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Discovering the Impacts of Implementing Digital Entrepreneurship Education in Business Incubation Program at Malaysian Polytechnics

Nur Syahirah Rosli[1], Suhaida Abdul Kadir[2], Rahimah Jamaluddin[3], Enio Kang Mohd Sufian Kang[4]

[1]Department of Technopreneurship, Faculty of Technology Management and Technopreneurship, Universiti Teknikal Malaysia Melaka, 75450 Ayer Keroh, Melaka, Malaysia, [2,3,4]Department of Science and Technical Education, Faculty of Educational Studies Universiti Putra Malaysia, 43400 Serdang, Selangor Malaysia

Corresponding Author Email: syahirah.rosli@utem.edu.my

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Abstract

Digitalization is transforming business models, paving the way for “digital entrepreneurship” as the dominating business environment. However, the Malaysian Ministry of International Trade and Industry emphasises that polytechnics must align their entrepreneurial ecosystem with the Fourth Industrial Revolution. Business incubators has become a favored tool in fostering digital entrepreneurship education. Despite established digital technology policies, there are no specific regulations governing digital entrepreneurship education in polytechnics’ business incubation program and its impacts remain unexplored. To address this deficiency, a multiple case study was conducted to gain an in-depth insight towards the impacts of implementing digital entrepreneurship education in business incubation programs at Malaysian polytechnics. Two selected polytechnics adopted distinct approaches. Eduvalley Polytechnic incorporates digital marketing and platforms, whereas Skillrise Eastside Polytech concentrates on digital software and technology solutions into their business incubation program. This qualitative study involves 14 participants including student entrepreneurs, entrepreneurship mentors, and incubator managers that was chosen using heterogenous sampling. To boost the trustworthiness, a semi-structured interview protocol was developed and multiple triangulation methods using direct observation and document analysis were employed. All interviews were recorded, transcribed, and analyzed. Within-case and cross-case analyses revealed similarities and differences in the polytechnics. Findings disclosed that the impacts of implementing digital entrepreneurship education enhances stakeholders' competencies, establishes solid foundation for digital-based ventures, and strengthen the collaboration between the internal and external stakeholders for commercial development. This study is anticipated to assist policymakers, particularly the Polytechnic and Community

College Education Department, in optimizing the utilization of business incubation programs for nurturing digital technology-driven ventures' growth.

Keywords: Digital Entrepreneurship, Digital Economy, Entrepreneurship Education, Business Incubator, Industry 4.0, Vocational Education, Tvet, Digitalization

Introduction

The Fourth Industrial Revolution (4IR) explores emerging digital technologies, including the Internet of Things, cloud computing, artificial intelligence, and augmented reality, that are being integrated in various sectors (World Economic Forum, 2020). Due to the impact of the COVID-19 pandemic, most sectors have been compelled to restructure their workforces in response to the rapid adoption of digital technology and job destruction by introducing greater technological integration (World Economic Forum, 2020). The conversion of information from a physical format to a digital form is defined as digitisation, whereas digitalisation refers to optimising digitisation to enhance business processes (ILO-UNESCO, 2020). To encapsulate the golden opportunities created through digitalisation that allow entrepreneurs to do things differently, business models are experiencing a significant shift towards digital worlds – creating "digital entrepreneurship" as the new context in business activities (Kraus et al., 2019). According to the World Bank Group (2016), digital entrepreneurship is the digital transformation process of creating a new or existing business, product, or service in the market. The implementation of digital technology has been a good influence, and the literature also reveals significant policy shifts to promote digitisation in major sectors (Kalolo, 2019).

Consequently, the increasing impact of 4IR is forcing the demand towards several new initiatives in digital entrepreneurship education development for Technical and Vocational Education and Training (TVET) (Halabisky, 2019). The emergence of the technology-driven economy has also blurred the limits between physical, digital, and human interactions, causing much debate about future TVET graduate employment rates (UNESCO, 2016). Thus, the initiative of UNESCO to highlight TVET in producing graduates to become trained student entrepreneurs has been seen as capable of adding value to the business digitalisation needs (ILO-UNESCO, 2020). Looking at how the world is switching towards acquiring entrepreneurial digital competencies, several experts revealed that business incubator is the game changer to speed up the exploitation of digital technology among student entrepreneurs in the education sector (Grimaldi & Grandi, 2005; Jansen et al., 2015; Yamockul et al., 2019; Hassan, 2020). A business incubation program refers to a structured entrepreneurship training and set of activities that helps developing businesses by providing flexible working space and shared infrastructure to boost entrepreneurs' potential and sharpen their business skills throughout their early ventures (Hackett and Dilts, 2004; Mian et al., 2016; UBI Global, 2019). Entrepreneurs will gain exposure to assistance services such as administrative services (bookkeeping, photocopying), technical services (access to expensive equipment), business advisory services (counselling, mentorship, training), and obtaining venture capital funds during the incubator period (InfoDev, 2010). Furthermore, entrepreneurs selected for the business incubation program will have an immense opportunity to network with other entrepreneurs as they share their space, ideas, motivation, and mutual support (Tang et al., 2019).

The Organisation for Economic Co-operation and Development (OECD, 2020) reported that it is critical to redesign the current education system to ensure student entrepreneurs can reap digitalisation benefits for product innovation. In the global context, leading education institutions in developed countries, such as Harvard University, Stanford University, and the University of California, are among the earliest to introduce business incubation programs to ensure student entrepreneurs are trained with the right skills and given sufficient guidance for their business digitalisation (Grimaldi and Grandi, 2005; Wonglimpiyarat, 2006; Forbes, 2019). In this scenario, UNESCO (2018) has urged the TVET education system to respond quickly towards technological changes through a business incubation program to ensure that digital entrepreneurship education can meet the skills required for the new era of co-operation between people and machines. According to the UBI Global World Rankings of Business Incubators 2019/2020, TVET institutions, including Istanbul Technical University and Polytechnic University of Milan, have been listed among the world's top five university business incubators (UBI Global, 2019).

For developing countries to become more innovative and capable of competing with advanced economies in this digital era, the impact of digital entrepreneurship education implementation in top universities' business incubation programs abroad can be utilised as benchmarks to enhance student entrepreneurs' product innovation in their respective institutions. In Malaysia, the fragmented TVET ecosystem, including polytechnic institutions, leads towards multiple issues related to skills, qualities, operations, and financial resources (Malaysian Ministry of Human Resource, 2019). As indicated by the Malaysian Ministry of Higher Education (2022), the rate of student entrepreneur graduates who venture into businesses in polytechnics were among the lowest of all Malaysian higher education institutions, at just 9.5 per cent in 2021. Therefore, polytechnics are required to leverage the usage of emerging digital technologies in their business incubation program to emphasise the entrepreneurship learning delivery approaches related to 4IR (Malaysian Ministry of International Trade and Industry, 2018).

Background of the Study

The COVID-19 pandemic has significantly altered business growth around the world and maximised the potential of the digital economy in achieving a high technology-based economy (Legese Feyisa, 2020; Goel et al., 2021; Jackson et al., 2021; Craven et al., 2022). However, the current global outbreak has also contributed to a sharp increase in job insecurity, change in the way people interact and brought new norms for how businesses can be manoeuvre through the boost of digital technology adoption (Fana et al., 2020; Lin et al., 2021). In this case, education training providers such as TVET institutions were identified as the strong catalyst for most countries to produce future-ready talent that is competent, knowledgeable, and highly skilled technical individuals for the successful adoption of 4IR (Wagiran et al., 2017). As outlined in the Twelfth Malaysia Plan 2021-2025, it is projected that graduate employability in higher education institutions, including career scope involving TVET-related skills will reach up to 86.7 percent in 2025 (Economic Planning Unit, 2021). The goal is aligned with shift number one and four of Malaysia Education Blueprint (Higher Education) 2015-2025, which focuses on producing holistic, entrepreneurial, and balanced graduates and providing quality TVET graduates (Ministry of Education Malaysia, 2015). Thus, Malaysia's Ministry of Education has established the goal of creating more job creators among

TVET graduates, especially in polytechnics, with an entrepreneurial mindset to meet changing business demands and reach the graduate employability target.

In 2020, Malaysia was the first developing country to move up from 15th place to 12th place out of 190 countries for ease of doing business in the Doing Business Report (World Bank Group, 2020). In this case, the Malaysian higher education system has undergone numerous changes to increase the percentage of student entrepreneur graduates to remain relevant to the industry's aspirations and increase the rate of student entrepreneurs from polytechnics. The TVET 4.0 Framework 2018-2025 has also been developed by the Malaysian Ministry of Education (2018) Malaysian Ministry of Education Malaysia (2018) to provide specific guidance for TVET institutions in dealing with business digitalisation through the implementation of a business incubation program. Malaysian polytechnics are no exception at this stage and must play an essential role in implementing digital entrepreneurship education, especially in business incubators. Due to this, Malaysian polytechnics should seize the opportunity to maximise the potential of business incubation programs by implementing digital entrepreneurship education as the reinforcement links to expand the business digitalisation market, technological expertise, and promote product commercialisation of institution-based ventures.

