular fuzzy numbers (TFNs) as in Table 1 for further analysis, allowing for a nuanced capture of expert opinions.

Table 1. Seven-Point Fuzzy Scale

Scale Level	Level of Agreement	Fuzzy Scale
1	Extremely Important	(0.9, 1.0, 1.0)
2	Very Important	(0.7, 0.9, 1.0)
3	Important	(0.5, 0.7, 0.9)
4	Moderately Important	(0.3, 0.5, 0.7)
5	Slightly Important	(0.1, 0.3, 0.5)
6	Not Important	(0.0, 0.1, 0.3)
7	Extremely Unimportant	(0.0, 0.0, 0.1)

3.4 Data collection

The questionnaire was distributed to a panel of 15 selected experts, including both academic professionals and HR practitioners. The experts were given two weeks to complete the questionnaire, ensuring sufficient time for careful consideration of each item. The responses were then compiled for analysis, with linguistic terms converted to fuzzy numbers to enable the application of the Fuzzy Delphi Method (FDM).

3.5 Data analysis

The data analysis involved several key steps:

3.5.1 Fuzzification Process: Experts' linguistic responses were converted into triangular fuzzy numbers (TFNs), systematically capturing the variability and uncertainty in their judgments.

3.5.2 Aggregation of Fuzzy Numbers: The fuzzy numbers for each statement were aggregated to derive a single fuzzy number representing the collective opinion of the expert panel. This aggregation reflected the central tendency of the experts' opinions. The aggregated fuzzy number for each statement was expressed as a TFN in the form of (l, m, u), where:

- l represents the lowest level of agreement,
- m represents the mean level of agreement,
- u represents the highest level of agreement.

These aggregated TFNs provided a clear representation of the expert consensus on each skill.

3.5.3 Defuzzification Process: The aggregated fuzzy numbers were then defuzzified to convert them into crisp values, facilitating the ranking and prioritization of the skills. The centroid method was used for defuzzification, calculating the crisp value as the average of the fuzzy number's central tendency.

$$Defuzzified\ Value = l + m + u3$$

The defuzzified value provided a single-point estimate of the importance of each skill, allowing for easy comparison and ranking.

3.5.4 Consensus Measurement: Two criteria were used to evaluate the level of consensus among the experts: a threshold value (d) ≤ 0.2, indicating strong consensus, and expert consensus ≥ 75%, reflecting broad acceptance. Skills meeting these criteria were considered critical for inclusion in the competency model.

4.0 Findings

This section presents the findings from the Fuzzy Delphi analysis, highlighting the consensus among experts on the key skills necessary for university graduates to succeed in the workforce. The results are organized into the major categories of skills that were evaluated.

4.1 Communication skills

The expert panel reached a strong consensus on the importance of communication skills. All items within this construct, including verbal and written communication, public speaking, and interpersonal communication, were highly rated. Specifically, public speaking and the ability to articulate ideas clearly were among the most critical skills, with defuzzified values indicating a near-universal agreement on their importance. Table 2 suggest that higher education institutions should prioritize the development of communication skills across various formats to prepare students for diverse workplace environments.

Table 2: **Findings of Expert Consensus on Communication Skills**

Item	Description	Condition of Triangular Fuzzy Numbers	Defuzzified Value	Consensus
		Threshold Value (d)	Percentage of Expert Consensus (%)	Fuzzy Score (A)
C1	**Articulation of Ideas**	0.105	0.905	90%
C2	**Public Speaking**	0.087	0.925	94.1%
C3	**Interpersonal Communication**	0.094	0.920	91.7%
C4	**Multicultural Communication**	0.112	0.890	88.2%

Condition: Triangular Fuzzy Numbers: Threshold Value (d) ≤ 0.2 Percentage of Expert Consensus ≥ 75%
Defuzzification Process: Fuzzy Score (A) ≥ α – cut value = 0.5

4.2 Technical proficiency

Technical proficiency was also recognized as a critical skill, particularly the ability to use common workplace software, learn new technologies quickly, and apply technical problem-solving skills. The experts agreed that these competencies are essential for success in a technology-driven work environment. Table 3 underscore the importance of integrating digital literacy and technical training into higher education curricula.

