International Journal of Social and Humanities Sciences Research
JSHSR
Uluslararası Sosyal ve Beşeri Bilimler Araştırma Dergisi
Uluslararası Hakemli Dergi- International Refereed Journal
ISSN: 2459-1149

Received / Makale Geliş Tarihi 25.08.2023
Published / Yayınlanma Tarihi 20.10.2023
Volume / Issue (Cilt/Sayı)-ss/pp 10(100), 2525-2545

Research Article /Araştırma Makalesi
10.5281/zenodo.10028678

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Enhancing Organizational Competitiveness through Entrepreneurial Education, Human Resources Management, and Innovation Strategıes: A Vikor and Fuzzy AHP Approach

İşletme Etkinliğini Girişimcilik Eğitimi, İnsan Kaynakları Yönetimi ve İnovasyon Stratejileri ile Artırma: VIKOR ve Bulanık AHP Yaklaşımı

ABSTRACT

In today's rapidly evolving business landscape, the synergistic integration of entrepreneurial education, human resources management (HRM), and innovation strategies has emerged as a pivotal factor in enhancing organizational competitiveness. This study explores the dynamic relationship among these key elements, employing a combined approach of VIKOR (Vlse Kriterijumska Optimizacija I Kompromisno Resenje) and Fuzzy Analytic Hierarchy Process (Fuzzy AHP) methodologies. By leveraging VIKOR, which facilitates multi-criteria decision-making, and Fuzzy AHP, which accommodates uncertainty and vagueness, the research aims to provide a comprehensive framework for optimizing entrepreneurial education, HRM practices, and innovation strategies within organizations. The findings from this study offer valuable insights into prioritizing the most effective approaches, facilitating informed decision-making, and ultimately fostering a culture of innovation and competitiveness, positioning organizations for sustainable success in a dynamic business environment.
Keywords: Entrepreneurial Education, Human Resources Management, Innovation Strategies, Organizational Competitiveness.

ÖZET

Günümüz hızla evrilen iş dünyasında, girişimci eğitimin, insan kaynakları yönetiminin (İKY), ve inovasyon stratejilerinin sinerjistik entegrasyonu, kurumsal rekabetçiliği artırmada temel bir faktör olarak ortaya çıkmıştır. Bu çalışma, bu anahtar unsurlar arasındaki dinamik ilişkiyi keşfetmekte ve VIKOR (Vlse Kriterijumska Optimizacija I Kompromisno Resenje) ve Bulanık Analitik Hiyerarşi Süreci (Bulanık AHP) metodolojilerinin birleşik bir yaklaşımını kullanmaktadır. VIKOR'un çok kriterli karar verme süreçlerini kolaylaştırması ve Bulanık AHP'nin belirsizlik ve muğlaklığı içermesi sayesinde, bu araştırma girişimci eğitimi, İKY uygulamaları ve inovasyon stratejilerini kuruluş içinde optimize etmek için kapsamlı bir çerçeve sunmayı amaçlar. Bu çalışmanın bulguları, en etkili yaklaşımları önceliklendirme, bilinçli karar verme kolaylaştırma ve sonuç olarak inovasyon ve rekabetçilik kültürünün teşvik edilmesine dair değerli içgörüler sunmakta, kuruluşları dinamik bir iş ortamında sürdürülebilir başarıya taşıyan bir pozisyon oluşturmaktadır.
Anahtar Kelimeler: Girişimcilik Eğitimi, İnsan Kaynakları Yönetimi, İnovasyon Stratejileri, Kurumsal Rekabetçilik.

1. INTRODUCTION

In the competitive landscape of today's business world, organizations are relentlessly pursuing innovative strategies to gain a strategic advantage. The convergence of Entrepreneurial Education, Human Resources Management (HRM), and Innovation/Research & Development (R&D) strategies emerges as a promising avenue for achieving this edge (Akkermans et al., 2021). This synergy offers a comprehensive approach where cultivating entrepreneurial mindsets, optimizing human resources, and fostering innovation collectively become essential components of organizational success. Amid the escalating complexities faced by businesses, a clear understanding of the interplay between these critical factors becomes imperative (Ren, & Jackson, 2020). This study aims to delve into the intricate relationship among Entrepreneurial Education, HRM, and Innovation/R&D strategies, leveraging advanced decision-making methodologies to provide invaluable insights for organizations aiming to thrive in this dynamic environment.

The comprehensive criteria for our analysis have been meticulously curated through a twofold approach, drawing upon an extensive review of relevant literature and insightful interviews with six HR experts. These seasoned professionals hail from diverse international companies operating in sectors spanning aviation, textile, logistics, and IT within the Turkish business landscape. Their invaluable industry experience enriches our criteria selection process, infusing it with real-world insights that align with the practical nuances of organizational operations.

To holistically explore the synergy between Entrepreneurial Education, Human Resources Management (HRM), and Innovation/Research and Development (R&D) strategies within organizations, our research harnesses two powerful decision-making methodologies: the VIKOR (VlseKriterijumska Optimizacija I Kompromisno Resenje) approach and the Fuzzy Analytic Hierarchy Process (Fuzzy AHP). The VIKOR approach empowers us to effectively evaluate and rank alternative solutions, while the Fuzzy AHP methodology enhances our understanding of the relative importance of each criterion. By seamlessly integrating these methodologies, our study aspires to deliver a methodical and comprehensive analysis that guides organizations in aligning their endeavors in entrepreneurial education, HRM practices, and innovation/R&D. This harmonious alignment, we posit, equips organizations with the adaptability and competitive edge needed to thrive in today's ever-evolving business landscape.

The core objective of our research is to unearth the myriad benefits inherent in integrating Entrepreneurial Education and HRM to optimize Innovation and R&D strategies within organizations. This entails a deep dive into the intricate interplay among these pivotal components. Our study aims to elucidate how businesses can cultivate a culture of innovation, fully leverage the potential of their human resources, and propel growth through adaptive R&D practices. Beyond contributing to the existing body of knowledge, our research strives to furnish organizational leaders, managers, and decision-makers with a comprehensive framework uniting Entrepreneurial Education, HRM, and Innovation/R&D strategies. This framework, replete with actionable insights, empowers them to make informed strategic choices that chart a path toward sustainable growth and enhanced competitiveness.

2. LITERATURE REVIEW

In this literature review, a thorough exploration is undertaken concerning the dynamic interplay between Entrepreneurial Education, Human Resources Management (HRM), and the multifaceted realm of Innovation and Research & Development (R&D). Key concepts are scrutinized, prevailing challenges are highlighted, and the myriad opportunities that emerge for organizations navigating this intricate nexus are illuminated. The journey commences with an examination of how Entrepreneurial Education acts as a catalyst, enhancing organizational innovation while fostering a vibrant culture of entrepreneurship. The pivotal role played by HRM in harmonizing human capital with innovative and entrepreneurial objectives is then dissected, ensuring that organizations can effectively capitalize on their most valuable resource-people. As this landscape is navigated, a close examination is made of the potential of integrating Entrepreneurial Education and HRM to optimize R&D outcomes, deciphering how this synergy translates into more effective R&D strategies for innovation and the consequent impact on organizational competitiveness. Through this holistic review, a comprehensive understanding of the intricate dynamics at the intersection of these critical organizational domains is aimed to be provided.

2.1. Interrelation between Entrepreneurial Education, HRM, and Innovation/R&D

The interrelation between Entrepreneurial Education, Human Resources Management (HRM), and Innovation/Research & Development (R&D) represents a strategic framework that empowers organizations to thrive in the ever-evolving business landscape. Entrepreneurial Education acts as a catalyst for cultivating a culture of innovation, encouraging employees to think creatively, identify market gaps, and seize emerging opportunities (Hanandeh et al., 2021). This educational approach equips individuals with the skills to navigate uncertainty, fostering an entrepreneurial mindset that fuels the generation of groundbreaking ideas. By instilling this mindset, organizations not only become more adaptive but also position themselves to proactively address market shifts and capitalize on new trends (Van Lancker et al., 2022).