However, it is highlighted in the National Entrepreneurship Policy 2030 that Malaysia received the lowest score among 132 countries, with only nine per cent in technology absorption and 12 per cent in product innovation. Thus, the Malaysian Ministry of Education (2018) has emphasised improving entrepreneurship education programs by developing 4IR-based business incubators in polytechnics. As highlighted in the Malaysian Polytechnics' Entrepreneurship Incubator Standard Operating Handbook (Polytechnic and Community College Education Department, 2021) launched by Entrepreneurship Development for Polytechnic and Community College (CEDev), the characteristics of an ideal business incubation program in polytechnics involve a robust support system in terms of business space, mentoring services, technical training, potential opportunities, internal mentorship, and industrial mentorship related to digitalisation. With constant guidance from mentors, agencies, and industry partners, polytechnic students will be more confident to become digital entrepreneurs after graduation. Therefore, the Ministry of Education Malaysia (2018b) is bonded to fully support the development of digital competencies through entrepreneurial innovation in polytechnics by integrating academicians, industry partners, communities, and governments to create a better 4IR ecosystem. Although the government has set out the digital technology policies and standard operation handbook for polytechnics, no specific documentation has highlighted on the impacts of implementing digital entrepreneurship education in Malaysian polytechnics' business incubation program. Therefore, a deeper understanding and clarification of the implications should be documented to increase the rate of polytechnics' business incubation programs integrating digital tools, digital marketing, digital platforms, or technological solutions.

Digital Entrepreneurship Education Implementation in Malaysian Polytechnics

The Graduate Tracer Report (Malaysian Ministry of Education, 2018a) from 2012 to 2017 has shown that polytechnic students continuously have a more significant percentage of graduates who immediately engage in entrepreneurship than students in public and private institutions. However, the Ministry of International Trade and Industry (2018) has also

documented a lack of awareness of the effects of 4IR among Malaysian entrepreneurs and that their digital adoption remains low in businesses. To ensure that TVET 4.0 Framework can be realised, the Strategic Plan of Polytechnics and Community Colleges 2018-2025 (Ministry of Education Malaysia, 2018a) was also been developed to ensure that Malaysian polytechnic is aligned with the government aspiration. Through the policy, Malaysian polytechnics are advised to incorporate values and attributes related to digitalisation across all courses in their curriculum to ensure the student entrepreneurs are well trained during their academic year. Most importantly, Malaysian polytechnics are encouraged to provide 4.0 infrastructure facilities according to their niche area. In relation to this, the second domain in the strategic plan has the aim to produce quality TVET graduates by improving the polytechnics' entrepreneurship ecosystem through two primary initiatives: (1) implementation of the digital entrepreneurship program and (2) developing 4IR-based business incubation program related to digital entrepreneurship.

The digital technological solution is defined as those that employ the use of algorithms, advanced computational methods, cloud-based systems, wireless technologies, and solutions that share common IT-platforms that are enabled by emerging Internet-based technologies or platforms such as the utilisation of verification technology, incorporation of Internet of Things (IoT), machine learning, blockchain technology and others (Mackey and Nayyar, 2017; World Economic Forum, 2020; Muafi et al., 2021; Primahendra et al., 2021). In this study's context, digital technological solution refers to the application of digital technologies that is being utilised by business incubation programs in Malaysian polytechnics to address specific challenges or problems and develop innovation solutions to improve efficiency or streamline processes such as the utilisation of Internet of Things, system integration, machine automation, recognition tools, and 3D printing. Based on the statistics of business types ventured by Malaysian polytechnics (Figure 1), the percentage of polytechnics that have developed business incubators related to digital technological solutions is still relatively low at just 38.89 per cent compared to the demand required by the government and industries. Given the rapid development and rising need for 4IR-based businesses related to digital technological solutions within the Malaysian Polytechnic business incubation program, the figures are still inedequate. According to the Ministry of Education Malaysia (2018b), Malaysian polytechnics play a vital role in preparing TVET students to venturing into digital entrepreneurship businesses through their business incubation program. To close this gap, multiple case studies needed to be done to gain an in-depth insight regarding the impacts of digital entrepreneurship education implementation in business incubation program at Malaysian polytechnics to ensure that each institution is able to comply with the nation's mission in preparing entrepreneurs for the digital business landscape. Previously, many scholars have been discussing business incubation programs at the university level, but the research that focuses on digital entrepreneurship education in business incubation programs at polytechnics, especially in developing countries such as Malaysia, is still not well documented and discoursed in most literature. Hence, this qualitative study seeks to discover the impacts of implementing digital entrepreneurship education in business incubation programs in Malaysian polytechnics.

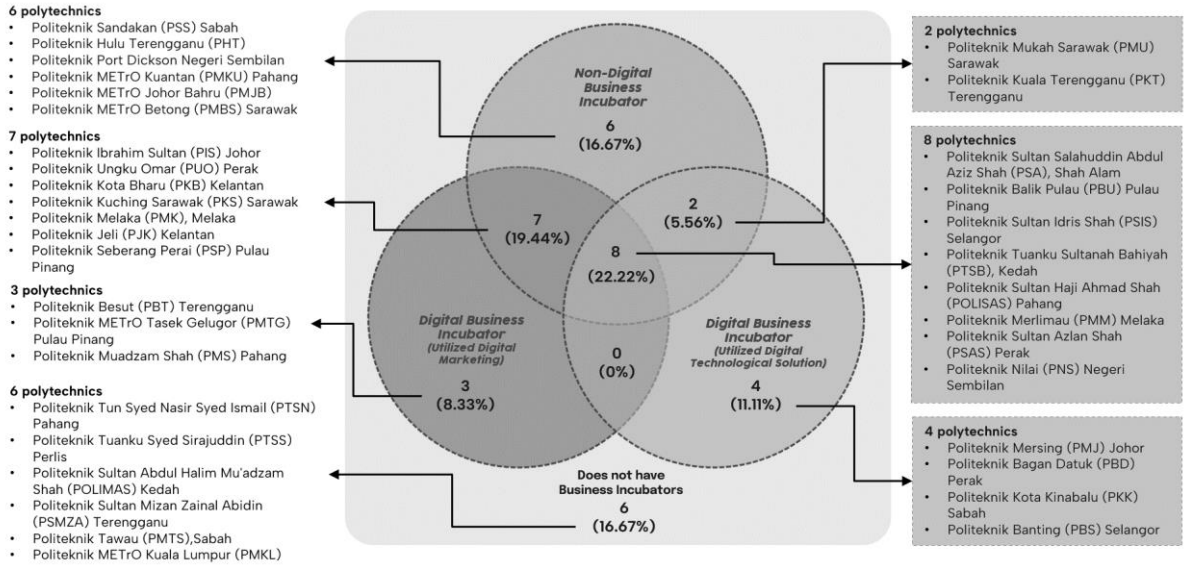

Figure 1 - Statistic of Businesses Types ventured by Malaysian Polytechnics

(Statistics provided are based on data collected until June 2022 from Malaysian Polytechnics' Official Website or Facebook page)

Theoretical Framework

For providing the guideline of this qualitative research based on the research questions, this study adopted the Student Entrepreneurship Encouragement Model (Jansen et al., 2015), Institutional Isomorphism Theory (DiMaggio & Powell, 1983), and New Venture Creation Theory (Gartner, 1985) that has been used as the theoretical lens to underlie the entire study (Figure 2). The Institutional Isomorphism Theory can influence the entrepreneurial motivations of student entrepreneurs, entrepreneurship mentors, and incubator managers to participate in the business incubation program at Malaysian polytechnics. Government initiatives that promote digital entrepreneurship education and the formation of incubation programs generated isomorphic pressure to the respective polytechnic's management. Gartner's New Venture Theory (1985) highlights the importance of acknowledging the interconnected dimensions including individual, environmental, organisational, and processes, that may influence entrepreneurs in establishing new ventures.

As for the Student Entrepreneurship Encouragement Model (Jansen et al., 2015), the model serves as a framework to assist this study in comprehending the multiple stages and strategies necessary to promote entrepreneurship education among students who venture into businesses. It also lays the groundwork for understanding the precise actions and aims needed at each phase of a business incubation program, as well the differences that will appear at the end of this research in the context of digital entrepreneurship education. The incubation stage in the model suggested by Jansen et al. (2015) also highlighted regarding the provide tangible and intangible support in order to facilitate the development of university-based businesses. According to Yin (2018), analytical generalisation from a theoretical framework can be classified into two different aspects either (1) modification, rejection, or advancement of the reference theoretical framework of a study, or (2) development of new concepts after completing the study. In this case, this study has managed to explore how the incorporation of multiple digitalisation strategies could enhance the impacts of digital

entrepreneurship education implementation in business incubation program at Malaysia polytechnics.

