The Impact of Start-up Culture on Engineering Education: Best Practices and Case Studies

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***Abstract*—The integration of start-up culture into engineering education is increasingly recognized as a pivotal factor in nurturing entrepreneurial mindsets and skills among students. This paper explores the impact of start-up culture on engineering education at RK University, highlighting best practices and case studies that demonstrate successful implementation and outcomes. By examining various initiatives and programs, such as incubators, innovation labs, and industry partnerships, this study aims to provide a comprehensive understanding of how start-up culture fosters innovation, creativity, and practical problem-solving skills in engineering students. Key elements of the research include an analysis of curriculum design, pedagogical approaches, mentorship, and support systems that encourage entrepreneurial activities. The paper also presents case studies of student-led start-ups that have emerged from these initiatives, showcasing the tangible benefits and challenges faced. Through qualitative and quantitative data, the study evaluates the effectiveness of these practices in enhancing students' entrepreneurial capabilities and readiness for the evolving job market. The findings suggest that embedding start-up culture within engineering education not only equips students with essential entrepreneurial skills but also promotes a dynamic and engaging learning environment. The paper concludes with recommendations for educators and policymakers to further integrate entrepreneurial education in engineering programs, ensuring that future engineers are well-prepared to innovate and lead in their respective fields.**

***Keywords*—Entrepreneurial, Start-up culture, Incubators, Creativity in education, Innovation.**

***ICTIEE* Track*:* Entrepreneurship, Collaboration and Administration**

ICTIEE Sub-Track: Start-up Incubation and Acceleration Programs

I. INTRODUCTION

In the rapidly evolving landscape of global industries, entrepreneurship and innovation have emerged as critical drivers of economic growth and technological advancement.

The engineering sector stands at the forefront of this transformation, with engineers playing a pivotal role in designing and implementing innovative solutions to complex problems. As such, engineering education must adapt to prepare students not only with technical expertise but also with the entrepreneurial mindset and skills necessary to thrive in dynamic, competitive environments. The traditional engineering curriculum has primarily focused on technical knowledge and problem-solving abilities. However, the increasing importance of start-ups and entrepreneurial ventures in the technology sector has highlighted a gap in the education system. Engineers today are expected to be not only proficient in their technical domains but also capable of translating innovative ideas into viable business ventures. This necessitates an educational approach that integrates entrepreneurial education with engineering training.

Activity based programming is practiced at RK University, according to Lathigara, A., Tanna, P., Bhatt, N., (2020) and out-of-classroom experiences are integrated for skill enhancement as mentioned by Bhatt, M., Durani, H., Tanna, P., Lathigara, A., (2024). At RK University, also the integration of start-up culture into engineering education in 5th semester of Bachelor of Technology program aims to bridge this gap by fostering an environment that encourages creativity, innovation, and practical application of knowledge. By embedding entrepreneurial principles into the curriculum, RK University seeks to prepare students to become not only skilled engineers but also visionary leaders capable of driving technological and economic progress.

This research paper aims to explore the impact of start-up culture on engineering education at RK University by examining best practices and case studies. The primary objectives of this study are:

- Evaluate how entrepreneurial principles and activities are incorporated into the engineering programs at RK University.
- Identify key elements of the curriculum that support entrepreneurial learning and innovation.
- Investigate the teaching methods, mentorship programs, and support systems that facilitate entrepreneurial education.
- Examine the role of faculty, industry partners, and innovation labs in nurturing entrepreneurial skills.

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- Present case studies of successful start-ups founded by engineering students at RK University.
- Highlight the challenges and achievements of these ventures, providing insights into the practical application of entrepreneurial education.
- Assess the impact of start-up culture on students' entrepreneurial capabilities, career readiness, and overall educational experience.
- Utilize qualitative and quantitative data to measure the success of entrepreneurial initiatives and programs.

The significance of this study lies in its potential to inform and inspire educational institutions, policymakers, and educators about the benefits and practicalities of integrating start-up culture into engineering education. By documenting and analyzing the experiences and outcomes at RK University, this research contributes to the broader discourse on educational innovation and the preparation of future engineers for the challenges and opportunities of the 21st century.

