THE VALUE OF TECHNOLOGY TRANSFER ON THE DEVELOPMENT OF ENTREPRENEURSHIP CAPABILITIES: A STUDY OF THE EDUCATIONAL TECHNOLOGY INDUSTRY IN HONG KONG

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Declaration

This work has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree.

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STATEMENT 1

This thesis is the result of my own investigations, except where otherwise stated. Where correction services have been used the extent and nature of the correction is clearly marked in a footnote(s). Other sources are acknowledged by footnotes giving explicit references. A bibliography is appended.

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Abstract:

Technology transfer, also known as knowledge transfer or knowledge exchange, is an integral mission of universities, supplementing their core functions of teaching, learning, and research. Each of the eight publicly funded universities in Hong Kong has set up Technology Transfer Offices (TTOs) to streamline this process. TTOs are vital for managing intellectual property, commercializing technology, and fostering entrepreneurship. Universities aim to enhance their TTOs' efficiency to transform research and development investments into tangible societal benefits, contributing to economic growth and entrepreneurship.

Educational Technology (EdTech) is a rapidly growing market, driven further by technological advancements and the impacts of COVID-19. This sector sees a surge in technology-based startups focusing on educational applications, and educators are increasingly launching commercial or social enterprises to address teaching and learning challenges. EdTech uniquely combines technological inventions with pedagogical innovations to create new educational tools. This study explores how entrepreneurs in the EdTech startup sector build technology value, educational value, and social networks, which constitute their knowledge capital and support their entrepreneurial capabilities.

The study's findings affirm that both formal and informal technology transfer and entrepreneurship development activities within universities positively impact the knowledge capital of EdTech startups, enhancing their innovativeness, entrepreneurial attitudes, and co-creation abilities. Educational value significantly influences entrepreneurial capability. Although absorptive capability positively impacts entrepreneurial capability, its moderating role between knowledge capital and entrepreneurial capability is insignificant. These findings offer managerial implications for university technology transfer activities and EdTech startups in Hong Kong. The model and findings can be adapted to other technology sectors like SportsTech, HealthTech, FemaleTech, and ArtTech, suggesting a versatile framework for understanding technology transfer and entrepreneurship in various specialised domains.

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The Value of Technology Transfer on the Development of Entrepreneurship Capabilities: A Study of the Educational Technology Industry in Hong Kong

Chapter 1. Introduction

1.1 Background

Universities, research institutes, and tertiary education establishments share the vital role in encouraging original knowledge innovation and technological invention that drives the tendency of economic growth of a country or city while benefiting the wider community (Grosse, 1996; Markman, *et* al., 2005; Mowery, 010; Qian& Acs, 2013; Audretsch & Caiazza, 2015; Daniela, *et al.*, 2018). In Hong Kong, universities widely adopted technology transfer as the third mission, in addition to teaching and research and development. This third pillar generated an income of over HK$100 million, approximately USD12.5 million, for the local universities in 2019. University knowledge covering innovation and technology is the major locomotive of economic growth and propels substantial productivity gains in society (Tsui *et al.,* 2020).

Technology transfer between universities and the external community covers translating university research outcomes, i.e. innovations and technology, into real business and daily life applications. The process involves applying university expertise and knowledge to update the operation and services standard of a particular company/industry (AUTM, 2014; Debackere, & Veugelers, 2005; Poticha, & Duncan, 019). The areas range from conventional medicine, machinery, manufacturing, electrics, electronics, and material science to the recent wave of cloud computing, biotech and fintech. Education Technology - "EdTech" is another hot topic covering technological inventions and innovations in teaching practices and pedagogies (Williamson, 2021; An, 2021). In universities, researchers in the faculty of engineering and science are changing our world and daily life experience with new technological inventions and solutions, while those in the faculty of education are advancing the frontier of teaching, learning and training with novel physical and psychological intervention and pedagogical methodologies. Technology transfer can be in the form of academic engagement, facilitating the action to bring knowledge into use in another organization's context, in addition to the translation and sharing of scientific data and technological inventions (de Wit-de *et al.* 2019). EdTech development has to rely on the interdisciplinary collaborations of scholars from technology and pedagogy fields to make use of recent theoretical and methodological approaches that are emerging

outside the usual purview of 'education research' (Selwyn, *et al*., 2019). Technology transfer offices in universities, as the link between universities and industries, foster the transfer of technology and education pedagogies from the research output of the universities into the applications in EdTech industries. EdTech companies can gain value from university knowledge in terms of both technological value and educational value (An, 2021).