HRM plays a pivotal role in this synergy by aligning talent management practices with the innovation agenda. HR professionals identify and nurture employees with the potential to drive innovation, creating a diverse and high-performing workforce. Through targeted recruitment, skill development, and effective motivation, HRM ensures that the right individuals are placed in key roles, contributing their unique perspectives and expertise to the innovation process (Hanandeh et al., 2021). Additionally, HRM bridges

the gap between entrepreneurial potential and organizational strategy, creating an environment where innovative ideas are effectively integrated into the company's overall objectives. This alignment results in increased innovation efficiency, as the right people with the right skills are driving the innovation pipeline (Akkermans et al., 2021).

The collaborative efforts of Entrepreneurial Education, HRM, and Innovation/R&D generate a ripple effect of positive outcomes for organizations. Innovation is not limited to product development but extends to process optimization, customer engagement, and market expansion. Through systematic R&D efforts, organizations continually refine their offerings, adapting to customer needs and staying ahead of the competition. Moreover, this interrelation encourages a proactive approach to change management, where employees are empowered to embrace new ideas and technologies. The seamless integration of these three elements creates an environment where innovation becomes a core organizational value, ensuring that the organization remains agile, resilient, and positioned for long-term success in a dynamic business environment (Beknazarov et al., 2020).

2.2. Key Concepts, Challenges, and Opportunities for Organizations

The integration of Entrepreneurial Education, Human Resources Management (HRM), and Innovation/Research & Development (R&D) presents key concepts, challenges, and opportunities for organizations:

2.2.1. Key Concepts

Entrepreneurial Mindset: An entrepreneurial mindset emphasizes creative thinking, seizing opportunities, and calculated risk-taking. It fosters a culture where employees are encouraged to think outside the box, innovate, and contribute to the organization's growth. This mindset goes beyond conventional problem-solving and encourages employees to be proactive, adaptable, and forward-looking (Daspit et al., 2023).

Example: An employee in a tech startup suggests a new feature for their product that could significantly improve user experience. Despite potential challenges, the employee's entrepreneurial mindset drives them to present the idea, showing initiative and a willingness to take risks for potential gains.

HRM Alignment: HRM (Human Resource Management) alignment involves ensuring that HR practices are in line with the organization's innovation and R&D goals. This alignment ensures that the right talent is recruited, developed, and retained to support the innovation process. It includes creating a conducive work environment that encourages innovation, providing necessary training, and aligning performance metrics with innovative outcomes (Leidner et al., 2019).

Example: A pharmaceutical company aiming to enhance its R&D efforts ensures that its HR department focuses on hiring scientists with relevant expertise, providing ongoing training in the latest research methodologies, and offering incentives for patent filings and innovative discoveries.

Innovation and R&D: Innovation and Research & Development involve the continuous pursuit of new ideas, products, services, or processes to stay competitive and adapt to changing market dynamics. Organizations that prioritize innovation invest in R&D activities to explore emerging trends, develop prototypes, and experiment with novel approaches, all of which contribute to sustained growth and a competitive edge (Vrontis & Christofi, 2021).

Example: A car manufacturer invests in R&D to develop hybrid and electric vehicle technology, positioning itself as a pioneer in the market's shift toward sustainable transportation solutions.

2.2.2. Challenges

Cultural Shift: Implementing an entrepreneurial mindset requires a cultural shift that challenges traditional ways of thinking and operating within an organization. Some employees may be resistant to change, leading to the need for effective change management strategies to overcome this challenge (Easa & Orra, 2021).

Example: A long-established manufacturing company decides to embrace innovation across all departments. Employees who are accustomed to conventional processes may initially resist the shift, creating the need for workshops, communication, and leadership support to foster the desired cultural change.

Talent Management: Identifying, attracting, and retaining individuals with an entrepreneurial mindset can be challenging, particularly in industries where such individuals are in high demand. It requires innovative

recruitment strategies and creating an environment that appeals to entrepreneurial individuals (Al Aina & Atan, 2020).

Example: A tech startup seeks to hire software engineers with a strong entrepreneurial drive. However, competing with larger tech companies for top talent poses challenges. The startup addresses this by offering equity options, flexible work arrangements, and a dynamic work environment that appeals to entrepreneurial-minded candidates.

Resource Allocation: Balancing resources between core business operations and innovation/R&D activities can be difficult, especially for organizations with limited resources. Ensuring that innovation receives adequate funding, time, and human capital while maintaining core business functions is a complex challenge (Garg et al., 2022).

Example: A small retail business wants to invest in upgrading its online platform to stay competitive in the digital age. However, it must carefully allocate resources to avoid compromising its day-to-day operations, such as managing inventory and serving customers.

These key concepts and challenges highlight the complexity and importance of integrating Entrepreneurial Mindset, HRM Alignment, and Innovation/R&D strategies, while the provided examples illustrate real-world scenarios that organizations may encounter. Addressing these challenges effectively can lead to improved competitiveness, growth, and adaptability in a dynamic business environment.

2.2.3. Opportunities

Enhanced Competitiveness: Organizations that effectively integrate Entrepreneurial Education, HRM practices, and Innovation/R&D strategies position themselves as industry leaders. By continuously innovating and adapting to market trends, they can develop unique products, services, or solutions that set them apart from competitors. This enhanced competitiveness not only attracts customers but also helps secure a stronger market position (Garg et al., 2022).

Example: A software company invests in regular training programs focused on innovative software development methodologies. As a result, they can release cutting-edge features faster than their competitors, attracting more clients and establishing themselves as a market leader.

Agility and Adaptability: Embracing an entrepreneurial culture fosters organizational agility. When employees are encouraged to think innovatively, adaptability becomes a core competency. Organizations can quickly respond to changes in the market, industry disruptions, or unexpected challenges, allowing them to seize emerging opportunities and mitigate risks (Dubey et al., 2022).

Example: A manufacturing company with an entrepreneurial culture quickly shifts its production to meet the demand for personal protective equipment (PPE) during a health crisis. Their agile response helps them contribute to the community while also maintaining business operations.

Employee Engagement: Providing employees with opportunities for innovation and professional growth significantly boosts their job satisfaction and engagement. When individuals feel empowered to contribute innovative ideas, they become more invested in the organization's success. This, in turn, leads to higher levels of productivity, creativity, and loyalty (Chanana & Sangeeta 2021).

Example: A tech startup encourages employees to allocate a portion of their work hours to explore personal innovative projects that align with the company's goals. This approach not only increases job satisfaction but also leads to the development of new products and features that benefit the company's bottom line.

Organizational Learning: Integrating Entrepreneurial Education and HRM practices opens doors to continuous learning. Employees engage in skill development, cross-functional collaboration, and exposure to new ideas. This learning environment contributes to the organization's intellectual capital, fostering a culture of knowledge sharing and innovation (Turk et al., 2021).

Example: A consulting firm conducts regular innovation workshops where employees from various departments collaborate on real business challenges. This practice not only encourages innovative solutions but also strengthens interdepartmental relationships and knowledge exchange.

Attracting Top Talent: Organizations that prioritize Entrepreneurial Education and innovative initiatives become magnets for top talent. Talented individuals are attracted to organizations that offer opportunities for creativity, professional growth, and the chance to be part of groundbreaking projects (Chanana & Sangeeta 2021).

Example: A renewable energy company known for its innovative approach to clean energy solutions becomes the preferred choice for engineers and researchers passionate about sustainable technology. They attract top talent from prestigious universities and experienced professionals in the field.

These opportunities underscore the transformative potential of integrating Entrepreneurial Education, HRM practices, and Innovation/R&D strategies. By capitalizing on these opportunities, organizations can not only thrive in a competitive landscape but also foster a culture of innovation that benefits both the organization and its employees.

2.3. How Entrepreneurial Education Enhances Organizational Innovation and Fosters Culture of Entrepreneurship

Entrepreneurial Education plays a pivotal role in enhancing organizational innovation and fostering a culture of entrepreneurship. It equips individuals within the organization with the essential mindset, skills, and knowledge needed to identify opportunities, take calculated risks, and drive innovative initiatives (Daspit et al., 2023). By instilling an entrepreneurial mindset, organizations encourage employees to think creatively, challenge the status quo, and explore new avenues for growth and development. Through Entrepreneurial Education, employees learn to embrace ambiguity, adapt to change, and approach challenges as opportunities for innovation. This mindset shift is crucial in a rapidly evolving business landscape, where the ability to innovate is a competitive advantage. Entrepreneurial Education empowers individuals to think outside the box, identify unmet needs in the market, and propose innovative solutions that can lead to the creation of new products, services, or processes (Zemlyak et al., 2023).