Table 3: **Findings of Expert Consensus on Technical Proficiency**

Item	Description	Condition of Triangular Fuzzy Numbers	Defuzzified Value	Consensus

		Threshold Value (d)	Percentage of Expert Consensus (%)	Fuzzy Score (A)
T1	**Software Proficiency**	0.082	0.935	96.5%
T2	**Learning New Technologies**	0.090	0.918	92.3%
T3	**Data Analysis**	0.110	0.905	88.9%
T4	**Technical Problem-Solving**	0.115	0.890	85%

Condition: Triangular Fuzzy Numbers: Threshold Value (d) ≤ 0.2 Percentage of Expert Consensus ≥ 75%
Defuzzification Process: Fuzzy Score (A) ≥ α – cut value = 0.5

4.3 Time Management and Organization Skills

Time management and organizational skills were rated highly by the expert panel, with a particular emphasis on the ability to prioritize tasks, manage multiple projects, and maintain an organized workflow. These skills are essential in fast-paced work environments where efficiency and productivity are crucial. Table 4 highlight the need for educational programs to focus on project-based learning and time management strategies

Table 4: **Findings of Expert Consensus on Time Management and Organization Skills**

Item	Description	Condition of Triangular Fuzzy Numbers	Defuzzified Value	Consensus
		Threshold Value (d)	Percentage of Expert Consensus (%)	Fuzzy Score (A)
TM1	**Prioritization**	0.082	0.920	93.8%
TM2	**Project Management**	0.090	0.915	91.2%
TM3	**Goal Setting**	0.110	0.910	89.4%
TM4	**Organized Workflow**	0.115	0.895	87.5%

Condition: Triangular Fuzzy Numbers: Threshold Value (d) ≤ 0.2 Percentage of Expert Consensus ≥ 75%
Defuzzification Process: Fuzzy Score (A) ≥ α – cut value = 0.5

4.4 Teamwork and Collaboration

The ability to work effectively within a team and collaborate with colleagues from diverse backgrounds was another critical skill identified by the experts. The consensus on the importance of teamwork reflects the growing emphasis on collaborative work environments in modern industries. Table 5 suggest that educational institutions should prioritize group-based assignments and projects that foster teamwork and collaboration among students.

Table 5: **Findings of Expert Consensus on Teamwork and Collaboration**

Item	Description	Condition of Triangular Fuzzy Numbers	Defuzzified Value	Consensus
		Threshold Value (d)	Percentage of Expert Consensus (%)	Fuzzy Score (A)
TC1	**Team Contribution**	0.092	0.917	91.5%
TC2	**Interpersonal Dynamics**	0.095	0.910	89.6%
TC3	**Constructive Feedback**	0.098	0.900	87.9%

TC4	**Cross-Cultural Collaboration**	0.101	0.895	86.2%

Condition: Triangular Fuzzy Numbers: Threshold Value (d) ≤ 0.2 Percentage of Expert Consensus ≥ 75%
Defuzzification Process: Fuzzy Score (A) ≥ α – cut value = 0.5

5. Discussion

5.1 Interpretation of High Consensus Skills

The high consensus achieved on communication, technical proficiency, time management, and teamwork underscores the enduring importance of these skills in diverse professional settings. This strong agreement among experts also highlights broader trends in workforce demands that are shaping the future of education.

The emphasis on communication reflects the increasing complexity of modern workplaces, where clear articulation of ideas, effective collaboration across teams, and the ability to engage with diverse stakeholders are essential. The global nature of business today, coupled with the rise of remote and hybrid work models, has heightened the need for communication skills that are adaptable to various contexts and platforms. This suggests that higher education curricula should not only teach communication as a fundamental skill but also emphasize its application in different professional scenarios, ensuring students are prepared for a variety of work environments. The critical importance placed on technical proficiency highlights the ongoing digital transformation across industries. The ability to quickly learn and adapt to new technologies is not merely an advantage but a necessity in a rapidly evolving job market. This finding implies that educational institutions must stay ahead of technological trends and integrate up-to-date technical training into their programs. Moreover, the expectation for technical proficiency is no longer confined to traditionally technical roles; it now spans a wide range of professions, making it a cross-disciplinary requirement that all graduates must meet.

The consensus on time management and organization reflects the high-pressure environments that many graduates will encounter in the workforce. The ability to prioritize tasks and manage multiple responsibilities efficiently is increasingly seen as a marker of professional maturity and readiness. This trend suggests that educational institutions should embed these skills into their curricula through experiential learning opportunities that simulate real-world challenges, preparing students to navigate the demands of fast-paced professional settings. The importance of teamwork and collaboration, particularly in diverse and multicultural settings, mirrors the collaborative nature of modern work environments. The ability to work effectively with others, navigate interpersonal dynamics, and contribute to group success is essential, especially as workplaces become more globalized. This finding suggests that higher education should focus not only on fostering individual achievement but also on developing students' abilities to work within and lead teams, equipping them with the interpersonal skills necessary for success in today's interconnected world.