The paper is structured as follows: The first section provides a comprehensive review of existing literature on entrepreneurial education and start-up culture in engineering programs. The second section details the methodology used in this study, including data collection and analysis techniques. The third section presents the findings, highlighting best practices, case studies, and the impact of start-up culture on engineering students. The fourth section discusses the implications of these findings for educational practice and policy. Finally, the paper concludes with recommendations for further integrating entrepreneurial education into engineering curricula and suggestions for future research.

II. LITERATURE REVIEW

The integration of entrepreneurship and start-up culture within engineering education has garnered significant attention in recent years. This literature review aims to synthesize existing research on the subject, focusing on key themes such as the necessity of entrepreneurial education in engineering, effective pedagogical approaches, and the outcomes of such integrations.

Several studies have highlighted the importance of incorporating entrepreneurial skills into engineering curricula. Engineers are increasingly required to possess not only technical skills but also the ability to innovate and bring new products to market. According to Byers, Seelig, Sheppard, and Weilerstein (2013), the modern engineering landscape demands a blend of technical proficiency and entrepreneurial acumen to drive technological advancements and economic growth. They argue that entrepreneurial education equips engineers with the skills needed to navigate complex, multidisciplinary problems and to capitalize on opportunities for innovation.

Incubators are the best resources for any educational institution for converting creative ideas into commercial ventures. Sehnert, S. (2023) mentioned the trend to acquire promising startup firms with research and development already under way, rather than doing all the basic research in-house.

Effective integration of entrepreneurship into engineering education requires innovative pedagogical approaches. Neck, Greene, and Brush (2014) emphasize experiential learning as a key method for teaching entrepreneurship. Their research suggests that hands-on projects, real-world problem-solving, and active participation in start-up activities are crucial for developing entrepreneurial skills. Similarly, Rae and Melton (2017) advocate for the use of project-based learning (PBL) and design thinking in engineering education, which encourages creativity, critical thinking, and practical application of theoretical knowledge.

University-based incubators and innovation labs play a significant role in fostering entrepreneurial culture among engineering students. According to Etzkowitz (2003), these facilities provide essential support, including mentorship, access to resources, and a collaborative environment conducive to innovation. His research highlights that incubators not only help students develop their start-up ideas but also facilitate valuable industry connections and networking opportunities.

Partnerships between academia and industry are pivotal in providing engineering students with real-world exposure and practical experience. Tseng and Tsai (2010) discuss the benefits of industry-academia collaboration, noting that such partnerships offer students insights into industry practices, challenges, and expectations. These collaborations often lead to internship opportunities, joint research projects, and co-creation of solutions, thereby enhancing students' entrepreneurial readiness.

Numerous studies have evaluated the outcomes of integrating start-up culture in engineering education. Pittaway and Cope (2007) conducted a meta-analysis of entrepreneurship education literature and found that students who participate in entrepreneurial programs exhibit higher levels of creativity, risk-taking, and opportunity recognition. Their findings suggest that entrepreneurial education positively impacts students' confidence and capability to launch and sustain start-up ventures.

Despite the benefits, there are challenges associated with integrating entrepreneurship into engineering education. Duval-Couetil, Reed-Rhoads, and Haghighi (2011) identify several barriers, including faculty resistance, lack of interdisciplinary collaboration, and insufficient resources. Their research underscores the need for institutional support and a cultural shift within engineering faculties to embrace entrepreneurial education fully.

In Research Policy, 49 (2020) David, A., and his team explored role of policy initiatives in supporting innovative start-ups, providing insights into how these policies can be integrated into educational programs to promote entrepreneurship.

Several universities have successfully integrated start-up culture into their engineering programs, serving as models for best practices. Stanford University's d.school and MIT's Martin Trust Center for MIT Entrepreneurship are often cited for their comprehensive approaches to entrepreneurial education.