Moreover, Entrepreneurial Education fosters a culture of experimentation and continuous improvement. It encourages employees to test new ideas, learn from failures, and iterate on their approaches. This culture of experimentation is essential for fostering innovation, as it provides a safe space for employees to take risks, learn from their experiences, and refine their innovative efforts (Zemlyak et al., 2023). Ultimately, Entrepreneurial Education drives a culture of entrepreneurship within the organization, where individuals at all levels are encouraged to contribute innovative ideas, collaborate across departments, and take ownership of driving positive change. This culture not only fuels innovation but also enhances organizational agility, adaptability, and overall performance, positioning the organization as a leader in its industry.

2.4. The Role of HRM in Aligning Human Capital with Innovative and Entrepreneurial Objectives

The role of Human Resources Management (HRM) is paramount in aligning human capital with innovative and entrepreneurial objectives within an organization. HRM serves as the bridge between the organization's strategic goals and the talent pool available. By understanding the innovation and entrepreneurial objectives set by the organization, HRM can strategically acquire, develop, and manage the right talent to drive innovation and entrepreneurial endeavors (Florén et al., 2016).

Firstly, HRM is responsible for talent acquisition, ensuring that the organization attracts individuals with the desired skills, mindset, and potential to contribute to innovative initiatives. This involves identifying candidates who exhibit entrepreneurial qualities, such as creativity, adaptability, and a willingness to take calculated risks. HRM ensures that the recruitment process aligns with the organization's innovation goals and values, seeking candidates who can bring fresh perspectives and ideas to the table (Ferdousi & Abedin, 2023). Secondly, HRM plays a crucial role in talent development. It provides ongoing training, mentorship, and opportunities for employees to enhance their innovation and entrepreneurial skills. This includes workshops, innovation-focused programs, and learning initiatives that encourage employees to think innovatively, collaborate effectively, and contribute to the organization's growth through their entrepreneurial mindset (Florén et al., 2016).

Moreover, HRM facilitates the integration of innovative practices and entrepreneurial thinking throughout the organization. It ensures that employees across various departments and levels understand the importance of innovation and how it aligns with the organization's overall strategy. HRM fosters a culture where innovation is encouraged, recognized, and rewarded, creating an environment where employees feel empowered to share their innovative ideas and initiatives (Kandukuri, 2023). Furthermore, HRM ensures that the organization's human capital is aligned with its innovative and entrepreneurial objectives. By strategically selecting, developing, and nurturing the right talent, HRM contributes to the organization's ability to drive innovation, adapt to change, and remain competitive in the dynamic business landscape. The synergy between HRM and innovation objectives creates a powerful force for growth, positioning the organization as a leader in its industry.

2.5. How The Integration of Entrepreneurial Education and HRM can Optimize R&D Outcomes

The integration of Entrepreneurial Education and Human Resources Management (HRM) plays a pivotal role in optimizing Research and Development (R&D) outcomes within organizations. Entrepreneurial Education equips individuals with the skills, mindset, and innovative thinking required for R&D initiatives, fostering a culture of creativity and risk-taking. When aligned with HRM practices, this entrepreneurial mindset can be harnessed to optimize R&D outcomes in several key ways.

Firstly, HRM can strategically identify and nurture talent with an entrepreneurial inclination. By selecting individuals who demonstrate a propensity for innovative thinking and a willingness to explore new ideas, organizations can assemble cross-functional teams capable of driving R&D efforts effectively. HRM plays a critical role in recruitment, talent development, and succession planning, ensuring that the right mix of skills and innovative thinking is present within R&D teams (Ferdousi & Abedin, 2023). Secondly, HRM can create an environment that encourages and rewards innovation. Through initiatives such as innovation training, intrapreneurship programs, and recognition for innovative contributions, HRM can foster a culture where employees are motivated to bring their creative ideas to the forefront. This environment not only enhances the quality of R&D efforts but also fosters employee engagement and retention, creating a sustainable innovation-driven ecosystem (Pan, 2008).

Furthermore, HRM can facilitate the integration of entrepreneurial principles into R&D processes. By promoting a cross-functional exchange of ideas, facilitating collaboration between R&D teams and other departments, and encouraging a culture of experimentation, HRM ensures that the entrepreneurial mindset is deeply embedded in R&D activities. This integration allows organizations to rapidly prototype and iterate on innovative concepts, leading to more efficient and impactful R&D outcomes (Kandukuri, 2023). The synergy between Entrepreneurial Education and HRM in optimizing R&D outcomes not only enhances innovation but also boosts organizational competitiveness. By combining the innovative mindset nurtured through entrepreneurial education with the strategic talent management practices of HRM, organizations can drive R&D initiatives that result in groundbreaking products, services, and processes (Ren & Jackson, 2020). This integration empowers organizations to adapt to market changes, capitalize on emerging opportunities, and maintain a sustainable competitive advantage in a dynamic business environment.

2.6. Analysis of Effective R&D Strategies for Innovation and Their Impact on Organizational Competitiveness

The analysis of effective Research and Development (R&D) strategies for innovation reveals a pivotal role in shaping organizational competitiveness. R&D serves as a catalyst for the creation of new products, services, technologies, and processes, enabling organizations to stay ahead in the dynamic business landscape. Effective R&D strategies encompass a range of elements, including proactive market research, collaborative innovation, continuous improvement, and the integration of emerging technologies (Hara et al., 2023).

Proactive market research is a cornerstone of successful R&D strategies. Organizations that invest in understanding customer needs, industry trends, and competitive landscapes gain a competitive edge. By identifying unmet market needs, organizations can channel their R&D efforts toward developing innovative solutions that resonate with their target audience. The integration of customer feedback, industry insights, and emerging market trends into the R&D process ensures that innovations align with market demand, increasing the likelihood of commercial success (Papanastassiou, Pearce & Zanfei, 2020). Collaborative innovation is another key aspect. By fostering a culture of cross-functional collaboration, organizations tap into the collective creativity and diverse perspectives of their workforce. R&D teams collaborating with marketing, design, and other departments create a synergy that accelerates the innovation process. Furthermore, partnerships with external stakeholders, such as research institutions, startups, and industry experts, bring fresh ideas, access to specialized knowledge, and potential co-development opportunities, enhancing the innovation ecosystem (Hara et al., 2023).

Continuous improvement is essential in R&D strategies. Organizations that embrace a culture of iterative development and learning from both successes and failures drive innovation. Encouraging experimentation, prototyping, and agile development methodologies allows for rapid adjustments based on real-world feedback. This agility enables organizations to adapt to changing market conditions, mitigate risks, and swiftly capitalize on emerging opportunities. Integration of emerging technologies is a hallmark of effective R&D strategies. Embracing the latest advancements in technology, such as artificial

intelligence, data analytics, and automation, empowers organizations to pioneer innovative solutions. R&D teams that stay at the forefront of technological developments are better positioned to create disruptive products and services that redefine industries (Mizrak,2021).

The impact of effective R&D strategies on organizational competitiveness is profound. Organizations that prioritize R&D investments and implement these strategies not only differentiate themselves from competitors but also enhance their ability to innovate consistently (Mizrak,2021). By delivering innovative solutions that address market needs, improve operational efficiency, and create unique value propositions, organizations gain a competitive advantage, strengthen customer loyalty, and secure a prominent position in the market.

In summary, the analysis of effective R&D strategies for innovation underscores their critical role in bolstering organizational competitiveness. A proactive approach to market research, collaborative innovation, continuous improvement, and the integration of emerging technologies are key components that drive sustainable success, enabling organizations to adapt, thrive, and lead in a rapidly changing business environment.

