A POTENTIAL FRAMEWORK FOR AN IMPACTFUL TECHNOPRENEURSHIP EDUCATION

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Abstract: This study aims to conceptually discuss the potential framework for an impactful technopreneurship education in response to the dynamic business environment. An integrative review based on the selected pertinent literature was utilized to undertake this study. Unlike a systematic review, the integrative review does not aim to cover all articles published on the topic but combines perspectives and insights from different fields or research traditions. Several steps were involved in conducting an integrative review comprising of defining the research questions, conducting a comprehensive search, screening and selecting studies, extracting data and analyzing findings, drawing conclusions and making recommendation. The changes in curriculum and learning processes as well as academic transformation by embedding technological innovation and capacity building are the main priorities in preparing technopreneurs. To prepare reliable technopreneurs, while it is important to focus on technological innovation and capacity building, yet to integrate these two aspects, collaboration is the key word hence the collaboration among universities, the business world, government, media, and the community becomes one of the interesting routes that need to be developed. The pentahelix collaboration plays a major role in the cycle of the technopreneurship from the idea formulation, research, precommercialization, commercialization and embarking the advanced market.

Keywords: entrepreneurship, technopreneurship, technological innovation, capacity building, pentahelix collaboration

Abstrak: *Penelitian ini bertujuan membahas secara konseptual kerangka potensial untuk pendidikan technopreneurship yang berdampak dalam menanggapi lingkungan bisnis yang dinamis. Tinjauan integratif berdasarkan literatur terkait digunakan dalam penelitian ini. Berbeda dengan tinjauan sistematis, tinjauan integratif tidak bertujuan untuk mencakup semua artikel yang pernah diterbitkan tentang topik tersebut melainkan menggabungkan perspektif dan wawasan dari berbagai bidang atau tradisi penelitian. Beberapa langkah yang dilakukan dalam melakukan kajian integratif terdiri dari mendefinisikan pertanyaan penelitian, melakukan pencarian komprehensif, menyaring dan memilih studi, mengekstraksi data dan menganalisis temuan, menarik kesimpulan dan membuat rekomendasi. Perubahan kurikulum dan proses pembelajaran serta transformasi akademik dengan menanamkan inovasi teknologi dan capacity building menjadi prioritas utama dalam mempersiapkan technopreneurs. Untuk mempersiapkan teknopreneur handal, meskipun penting untuk fokus pada inovasi teknologi dan peningkatan kapasitas, namun untuk mengintegrasikan kedua aspek tersebut, kolaborasi adalah kata kuncinya sehingga kolaborasi antara perguruan tinggi, dunia usaha, pemerintah, media, dan masyarakat menjadi satu kesatuan. rute menarik yang perlu dikembangkan. Kolaborasi pentahelix memainkan peran utama dalam siklus technopreneurship dari perumusan ide, penelitian, prakomersialisasi, komersialisasi dan memasuki pasar maju.*

Kata kunci: *kewirausahaan, technopreneurship, inovasi teknologi, peningkatan kapasitas, kolaborasi pentahelix*

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INTRODUCTION

The emergence of today's disruption due to technological developments has been notably impacting the business world (An and Rau, 2019). It forces business players to have a comparative advantage, competitive niche and a unique position in the market (Yeganegi, Laplume and Dass, 2021). However, there are still many business entities that are not adaptive to technological developments hence they are unable to compete. In addition, the recent COVID-19 pandemic has a fairly large decreasing impact on the business world and many businesses which must integrate technology and innovation into their activities to adapt in post COVID-19 era (Arianto, 2020; Koe et al. 2021). In this regard, entrepreneurship education is central in creating entrepreneurship during the challenging time. Entrepreneurship education has gained popularity globally (Katz, 2003) as it develop further the entrepreneur's intentions and materialize their ideas into a full-blown business concept, model or plan (Ardichvili, Cardozo and Ray, 2003).