Research Methodology

The knowledge in qualitative study can be discovered based on the co-constructed reality between the researcher and subjects studied, shaped by their individual experiences (Creswell and Poth, 2018). With respect to constructivism, the researchers believed that information gained from the participants is subjective and socially established in order to form new knowledge of this qualitative study. Case study research is a research design in which the researcher can explore a bounded system's real-life by gathering multiple sources of information and reports it as a case description and case themes in detail (Yin, 2016). Merriam and Tisdell (2016) emphasised that the case could represent an individual, group, program, community, institution, and specific policy. In regard to this study's context, the researchers adopted multiple case studies as it fits exquisitely with a case study's characteristics, concerning selecting two business incubation programs from two selected Malaysian polytechnics to show the different perspectives pertaining to the research question developed for this study. Two business incubation programs at the selected polytechnics differ significantly, with Eduvalley Polytechnic integrating digital marketing and digital platforms into their business incubators. As for Skillrise Eastside Polytech, the institution has adopted the use of digital software and technological solutions in their business incubators.

Prior to the study, the researchers are required to obtain three different approval letters to conduct this qualitative research from Universiti Putra Malaysia (UPM), Malaysian Ministry of Higher Education (MOHE), and Department of Polytechnic and Community Colleges (JPPKK). The inclusion criteria to select the study case participants using purposive sampling has been outlined accordingly to establish the boundaries and provide a specific scope of study who can provide valuable perspectives related to the research topic. Student entrepreneurs are apprentices who enrolled into a business incubation program at any Malaysian polytechnics for a minimum of one semester, registered at least two credit hours of courses related to entrepreneurship or digital entrepreneurship, and operated a business that benefited from the usage of digital tools, digital marketing, digital platforms, or technological solution to enhance their business operations. The entrepreneurship mentors must be lecturers in Malaysian polytechnics with at least two years of experience teaching any subject relevant to digital entrepreneurship and be actively involved as trainers or advisors in the entrepreneurship unit's business incubation program. As for incubator managers, the individual should be the officers or lecturers who is in charge of the business incubation program with more than two years' experience working at Malaysian polytechnics and who are actively involved in implementing digital entrepreneurship for the student entrepreneurs enrolled in the business incubation program under entrepreneurial unit at Malaysian polytechnics.

Thus, a total of 14 individuals who fits the inclusion criteria were selected using heterogenous sampling strategy in this multiple case studies from both polytechnics, combining seven entrepreneurship mentors, two incubator managers, and five student entrepreneurs, to ensure that the researchers can achieve data saturation prior to analysing the research findings (Table 1). It is aligned with Cohen et al. (2018), whereby the report

findings from various aspects covering the whole range of perspectives are critical characteristics of good qualitative research.

Data Collection

In this qualitative case study research, the researcher herself is the primary instrument for collecting data in this study. The primary data collection technique that has been chosen to carry out this qualitative research are semi-structured interviews, direct observation and document analysis were utilised to increase the trustworthiness of this study through data triangulation. At the beginning of the data collection procedures, the researchers designed the interview protocol that matches the research question of this study. The interview protocol that the researchers developed was validated on its content by four experts with a strong background in methodology, entrepreneurship education, and technical education. The semi-structured interviews were conducted face-to-face and online using the Microsoft Team platform according to the time suitability of each research participant. Each interview session lasted between 50 minutes to two hours. The semi-structured interview session was recorded by the researchers using voice recorder that is accessible via smartphone and portable media player. This recording procedure has been well-informed to the research participants in the informed consent form to avoid unethical actions. The researchers also jotted down important notes during the interview for transcribing purposes that followed. Every research participant has been verbally prompted from time to time about the confidentiality of their responses to ensure they can communicate openly and honestly.

Data Analysis

At the early stage of the analysis process, the researchers focused on organising the data into digital files and consistently creating a file naming system to ensure every material could be located easily. To maintain the authenticity of the data interpretation, it is the researchers' responsibility to listen to the voice recording and transcribe every word spoken by the participants in Microsoft Word documents. In order to ensure data confidentiality, each interview transcript was given pseudonyms for the participants, polytechnic names, and the date of the interview. Prior to descriptive analysis, every interview transcript was read and reread to help the researchers in visualising the emergent idea as well as to recall and refreshing process. Coding refers to identifying and labelling the bits of data to build a thematic idea that could potentially address the research questions (Creswell, 2018). During axial coding that was performed using ATLAS.ti software (version 8), the iterative process of sorting and resorting the in-vivo coded text information was employed by the researchers to ensure that there is a significant connection between categories according to the researchers' interpretation of the meaning patterns.

To ensure that all categories formed were accurate with regard to the research question, the theoretical framework developed at the beginning was frequently referred throughout the inductive approach of this study. In order to determine the themes, assessing the meanings of each category is a repetitive process in which the researchers verified that each category corresponds to the pre-defined themes. Since this study involved two case studies, the same procedure was repeated with another set of interview transcriptions. It is consistent with Creswell and Poth (2018) because when multiple case studies are selected in a study, the initial procedure is to provide a detailed explanation of each case and themes within the case, referred to as within-case analysis. This level of detail contributes to the overall richness and

depth of the research findings. Finally, the cross-case analysis, which is a constant comparative analysis, was conducted to seek for similarities and differences across both studied cases and develop a broader understanding across different contexts of digital entrepreneurship education implementation.

Findings and Discussion

Research Question: To what extent are the impacts of implementing digital entrepreneurship education in business incubation programs in Malaysian polytechnics?

The integration of New Venture Theory (Gartner, 1985) and Institutional Isomorphism Theory (DiMaggio and Powell, 1983) as the theoretical perspectives of this study has enabled the researchers to gain a deeper understanding of how the impacts of implementing digital entrepreneurship education in business incubation program aligns with the principles of both theories. By acknowledging the pushing factors such as government policies and education standards that will have a direct or indirect effect on the digitalisation impacts, other institutions within the same context of this study will be able to imitate the successful aspects implemented by both polytechnics in this research. Jansen et al. (2015) have developed the Student Entrepreneurship Encouragement Model to visualise the elements that should be considered during business incubation programs. As suggested by Jansen et al. (2015), three distinct stages which are stimulation stage, education stage, and incubation stage, have been addressed accordingly in this study. Although the implementation of digital entrepreneurship education in Malaysian polytechnics has a different approach, the core characteristics needed within the business incubation program were extended precisely in this study's context. Thus, the discussions of this study have revolved around three themes emerged during constant comparative analysis including the ability to expand stakeholders' competencies, build solid foundation for digital-based ventures, and strengthen the collaboration between the internal and external stakeholders for commercial development. The following Table 2 summarises the research findings from the semi-structure interview based on the research question formulated for this current qualitative study:

Table 2
Summary of the Findings from the Semi-Structured Interview based on Formulated Research Question

Themes	Categories & Code Excerpts
Theme 1: Ability to expand stakeholders' competencies	**Category 1: Platform to upskill individual field of interest** […I managed to learn a lot about baking techniques, before this I only had basic skills. I can feel that baking skills started to increase from time to time through this incubator…] *RP6* […As for this bakery incubator, students do not have the skills to make any bakery products before they participate as apprentices. Apprentices will become kitchen helpers first because they might be afraid to become the one who is responsible to mix the dough. There also some of new apprentices will measure the ingredients, and some even started with washing dishes for the first 1 to 2 weeks. Then as time goes by, they will learn from phase to phase to measure ingredients, mix the dough and so on during their involvement in this incubator…] *RP1* […Students will get practical knowledge through this incubator. As their mentor, I will fully guide each of them, what you can and cannot do, why