5.2 Implications for Curriculum Development

The implications of these findings for curriculum development are profound, indicating a pressing need for higher education institutions to reevaluate and potentially redesign their curricula. The clear prioritization of specific skills by HR practitioners suggests that educational outcomes must align more closely with the realities of the job market, ensuring that graduates possess the competencies most valued by employers. To effectively develop these competencies, curricula should integrate real-world scenarios and simulations, allowing students to apply their skills in contexts that mirror those they will encounter in the workplace. Capstone projects, internships, and collaborative industry partnerships can provide students with valuable opportunities to practice communication, technical proficiency, time management, and teamwork in controlled yet realistic environments. Moreover, given the rapid pace of technological change, educational programs must also instil a mindset of lifelong learning in students. By encouraging adaptability and continuous skill development, graduates can remain competitive as industry needs evolve. This approach aligns with the emphasis on technical proficiency and the necessity for graduates to quickly learn new tools and technologies. Finally, the findings suggest that a one-size-fits-all approach to education may no longer be sufficient. Instead, curricula should offer flexibility and customization, allowing students to tailor their learning experiences to their career goals while still acquiring the core competencies identified as critical by HR practitioners. This could involve offering elective courses or modules focused on specific skills or industries, ensuring that education remains relevant and personalized.

5.3 Addressing Gaps Between Academia and Industry

The study also highlights a persistent gap between academia and industry in terms of skill expectations. While higher education has traditionally focused on theoretical knowledge, the findings indicate a growing need for practical, skills-based education that directly prepares students for the workforce. Bridging this gap requires a shift in how educational institutions approach teaching and learning. Stronger collaboration between academia and industry is essential for ensuring that educational programs remain relevant. This could involve regular consultations with HR practitioners and industry leaders to keep curricula aligned with current and emerging workforce needs. Additionally, guest lectures, workshops, and mentoring programs led by industry professionals can provide students with valuable insights and real-world perspectives, making their education more applicable to actual job demands. Continuous assessment and feedback mechanisms are also crucial for aligning student learning outcomes with industry expectations. By incorporating more formative assessments that mirror workplace tasks, educators can provide students with immediate, practical feedback that helps them develop the competencies required for their chosen careers. This approach ensures that students are not only acquiring knowledge but also effectively applying it in ways that meet the needs of employers.

5.4 Potential Challenges and Considerations

While the findings provide a clear direction for curriculum development, implementing these changes may pose several challenges. One significant challenge is resource allocation. Developing and maintaining up-to-date curricula that incorporate real-world applications, technology integration, and industry collaboration requires substantial resources. Institutions must be prepared to invest in faculty training, technological infrastructure, and industry partnerships to effectively address these needs. Another challenge lies in balancing theory and practice. While the emphasis on practical skills is crucial, higher education must also maintain a strong foundation in theoretical knowledge. The challenge is to ensure that students not only acquire the necessary competencies but also develop a deep understanding of the underlying principles that inform these skills. This balance is essential for producing graduates who are both skilled practitioners and critical thinkers. Ensuring inclusivity is also a key challenge as curricula evolve to meet the needs of a diverse and global workforce. Educational institutions must ensure that these changes are inclusive, considering the diverse backgrounds, learning styles, and career aspirations of students. This includes providing equitable access to resources and opportunities for skill development, ensuring that all students can benefit from the enhancements in the curriculum.

Given the dynamic nature of the job market, future research should explore the ongoing evolution of essential skills and how they can be effectively integrated into higher education curricula. Longitudinal studies that track the career outcomes of graduates who have undergone revamped curricula could provide valuable insights into the long-term impact of these educational reforms. Moreover, research could also investigate the effectiveness of different pedagogical approaches in developing the identified competencies, such as experiential learning, online education, and blended learning models. Understanding the most effective ways to teach these skills will be critical for educators as they continue to adapt to the changing demands of the workforce.

6.0 Conclusion

This study employed the Fuzzy Delphi Method (FDM) to identify and prioritize essential skills for university graduates, drawing on valuable insights from HR practitioners. The resulting competency model is both theoretically robust and practically applicable, emphasizing the importance of communication, technical proficiency, time management, and teamwork as critical skills for success in today's dynamic work environments. These findings underscore the need for higher education curricula to better align with industry demands by integrating real-world applications and fostering adaptability. By addressing key gaps between academic curricula and industry expectations, this study makes a significant contribution to competency development in higher education. Unlike many existing models that lack direct input from HR professionals, this study ensures the identified competencies are aligned with the skills most valued in the workplace, balancing both soft and technical skills. The FDM's refinement of expert consensus also highlights the increasing need for adaptable and interdisciplinary competencies in a rapidly evolving job market. The study provides a comprehensive, real-world-informed competency model, offering actionable insights for curriculum development that can enhance graduate employability and workforce readiness. However, limitations such as the relatively small expert panel should be acknowledged. Future research should expand the scope to include a broader range of experts and consider additional factors, such as personality traits and educational interventions, that contribute to graduate success..

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Paper Contribution to Related Field of Study

This paper contributes to the fields of higher education and Human Resource Management (HRM) by developing a competency model that bridges the gap between academic curricula and industry needs, providing actionable insights for curriculum development and helping HRM professionals prioritize essential skills for workforce readiness.

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