Universities in particular plays a significant role in encouraging students and members of their communities to develop entrepreneurial skills and adopt entrepreneurial attitudes (Bomani, Gamariel and Juana, 2021, Batmetan & Palilingan, 2022). Learning entrepreneurship has been implemented in various universities as a required subject in every study program for students to encourage students embarking their own businesses, with the goal of fostering knowledge that entrepreneurship should have, and during the class, students must be engage directly with business owners so not only limited to the theory (Hasanudin et al. 2021). The entrepreneurships class is one of strategy to develop their willingness to start a business. This effort can help decrease the strain on the government to provide job opportunities and because of the uncertain economic climate following the COVID-19 outbreak, finding work could also be difficult for graduates (Koe et al. 2021). The graduates must deal with issues related to independence, self-realization and self-employment (Soomro and Shah, 2020).

An entrepreneurship education program must meet an entrepreneur's requirements and be equipped with knowledge and exposure to technology innovation to carry out business transformation(Wong, Sam and Yu, 2020). Technopreneurship represents a new breed of entrepreneurship which is a combination of technology and business (Abbas, 2018). The word "Technopreneurship" is a combination of the words "Technology" and "Entrepreneurship," which can conclude as a process of formation and collaboration between business fields and the application of technology as a supporting instrument and as the basis of the business itself, both in the process, system, parties involved, and products produced. In general, the word technology is used to refer to the practical application of science to industry or as a knowledge framework used to create tools, to develop skills and extract materials to solve existing problems.

A comprehensive approach needs to be formulated for the purpose of designing a technological based entrepreneurship (technopreneurship) education program. Two of them is by technological innovation and capacity building. The program should be focused on increasing the ability and skill of the participant in technology aspect and business skills hence they can develop an innovative product or service. Nevertheless, technological aspects as well capacity building will not be effective in developing technopreneurship if it only executed by one party, hence there is a need of collaboration in the form of pentahelix collaboration which is a collaboration between university, government, business, community, and media. This collaboration have a purpose to minimize the burden in creating an advanced technopreneurship program (Suradi, M. Yasin and Rasul, 2017). Various forms of collaboration are suggested to develop actively bold projects, produce innovative ideas to encourage innovation creativity, and enhance resources to support high-tech businesses (Polyakov, 2021). The participants expected to learn from the industry, thus this kind of practical experience will be highly helpful for any issues they may face in the future (Wahyudi, Tileng and Kurniawan, 2018). Collaboration between universities and the business world in particular is an interesting thing that needs to be developed, which allows the business world to obtain higher education research data and information that is rich in innovation and commercial value. On the other hand, universities will also get accurate information about market trends and changes.

Research on entrepreneurship and technopreneurship have been extensively carried out by many previous researchers (Kholmuminov, 2014; Marti'ah, 2017; Liguori et al. 2018; Rachmasari, 2018; Arianto, 2020;

Hati et al. 2021; Martínez-Gregorio, Badenes-Ribera and Oliver, 2021; Soluk, Kammerlander and Darwin, 2021; Yeganegi, Laplume and Dass, 2021). However, previous research still focuses on the development of entrepreneurship (Kholmuminov, 2014; Arianto, 2020; Hati et al. 2021) and technology-based entrepreneurship or digital entrepreneurship only (Marti'ah, 2017; Soluk, Kammerlander and Darwin, 2021; Yeganegi, Laplume and Dass, 2021). Meanwhile, studies on entrepreneurship development by using pentahelix collaboration can be said to be very rare or non-existent, hence there is gap in a conceptual as well empirical studies in connecting the technology innovation, capacity building and pentahelix collaboration to create an impactful technopreneurship education program. This research aims to embark on the conceptual perspective on how these three notions potentially build up a more effective technopreurship education. Hence this research aims to conceptually discuss potential framework for an impactful technopreneurship education with the support of technological innovation, capacity building and pentahelix collaboration. The rest of the paper is structured as follow. Elaboration of research method is provided in the next section followed by discussion of results. Finally the last section concludes.

METHODS

This study adopts the integrative review method which assess, critique and systesize the literature on a research topic in a way that enables new theoretical frameworks and perspectives to emerge (Torraco, 2005; Synder, 2019). Literature review in its various forms has been recognized as the effective research method which creates a firm foundation for advancing knowledge and facilitating theory development (Webster & Watson, 2002). As contrast to systematic review, the integrative review in particular does not aim to cover all articles ever published on the topic but rather combine perspectives and insights from different fields or research traditions (Synder, 2019).