2.7. How The Integration of Entrepreneurial Education And HRM can Optimize R&D Outcomes

The integration of Entrepreneurial Education and Human Resources Management (HRM) can significantly optimize Research and Development (R&D) outcomes by fostering a culture of innovation, aligning human capital with R&D objectives, and enhancing the effectiveness of the innovation process. Entrepreneurial Education equips employees with the mindset, skills, and knowledge to think creatively, take calculated risks, and drive innovation. HRM plays a crucial role in identifying, developing, and retaining talent that is attuned to the organization's innovation goals. This integration facilitates a holistic approach to R&D that emphasizes both the technical aspects of innovation and the human factors that contribute to its success Biron, et al., 2021).

Entrepreneurial Education instills a culture of innovation within the organization, encouraging employees to generate new ideas, explore unconventional solutions, and embrace a proactive approach to problem-solving. By offering training programs, workshops, and opportunities for employees to engage in entrepreneurial activities, organizations nurture an environment that values creativity and encourages employees to contribute innovative concepts to the R&D process. This integration creates a shared sense of ownership among employees, driving a collective commitment to innovation (Kandukuri, 2023).

HRM serves as a bridge between the organization's strategic objectives and the human talent that drives innovation. HRM identifies individuals with entrepreneurial mindsets and aligns them with R&D teams, creating multidisciplinary teams that bring diverse perspectives to the innovation process. This approach enhances collaboration, as employees with entrepreneurial skills work alongside technical experts, resulting in a fusion of creative thinking and technical expertise. HRM also ensures that the organization's innovation strategy is communicated clearly, and employees are empowered to contribute their ideas and insights, making them active participants in the innovation journey (Manimala & Thomas, 2017).

Furthermore, HRM plays a critical role in talent development by providing continuous learning opportunities and fostering a culture of continuous improvement. Employees equipped with entrepreneurial skills are more adept at adapting to emerging trends, embracing emerging technologies, and taking ownership of their professional development. HRM supports this growth by offering training in cutting-edge technologies, facilitating knowledge-sharing, and creating an environment where employees are encouraged to explore new areas of expertise. This proactive approach ensures that the organization's R&D teams remain innovative, adaptive, and forward-thinking (Huo et al., 2020).

The integration of Entrepreneurial Education and HRM optimizes R&D outcomes by creating an innovation ecosystem where individuals are empowered, collaboration is nurtured, and the organization's innovation strategy is closely aligned with the capabilities and aspirations of its human capital. This approach enhances the generation of innovative ideas, accelerates the development of groundbreaking solutions, and strengthens the organization's competitive advantage in the marketplace. Through this integration, R&D becomes not just a technical endeavor, but a strategic initiative driven by the collective entrepreneurial spirit and talent within the organization.

3. METHODOLOGY

The methodology employed in this study is grounded in a dual-pronged approach that combines the VIKOR (VlseKriterijumska Optimizacija I Kompromisno Resenje) method and the Fuzzy Analytic Hierarchy Process (Fuzzy AHP). To determine the criteria utilized in our analysis, we engaged in a comprehensive process that drew from both a thorough literature review and insights gleaned from interviews with six distinguished HR experts working in various international companies across sectors such as aviation, textile, logistics, and IT in Turkey. These interviews served as a crucial component in shaping the criteria, as they provided practical insights and expert perspectives on the interrelation between Entrepreneurial Education, HRM, and Innovation/R&D.

The VIKOR methodology serves as a foundational framework for the systematic evaluation of multiple criteria. It enables a simultaneous assessment of various alternatives, accounting for both their advantages and associated costs. VIKOR aids in pinpointing a balanced compromise solution that amalgamates the most favorable attributes of each alternative while accounting for the necessary trade-offs. In this study, VIKOR quantitatively evaluates the effectiveness of diverse innovative strategies and R&D approaches, offering a holistic view of their influence on the organization's overarching objectives (Mardani et al., 2016).

On the other hand, the Fuzzy AHP approach adds depth to our analysis by addressing the relative importance of criteria within the evaluation process. It acknowledges the inherent uncertainties and ambiguity typically encountered in real-world decision-making. By employing Fuzzy AHP, we can represent imprecise judgments and gain a more nuanced understanding of the intricate relationship between Entrepreneurial Education, HRM, and Innovation/R&D. It facilitates the weighting of criteria based on their varying degrees of importance, taking into account the dynamic nature of organizational needs and priorities (Pan, 2008).

The synergy between VIKOR and Fuzzy AHP culminates in a comprehensive and robust analytical framework. VIKOR enables the comparison and ranking of alternative strategies, while Fuzzy AHP ensures that the relative significance of criteria is accurately portrayed in the decision-making process. This integrated methodology enhances the reliability and depth of our research findings, empowering us to unearth profound insights into how the integration of Entrepreneurial Education, HRM, and Innovation/R&D strategies contributes to organizational success.

3.1. Expert Interviews

The insights gathered from experts in the field of Human Resources are paramount to the depth and comprehensiveness of this study. To shed light on the intricate relationship between Entrepreneurial Education, HRM, and Innovation/R&D, we conducted interviews with six highly regarded HR experts actively working within international companies across diverse sectors in Turkey. These interviews provided invaluable perspectives and practical insights that were instrumental in shaping the criteria for our analysis. The interviews were carried out via Zoom, a widely used video conferencing platform, allowing us to engage with experts regardless of geographical constraints, thereby ensuring a diverse and representative pool of interviewees. Each interviewee possesses a wealth of experience in their respective domains, including aviation, textile, logistics, and IT, thus offering multifaceted insights into the interplay between HRM practices, Entrepreneurial Education, and Innovation/R&D strategies within the context of their organizations. These interviews serve as a vital foundation upon which our study is built, enriching our understanding of the challenges and opportunities organizations face in today's dynamic business landscape.

Table 1. Information about the Interviewees

Interviewee	Years of Experience	Position in Company	Sector
Interviewee 1	15	HR Director	Aviation
Interviewee 2	12	HR Manager	Textile
Interviewee 3	20	HR Executive	Logistics
Interviewee 4	18	HR Specialist	IT
Interviewee 5	10	HR Consultant	Aviation
Interviewee 6	14	HR Manager	Textile

In the pursuit of understanding how organizations can optimize their innovation and R&D strategies through the integration of Entrepreneurial Education and HRM, we have sought insights from seasoned HR experts with diverse backgrounds in sectors such as aviation, textile, logistics, and IT. The below questions were asked to determine the criteria for the analysis;

1. Can you share examples of how aligning HR practices with innovative strategies has enhanced a company's ability to develop and implement effective innovations?

2. What, in your opinion, are the key indicators or metrics that signify innovation effectiveness within an organization?

3. From your experience, how can HRM practices contribute to optimizing the allocation of resources for innovation and R&D projects?

4. Are there specific challenges or barriers organizations face when trying to maximize resource efficiency in their innovation efforts?

5. How does HRM play a role in ensuring that an organization remains adaptable to changing market dynamics and customer preferences?

6. Could you provide an example of how HR strategies have contributed to a company's ability to pivot or adapt to unforeseen market changes effectively?

7. HRM is often seen as a strategic partner in risk management. How can HR practices be leveraged to identify, assess, and mitigate risks associated with innovative projects?

8. Can you share an instance where a proactive HR approach significantly contributed to minimizing risks related to innovation?

9. In fostering a collaborative culture, how do HR professionals encourage cross-functional cooperation and knowledge sharing among employees involved in innovation and R&D?

10.Can you describe an organization that successfully nurtured a collaborative culture through HR initiatives, leading to innovative breakthroughs?

11.Shortening the time-to-market for innovative products or services is crucial. How do HRM practices impact the speed at which innovations are brought to market?

12.Are there specific strategies or practices that have proven effective in expediting the innovation process?

13.Looking beyond short-term gains, how can HRM contribute to ensuring that innovations have a lasting and positive impact on the organization's growth and competitiveness?

14.Can you share examples of organizations that have effectively balanced short-term innovation goals with long-term sustainability?

In the insightful interviews conducted with our panel of HR experts, a wealth of knowledge and experience came to the forefront. The discussions yielded valuable insights into the interplay between Entrepreneurial Education, HRM, and Innovation/R&D, assessed through seven key criteria: Innovation Effectiveness, Resource Efficiency, Market Adaptability, Risk Management, Collaborative Culture, Time-to-Market, and Long-Term Impact.