According to Seelig (2012), Stanford's emphasis on design thinking and interdisciplinary collaboration has been

instrumental in fostering a vibrant entrepreneurial ecosystem. Similarly, Aulet (2013) attributes MIT's success to its structured entrepreneurship curriculum and extensive support network for student ventures.

The literature indicates a growing recognition of the importance of integrating entrepreneurship into engineering education. Effective pedagogical approaches, supportive infrastructure such as incubators and innovation labs, and strong industry partnerships are essential for fostering an entrepreneurial mindset among engineering students. While challenges exist, the benefits of such integration, as evidenced by successful case studies, underscore the potential of entrepreneurial education to transform engineering programs and prepare students for the demands of the modern workforce.

III. METHODOLOGY

This section outlines the research design, data collection methods, and analysis techniques employed in this study to investigate the impact of start-up culture on engineering education at RK University. The study adopts a mixed-methods approach, combining qualitative and quantitative data to provide a comprehensive understanding of the integration and outcomes of entrepreneurial education within the engineering curriculum.

The research design comprises three main phases:

1) *Exploratory Phase:*
   - Conducting a literature review to identify existing frameworks and best practices for integrating start-up culture in engineering education.
   - Developing a conceptual framework to guide the study.

2) *Data Collection Phase:*
   - Gathering qualitative data through interviews and focus groups.
   - Collecting quantitative data through surveys and academic performance records.

3) *Analysis Phase:*
   - Analyzing qualitative data using thematic analysis.
   - Analyzing quantitative data using statistical methods.

Data collection methods comprise of:

1) *Qualitative Data Collection:*
   - Semi-structured interviews were conducted with faculty members, industry partners, and program administrators involved in the entrepreneurial initiatives at RK University. These interviews aimed to gain insights into the design, implementation, and perceived impact of start-up culture on engineering education. Key areas of focus included curriculum development, pedagogical approaches, and support systems.
   - Focus groups were organized with engineering students who participated in entrepreneurial programs and activities. The discussions explored students' experiences, challenges faced, and the skills acquired through these initiatives. The focus groups also aimed to gather feedback on the effectiveness of various support mechanisms, such as mentorship and incubation facilities.

2) *Quantitative Data Collection:*
   - Surveys were administered to a broader sample of engineering students across different semesters. The survey questionnaire included items on students' entrepreneurial attitudes, perceived skill development, and their engagement with start-up activities. Likert-scale questions were used to measure students' responses, ensuring ease of analysis and comparison.
   - Academic records of students participating in entrepreneurial initiatives were analyzed to assess any correlation between engagement in start-up activities and academic performance. Metrics such as grades, project evaluations, and participation in competitions were examined.

A purposive sampling method was used to select faculty members and industry partners who are actively involved in the entrepreneurial education initiatives at RK University.

A combination of purposive and random sampling methods was employed. Students who have participated in entrepreneurial programs were purposively selected for interviews and focus groups, while a random sample of engineering students was surveyed to ensure representation across different academic levels and disciplines.

1) *Qualitative Data Analysis:*

Thematic analysis was used to identify common themes and patterns in the qualitative data. Interview and focus group transcripts were coded and categorized based on recurring topics and insights related to the integration of start-up culture in engineering education. This analysis helped in understanding the subjective experiences of participants and the contextual factors influencing the success of entrepreneurial initiatives.

2) *Quantitative Data Analysis:*
   - Descriptive statistics were computed to summarize the survey responses, providing an overview of students' attitudes towards entrepreneurship and their engagement in start-up activities.
   - Inferential statistical methods, such as t-tests and ANOVA, were applied to compare the academic performance of students involved in entrepreneurial activities with those who were not. Regression analysis was also conducted to explore the relationship between participation in start-up initiatives and various academic and attitudinal outcomes.

To ensure the validity of the findings, multiple data sources were triangulated. The use of both qualitative and quantitative

methods provided a comprehensive view of the research problem. Additionally, member checking was performed by sharing preliminary findings with interview and focus group participants to verify the accuracy of the interpretations.