As the aim of this study is to enhance the potential approach in designing technopreneurship education, this study selects various pertinent relevant literature in the field, review, summarize and systesize them to propose the potential conceptual framework. several steps were involved in conducting an integrative review on technopreneurship education comprising of defining the research questions, conducting a comprehensive search, screening and selecting studies, extracting data and analyzing findings, drawing conclusions and making recommendation.

1. **Defining the research question**: In this activity we set the question to understand what are the key components of a potential framework for an impactful technopreneurship education that focuses on technological innovation and capacity building, with a key role of pentahelix collaboration. This research question aims to identify the essential elements that should be considered in developing a framework for technopreneurship education that is impactful in terms of technological innovation and capacity building, and which involves the collaboration of stakeholders from academia, industry, government, civil society, and the community. This research question is broad enough to encompass the different aspects of technopreneurship education and pentahelix collaboration, yet specific enough to provide clear direction for this research study.

2. **Conducting a comprehensive search**: Next, we conducted a comprehensive search of academic databases, relevant journals, and other sources by searching the most relevant literature with the main keywords used were technopreneurship, entepreneurship education, technology, innovation, capacity building and collaboration. The literature searching was only conducted using prominent international databases such as scopus, emerald and science direct. Nevertheless, throughout the writing and finalizing the concept other relevant articles from other databases were also utilized hence relevance of the articles used is the main criteria of selection.

3. **Screening and selecting studies**: After compiling a list of potential articles, we evaluated their relevance to the research question defined earlier. We read the abstracts and scan the full text of the articles to determine whether they focus on technopreneurship education, technological innovation, capacity building, and pentahelix collaboration. We then select the articles that present theoretical or empirical frameworks, or discuss the key components or elements of technopreneurship education programs that emphasize technological innovation, capacity building, and pentahelix collaboration.

4. **Extracting data and analyzing findings**: We then summarized previous research by highlighting patterns, themes, and problems that can help identify

the conceptual concepts of the issue and contribute to theory development (Seuring and Müller, 2008). Applying an integrated conceptual development process that starts with the abstract and simple to the general and ends with precise models for comprehending the entire process and identifying real-world complexities, viewing the problem as whole entities and immersed in the context (Jones and Coviello, 2005). A conceptual paper reports on a specific conceptual framework (or work related to it) (Rocco and Plakhotnik, 2009). Effectively and properly structuring either a theory or a conceptual paper is just as important as the conceptualization of the actual theory or the framework (Smithey Fulmer, 2012).

5. **Drawing conclusions and making recommendations**: In this final step, we draw conclusions and make recommendations based on the review findings. We highlight the key findings of the review, and the recommendations to provide guidance on how to implement the findings in practice.

This study did not limit specific period of literature searching yet as the topic revolves around the contemporary term of technopreneruship hence the final articles used in the review mainly consist of the most recent literature published within the topic. The conceptual attempt of this study is hoped to sets the model of technopreneurship education which can be empirically tested in future studies.

RESULTS

Technological Innovation and Technopreneurship Education

Entrepreneurs must improve their technological skills because technology is used in the majority of interactions now and in the future. Lynch et al. (2021) signified that students need to have advanced technological skills that meet the demands of knowledge-based economy. Based on result of interview conduct by Hashimi et al. (2021) with tech-startups founders/co-founders in Bahrain who we mostly from the science program, they state that they need to read books about entrepreneurship and participate in a business training program. However, they did not only emphasize the importance of entrepreneurial classes, but also recommend optional classes or workshops in information technology, programming, and coding to all college students, regardless of their majors or disciplines. According to the interviewee, higher education institutions must provide these topics as part of programs, courses, or workshops to overcome the skills gap and encourage digital innovation and technopreneurship i.e.: digital marketing, artificial intelligence, programming, design, creative thinking, data science, mobile app prototyping, collaboration, financial technology, pitch coaching, securing funds, financial planning, market dynamics, how to market your products, and entrepreneurship.

This is in line with the result of research conduct by Sumarno & Suarman (2017) at the University of Riau, Indonesia where they signified that university must allow integration or cohesion between non-entrepreneurial curricular and entrepreneurial components to enhance the entrepreneurship education program's policy, implementation, and the outcome so that the purpose of creating and/or improving entrepreneurial students' or graduates' competence can be achieved. The entrepreneurship development program is meant to be a method for synergistically combining scientific and technological skills with entrepreneurial spirit.