	certain thing they should or should not do, and how to open components during repairing the car from A to Z. If they don't know, they can reach out to me. My room is right next to their incubator. I will always remind them to be responsibility whenever they are dealing with the tasks given…] *RP9* […My apprentices used to have zero knowledge before the participate in this incubator. But through their involvement in this incubator, they can increase their skills in a practical setting, and of course their knowledge has also increase. When they have to leave for the practical end of the semester, students can do the job at their respective companies…] *RP11*
	Category 2: Increase entrepreneurial skills […As for my apprentices, I can see that most of them has high entrepreneurial competence because they are able to act without waiting for instructions from lecturers…] *RP2* […I don't mind to do extra works and I am willing to help them whenever they need…] *RP12* […As a lecturer, we have many daily tasks related to teaching and learning as well as management aspect that we need to do including marking papers, courses and attend classes but I will still give my commitment as the entrepreneurship mentor. I also have no problem doing the paperwork related to my incubator. In order to quickly receive the funds needed, we can't wait for someone else to tell us to do it and we have to start our own…] *RP5* […Actually, the amount of workload that I have is more than double the amount of work as a lecturer. During weekend, I will also come to this incubator to assist my students…] *RP9* **Category 3: Gain positive effects on career growth through promotion** […This incubator also provides opportunities for lecturers in terms of promotion to a higher lecturer grade…] *RP4* […Our participation in this incubator can be evaluated for promotion…] *RP11* […As for lecturers who wish to be promoted to higher lecturer grade, they will be able to score more if they participate in the Lecturer-Industry Linkage Program (SIP). Since we have established a strong partnership with the industry partner through this incubator, it's easier for lecturers or students to complete their practical period because there is already a place available and the industry is also willing to accept our lecturers or students…] *RP9*
Theme 2: Build solid foundation for digital-based ventures	**Category 1: Engage directly in business ideation** […In this incubator, we also provide an opportunity for apprentice to build their self-confidence to place the food products produced by the students themselves so that they can do Market Research…] *RP5* […I have a good relationship with the alumni of this incubator. We have alumni from this incubator who continue with the bakery business after they graduated and are able to generate high income per month. This has motivated my apprentices since they can witness someone from this polytechnic who is capable to be successful once they have graduated…] *RP2* […When we pitched our product innovation or showcased the product, there will always be new improvements because we get feedback from the jury or outsiders about our products. When apprentices introduce products to the

	public, students will be more courageous to come forward to provide exposure about the innovative products they make…] *RP11* […Once they have graduated from this polytechnic, students have the basic knowledge on how to create any product because they already know the way it should be produced. For example, if students want to make their own products, they know the steps involved are to start with R&D, send samples for analysis so that they can see the expired date. Once they figure out the nutrition aspects and expiry date, it will be easier for them to do the product packaging and marketing aspects…] *RP10* […In the future, I hope to be able to use the editing skills that I have using Photoshop to open my own business related my interest…] *RP7* […I learned a lot about IoT technology that we use in this incubator. When I'm in class, I feel more comfortable because I've done it before and I feel happy…] *RP13* **Category 2: Boost job productivity** […I feel more productive because we have the opportunity to come to the incubator to monitor my apprentices, rather than just spending my day for teaching in class every day…] *RP4* […I feel reluctant to step out of this incubator since I've witnessed the ups and downs of this incubator from zero, from a place that is covered in spiderwebs, then we changed it to a printing premise and then we have to make a paperwork to get our industry partner's confidence to provide funding for us to create a bakery incubator. Since I've been with this incubator since day 1 as the mentor, there were few batches of apprentices and we have nearly six CEOs already for this incubator. It gave an emotional impact on me and makes me even more eager to improve this incubator…] *RP5* […We notice our management has started to improve and getting better with the production of 4.0 products produced by our digital-based incubator because our key management is more organised and efficient now…] *RP11*
Theme 3: Strengthen the collaboration between the internal and external stakeholders for commercialisation	**Category 1: Ability to cooperate with society and industry players from different backgrounds** […Entrepreneurship Unit gave me the opportunity to be the head of entrepreneurship in this department and I also get the opportunity to meet with outsiders. There is also certain time that I need to communicate with them according to the social background…] *RP4* […I am currently aiming to place practical students in industries such as Denso and Easy Expert who are also industry advisors for our incubators, probably around 2 of them. If there are no students who want to do practical work, we will send Polytechnic staff to do practical work through the Lecturer-Industry Linkage Program…] *RP9* […Industry can increase collaboration with educational institutions. On behalf of the Polytechnic, we are able to send students to the industry to be more exposed to real business. We used to send our students for a course with the Hometown Mushroom Enterprise, right after the course students came to us and asked when they can start a business. From there, we can see that students will be able to increase their interest because they have personally met the industry…] *RP13* […We help soy sauce factories to get halal certificates and we help fertigation companies to make chili plants. We also provide services to help SME enterprise during their business plan presentation to get fund from industry.

	Some of SME enterprise We have different stages of consultation, so our service charge will be based on the stages...] *RP10*
	Category 2: Receive appreciation and recognition
	[…The establishment of this incubator is actually the indicator of my success as well as my commitment and hard work. As a mentor, I have not been given any salary, but I feel responsible to assist my apprentices in organising their profit to ensure that it can be stored safely…] *RP5*
	[…We give 70 per cent of the revenue to the apprentices as their incentives. If they work as a part-timer outside of this polytechnic, they will receive only 30 per cent and rest will be the company's profit. They spent the same amount of effort in their work, but here they get compensated more…] *RP9*
	[…Our digital-based incubator raised our polytechnic name for several times due to our achievements in various competitions, partnership with SME enterprises, and also our involvement in social entrepreneurship. We also actively provide high school students with technical training related to digital technology…] *RP13*
	[…This incubator is able to increase the achievement of the Polytechnic KPI itself. For example, our Coconut Kaya Slices N Bite product has reached the international level because we managed to penetrate the international market through online platform. So not only has the Polytechnic KPI been achieved but this product can also help MOHE to achieve their KPI…] *RP10*

Ability to Expand Stakeholders' Competencies

Platform to upskill individual field of interest

The implementation of digital entrepreneurship education in business incubation program has emerged as an effective approach to expand incubator stakeholders' competencies that can lead to the increase of entrepreneurial spirit and providing hands-on experience. Through the implementation of the "One Incubator One Department" policy that was employed by both polytechnics to align with the Malaysian Polytechnics' Entrepreneurship Incubator Standard Operating Handbook (Polytechnic and Community College Education Department, 2021), these institutions have strengthened their legitimacy by emphasising the significance of providing a platform to upskill individual fields of interest within their business incubation program. By adhering to their organisational policies with national policies, each polytechnic demonstrates its commitment to bridging the gap between theory and digital entrepreneurial practices among its student entrepreneurs. This is a manifestation of isomorphism as highlighted by DiMaggio and Powell (1983), which occurs when organisations face pressures from government regulations to meet certain polytechnic standards. In both polytechnics of this multiple case study, participants highlighted the core similarity, which is providing opportunities for individuals to increase their skills in their chosen business fields related to digital entrepreneurship. Participants emphasised that the business incubation has enabled them to expand their digital-related business knowledge and practical aspects, showcasing how the business incubation program contributes to personal growth and expertise.

Another identical component that emerged as one of the impacts is the aspect of progressive learning within the business incubation program. In both cases, participants noted that student entrepreneurs often start with basic tasks and gradually progress to more complex responsibilities. This approach allows individuals to overcome initial fears, obstacles and build confidence in their abilities. This phased learning model facilitates a comprehensive

understanding of the field and contributes to the upskilling process. The platform provided by the business incubation program enables individuals to learn and advance through different phases, gradually building their skills and competence in their field of interest. As highlighted by entrepreneurship mentors, their apprentices' industry readiness after participating in the business incubation program has highlighted a distinctive aspect of the business incubation program. In this case, the level of practical experience gained and the preparedness for the professional world may differ based on the nature of the field and the business incubation program's curriculum. This study is consistent with research conducted by Pauwels et al., (2016), as it has been shown that the curriculum of incubation training program should cover a variety of aspects or courses, including marketing, finance, management, public relations, user design, legal aspects, and a program of ad hoc events, such as inspiring lectures or expert workshops, that is tailored to specific ventures. In Malaysian polytechnics context, some business incubation programs place a stronger emphasis on practical training due to their product innovation, while others have a more balanced approach between theory and preparing their student entrepreneurs' intrapreneurship values. This reflects the adaptability and flexibility of the digital entrepreneurship education implementation in business incubation programs to cater to the unique needs of various fields of interest.

Increase Entrepreneurial Skills

Business incubation programs in Malaysian polytechnics serve as valuable platforms for aspiring student entrepreneurs to develop their entrepreneurial competencies. This subtopic explores the impact of implementing digital entrepreneurship education in polytechnics' business incubation programs, focusing specifically on the increase in multi-tasking skills among incubator stakeholders. In both polytechnics, lecturers in their respective departments have demonstrated high commitment to their roles as entrepreneurship mentors in the business incubation program. Despite their existing daily tasks, they willingly undertake additional responsibilities related to the business incubator and are proactive in their approach to digital entrepreneurship. This shared commitment reflected a key similarity in their recognition of the importance of personal initiative and the need to be proactive in order to excel in the multi-faceted environment of digital entrepreneurship. Participants have also provided their point of view in the context of entrepreneurship mentor regarding their willingness to provide extra support to their students and this has illustrated the importance of educators' self-initiation. Similarly, study by Yu et al. (2022), has shown that when educators experience an increase of their psychological mechanism including having the autonomy, sense of relatedness, problem-solving skills, it will potentially drive them to engage more in digital entrepreneurship education, make necessary adjustments to teaching materials, and enhance their teaching commitment.