Reliability was ensured through consistent data collection procedures and the use of standardized survey instruments. A pilot study was conducted to test the survey questionnaire, and necessary adjustments were made based on the feedback received.

Ethical approval for the study was obtained from the Institutional Review Board at RK University. Informed consent was obtained from all participants, ensuring that they were aware of the study's purpose, their voluntary participation, and their right to withdraw at any time. Confidentiality was maintained by anonymizing all data and securely storing research materials.

IV. RESULTS AND DISCUSSION

This section presents the key findings from the research, highlighting best practices, case studies, and the overall impact of start-up culture on engineering students at RK University. The findings are categorized into three main areas: integration of start-up culture into the curriculum, case studies of successful student ventures, and the impact on students' entrepreneurial capabilities and academic performance.

1) Integration of Start-up Culture into the Curriculum

- The incorporation of PBL in the engineering curriculum has been highly effective. Courses that integrate real-world projects, where students are encouraged to develop solutions to practical problems, have shown a significant increase in student engagement and creativity. For example, the "Engineering Innovation and Entrepreneurship" course requires students to create prototype solutions, fostering hands-on learning and innovation.
- Encouraging collaboration between different engineering disciplines and business students has proven beneficial. Students working on multidisciplinary teams reported enhanced problem-solving skills and a broader understanding of how to translate technical ideas into marketable products.
- The establishment of the K. S. Patel Center for Entrepreneurship at RK University has been instrumental in providing students with the necessary resources and mentorship. The center offers access to state-of-the-art prototyping equipment, co-working spaces, and a network of experienced mentors. Students have benefited from regular workshops on business model development, funding strategies, and pitch preparation.
- Partnerships with local industries and start-ups have facilitated internships, project collaborations, and real-world exposure. For instance, a collaboration with Nirav Precision Pvt Ltd allowed students to work on optimizing manufacturing processes, which provided practical experience and industry insights.

2) Case Studies of Successful Student Ventures

Case Study 1: Anlon Technology Research Organization LLP.

Anlon Technology, founded by a group of final-year engineering students, focuses on developing eco-friendly and sustainable technology solutions. Their flagship product is a solar-powered water purification system designed for rural areas.

The idea was conceived during a project-based learning course. With support from the university's incubation center, the team developed prototypes, conducted field testing, and iterated their designs based on feedback.

Anlon Technology won several innovation awards and secured seed funding from a local investor. The project not only provided practical engineering experience but also instilled a sense of social responsibility among the team members.

Case Study 2: Dharmarth Engineering

Dharmarth Engineering is a start-up focused on developing IoT-based automation solutions for smart homes. It was founded by second-year students who identified a market need for affordable and user-friendly home automation systems.

Through the mentorship program at RK University, the team gained insights into product development and market strategies. They utilized the university's innovation lab to develop and test their prototypes.

Dharmarth Engineering successfully launched a pilot program in collaboration with a local real estate developer. The start-up's success highlighted the importance of early exposure to entrepreneurial activities and the support of a robust innovation ecosystem.

Case Study 3: Conduct Exam Technologies

Conduct Exam Technologies, a start-up developing applications for conducting various online examinations based on requirements. It was founded by a few of RK University's graduating students using leveraged the university's innovation labs and mentorship programs and developed a robust online examination platform. The support from university-led industry partnerships allowed them to refine their product, leading to successful commercialization.

Conduct Exam Technologies is now a recognized player in the EdTech sector, showcasing the effectiveness of embedding entrepreneurial education in engineering programs, enabling students to turn innovative ideas into viable businesses.

3) Impact on Students' Entrepreneurial Capabilities and Academic Performance

- Students involved in entrepreneurial activities reported higher levels of creativity and innovation. The opportunity to work on real-world problems and develop marketable solutions significantly boosted their confidence and innovative thinking.
- The integration of start-up culture into the curriculum improved students' problem-solving abilities. They learned to approach problems with an entrepreneurial mindset, considering both technical feasibility and market viability.
- Quantitative analysis revealed a positive correlation between participation in start-up activities and academic performance. Students engaged in entrepreneurial programs tended to have higher grades and better project evaluations. This suggests that the practical application of theoretical knowledge in start-up activities reinforces learning and academic achievement.
- Graduates who participated in the university's entrepreneurial initiatives reported higher employability rates. Employers valued their practical experience, problem-solving skills, and innovative mindset. Many students received job offers from companies they collaborated with during their studies.
- A significant number of students expressed interest in pursuing entrepreneurial careers post-graduation. The exposure to start-up culture at RK University inspired many to consider starting their own ventures or joining early-stage start-ups.