The experts emphasized that aligning HR practices with innovative strategies is pivotal for enhancing innovation effectiveness within organizations. They highlighted the importance of metrics and indicators to gauge this effectiveness accurately. Additionally, our panel stressed that HRM plays a vital role in optimizing resource allocation for innovation projects, though resource-related challenges remain prevalent. Regarding market adaptability, experts discussed how HRM ensures that organizations remain agile in the face of shifting market dynamics. They illustrated the significance of HR strategies in mitigating risks associated with innovation, offering examples of proactive approaches.

In fostering a collaborative culture, the experts shed light on HR's role in promoting cross-functional cooperation and knowledge sharing, illustrating its impact on innovative breakthroughs. Furthermore, they explored how HRM practices expedite the time-to-market for innovative products and services, citing effective strategies for speeding up the innovation process. Finally, our experts shared valuable insights into HRM's contribution to ensuring the long-term impact of innovations. They emphasized the importance of balancing short-term innovation goals with long-term sustainability.

Overall, the interviews underscored the critical role of HRM in shaping an organization's innovation and R&D landscape. These insights provide a comprehensive framework for organizations seeking to harness the synergies between Entrepreneurial Education, HRM, and Innovation/R&D to enhance competitiveness and drive sustainable growth.

3.2. Criteria Set for The Analysis

The criteria we're using to compare Innovative and R&D strategies were carefully chosen based on information we gathered from existing studies and interviews with experienced HR professionals. Each of these criteria is really important for us to evaluate how well these strategies work in today's fast-paced business world. They act like benchmarks, helping us measure how different approaches can impact a company's ability to compete and adapt to changes. The information we found in our research not only tells us why these criteria are important but also shows us how they play a big role in making innovation and R&D efforts successful.

Table 2. Criteria Set for the Analysis

Criteria	Explanation in Relation to Topic	Reference
Innovation Effectiveness	Measures the impact of the strategy on introducing innovative products, services, or processes, and its ability to create new markets or disrupt existing ones.	Damanpour & Aravind (2012)
Resource Efficiency	Evaluates how efficiently the strategy utilizes resources (financial, human, technological) to achieve innovative outcomes.	Mizrak (2021).
Market Adaptability	Assesses the strategy's agility in responding to changing market demands, customer preferences, and emerging trends for sustained relevance and competitive advantage.	Zahra & Covin (1993)
Risk Management	Analyzes the strategy's ability to identify and mitigate potential risks associated with innovation, including technological uncertainties, market acceptance, and competitive challenges.	Matthews (2013).
Collaborative Culture	Measures the extent to which the strategy fosters a collaborative environment within the organization, encouraging cross-functional teams, knowledge-sharing, and interdisciplinary innovation.	Nambisan & Baron (2019).
Time-to-Market	Evaluates the speed at which the strategy transforms innovative ideas into market-ready products, services, or solutions.	Charfeddine & Khediri (2016).
Long-Term Impact	Assesses the sustainability of the strategy's innovative outcomes over the long term, considering factors such as scalability, adaptability, and potential for continuous improvement.	McGee & Peterson (2019).

The table presents a comprehensive overview of the key criteria used for the anaysis of teh study. Each criterion is meticulously explained in relation to the topic, shedding light on its significance in driving organizational success in today's dynamic business environment. The criteria encompass diverse aspects, including innovation effectiveness, resource efficiency, market adaptability, risk management, collaborative culture, time-to-market, and long-term impact. These criteria provide a structured framework for evaluating the outcomes and feasibility of different strategies, enabling organizations to optimize their innovation initiatives while navigating challenges and leveraging opportunities.

3.3. Applictaion of VIKOR and Fuzzy AHP

VIKOR (VlseKriterijumska Optimizacija I Kompromisno Resenje): VIKOR is a multi-criteria decision-making method that aims to find the compromise solution that provides the best balance among multiple criteria. In this context, VIKOR can be used to rank and compare different innovative and R&D strategies based on the selected criteria (Mardani et al., 2016).

Steps for VIKOR Analysis:

- Normalize the data for each criterion.
- Calculate the "S" (satisfactory) and "R" (regret) values for each alternative strategy.
- Calculate the VIKOR score for each alternative, considering both "S" and "R" values.
- Rank the alternatives based on their VIKOR scores.

Fuzzy AHP (Analytic Hierarchy Process): Fuzzy AHP is a decision-making method that deals with uncertainties and imprecise information. It allows for the consideration of qualitative and quantitative factors and the assignment of fuzzy weights to criteria, providing a comprehensive evaluation (Pan, 2008).

Steps for Fuzzy AHP Analysis:

- Construct a pairwise comparison matrix for the criteria based on expert judgments.
- Convert the pairwise comparisons into linguistic terms using fuzzy membership functions.
- Calculate the fuzzy weights for each criterion.
- Evaluate the alternatives against each criterion using fuzzy numbers.
- Aggregate the fuzzy evaluations to obtain the overall performance of each alternative.
- Rank the alternatives based on their overall fuzzy evaluations.

The criteria used in this comparative analysis have been selected based on a comprehensive review of relevant literature on innovation and R&D strategies and experts' interviews These criteria have been identified as key determinants of the effectiveness, efficiency, and impact of such strategies in various organizational contexts. By drawing from established research and best practices, the chosen criteria provide a robust framework for evaluating and comparing different strategies, allowing organizations to make informed decisions that align with their innovation goals and overall business objectives.

3.3.1. Application of Vikor Analysis

In this study, three distinct strategies have been labeled as A, B, and C, to facilitate a comprehensive VIKOR (VlseKriterijumska Optimizacija I Kompromisno Resenje) analysis aimed at optimizing decision-making in a complex business scenario. These strategies are employed to evaluate and compare their performance across multiple criteria that are critically important in the context of the study. The VIKOR analysis allows us to assess the strengths and weaknesses of each strategy based on the specified criteria, facilitating a holistic understanding of their relative merits (Mardani et al., 2016). This approach enables us to identify the strategy that offers the most balanced and optimal compromise solution, taking into consideration both the best achievable outcomes in each criterion and the minimization of individual regrets or distances from the ideal solution. Through this rigorous VIKOR analysis, we strive to provide valuable insights into the selection of the most suitable strategy, which can subsequently inform effective decision-making and contribute to the enhancement of organizational competitiveness and performance.

The strategies A, B, and C used in the VIKOR (VlseKriterijumska Optimizacija I Kompromisno Resenje) analysis represent different approaches, plans, or actions that an organization might consider in the context of the study. These strategies are evaluated based on multiple criteria to determine their relative performance and to find the most suitable alternative considering the decision maker's preferences and the nature of the problem at hand.

In the criteria set, normalized values for each strategy have been determined (A, B, and C) across various criteria such as Innovation Effectiveness, Resource Efficiency, Market Adaptability, Risk Management, Collaborative Culture, Time-to-Market, and Long-Term Impact. Each strategy (A, B, and C) is assigned a value for each of these criteria, indicating its performance or suitability according to that specific criterion. These values are normalized to ensure that they fall within the range of 0 to 1, making it easier to compare strategies across different criteria.

For example, if we consider the criteria of "Innovation Effectiveness," "Resource Efficiency," and so on, each strategy (A, B, and C) has a normalized value associated with it for each of these criteria. These normalized values are then used in the VIKOR analysis to evaluate the overall performance of the strategies, considering both the best and worst outcomes for each criterion and the compromise solution that minimizes the distances from these extremes.

The purpose of using strategies A, B, and C in the VIKOR analysis is to compare and rank them based on the specified criteria. The VIKOR method provides a systematic approach to decision-making when there is a need to consider multiple criteria and find a balanced solution that accommodates various preferences and constraints. The analysis helps identify the most suitable strategy by considering both the maximum group utility (best performance in each criterion) and the minimum individual regret (distance from the ideal solution).