Not only that, student entrepreneurs in business incubation programs displayed high levels of entrepreneurial competence, indicating their capacity to take independent action and ability to act without constant instruction. This shared emphasis on self-reliance of both student entrepreneurs and entrepreneurship mentors highlights the role of digital entrepreneurship education in fostering independence and the ability to multi-task effectively. Another aspect that participants from both polytechnics have highlighted was related to educator's workload. In Eduvalley Polytechnic, several participants highlighted the substantial workload they face, which they perceived as more than double that of their role

as a lecturer. While participants from both polytechnics emphasised the need for multi-tasking, the nature and extent of their daily tasks differ, potentially influencing how their multi-tasking skills are honed and their distinct commitments towards digital entrepreneurship. By encouraging proactive behavior, nurturing entrepreneurial competencies, and providing access to digital tools and resources, the business incubation program can empower incubator stakeholders to handle diverse responsibilities effectively.

Gain Positive Effects on Career Growth through Promotion

Implementing digital entrepreneurship education within polytechnics' business incubation programs has proven to positively impact career advancement, particularly through promotion opportunities. One fundamental similarity observed across the participants is the provision of promotion opportunities for lecturers. Regardless of the specific business incubation program or polytechnic involved, lecturers who are also incubator managers or entrepreneurship mentors have reported being able to advance to higher lecturer sgrades due to their participation in the business incubation program. Similarly, Wright (2022) has revealed that job evaluation will not only create environments conducive to effective and efficient job performance when appropriate compensations are awarded, but it will also improve career progression and development for employees and foster a win-win situation between employer and employee. This is consistent with the research findings since the recognition of lecturers' dedication, expertise, and contribution to fostering entrepreneurship and innovation within their institutions played a pivotal role in their promotion. This commonality underscored the overarching positive impact of digital entrepreneurship education on career growth through promotion within the academic environment.

While the promotion opportunities are similar for both cases, there are several pathways to promotion that has been mentioned by participants during the interview. For instance, entrepreneurship mentors emphasised the importance of the Lecturer-Industry Linkage Program (SIP) as a key factor for promotion in the Malaysian polytechnics context. Through establishing solid partnerships with industry partners, lecturers and students can easily access practical periods and gain valuable industry insights. Active participation in SIP enhances lecturers' practical skills and industry connections, thereby increasing their chances of promotion. Another noteworthy aspect lies in the recognition of practical experience as a catalyst for lecturers' career growth. As elaborated further by Ibrahim Kassim et al. (2016), emotional intelligence helps academics to regulate their emotions and fellow colleagues' emotions to ensure adequate job performance and heighten lecturer's ability to cope with physiological and psychological stress while performing their duties in respective institutions. By engaging with real-world entrepreneurship and innovation, polytechnic lecturers will be able to acquire practical and social skills and develop a deeper understanding of industry dynamics through their collaboration with colleagues that has the same entrepreneurial goal. Thus, the practical experience not only strengthens their teaching methodologies but also enhances their emotional intelligence, credibility and effectiveness as educators for digital entrepreneurship education.

On the other hand, participants also highlighted the significance of evaluation for educator's promotion. The business incubation program itself served as platforms for lecturers who are also entrepreneurship mentors to showcase their skills, creativity, and ability to foster digital entrepreneurship among student entrepreneurs. Successful outcomes

and impactful initiatives developed within each business incubator are assessed during the promotion evaluation process. This evaluation process will be able to recognise the importance of practical experience, hands-on knowledge, and entrepreneurial mindset, contributing to lecturers' career advancement. By recognising these similarities and differences, each polytechnic can strategise its approaches to maximise the benefits of digital entrepreneurship education, empowering individuals to thrive in their careers and contribute to the broader digital entrepreneurial ecosystem.

Build Solid Foundation for Digital-Based Ventures

Engage Directly in Business Ideation

Digital entrepreneurship education has become an essential component of polytechnics' business incubation program, enabling their student entrepreneurs to engage directly in business ideation that will increase their mindset towards digitalisation of products or services. Although both polytechnics were forced to adhere towards certain policy related to digitalisation such as TVET 4.0 Framework 2018 to 2025 (Malaysian Ministry of Education, 2018b), but the establishment of digital related-business incubators in their respective polytechnic's departments has given a positive impact as it created a conducive environment for product innovation. This study has highlighted the aspects including practical market research and technological skills development that can foster self-confidence and enhance the digital literacy of those involved in business incubation programs to develop new digital-related products or services. This study's finding corresponds to previous studies as they indicated that students' interest in integrating technology into the learning process is stimulated to their reliance on learning media and students express their preference for interactive multimedia to learn entrepreneurship, particularly among technologically literate students, while also optimising available facilities within the institutions (Fellnhofer, 2017; Shamsuddin and Kaur, 2020).

As for both Eduvalley Polytechnic and Skillrise Eastside Polytech's business incubation programs, there is the exact similarity in providing student entrepreneurs with practical market research experiences to help them engage with business while still studying in the respective polytechnic. The hands-on experience enabled student entrepreneurs to understand consumer preferences, assess product viability, and gain valuable insights into business operations. Not only that, participants also mentioned that the existence of alumni who continue with successful businesses after graduating from the business incubation program serves as a testament to the effectiveness of entrepreneurship education and able to give student entrepreneurs the understanding regarding the impact of their involvement in business incubators for their future.

Aside from that, participants from both polytechnics exhibited the same perspectives on the impact of their involvement in the business incubation program as it enabled them to increase the development of their technological skills that will undoubtedly inspire them towards digitalisation of services or products in the future. The market research experiences ensured that incubator apprentices will receive feedback from industry experts that can help them refine and enhance their product innovation. Through the engagement in such activities, there would be an impact on the development of entrepreneurial abilities and students' readiness for digitalisation, as they have received vital insights into their customers'

preferences and acquired specialised skills related to research and development (R&D) while still in polytechnic. By incorporating technology-focused components into the curriculum, polytechnics can effectively prepare aspiring digital entrepreneurs, enabling them to launch and expand businesses that align with their interests and capitalise on emerging opportunities. As evident in this study, participants expressed that they felt extra confident due to the fact that they have already familiar with the digital technology such as Internet of Things and robotics before they learned it in their classroom.

Theory-wise, although DiMaggio and Powell (1983) have mentioned that the niche or goal that has been set by the authority such as the ministry will be able to influence the drive of student entrepreneurs to choose specific business incubator under their department, but both polytechnics of this study has further encouraged the involvement of student entrepreneurs from diverse background and department in technology-related business incubators to ensure that they are able to exchange their expertise and skills. These instances demonstrated the integration of technology-focused components within the curriculum will have a crucial impact on each student entrepreneur in navigating the digital landscape and succeeding in the realm of digital entrepreneurship. By embracing digital entrepreneurship education, polytechnics can nurture a new generation of student entrepreneurs who are equipped to navigate the challenges and opportunities of the digital age, making meaningful contributions to the business landscape. Through the active engagement in business incubation program, it will definitely foster self-confidence, develops technical skills, facilitates market research, cultivates alumni networks, and equips individuals with comprehensive knowledge of the product creation process.

Boost Job Productivity

Digital entrepreneurship education has emerged as a transformative force in the entrepreneurial landscape, empowering aspiring entrepreneurs with the knowledge, skills, and resources needed to succeed in the digital era. Polytechnics' business incubation program plays a vital role in fostering entrepreneurship by providing a supportive environment for innovative ventures. This study has discovered the positive impact of digital entrepreneurship education on job productivity in which participants have noted that the implementation of business incubator in the engineering department has led to increased organisation and efficiency. In Malaysian polytechnics context, the digital entrepreneurship education equips incubator stakeholders with essential managerial skills, enabling them to organise their teams better, streamline processes, and allocate resources effectively. By adopting digital tools and techniques, entrepreneurs can optimise their decision-making, enhance collaboration, and leverage automation, all of which contribute to increased productivity and improved outcomes. In developed country such as the United States, incentives system for those involved in entrepreneurship are viewed as the most important factor for a university to succeed in its functions whereby faculty members are permitted to retain 75 per cent of business revenue to greater productivity in technological transfer and entrepreneurship (Hassan, 2020).

The implementation of digital entrepreneurship education within polytechnics has demonstrated that productivity as the business incubation program's impact can manifest in diverse ways, such as the stakeholders’ emotional attachment to the program. For instance, entrepreneurship mentors expressed a deep emotional attachment to the business

incubation program they mentored for quite some time, stemming from witnessing the business incubator's growth. This emotional attachment coupled with educators' dedication to seeing the business incubator succeed has contributed to their personal drive that will potentially leading to increase of job productivity. As educators have more positive emotions toward their involvement in entrepreneurship, their willingness and continuous investment in guiding their student entrepreneurs will also start to increase from time to time (Shir et al., 2019; Iwu et al., 2021). Thus, these findings underscore the need for tailored approaches in incorporating digital entrepreneurship education within business incubation programs to meet their own institution's unique needs and objectives that can boost the institution's efficiency. By recognising the similarities and differences, polytechnics can further optimise their business incubation program according to their own entrepreneurship ecosystem that will ultimately foster a culture of innovation, productivity, and success among aspiring stakeholders.