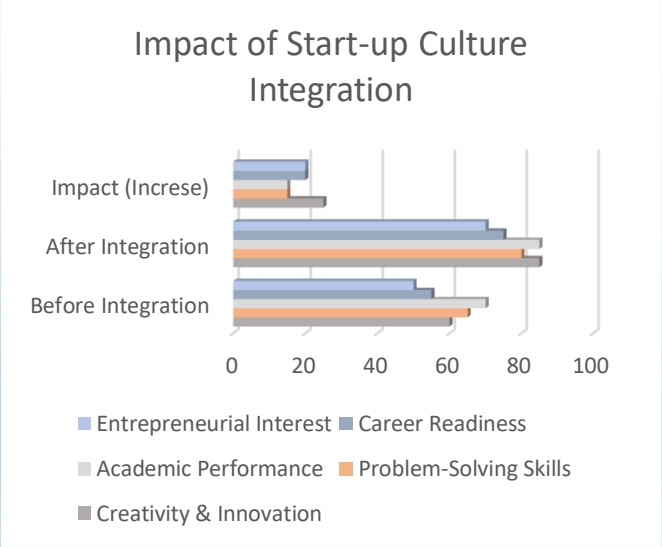

Fig. 1. Impact of Start-up Culture Integration

Below is the graph to represents impact of the implementation of start-up culture in engineering curriculum:

Figure 1 represents a chart based on the provided data, which shows the positive impact of integrating start-up culture into engineering education. It highlights significant improvements in key areas such as creativity, innovation, problem-solving skills, academic performance, career readiness, and entrepreneurial interest. Each of these categories saw an increase ranging from 15% to 25%, demonstrating that the introduction of start-up culture not only enhances academic outcomes but also prepares students better for their careers and fosters a stronger entrepreneurial spirit.

Overall, the chart would illustrate the clear benefits of integrating start-up culture into education, with notable improvements in both soft and hard skills essential for the modern job market.

Challenges and Areas for Improvement are as follows:

- Despite the successes, some students highlighted resource limitations, such as insufficient funding and limited access to advanced prototyping tools. Addressing these limitations could further enhance the effectiveness of the entrepreneurial programs.

- Another area for improvement is the training of faculty members in entrepreneurial education. Providing faculty with professional development opportunities in entrepreneurship can improve the support and guidance available to students.

Implications for Educational Practice and Policy

The findings from this research provide valuable insights into how integrating start-up culture into engineering education can profoundly impact students' entrepreneurial capabilities, academic performance, and career readiness. These implications inform both educational practice and policy, highlighting areas for development and strategic improvement.

1) Enhancing Curriculum Design

- Curriculums should be redesigned to foster interdisciplinary collaboration. Engineering programs can incorporate courses from business, design, and social sciences to provide students with a well-rounded education that enhances their entrepreneurial skills.
- Educational institutions should adopt policies that mandate interdisciplinary projects and courses as part of the engineering curriculum. This can be achieved through accreditation requirements that emphasize the importance of a holistic education.
- The incorporation of experiential learning methods such as project-based learning (PBL), internships, and real-world problem-solving projects should be expanded. These methods have been proven to enhance creativity, innovation, and practical skills.

- Policies should encourage the allocation of resources and funding towards experiential learning initiatives. Governments and educational bodies can provide grants and incentives for institutions that implement and sustain these programs.