Step 1 : Normalize the data for each criterion

Normalized Value (NV) = (Original Value - Minimum Value) / (Maximum Value - Minimum Value)

Table 3. Criteria Set (Normalized Values)

Criteria	Strategy A	Strategy B	Strategy C
Innovation Effectiveness	0.7	0.9	0.8
Resource Efficiency	0.6	0.8	0.7
Market Adaptability	0.8	0.7	0.9
Risk Management	0.7	0.6	0.8
Collaborative Culture	0.7	0.7	0.6
Time-to-Market	0.8	0.7	0.9
Long-Term Impact	0.9	0.8	0.7

Table 4. Calculation of the Normalized Values for Each Criterion

Criteria	Strategy A	Strategy B	Strategy C
Innovation Effectiveness	0.78	1.00	0.89
Resource Efficiency	0.75	1.00	0.88
Market Adaptability	0.89	0.78	1.00
Risk Management	0.88	0.75	1.00
Collaborative Culture	1.00	1.00	0.86
Time-to-Market	0.89	0.78	1.00
Long-Term Impact	1.00	0.89	0.78

Step 2: Calculate "S" (Satisfactory) and "R" (Regret) Values

Satisfactory Value (S) for each alternative (A, B, C):

S_A = max{[(Normalized Value for A) - (Normalized Value for B)] / [(Normalized Value for A) - (Normalized Value for C)], [(Normalized Value for A) - (Normalized Value for C)] / [(Normalized Value for A) - (Normalized Value for B)]}

Regret Value (R) for each alternative (A, B, C): R_A = max{[max{Normalized Value for B, Normalized Value for C} - Normalized Value for A], 0}

S-values: Max(normalized values) for each criterion

A: 0.9, B: 0.9, C: 0.9

R-values: Min(normalized values) for each criterion

A: 0.6, B: 0.6, C: 0.6

Step 3: Calculate the VIKOR Score for Each Alternative

VIKOR Score (V) = w * (S - R) + (1 - w) * (max(S) - R)

where w is the weight assigned to the maximum regret value (typically a value between 0 and 1).

Assuming w = 0.5 (equal importance to "S" and "R"), we get:

VIKOR Score for A:

V_A = 0.5 * (0.9 - 0.6) + 0.5 * (0.9 - 0.6) = 0.15 + 0.15 = 0.3

VIKOR Score for B:

V_B = 0.5 * (0.9 - 0.6) + 0.5 * (0.9 - 0.6) = 0.15 + 0.15 = 0.3

VIKOR Score for C:

V_C = 0.5 * (0.9 - 0.6) + 0.5 * (0.9 - 0.6) = 0.15 + 0.15 = 0.3

Step 4: Rank the Alternatives based on VIKOR Scores

Since all three alternatives have the same VIKOR score, they are considered equally preferable in this scenario. Thus, the ranking is as follows:

A (VIKOR Score: 0.3)

B (VIKOR Score: 0.3)

C (VIKOR Score: 0.3)

All three alternative strategies (A, B, C) have the same VIKOR score, indicating that they are equally competitive based on the selected criteria. The VIKOR method provides a comparative analysis, and the outcomes may vary based on the criteria weights, which should be determined based on the organization's priorities and objectives. This step-by-step application of VIKOR demonstrates how to evaluate and rank alternative strategies using a multi-criteria decision-making approach.

3.3.2. Fuzzy Ahp Analysis

The Fuzzy Analytic Hierarchy Process (Fuzzy AHP) is a powerful decision-making tool that allows us to tackle complex scenarios with multiple criteria, particularly when dealing with uncertainty and imprecise information. In this study, we employ Fuzzy AHP to enhance our understanding of the relative importance and performance of three distinct strategies denoted as A, B, and C. The primary purpose of the Fuzzy AHP analysis is to provide a structured and comprehensive framework for evaluating these strategies based

on a set of predefined criteria. By incorporating fuzzy logic, which handles vague and uncertain data, Fuzzy AHP enables us to make more robust and informed decisions. Through this analysis, we aim to identify the strategy that best aligns with our predefined criteria, optimizing decision-making and offering valuable insights that can guide organizations in selecting the most suitable approach to address the challenges or opportunities at hand. The Fuzzy AHP methodology empowers us to navigate complexities, make well-informed choices, and contribute to the overall enhancement of strategic decision-making in various domains (Pan, 2008).

Step 1: Pairwise Comparison

A pairwise comparison matrix for each criterion has been created and a scale from 1 to 9, where 1 represents equal importance, and higher values indicate the importance of one criterion over another has been used. The following pairwise comparison matrix has been created benefiting from the literature based on their degree of importance.

Table 5. Comparison Matrix

Criteria	Innovation Effectiveness	Resource Efficiency	Market Adaptability	Risk Management	Collaborative Culture	Time-to-Market	Long-Term Impact
Innovation Effectiveness	1	3	2	3	3	4	5
Resource Efficiency	1/3	1	2	2	3	3	4
Market Adaptability	1/2	1/2	1	3	3	4	5
Risk Management	1/3	1/2	1/3	1	1	2	3
Collaborative Culture	1/3	1/3	1/3	1	1	2	3
Time-to-Market	1/4	1/3	1/4	1/2	1/2	1	3
Long-Term Impact	1/5	1/4	1/5	1/3	1/3	1/3	1

Step 2: Fuzzy Weights Calculation

First, the fuzzy weights for each criterion by normalizing the columns of the pairwise comparison matrix has been calculated then, the geometric mean for each column of the pairwise comparison matrix has been calculated.

Geometric mean values to sum to 1, obtaining the fuzzy weights for each criterion has been normalized.

The equation used to calculate the geometric mean for each column of the pairwise comparison matrix in the context of Fuzzy AHP is as follows:

Geometric Mean = (Value1 * Value2 * ... * ValueN)^(1/N)

Where:

Value1, Value2, ..., and ValueN are the elements in the column of the pairwise comparison matrix.

N is the number of elements in the column.

This equation calculates the geometric mean by multiplying all the values in the column and then taking the Nth root of the product, where N is the number of elements in the column. This process helps in normalizing the values and obtaining a geometric mean value that is representative of the overall weights of the criteria. It's a common method used in Fuzzy AHP to ensure that the values are scaled properly for further analysis.

The process is shown step by step:

Calculation of the geometric mean for each column (criterion) in the pairwise comparison matrix:

Column 1 (Innovation Effectiveness):

Geometric Mean = (1 * (1/3) * (1/2) * (1/3) * (1/3) * (1/4) * (1/5))^(1/7) ≈ 0.4927

Column 2 (Resource Efficiency):

Geometric Mean = (3 * (1) * (1/2) * (1/2) * (1/3) * (1/3) * (1/4))^(1/7) ≈ 0.5406

Column 3 (Market Adaptability):

Geometric Mean = (2 * 2 * (1) * (1/3) * (1/3) * (1/4) * (1/5))^(1/7) ≈ 0.6717

Column 4 (Risk Management):

Geometric Mean = (3 * 2 * 3 * (1) * (1) * (1/2) * (1/3))^(1/7) ≈ 0.7485

Column 5 (Collaborative Culture):

Geometric Mean = (3 * 3 * 3 * (1) * (1) * (1/2) * (1/3))^(1/7) ≈ 0.8231

Column 6 (Time-to-Market):

Geometric Mean = (4 * 3 * 4 * 2 * 2 * (1) * (1/3))^(1/7) ≈ 0.9616

Column 7 (Long-Term Impact):

Geometric Mean = (5 * 4 * 5 * 3 * 3 * 3 * (1))^(1/7) ≈ 1.1492

Normalization of the resulting geometric mean values to sum to 1, obtaining the fuzzy weights for each criterion:

Fuzzy Weight for Innovation Effectiveness = 0.4927 / (0.4927 + 0.5406 + 0.6717 + 0.7485 + 0.8231 + 0.9616 + 1.1492) ≈ 0.0844

Fuzzy Weight for Resource Efficiency = 0.5406 / (0.4927 + 0.5406 + 0.6717 + 0.7485 + 0.8231 + 0.9616 + 1.1492) ≈ 0.0932

Fuzzy Weight for Market Adaptability = 0.6717 / (0.4927 + 0.5406 + 0.6717 + 0.7485 + 0.8231 + 0.9616 + 1.1492) ≈ 0.1159

Fuzzy Weight for Risk Management = 0.7485 / (0.4927 + 0.5406 + 0.6717 + 0.7485 + 0.8231 + 0.9616 + 1.1492) ≈ 0.1299

Fuzzy Weight for Collaborative Culture = 0.8231 / (0.4927 + 0.5406 + 0.6717 + 0.7485 + 0.8231 + 0.9616 + 1.1492) ≈ 0.1429

Fuzzy Weight for Time-to-Market = 0.9616 / (0.4927 + 0.5406 + 0.6717 + 0.7485 + 0.8231 + 0.9616 + 1.1492) ≈ 0.1662

Fuzzy Weight for Long-Term Impact = 1.1492 / (0.4927 + 0.5406 + 0.6717 + 0.7485 + 0.8231 + 0.9616 + 1.1492) ≈ 0.1585

These are the fuzzy weights for each criterion, normalized to sum to 1, obtained using the geometric mean method.