Strengthen the Collaboration between the Internal and External Stakeholders for Commercialisation

Ability to Cooperate with Society and Industry Players from Different Backgrounds

In today's interconnected and dynamic digital-based business landscape, the ability to work and cooperate with individuals from diverse backgrounds is essential for entrepreneurial success. Prior studies have discovered that entrepreneurs with greater entrepreneurial experience experienced higher levels of entrepreneurial passion for inventing, founding, and developing when they perceived increased support from their social networks (Liu et al., 2019; Su et al., 2020). Thus, another impact of implementing digital entrepreneurship education in the business incubation program at Malaysian polytechnics that has emerged in this study is the ability of incubator stakeholders to cooperate with society and industry players from different backgrounds. Mian et al. (2016) also claimed that a business incubation program serves as a platform to expose new venture incubator teams to angel investors, corporate executives, former entrepreneurs, and venture capitalists through the initiative of public pitch events in which apprentices can pitch their businesses to large group of industry players. Through these insights, we understand how this educational approach facilitates practical experience, industry collaboration, talent development, and establishment of consulting services for small and medium enterprises (SMEs) to benefit incubator stakeholders in Malaysian polytechnics.

This collaboration with industry advisors has also enabled students to gain firsthand experience, spark their curiosity and knowledge about industry practices, preparing them for the demands of the job market. Based on the research findings, integrating industry-specific courses, internships, and practical work placements provides student entrepreneurs with a comprehensive understanding of business operations, fosters their entrepreneurial mindset, and nurtures their creativity and innovation. Participants emphasised that when incubator stakeholders were given the opportunities to engage directly with industries, their interest, and enthusiasm towards business digitalisation were significantly heightened. As indicated by Gundolf et al. (2017), individuals who have identified business opportunities or developed new ideas in the past are likely to continue generating new or advanced ideas in the future due to their innovative mindset that initially sparked the original idea. By connecting student entrepreneurs with professionals from the industry, they witness the practical application of

their academic knowledge, inspiring them to pursue entrepreneurial endeavors and further develop their talent in digital entrepreneurship for product commercialisation.

Participants also illustrated the role of polytechnics' business incubation program in supporting small and medium-sized enterprises (SMEs) through business consultation services. By leveraging lecturers' expertise, incubator stakeholders specifically entrepreneurship mentors in polytechnics can assist SMEs in various aspects, including obtaining business grants, acquiring certifications, and preparing business plans for funding. The collaboration between SMEs and polytechnics benefits the enterprises and provides valuable practical learning experiences for student entrepreneurs in business incubation programs. The staged consultation approach ensures that SMEs receive tailored support and enables polytechnics to offer their services at an appropriate charge. These collaborative experiences prepare student entrepreneurs to navigate complex business challenges, embrace product innovation, and create ventures that address the needs of a diverse society. Supported by Dalmarco et al. (2018), most education institutions have been striving to create new spin-off ventures based on the technology transfer produced by their researchers and begin to generate revenue by licensing the knowledge and encouragement of knowledge commercialisation in order to establish collaborative R&D projects that has social economic value. Through digital entrepreneurship education, business incubation programs in polytechnics will play a vital role in equipping the next generation of entrepreneurs with the ability to work collaboratively with a wide range of stakeholders that can offer various societal impacts. By creating a diverse ecosystem, fostering cross-disciplinary collaboration, leveraging industry expertise, building social connections, and embracing cultural diversity, student entrepreneurs develop the necessary digitalisation skills and mindset to thrive in the dynamic digital entrepreneurial landscape.

Receive Appreciation and Recognition

The implementation of digital entrepreneurship education at polytechnics' business incubation program has brought various impacts, including the receipt of appreciation and recognition, as mentioned by incubator stakeholders of this study. By analysing the perspectives of participants, the finding that was presented in this subtopic delves into the nuances of how appreciation and recognition manifest within these TVET educational environments. Despite operating in different business sectors and Malaysian polytechnics, the participants' experiences have revealed some commonalities, including the acknowledgement of expertise and financial incentives within polytechnics' business incubation programs. As agreed by scholars, the extrinsic motivation of an individual to pursue their desired goal is fueled by external factors such as financial rewards, recognition, status, and social approval (Kirkwood, 2009; Zarnadze et al., 2022). In this study context, individual's expertise and hard work were acknowledged significantly and entrepreneurship mentors participated enthusiastically in their respective incubator's operation although they were not given any allowance. However, the recognition of their knowledge and experience has motivated entrepreneurship mentors to take on mentoring roles and actively assist their incubator apprentices, fostering a culture of collaboration and knowledge sharing within business incubation programs in polytechnics.

Another significant aspect related to the impact of business incubation programs is the ability of student entrepreneurs to receive financial incentives, which has been highlighted

precisely in this study. For instance, participants emphasised the monetary and non-monetary rewards given to their student entrepreneurs as a token of appreciation for their constant dedication. A study by Ali and Anwar (2021) indicated that it is crucial to ensure that rewards or incentives are given to motivate individuals to accomplish the given goals better. By guaranteeing a minimum wage as the monetary reward for student entrepreneurs depending on their duties, the polytechnic fostered active engagement and acknowledged the student entrepreneurs' dedication to the business incubation program by recognising their hard work. Since salaries are part of the incentive, an organisation's ability to give a particular number of wages should be highlighted, as this has the potential to increase the motivation and productivity of team members (Hassan, 2020; Ogunmakin, 2023). The business incubation program not only compensated more fairly by offering a more substantial financial reward compared to external part-time work, but also able to portray their appreciation towards incubator apprentices' contributions. Aside from that, non-monetary rewards, including competition trips, retreats, and government acknowledgement, played a significant influence in increasing incubator stakeholders' entrepreneurial motivation. This demonstrated a recognition of the apprentices' efforts and the fair compensation they receive impacted from the establishment of business incubation program in polytechnics. Although there is no one-size-fits-all approach to providing these types of non-monetary rewards, management should constantly adapt their strategies in order to retain employees and keep them motivated that will increase the impacts of the program (Anwar and Shukur, 2015; Mullabayev, 2022).

While there are similarities found during the data analysis, the participants' experiences also highlighted some distinct ways in which appreciation and recognition manifest within the polytechnics' business incubation programs. The reputation and achievements garnered through participation in competitions and partnerships, as well as the contribution to institutional KPIs, highlighted the distinct forms of recognition experienced by stakeholders in both of polytechnics. In line with González-Padilla et al. (2023), innovative entrepreneurs frequently have strong digital personalities, such as being altruistic in providing benefits to others, boomerang by seeking feedback from their network, professional when dealing with others about their work, rebel in terms of being at the forefront, selective when choosing preferences, and connector by willingly sharing their information to expand their business growth. Some participants also emphasised how their business incubator's achievements, such as providing technical training related to digital technology to high school students, positively impacted and elevated their polytechnic's reputation. This recognition not only benefits the individual entrepreneurs but also bolsters the polytechnic's image as a hub of innovation and digital entrepreneurship. The outreach program together with stakeholders' commitment to develop skills within their institution and outside of the institution further contribute to the polytechnic's reputation. Not only that, participants have also underlined how the success of a product developed within the business incubator can elevate the polytechnic's reputation at the national level. This recognition extends beyond individual accomplishments to broader institutional goals. The incubator program's ability to align with the key performance indicators (KPIs) of both the polytechnic and the higher education ministry underscores the significance of its impact and the recognition it receives at a systemic level.

Conclusion

The rise of digitalisation offers entrepreneurs numerous opportunities to innovate and embrace new practises. As a result, business models are undergoing a significant upheaval, moving to digital domains and giving rise to the concept of "digital entrepreneurship" as the dominant business environment. Studies indicate that business incubation programs play a vital role in expanding the use of digital technology in the education sector by student entrepreneurs. Consequently, the TVET education system must prioritise the integration of digital entrepreneurship education into business incubation program, since this serves as a platform to equip student entrepreneurs with the necessary skills to adopt business digitalisation of their ventures. With respect to constructivism, the researchers believed that participant information is subjective and socially constructed in order to generate new knowledge. The purpose of this qualitative study was to explore an in-depth insight into the impacts of implementing digital entrepreneurship education in the business incubation program at Malaysian polytechnics. The constant comparative analysis has uncovered three major themes regarding the impacts, including the ability to enhance stakeholders' competencies, establishment of a solid foundation for digital-based ventures, and strengthening the collaboration between the internal and external stakeholders for commercial development.