According to Amante and Ronquillo (2017), a survey taken before and after a technopreneurship program at Batangas State University in the Philippines indicated an improvement in the students' opinions on technopreneurship skills. The survey also revealed an increase in the number of students who planned to take a chance and establish their own business after graduating instead of working for someone else. Students were equipped with a perspective that encouraged them to think innovatively and have the confidence to be the owners of their own startups, as opposed to a traditional perspective of becoming an employee after graduate.

Nevertheless, King (2012) and Litzinger et al (2011) argued that scientific and technological skills alone are no longer enough but it is also imperative to understand how technology can be brought successfully to the market through commercialization (Bilan et al. 2005; Barr et al. 2009). Therefore, the institution needs to create a technopreneurship curriculum that heavily includes technological based activities to help students master the technology that can lead towards commercialization while building up the entrepreneurial skills hence they can be called as technopreneurs.

Capacity Building and Technopreneurship Education

Technopreneurship program was usually designed as an Outcomes–Base Education (OBE) (Ayub, Jaafar and Majid, 2011; Amante and Ronquillo, 2017). Students are supposed to show that they understand the issue by proposing solutions in the form of a prototype, proof of concept, design and simulation of a mechanical model, landing page for websites, mock-up application for mobile applications, video explainer, etc. Students should be able to look for issues or problems to which they might be able to apply real solutions.

Capacity building for technopreneurship education program can be performed by focusing on some factors such as personal competencies, entrepreneurship skill, technology skills and policy advocacy or facilitation that are given by the university, government and industries (Abdullah, Rahim and Zakaria, 2017; Alinsunod et al. 2019; Games et al. 2020; Hashimi et al. 2021). The concept of capacity building for technopreneurship students can be seen in Figure 1.
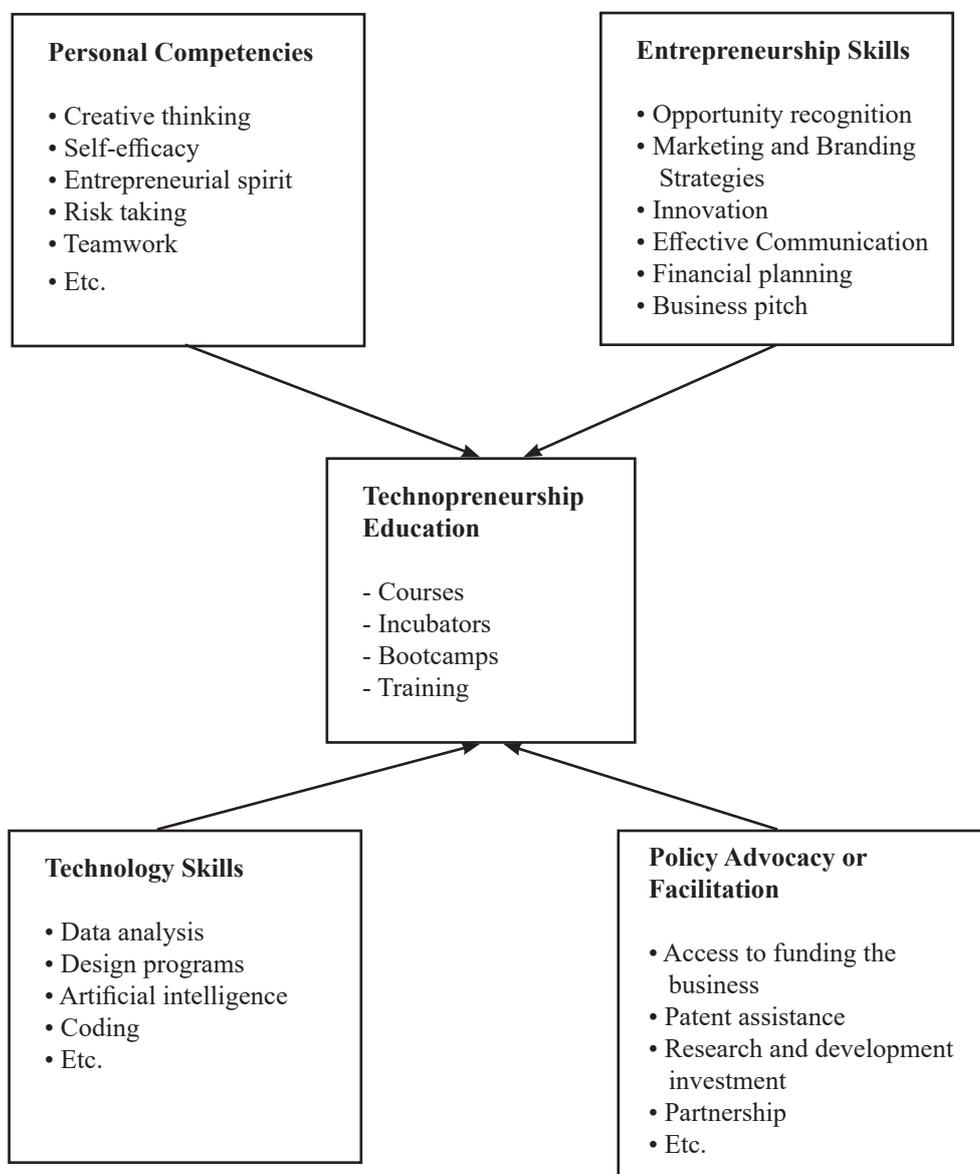