2) Strengthening Support Systems

- Universities should establish and expand innovation and incubation centers that provide students with access to resources, mentorship, and networking opportunities. These centers should be equipped with state-of-the-art facilities and staffed with experienced professionals.
- Policies should support the creation and maintenance of such centers through funding, tax incentives, and partnerships with industry stakeholders. Additionally, guidelines for the establishment and operation of these centers can ensure consistency and quality across institutions.
- Developing strong mentorship programs that connect students with industry professionals is crucial. Universities should facilitate regular interactions between students and entrepreneurs, fostering a culture of learning and networking.
- Building robust mentorship networks by assembling a pool of accomplished entrepreneurs who can guide students and their teams in transforming ideas into prototypes, exploring funding opportunities, crafting compelling pitches, and preparing for participation in various competitions.
- Policies should encourage and formalize partnerships between academia and industry. This can include incentives for companies that actively participate in educational programs and mentorship schemes, as well as frameworks for collaboration on research and development projects.

3) Faculty Development and Training

- Faculty members should receive ongoing training in entrepreneurial education and the latest pedagogical techniques. Workshops, seminars, and sabbaticals focused on entrepreneurship can help faculty stay updated and effective in their teaching.
- Policies should mandate professional development for faculty as a part of their career progression. Funding and support for such initiatives can be provided at the institutional or governmental level, ensuring that faculty have access to high-quality training programs.

4) Resource Allocation and Infrastructure Development

- Universities should prioritize the allocation of funds towards entrepreneurial education initiatives. This includes providing students with access to advanced prototyping tools, funding for start-up projects, and opportunities to participate in innovation competitions.
- Policies should support increased funding for educational institutions, specifically earmarked for entrepreneurial initiatives. This can include grants, scholarships, and financial support for student start-ups. Additionally, infrastructure development grants can help universities build the necessary facilities.

5) Promoting a Culture of Innovation

- Universities should foster a culture of innovation and entrepreneurship across all levels of the institution. This includes promoting entrepreneurial thinking in all courses, encouraging risk-taking, and celebrating entrepreneurial successes among students and faculty.
- Policies should encourage the integration of entrepreneurship into the institutional culture. This can be achieved through national awards, recognition programs for entrepreneurial achievements, and public campaigns that highlight the importance of innovation in education.

6) Continuous Evalua-tion and Improvement

- Implementing robust feedback mechanisms to continuously evaluate the effectiveness of entrepreneurial programs is essential. Regular surveys, focus groups, and performance metrics can help institutions refine their approaches and address any gaps.
- Policies should mandate periodic reviews and assessments of entrepreneurial education initiatives. Standardized evaluation criteria can ensure that programs are meeting their objectives and contributing to the overall goals of engineering education.

7) Encouraging Global Collaboration

- Encouraging global collaboration through exchange programs, joint research projects, and international competitions can provide students with a broader perspective and access to diverse resources.
- Policies should facilitate international partnerships by providing funding for exchange programs, simplifying visa processes for students and researchers, and promoting cross-border collaborations in entrepreneurship education.

CONCLUSION

The integration of start-up culture into engineering education at RK University has yielded significant benefits, demonstrating the potential to profoundly impact students' entrepreneurial

skills, academic performance, and career readiness. The findings of this study underscore the importance of embedding entrepreneurial principles within the engineering curriculum to foster innovation, creativity, and practical problem-solving abilities. However, to maximize the benefits and further enhance the educational experience, there are several key recommendations for integrating entrepreneurial education into engineering curricula and areas for future research.

To further enhance the integration of entrepreneurial education, universities should expand interdisciplinary programs that combine engineering with business, design, and social sciences. This approach provides students with a comprehensive understanding of how to translate technical innovations into viable business solutions. Strengthening partnerships with industry is also crucial, as these collaborations offer students real-world experience and exposure to market trends and challenges. Formal agreements with companies for internships, joint research projects, and guest lectures can bridge the gap between academic learning and industry needs.