The first findings revealed that the implementation of digital entrepreneurship education in business incubation programs is an effective method for enhancing the competencies of stakeholders. The "One Incubator One Department" policy practised by both polytechnics, which is consistent with national standards, focuses on upskilling individuals in their respective disciplines, linking theory and practise, and fostering the digitisation of student entrepreneurs' businesses. The phased learning strategy enables incubator apprentices to progress from basics to complex non-digital and digitalisation tasks in order to build confidence and digital competence. This adaptable curriculum covers various entrepreneurship aspects, highlighting the flexibility of digital entrepreneurship education. Lecturers, as entrepreneurship mentors, also play a crucial role in empowering student entrepreneurs with independent action and multitasking abilities. Additionally, the business incubation program has a favourable impact on the career development and advancement chances of lecturers, demonstrating its value in academia. The promotion of polytechnic lecturer grades is a result of the business incubation program's recognition of commitment and expertise. Practical experience gained through initiatives like the Lecturer-Industry Linkage Program and successful outcomes within the business incubation program are crucial factors in promotion evaluations.

The findings of this study also indicated that the implementation of digital entrepreneurship education in the business incubation program at Malaysian polytechnics will have a remarkable impact to the establishment of a solid foundation for digital-based ventures. Direct participation in business ideation has greatly shifted the perspective of incubator stakeholders toward the digitalisation of products and services through the utilisation of the Internet of Things, robotics, and machine automation. Despite governmental policies, the emergence of digital technology-related business incubators in polytechnics has fostered innovation in multiple sectors, including agriculture, food technology, and education. Hands-on experiences in market research provided invaluable insights into consumer preferences and business operations, while alumni success stories validated the business

incubation program's effectiveness. The familiarity with digital technology acquired through business incubation programs prior to their classroom learning instilled extra confidence for student entrepreneurs in their academics. The inclusion of students from varied backgrounds into digital technology incubators facilitated skill exchange. The business incubation program has led to increased organisation and efficiency, showcasing the program's multifaceted impact. Emotional attachment among incubator stakeholders, especially mentors, adds further to increased commitment, dedication, and productivity.

Aside from that, implementing digital entrepreneurship education in the business incubation program at Malaysian polytechnics has had an impact on the creation of a vibrant ecosystem where stakeholders from diverse backgrounds congregate to drive innovation and knowledge exchange for commercialisation. This synergy exposes student entrepreneurs to real-world industrial practices and sparks their curiosity and creativity, preparing them for the competitive employment market. The provision of consultation services to SMEs exemplifies the program's dedication to bridging the gap between academics and industry by providing customised support for the program's sustained growth. The appreciation and recognition garnered by stakeholders further validate the program's efficacy. This recognition, whether through financial incentives, recognition of knowledge, or institutional accomplishments, not only inspires and enables individuals, but also enhances the polytechnic's status as an innovation hub. Ultimately, the holistic approach of this initiative not only cultivates a collaborative entrepreneurial environment but also equips emerging entrepreneurs with the digital prowess and adaptability needed to flourish in the dynamic digital era.

In conclusion, several concluding remarks have been drawn precisely that can be used as guiding principles for policy recommendations, especially for TVET education sectors with similar characteristics to this study. Through this multiple case studies, the researcher has identified a novel discovery through the developed research question that has broaden the Student Entrepreneurship Encouragement Model by Jansen et al. (2015), which is the incorporation of the commercialisation phase to boost product innovation within the business incubation program at Malaysian polytechnics. Since the commercialisation phase is still not widely integrated in most Malaysian polytechnics, this research has the full potential to extend the current literature by conceptualising the practicality within business incubation programs through the integration of two main theories, which are Institutional Isomorphism Theory (DiMaggio and Powell, 1983) and New Venture Creation Theory (Gartner, 1985) in the context of TVET institutions. This context-specific approach explores how polytechnics in developing countries are adapting to the demands of the 4IR by aligning their reskilling and upskilling initiatives depending on their institution capabilities.

Research Implications and Recommendation

It is advocated that policymakers construct a national accreditation evaluation in order to assess the impacts of the business incubation program on an individual's potential or career advancement by employing effective digital competency outcomes as key performance indicators. Through the initiative, it will allow for continuous improvement and adaptation of the digital entrepreneurship curriculum and teaching methodologies in business incubation programs within polytechnics.

Practically, consideration should also be given to the development of interactive and immersive learning experiences that gamify digital entrepreneurship education. This may involve the development of virtual business simulations or competitions that require students to apply their talents in a dynamic and competitive digital-based entrepreneurial environment. In addition, it is suggested that the Malaysian Ministry of Higher Education (MOHE) to collaborate with the Polytechnic and Community College Education Department (JPPKK) to construct virtual reality incubation spaces where students can cooperate and innovate in a simulated digital environment by forming partnerships with significant digital ecosystem stakeholders. This would allow student entrepreneurs to complete entrepreneurial projects remotely, building a global network of digital entrepreneurs.

Moreover, it is significant for higher authorities to create a sandbox tailored explicitly for digital entrepreneurship initiatives for polytechnics as this controlled environment allows startups to test new business models and technologies without facing immediate regulatory constraints. This would also provide a safety net for student entrepreneurs, allowing them to focus on their ventures without immediate financial pressure. As for polytechnic practise, incubator management should facilitate exchange programs with international institutions and startups for student entrepreneurs in order to expose them to diverse cultural perspectives and provide opportunities to collaborate on global digital-based projects, fostering a truly global entrepreneurial mindset.

Since this study has focused on the perspectives of internal incubator stakeholders, future research should also be done to discover the impact of external support systems in order to have a comprehensive understanding of the implementation of digital entrepreneurship education in Malaysian polytechnics. The perspective of external stakeholders, such as industry partners, financial providers, alumni, and government agencies, should be valued because it is essential to comprehending and optimising the implementation of digital entrepreneurship education in polytechnics' business incubation programs.

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References

Barbero, J. L., Casillas, J. C., Ramos, A., & Guitar, S. (2012). Revisiting Incubation Performance: How Incubator Typology Affects Results. *Technological Forecasting and Social Change*, *79*(5), 888–902. https://doi.org/10.1016/j.techfore.2011.12.003

Bergek, A., & Norrman, C. (2008a). Incubator best practice: A framework. *Technovation*. https://doi.org/10.1016/j.technovation.2007.07.008

Bergek, A., & Norrman, C. (2008b). Linköping University Post Print Incubator best practice : A framework Incubator best practise. *Technovation*, *28*(1–2), 20–28.

http://www.elsevier.com/

Caena, F., & Redecker, C. (2019). Aligning teacher competence frameworks to 21st century challenges: The case for the European Digital Competence Framework for Educators (Digcompedu). *European Journal of Education*, *54*(3), 356–369. https://doi.org/10.1111/ejed.12345

Cohen, L., Manion, L., & Morrison, K. (2018). Research Methods in Education. In *Taylor & Francis Group* (Eight). Taylor & Francis.

Dalmarco, G., Hulsink, W., & Blois, G. V. (2018). Creating entrepreneurial universities in an emerging economy: Evidence from Brazil. *Technological Forecasting and Social Change*, *135*(April), 99–111. https://doi.org/10.1016/j.techfore.2018.04.015

European Commission.; (2017). *Digital Competence of Educators : DigCompEdu*. https://moodle.ktu.edu/pluginfile.php/428841/mod_resource/content/1/pdf_digcomedu_a4_final.pdf

European Commission. (2017). *Synthesis of the DigCompEdu Framework*. https://ec.europa.eu/jrc/sites/jrcsh/files/digcompedu_leaflet_en-2017-10-09.pdf

González Calleros, C. B., Guerrero García, J., Navarro Rangel, Y., González Calleros, J. M., & Collazos Ordoñez, C. A. (2022). Digital Competencies of Higher Education Institutions in Mexico: A Systematic Literature Review. *Lecture Notes in Educational Technology*, 313–343. https://doi.org/10.1007/978-981-19-1738-7_17

Greene, P. G., & Butler, J. S. (1996). The Minority Community As A Natural Business Incubator. *Journal of Business Research*, *36*(1), 51–58. https://doi.org/10.1016/0148-2963(95)00162-X

Grimaldi, R., & Grandi, A. (2005). *Business Incubators and New Venture Creation : An Assessment of Incubating Models*. *25*, 111–121. https://doi.org/10.1016/S0166-4972(03)00076-2

Hassan, N. A. (2020). University Business Incubators As A Tool For Accelerating Entrepreneurship : Theoretical Perspective. *Review of Economics and Political Science*, *Emerald Publishing Limited*.