Figure 1. Technopreneurship Education Program (Abdullah et al. 2017; Alinsunod et al. 2019; Games et al. 2020; Hashimi et al. 2021)

Entrepreneur development institutions and programs such as MIT, Cambridge PGDE, Babson College, Renmin University and YEP Ireland discover that innovative entrepreneurial teaching and learning (ETL) consists of three (3) core aspects which consist of fostering an entrepreneurial culture, clearly defining and validating the most useful knowledge needed for innovative ETL, and implementing the ETL which emphasizes on how students should be taught about entrepreneurship (Abdullah, Rahim and Zakaria, 2017). To enhance entrepreneurial culture, the university must develop an entrepreneurial mindset, appreciate values by improving the students' overall strengths, cultivate innovation, creativity, and entrepreneurship in all courses, and turn entrepreneurship into a style of living for all students and faculty on campus. These are the key drivers of entrepreneurial culture, which fosters the ability of students and instructors to act like entrepreneurs. Second, the main objective of entrepreneurship education is to create entrepreneurial skills in students, which will enable them to create new business and entrepreneurial competitive activities. Personal capacities and entrepreneurship skills are included in entrepreneurial competitive activities. Finally, according to the research on innovative ETL execution, academics must support the implementation of theory and practice by incorporating innovation, creativity, and entrepreneurship into all classes, as well as introducing an industry expert as a coach to enhance an entrepreneurship culture as a strategy of the implementation.

This is consistent with the research conduct by Hashimi et al. (2021). Based on the results of an interview with founding members of start-up companies in Bahrain highlighted the importance of innovative thinking, collaboration, strategic planning, marketing, and communication skills because these skills have seemed to be important for technopreneurs to convince investors of their ideas in a matter of seconds. In addition, the interview suggested some specific courses, skills, or subjects to be taught in order to qualify technopreneurs and improve their chances of success, such as design thinking aspects, scientific methodologies, and software programs. The report of the Bahrain Government's National Higher Education Strategy 2014-2024, highlighted the need of providing policy advocacy and facilities for graduate entrepreneurship as a strategy, as well as planned practices and techniques for entrepreneurship education integration.

Another example is Majlis Amanah Rakyat (MARA) which is involved in the development of technopreneurships in Malaysia. In one of MARA technoprenuership program namely Strategic Technology Enhancement Program focused on giving technology consultancy, product design and development, facilities and support for research, space technology incubators, attachments, business consulting, promotion and marketing, and entrepreneurship training via module for duration of one year and participants who pass are awarded the Certificate of Proficiency (Suradi, M. Yasin and Rasul, 2017). MARA has succeeded in achieving 141.7 percent of the targeted technopreneurs in 2013. Through the improvement of formal and informal education, research and innovation, collaboration between MARA and outside parties, and also active participation of alumni, technopreneur development plans have been successfully executed.