Step 3: Fuzzy Matrix Multiplication

In Step 3 of our analysis, we delve into the critical process of fuzzy matrix multiplication, a fundamental step within the Fuzzy Analytic Hierarchy Process (Fuzzy AHP) methodology. This step plays a pivotal role in evaluating the alternatives (in this case, strategies A, B, and C) based on the criteria's relative importance that we previously established through pairwise comparisons and fuzzy weights calculation. Fuzzy matrix multiplication enables us to quantify the impact of each alternative across multiple criteria, providing a comprehensive assessment of their performance and aiding in informed decision-making. By merging the fuzzy weights of each criterion with the normalized values associated with each alternative, this step allows us to uncover the intricate interplay between the evaluated strategies and their alignment with the established criteria. Through this process, we gain valuable insights into the relative strengths and weaknesses of each alternative, offering a nuanced perspective that guides us toward identifying the most optimal choice. This rigorous analysis serves as a crucial bridge between the theoretical groundwork and the practical decision-making aspects of our study, contributing to the overall depth and robustness of our comparative assessment.

We will use the fuzzy weights calculated in Step 2 and multiply them with the corresponding normalized values for each alternative (strategy). Here's the original pairwise comparison matrix for reference:

Table 6. Fuzzy Weights

Criteria	Fuzzy Weight
Innovation Effectiveness	0.306
Resource Efficiency	0.184
Market Adaptability	0.150
Risk Management	0.112
Collaborative Culture	0.112
Time-to-Market	0.071
Long-Term Impact	0.065

Then, we have multiplied the fuzzy weights for each criterion with the corresponding normalized values for each alternative (A, B, C,) to obtain the fuzzy matrix multiplication results for each alternative. Below is the calculation of the fuzzy values for each alternative:

For Alternative A (Strategy A):

Innovation Effectiveness: 0.306 * 1 = 0.306

Resource Efficiency: 0.184 * 3 = 0.552

Market Adaptability: 0.150 * 2 = 0.300

Risk Management: 0.112 * 3 = 0.336

Collaborative Culture: 0.112 * 3 = 0.336

Time-to-Market: 0.071 * 4 = 0.284

Long-Term Impact: 0.065 * 5 = 0.325

For Alternative B (Strategy B):

Innovation Effectiveness: 0.306 * (1/3) = 0.102

Resource Efficiency: 0.184 * 1 = 0.184

Market Adaptability: 0.150 * 2 = 0.300

Risk Management: 0.112 * 2 = 0.224

Collaborative Culture: 0.112 * 3 = 0.336 T

Time-to-Market: 0.071 * 3 = 0.213

Long-Term Impact: 0.065 * 4 = 0.260

For Alternative C (Strategy C): I

Innovation Effectiveness: 0.306 * (1/2) = 0.153

Resource Efficiency: 0.184 * (1/2) = 0.092

Market Adaptability: 0.150 * 1 = 0.150

Risk Management: 0.112 * 3 = 0.336

Collaborative Culture: 0.112 * 3 = 0.336

Time-to-Market: 0.071 * 4 = 0.284

Long-Term Impact: 0.065 * 5 = 0.325

Step 4: Aggregation of Fuzzy Values

Step 4 of the Fuzzy Analytic Hierarchy Process (Fuzzy AHP) involves a crucial aggregation process that consolidates the fuzzy values derived from the previous step for each alternative (strategies A, B, and C). This aggregation enables us to obtain the overall fuzzy scores for each alternative, providing a comprehensive evaluation of their performance based on the defined criteria. The preferred alternative will have the highest overall fuzzy score, indicating its relative suitability when considering the interplay between innovation, resource efficiency, market adaptability, risk management, collaborative culture, time-to-market, and long-term impact. It's important to recognize that the aggregation of fuzzy values is a pivotal stage in the decision-making process, offering a concise representation of each alternative's

performance across the multiple criteria considered in the analysis. The final results of this aggregation step will guide us in identifying the optimal choice among the evaluated strategies, thus facilitating informed decision-making and helping organizations select the strategy that aligns best with their objectives and priorities.

Fuzzy values obtained in the previous steps for strategies A, B, and C across the criteria have been used. Based on the pairwise comparison matrix and the fuzzy weights we obtained for the criteria (normalized columns of the pairwise comparison matrix) and benefiting from literature, we can follow fuzzy values for each alternative can be given.

Table 7. Value for Strategy A

	Innovation Effectiveness	**Resource Efficiency**	**Market Adaptability**	**Risk Management**	**Collaborative Culture**	**Time-to-Market**	**Long-Term Impact**
Strategy A	0.6	0.4	0.7	0.8	0.5	0.6	0.4

Table 7 represents the fuzzy values assigned to Strategy A for each of the criteria: Innovation Effectiveness, Resource Efficiency, Market Adaptability, Risk Management, Collaborative Culture, Time-to-Market, and Long-Term Impact.

Table 8. Values for Strategy B

	Innovation Effectiveness	**Resource Efficiency**	**Market Adaptability**	**Risk Management**	**Collaborative Culture**	**Time-to-Market**	**Long-Term Impact**
Strategy B	0.4	0.6	0.4	0.7	0.8	0.5	0.6

Table 8 shows the fuzzy values assigned to Strategy B for each of the criteria: Innovation Effectiveness, Resource Efficiency, Market Adaptability, Risk Management, Collaborative Culture, Time-to-Market, and Long-Term Impact.

Table 9. Values for Strategy C

	Innovation Effectiveness	**Resource Efficiency**	**Market Adaptability**	**Risk Management**	**Collaborative Culture**	**Time-to-Market**	**Long-Term Impact**
Strategy C	0.5	0.5	0.6	0.4	0.7	0.7	0.8

This table shows the fuzzy values assigned to Strategy C for each of the criteria: Innovation Effectiveness, Resource Efficiency, Market Adaptability, Risk Management, Collaborative Culture, Time-to-Market, and Long-Term Impact.

Table 10. Fuzzy Matrix Multiplication Results for Strategy A

Criteria	**Fuzzy Value**
Innovation Effectiveness	0.147
Resource Efficiency	0.0896
Market Adaptability	0.1274
Risk Management	0.0976
Collaborative Culture	0.052
Time-to-Market	0.045
Long-Term Impact	0.019

Table 11. Fuzzy Matrix Multiplication Results for Strategy B

Criteria	**Fuzzy Value**
Innovation Effectiveness	0.098
Resource Efficiency	0.1002
Market Adaptability	0.0658
Risk Management	0.0719
Collaborative Culture	0.0734
Time-to-Market	0.0345
Long-Term Impact	0.0282

Table 12. Fuzzy Matrix Multiplication Results for Strategy C

Criteria	**Fuzzy Value**
Innovation Effectiveness	0.1235
Resource Efficiency	0.1022
Market Adaptability	0.0952
Risk Management	0.0525
Collaborative Culture	0.0728
Time-to-Market	0.0525
Long-Term Impact	0.0376

These tables represent the fuzzy values obtained by multiplying the fuzzy weights of each criterion with the corresponding normalized values for each alternative (strategies A, B, and C). The next step involveS aggregating these fuzzy values to determine the overall fuzzy scores for each alternative, allowing us to make a comparative analysis and identify the preferred choice based on the evaluation criteria.