Enhancing support systems such as innovation labs, incubators, and mentorship programs is essential to provide students with the resources and guidance necessary for pursuing entrepreneurial ventures. Dedicated funding, experienced mentors, and regular workshops focused on start-up development can significantly bolster these support systems. Incorporating more experiential learning opportunities, such as hackathons, start-up competitions, and project-based courses, can further enrich the curriculum and provide students with hands-on experience in developing and executing innovative ideas. Promoting an entrepreneurial mindset across the university by embedding entrepreneurial thinking into all aspects of the curriculum and campus activities will create a culture that values and nurtures innovation.

For future research, conducting longitudinal studies to track the long-term impact of entrepreneurial education on students' career trajectories and start-up success rates will provide valuable insights into the sustained benefits of these programs. Comparative studies between institutions with varying levels of entrepreneurial integration can help identify best practices and common challenges, informing strategies for effective implementation. Investigating the impact of entrepreneurial education on diverse student populations, including underrepresented groups in engineering, is crucial for developing targeted support strategies and ensuring inclusivity.

Evaluating the effectiveness of specific pedagogical approaches, such as design thinking, lean start-up methodology, and agile project management, in fostering entrepreneurial skills will help refine and optimize educational methods. Exploring the role of digital technologies, such as online platforms, virtual incubators, and simulation tools, in enhancing entrepreneurial education can provide new avenues for supporting student start-ups and facilitating remote collaboration.

In conclusion, the integration of start-up culture into engineering education is a critical step towards preparing students for the complexities of the modern workforce. By embracing entrepreneurial education, universities can cultivate a generation of engineers who are not only technically proficient but also innovative, resilient, and capable of driving economic and technological progress. Implementing the recommendations outlined in this paper and pursuing further research will ensure that entrepreneurial education continues to evolve and meets the needs of future engineers. By fostering an environment that encourages creativity, risk-taking, and practical application of knowledge, educational institutions can significantly contribute to the development of a robust and dynamic entrepreneurial ecosystem.

REFERENCES

Aulet, B. (2013). Disciplined Entrepreneurship: 24 Steps to a Successful Startup. Wiley

Byers, T., Seelig, T., Sheppard, S., & Weilerstein, P. (2013). Entrepreneurship: Its Role in Engineering Education. The Bridge, 43(2), 35-40.

David, A., Colombelli, A., Grilli, L., Minalo, T., Rasmussen, E. (2020). Innovative Start-ups and policy initiatives. Research Policy, 49, 104027.

Lathigara, A., Tanna, P., Bhatt, N., (2020). Activity Based Programming. Journal of Engineering Education Transformations, 34, 499-506.

Duval-Couetil, N., Reed-Rhoads, T., & Haghighi, S. (2011). The engineering entrepreneurship survey: An assessment instrument to examine engineering student involvement in entrepreneurship education. The Journal of Engineering Entrepreneurship, 2(2), 35-56.

Sehnert, S. (2023). Innovation hubs and incubators drive academic research to commercialization. Tradeline Inc

Bhatt, M., Durani, H., Tanna, P., Lathigara, A., (2024). Enhancing Real-World Applications Learning in Industrial Engineering: Integrating Out-of-Classroom Experiences for Optimal Skill Development. Journal of Engineering Education Transformations, 37, 607-611.

Etzkowitz, H. (2003). Research groups as ‘quasi-firms’: the invention of the entrepreneurial university. Research Policy, 32(1), 109-121.

Neck, H. M., Greene, P. G., & Brush, C. G. (2014). Teaching Entrepreneurship: A Practice-Based Approach. Edward Elgar Publishing.

Pittaway, L., & Cope, J. (2007). Entrepreneurship education: A systematic review of the evidence. International Small Business Journal, 25(5), 479-510.

Rae, D., & Melton, D. E. (2017). Developing an

entrepreneurial mindset in US engineering education: An international view of the KEEN project. Journal of Engineering Entrepreneurship, 7(3), 1-16.

Seelig, T. (2012). inGenius: A Crash Course on Creativity. HarperOne.

Tseng, K. C., & Tsai, H. T. (2010). Industry-academia collaboration in entrepreneurship education: The case of Taiwan. Journal of Engineering Education, 99(4), 529-546.