Pentahelix Collaboration and Technopreneurship Education

The development of the business ecosystem can be best carried out through collaboration and penta-helix synergy between the government, universities, the business world, the community and the media. The penta-helix model where "penta" which means five and "helix" is interwoven, integrating close interactions between key stakeholders and embracing stakeholders from elements of government, academia, business, society and the media as a unit so that innovation and capacity building can be realized and building the entrepreneurs under the guidance. The Penta helix is a conceptual framework involving academicians, government, industry, civil society, and media with the intention of fostering economic growth by encouraging innovation and entrepreneurship through collaboration and synergy (Sudiana et al. 2020b). The collaboration model and the stages/timeline of the entrepreneurship intervention program can be seen in Figure 2.

The best outcomes for innovation come from solid partnerships and collaboration between important parties (Von Stamm, 2004). The role of each element as follow:

1. **University:** University or higher education institutions lead to the growth of human resources, including graduates, lecturers, and researchers, who are vital to the application of knowledge and research to innovation and the development of new

products and businesses (Sudiana et al. 2020b).

2. **Government:** This helix has a 'political and legal capital' (Carayannis, Barth and Campbell, 2012). The government significantly contributes to the promotion and support of an entrepreneurial ecosystem by investment projects in research and development and knowledge facilities, public innovation policies, and encouragement for innovation networks and public-private partnerships (Halibas, Sibayan and Maata, 2017).

3. **Business:** When establishing the research agenda for innovation network projects in early phases, the industry should be involved rather than only letting academia decide, by doing this it will be possible to integrate standardized results into the industry (Rampersad, Quester and Troshani, 2010). This helix is expected to provide the initial funding required and knowledge regarding running a business through training or coaching programs (Sudiana et al. 2020a).

4. **Community:** The community can help start-ups be more inventive by providing a place for community interaction and fostering their creative abilities (Sudiana et al. 2020b).

5. **Media:** Startups expected support from the media in the form of publicity, such as exposure of their products and businesses in media-specific programs

(Sudiana et al. 2020a). The media play a part in spreading information about all the different variables that various stakeholders need (Sudiana et al. 2020b).

The collaboration between government, academia, business, society and the media implemented in technopreneurship education through courses, incubators, bootcamps or training expected to create an integrated technoprenuership education. The technoprenuership program can be done step by step as follow (Amante and Ronquillo, 2017; Hidayat et al. 2018; Khofiyah, Sutopo and Hisjam, 2020):

1. **Idea:** An idea is the foundation of everything. Students are encouraged to keep an eye on their surroundings for any challenges and issues to which they could be able to apply true solutions.

2. **Research:** The participant can observe the behavior in the field, at workplace, and in the community, as well as discuss and gather information from groups or individuals who are having issues. Students are also encouraged to seek feedback and ideas from technical experts. They must discover alternative solutions, technology-based business prospects, and technological features that are adopted should include aspects of marketing, distribution, and sales, not only items and services.
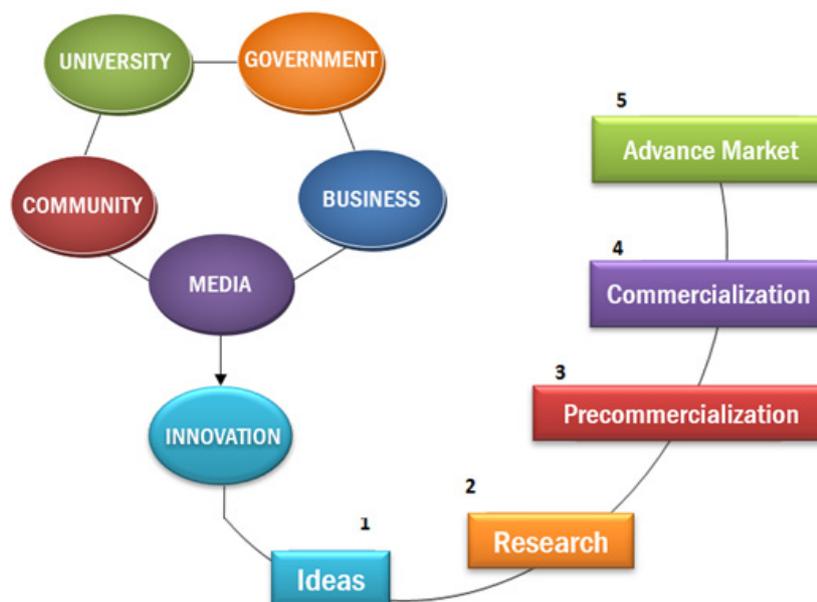