Ho, Y. F., & Turner, J. J. (2019). Entrepreneurial Learning'-The Role of University Led Business Incubators and Mentors in Equipping Graduates with The Necessary Skills Set for Industry 4.0. *International Journal of Education*, *4*(30), 283–298. www.ijepc.com

Jamil, F., Ismail, K., Siddique, M., Khan, M. M., Kazi, A. G., & Qureshi, M. I. (2016). Business incubators in Asian developing countries. *International Review of Management and Marketing*, *6*(4), 291–295.

Jansen, S., van de Zande, T., Brinkkemper, S., Stam, E., & Varma, V. (2015). How education, stimulation, and incubation encourage student entrepreneurship: Observations from MIT, IIIT, and Utrecht University. *International Journal of Management Education*. https://doi.org/10.1016/j.ijme.2015.03.001

Khalid, F. A., Gilbert, D., & Huq, A. (2014). The way forward for business incubation process in ICT incubators in Malaysia. *International Journal of Business and Society*, *15*(3), 395–412.

Khin, S., & Ho, T. C. F. (2019). Digital technology, digital capability and organizational performance: A mediating role of digital innovation. *International Journal of Innovation Science*. https://doi.org/10.1108/IJIS-08-2018-0083

Koehler, M. J., Mishra, P., & Cain, W. (2013). What is Technological Pedagogical Content Knowledge (TPACK)? *Journal of Education*, *193*(3), 13–19. https://doi.org/10.1177/002205741319300303

Kraus, S., Palmer, C., Kailer, N., Kallinger, F. L., & Spitzer, J. (2019). Digital entrepreneurship: A research agenda on new business models for the twenty-first century. In *International Journal of Entrepreneurial Behaviour and Research*. https://doi.org/10.1108/IJEBR-06-2018-0425

Lalkaka, R. (2002). Technology business incubators to help build an innovation-based economy. *Journal of Change Management*, *3*(2), 167–176. https://doi.org/10.1080/714042533

Le Dinh, T., Vu, M. C., & Ayayi, A. (2018). Towards a living lab for promoting the digital entrepreneurship process. *International Journal of Entrepreneurship*.

Lubis, R. L. (2019). Digital Entrepreneurship in Academic Environment: Are We There Yet? *Journal of Teaching and Education*, *09*(01), 167–194.

Malaysian Ministry of Education. (2018). TVET 4.0 Framework 2018 - 2025. In *Department of Polytechnic and Community College Education Ministry of Education Malaysia*.

Mattar, J., Santos, C. C., & Cuque, L. M. (2022). Analysis and Comparison of International Digital Competence Frameworks for Education. *Education Sciences*, *12*(12). https://doi.org/10.3390/educsci12120932

McAdam, M., Miller, K., & McAdam, R. (2016). Situated regional university incubation: A multi-level stakeholder perspective. *Technovation*, *50–51*, 69–78. https://doi.org/10.1016/j.technovation.2015.09.002

Mele, G., Sansone, G., Secundo, G., & Paolucci, E. (2022). Speeding Up Student Entrepreneurship: The Role of University Business Idea Incubators. *IEEE Transactions on Engineering Management*, 1–15. https://doi.org/10.1109/TEM.2022.3175655

Mian, S. A. (1996). The University Business Incubator : A Strategy For Developing New Research/Technology-Based Firms. *The Journal of High Technology Management Research*, *7*, 191–208.

Mian, S., Lamine, W., & Fayolle, A. (2016). Technology Business Incubation: An overview of the state of knowledge. *Technovation*, *50–51*, 1–12. https://doi.org/10.1016/j.technovation.2016.02.005

Mohd Ghazali, M. Y. (2010). Building an innovation-based economy: The Malaysian technology business incubator experience. *Journal of Change Management*, *3*(2), 177–188. https://doi.org/10.1080/714042527

Muafi, M., Syafri, W., Prabowo, H., & Nur, S. A. (2021). Digital Entrepreneurship in Indonesia: A Human Capital Perspective. *Journal of Asian Finance, Economics and Business*, *8*(3), 351–359. https://doi.org/10.13106/jafeb.2021.vol8.no3.0351

Narayanasamy, S. S. Al, Hajamydeen, A. I., & Ishak, Z. (2019). Theoretical framework of digital marketing and the future availability in Malaysia. *2019 IEEE 9th International Conference on System Engineering and Technology, ICSET 2019 - Proceeding*. https://doi.org/10.1109/ICSEngT.2019.8906342

Pereira, R. Q., & Nganga, C. (2020). TPACK and Business Education: a Review of Literature (2008-2017). *Revista de Informação Contábil*, *14*(0), 020001–020001.

Polytechnic and Community College Education Department, J. (2021). *Panduan Operasi Standard Inkubator Keusahawanan Politeknik dan Kolej Komuniti* (First Edit, Vol. 148). Centre of Entrepreneurship Development Polytechnic and Community College (CEDev) Bahagian Ambilan dan Pembangunan Pelajar (BAPP) JPPKK.

Primahendra, R., Purba, J. T., Ugut, G. S. S., & Budiono, S. (2021). Do Digital Literacy and Digital Entrepreneurship Among University Students Contribute to Digital Economy. *Budapest International Research and Critiics Institute-Journal (BIRCI-Journal): Humanities and*

Social Sciences, *4*(3), 7388–7394. https://doi.org/10.33258/birci.v4i3.2617

Rahmi, E., & Cerya, E. (2020). *Analysis of Lecturer Digital Literacy Skills in Entrepreneurship Course*. *124*, 516–520. https://doi.org/10.2991/aebmr.k.201126.042

Rippa, P., & Secundo, G. (2019). Digital academic entrepreneurship: The potential of digital technologies on academic entrepreneurship. *Technological Forecasting and Social Change*, *146*(July), 900–911. https://doi.org/10.1016/j.techfore.2018.07.013

Ruslan, M. F. (2018). A Review and Research Direction: Business Incubators in Malaysia. *The Journal of Social Sciences Research*, *SPI4*, 106–111. https://doi.org/10.32861/jssr.spi4.106.111

Secundo, G., Rippa, P., & Meoli, M. (2020). Digital transformation in entrepreneurship education centres: preliminary evidence from the Italian Contamination Labs network. *International Journal of Entrepreneurial Behaviour and Research*, *26*(7), 1589–1605. https://doi.org/10.1108/IJEBR-11-2019-0618

Sufian, J. (2006). Incubators As Catalysts in Developing High Technology Businesses : Malaysia ' S Experience. *ATDF Journal Volume*, *3*(1), 25–29.

Tang, M., Walsh, G. S., Li, C., & Baskaran, A. (2019). Exploring technology business incubators and their business incubation models: case studies from China. *Journal of Technology Transfer*. https://doi.org/10.1007/s10961-019-09759-4

Thomas, M., & Chukhlomin, V. (2020). Introducing TCA-TPACK: A Competency Based Conceptual Framework for Faculty Development in Technology-Enhanced Accounting and Business Education. *Society for Information Technology & …*, *July*.

UNESCO. (2018). A Global Framework of Reference on Digital Literacy for Indicator 4.4.2. *Information Paper*, *51*(51), 1–146.

Wagiran, M., Pardjono, M., Suyanto, W., & Sofyan, H. (2017). Vocational Education Development Framework in 21st Century. *Advances in Social Science, Education and Humanities Research*, *102*(Ictvt), 395–398. https://doi.org/10.2991/ictvt-17.2017.68

Wasdani, K. P. (2022). *Business Incubators : A Need-Heed Gap Analysis of Technology-based Enterprises*. https://doi.org/10.1177/09721509221074099

Wibowo, A., Narmaditya, B. S., Saptono, A., Effendi, M. S., Mukhtar, S., & Mohd Shafiai, M. H. (2023). Does Digital Entrepreneurship Education Matter for Students' Digital Entrepreneurial Intentions? The Mediating Role of Entrepreneurial Alertness. *Cogent Education*, *10*(1). https://doi.org/10.1080/2331186X.2023.2221164

Xu, L. (2010). Business Incubation in China: Effectiveness and Perceived Contributions To Tenant Enterprises. *Management Research Review*, *33*(1), 90–99. https://doi.org/10.1108/01409171011011599

Yin, R. K. (2018). Case study research and applications: Design and methods. In *Journal of Hospitality & Tourism Research* (Sixth Edit, Vol. 53, Issue 5). SAGE Publications. https://doi.org/10.1177/109634809702100108

Yu, T. K., Chao, C. M., & Wang, Y. J. (2022). Factors Influencing the Teaching Intention of Business College Teachers to Fulfill Digital Entrepreneurship Courses. *Frontiers in Psychology*, *13*(May), 1–14. https://doi.org/10.3389/fpsyg.2022.860808

Zaheer, H., Breyer, Y., & Dumay, J. (2019). Digital entrepreneurship: An interdisciplinary structured literature review and research agenda. *Technological Forecasting and Social Change*, *148*(August). https://doi.org/10.1016/j.techfore.2019.119735