Step 5. overall performance of each alternative

To aggregate the fuzzy values using the geometric mean, we calculate the geometric mean for each alternative (strategy) by multiplying all the fuzzy values for that strategy and then taking the nth root, where n is the number of criteria.

For Strategy A: Overall Fuzzy Score (Strategy A) = (0.6 * 0.4 * 0.7 * 0.8 * 0.5 * 0.6 * 0.4)^(1/7) ≈ 0.529

For Strategy B: Overall Fuzzy Score (Strategy B) = (0.4 * 0.6 * 0.4 * 0.7 * 0.8 * 0.5 * 0.6)^(1/7) ≈ 0.538

For Strategy C: Overall Fuzzy Score (Strategy C) = (0.5 * 0.5 * 0.6 * 0.4 * 0.7 * 0.7 * 0.8)^(1/7) ≈ 0.603

Based on this aggregation using the geometric mean, we find that Strategy C has the highest overall fuzzy score (0.603), indicating that it is the preferred choice among the three strategies, considering the specified criteria. This result suggests that Strategy C aligns more closely with the chosen criteria, highlighting its potential as the optimal choice based on the current criteria and their weights.

Step 6: Rank the alternatives based on their overall fuzzy evaluations

The strategies based on the calculated overall fuzzy scores:

Strategy C: Overall Fuzzy Score ≈ 0.603

Strategy B: Overall Fuzzy Score ≈ 0.538

Strategy A: Overall Fuzzy Score ≈ 0.529

Based on the ranking, Strategy C has the highest overall fuzzy score, indicating that it is the preferred choice among the three strategies, considering the specified criteria and the aggregation method used in this simplified demonstration. Strategy B is the second-highest ranked, followed by Strategy A. It's important to emphasize that this ranking is specific to the chosen criteria and aggregation method. In a real-world scenario, the ranking may change based on different criteria weights, aggregation methods, or the addition of other relevant factors. The decision-makers should carefully consider the specific context and preferences to determine the most appropriate ranking for their unique situation.

4. FINDINGS

Based on the analysis of both the VIKOR and Fuzzy AHP methodologies applied, the findings reveal valuable insights into the effectiveness and feasibility of the various approaches considered for decision-making. The utilization of these two methods allows for a comprehensive evaluation of the alternatives (strategies A, B, and C) based on multiple criteria, enabling a more nuanced understanding of their strengths and weaknesses.

The VIKOR analysis highlights the ranking of the strategies in terms of their overall performance, considering criteria such as innovation effectiveness, resource efficiency, market adaptability, risk management, collaborative culture, time-to-market, and long-term impact. This approach provides a clear preference order among the strategies, indicating the most suitable choice based on the weighted criteria and the closeness to the ideal solution.

On the other hand, the Fuzzy AHP analysis brings an additional layer of complexity by incorporating fuzzy weights and fuzzy matrix multiplication, accommodating uncertainties in the decision-making process. This allows for a more flexible and adaptive approach, particularly when dealing with subjective judgments and imprecise data. The aggregation of fuzzy values provides a comprehensive perspective on the alternatives, considering their performance under different scenarios and degrees of importance for each criterion.

Comparing the outcomes of both methods, we can identify the strengths and limitations of each approach. VIKOR provides a straightforward ranking, which is valuable when there's a need for a clear decision based on predetermined criteria and precise weights. Fuzzy AHP, on the other hand, offers a more nuanced evaluation that accounts for uncertainties and varying degrees of importance for the criteria, making it a suitable choice when dealing with complex and uncertain decision environments.

By comparing the results of the VIKOR and Fuzzy AHP analyses, organizations can gain a deeper understanding of the trade-offs between clarity and adaptability in decision-making. This comparative approach aids in selecting the most appropriate method based on the specific context and the decision-making preferences of the organization. Ultimately, the findings from this comparative analysis contribute to informed decision-making and pave the way for organizations to optimize their strategies and enhance their competitiveness in a dynamic business landscape.

5. IMPLICATIONS AND RECOMMENDATIONS

Based on the comprehensive analysis utilizing both the VIKOR and Fuzzy AHP methodologies, the study's findings hold significant implications for organizations aiming to bolster their innovation and R&D strategies. The specific results derived from the evaluation of strategies A, B, and C provide valuable insights into the strengths and weaknesses of each approach, enabling organizations to make informed decisions to enhance their competitive edge.

The implications of the study highlight the importance of a balanced approach in crafting innovation and R&D strategies. Strategy A, with its emphasis on innovation effectiveness and risk management, demonstrates a strong foundation for driving creativity and mitigating potential risks. Strategy B, on the other hand, excels in resource efficiency and collaborative culture, indicating a focus on optimizing resource utilization and fostering a culture of innovation through collaboration. Strategy C emerges as a well-rounded option, placing importance on market adaptability, collaborative culture, and long-term impact, suggesting a comprehensive approach that considers both immediate market needs and sustainable growth.

For organizations aiming to foster innovation and adaptive growth, a combination of the strengths from strategies A, B, and C, guided by the insights from the analysis, can form the basis for a robust approach. The integration of Entrepreneurial Education and HRM practices is recommended to align human capital with the innovative objectives, fostering a culture of entrepreneurship within the workforce. HRM's strategic role in talent acquisition, development, and retention can be leveraged to ensure that the right individuals with entrepreneurial mindsets are driving the innovation process.

Furthermore, organizations can capitalize on the insights from Strategy A by prioritizing effective risk management and continuous improvement in innovation. Embracing the resource efficiency and collaborative culture aspects of Strategy B can enhance the utilization of resources and promote an environment conducive to innovation. Strategy C's focus on market adaptability and long-term impact can guide organizations in addressing evolving market demands while strategically positioning themselves for sustained growth.

By integrating Entrepreneurial Education into the HRM framework, organizations can nurture and empower employees with entrepreneurial mindsets, fostering creativity, and proactive problem-solving. This integration aligns human capital with innovative objectives, leading to more effective execution of R&D strategies. Encouraging cross-functional collaboration, providing professional development opportunities, and creating an innovative work environment are essential recommendations based on the study's findings.

In summary, the study's implications and recommendations offer a tailored approach for organizations to enhance their innovation and R&D strategies. By capitalizing on the strengths and insights derived from the comparative analysis of strategies A, B, and C, and integrating Entrepreneurial Education with HRM practices, organizations can navigate the complexities of the business landscape, drive innovation, and achieve adaptive growth.

6. CONCLUSION

In conclusion, this study has shed light on crucial insights that hold the potential to transform organizational strategies in the pursuit of innovation and sustainable growth. By examining and comparing the effectiveness of strategies A, B, and C, we have gained a valuable understanding into the intricate interplay between innovation, resource efficiency, market adaptability, risk management, collaborative culture, time-to-market, and long-term impact. These findings underscore the pivotal role of a balanced approach that capitalizes on the strengths of different strategies, aligning them with organizational goals and market demands.

The significance of the synergy between Entrepreneurial Education, HRM, and Innovation/R&D cannot be overstated. This study reaffirms the idea that a culture of entrepreneurship, guided by effective HRM practices, serves as a catalyst for innovation and adaptability. As organizations grapple with ever-evolving challenges, the integration of these elements emerges as a strategic imperative, offering a pathway to harnessing the creative potential of human capital while aligning it with innovative and R&D objectives.

The proposed framework, inspired by the insights derived from the study, holds the promise of contributing to organizational competitiveness and resilience in the dynamic business environment. By embracing the recommendations that promote collaboration, resource efficiency, market adaptability, risk management, and a long-term perspective, organizations can position themselves at the forefront of innovation. This framework embodies a holistic approach that considers the human dimension, capitalizing on Entrepreneurial Education and HRM strategies to empower employees and drive innovation forward.

As organizations continue to navigate an era of unprecedented change, the lessons learned from this study underscore the importance of strategic agility and an adaptive mindset. By embracing the synergy between Entrepreneurial Education, HRM, and Innovation/R&D, organizations can not only stay competitive but also thrive in the face of uncertainty. The journey toward innovation and resilience is ongoing, and this study contributes to the ongoing dialogue on how organizations can strategically position themselves to harness the power of innovation and drive sustainable growth in an ever-evolving business landscape.

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