Figure 2. The collaboration model and the stages/timeline of the entrepreneurship intervention program (Carayannis et al. 2012; Sudiana et al. 2020b; Halibas et al. 2017; Muhammad, 2021)

3. **Precommercialization:** Participants are asked to construct a prototype, proof of concept, design and simulation of a mechanical model, landing page for websites, mock-up application for mobile applications, or video explainer based on the product or service they intend to improve. The next step is to provide a product demo or sample to the target market so that they can give input on the product/service.

4. **Commercialization:** Incubators in the commercialization phase are required to avoid the "death valley," which is strongly influenced by the commercialization strategy (Games et al. 2020). The valley of death usually causes various technology products that are unsuccessful to be launched in the market so in order to prevent the commercialization potential of research output from entering the valley of death, there should be a framework that bridges technology development and commercialization (Sutopo, 2019).

5. **Advance Market:** The product that has gone through many processes launched in the market. Many challenges will appear and improvements are always needed to upgrade the product/services to match the need of the customer. Business owners should not be satisfied and stop the research or development after the product has been on the market, on the contrary, the research and development department should develop their product.

Managerial Implication

Based on the role of multiple stakeholders such as government, university, community, business and media that have been explored in this study, there are several managerial implications that can be identified, including developing collaborative partnerships, integrating technology, fostering innovation, building capacity, and creating an entrepreneurial ecosystem.

First, developing collaborative partnerships will emphasize the need for collaboration between academia, industry, government, civil society, and entrepreneurs. Therefore, managers can develop partnerships with these key stakeholders to create a conducive environment for technopreneurship education. Next, the framework also emphasizes the importance of integrating technology into the curriculum of technopreneurship education programs. Managers can ensure that their organizations invest in technology infrastructure and resources to support such programs.

Petahelix collaboration also fosters innovation among students and entrepreneurs. Managers can provide resources, such as innovation labs and funding, to support the development of innovative ideas and products. Managers can also invest in training and development programs to build the capacity of their employees and stakeholders. This implication indicates that capacity building is part of technopreneurship education. Last, managers can work with key stakeholders to create an environment that supports entrepreneurship, such as providing access to funding, mentorship, and networking opportunities.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

This study describes the potential approach in designing technopreneurship education using integrative review utilizing selected pertinent literature in the field and other related filed of entrepreneurship education. The conceptual attempt of this study is hoped to set the model of technopreneurship education which can be empirically tested in future studies. It is argued that technopreneurship education must emphasize the elements of technological innovation and capacity building programs which can only be effectively and efficiently executed with the pentahelix collaboration. While technopreneurship program was usually designed as an Outcomes–Base Education which focus on launching an innovative product, previous research also found there is a need of integration or cohesion between technology courses and entrepreneurial components to enhance the technopreneurship education program. Futhermore, the capacity building for technopreneurship education program can be perfomed by focusing on important factors such as personal competencies, entrepreneurship skill, technology skills and policy advocacy or facilitation that given by the university, government and industries.

The main strategy to ensure the successful implementation of technological innovation and capacity building element in the technopreneurship education program is through collaboration and penta-helix synergy between the government, academic institutions, business sector, the community, and media. In order to realize innovation and capacity building, the penta-helix model integrates strong connections between key stakeholders and embraces

stakeholders from elements of government, academia, business, society, and the media as a unit. The pentahelix collaboration plays a major role in the cycle of the technopreneurship from the idea formulation, research, pre-commercialization, commercialization and embarking the advanced market.

Recommendations

While this research provides a different conceptual perspective on the interaction of important factors in the technopreneurship education program with the key role of pentahelix collaboration, yet this study is merely a conceptual step and further empirical testing is needed in future studies to validate the proposed concept. Above all, the researchers hoped that this conceptual framework of a technopreneurship education program can be implemented not only for academic research purpose but for real implementation by the universities or other institutions aiming to create technopreneurs of the contemporary age.

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