Lackéus & Williams Middleton (2015) described EdTech is an emerging market created by the digital transformations of conventional public services. It evolves the existing interactions' structures, organisations, operations and business models. By nature, EdTech consists of two parts. Firstly, it is the education meaning. It is about the education system, involving students, teachers, schools, educators, classroom equipment, pedagogies and lesson content. Secondly, it is the technology to enable new formats of delivery and reception of education (Luckin, *et al.*, 2019; An, 2021; Viner, 2023). Scholars illustrated that the successful development of EdTech has to incorporate educational and technological value via an interdisciplinary partnership between learning scientists and technologists (Luckin, *et al.*, 2019). It is about reform and re-construction of educational communication channels, media and tools. EdTech positively impacts traditional K12 in-school education from kindergarten to high school levels. In addition to the class contents, EdTech creates blended learning platforms and mobile learning platforms for a more efficient, interactive way of teaching and learning. More importantly, it boosts the market development of community learning and employability platforms (Ramiel, *et al.*, 2019; IBIS Capital *et al.*, 2019)

EdTech is an expanding market. On top of the traditional postsecondary space in the education industry, there is a wide variety of niches radiating from the divisional sector, compensating products and supporting services. The BMO Capital Markets Education Index indicated educational technology businesses were running 69.3% and 22.6 % better than other industries in 2017 and 2018, respectively. More and more players were entering the EdTech market. Education IPOs have shifted from schools to service providers. In 2017-18, 20 sizeable cases of IPO of EdTech enterprises were recorded. Nine of them were at the Hong Kong Stock Exchange, five at the NYSE and two at the Nasdaq. The total transaction value was measured at USD2,315 million (BMO, 2018). Other market research and investment advisory firms' reports also echoed BMO's measurement of EdTech. IBIS Capital measured the EdTech expenditure valued at USD 228 billion in the global market in 2019 and will increase by no less than 15% per year. Meanwhile, the international education expenditure reached USD5 trillion in 2019, eight times the software market and three times the media and entertainment market. However, education was only 2% digitised (IBIS Capital, *et al*., 2019). This means there is a 98% blue ocean for new forms of EdTech, for instance, gamification of learning and edutainment development. An analysis forecasts that the digitisation of education is changing fast,

projected to grow to USD 404 billion by 2025. The impact of COVID-19 can boost the market with the transformation of education models (Holon IQ, 2021).

The arena of higher education offers a vast expanse of potential development and growth for the sphere of EdTech start-ups, both technologically and pedagogically. Distance learning, social networking, technology integration, and the use of technology by teachers and students are current issues in educational technology research (Karakus, 2014). Universities are teeming with knowledge and innovative ideas that can significantly contribute to the expansion and enhancement of EdTech operations, like in other knowledge- and innovation- based industries (Billups, *et al*., 2019; Sosa-Diaz, 2022). This research aims to illuminate the intricacies of the EdTech sector, with a particular focus on how university-based technology transfer can bolster the growth of an EdTech start-up during its nascent stages. Moreover, this study will delve into the value generated within an EdTech start-up through the integration of evidence-based technology inventions, innovations in education, and the incorporation of professional entrepreneurship training provided by universities. These elements serve as the foundation for an EdTech start-up, driving its growth and paving the way for its success in the market. We will explore the symbiotic relationship between technology transfer in universities and EdTech start-ups, illustrating how technology, knowledge, innovation transfer and entrepreneurship training can fuel the growth and development of the latter. The goal is to provide a comprehensive understanding of how university knowledge can be leveraged to spur technological advancement and educational innovation in the burgeoning field of EdTech.

1.2 Technology Transfer Offices in Universities

The history of Technology Transfer Offices (TTOs) in universities can be dated back to the records in the 1920s, when the top research universities were dominating the patenting activities (Mowery & Sampat, 2004). On 12 December 1980, then-US President Jimmy Carter signed the Public Law 96-175 Amendments to the Patent and Trademark Act, which afterwards was commonly referred to as the Bayh-Dole Act. The number of TTO establishments exponentially increased after the Bayh-Dole Act (Link & van Hasselt, 2019). Scholars described the Bayh–Dole Act of 1980 as the parents of modern TTOs. Markel (2013) said, "the Act permitted scientists, universities, and businesses to patent and profit from discoveries made through federally funded research. It has been beloved by the biotechnology and investment communities. Much has changed since then." Universities incorporated diffusion of their knowledge to the industry in their strategic plans and set up TTOs to commercialise university inventions and spawn new innovative firms (Daniela, *et al*., 2018). In the US, the number of universities formally established one or more TTOs had increased from 25 in 1980 to over 200 in 2005 (Castillo, *et al.,* 2016). In reference to the Bayh-Dol Act of 1980, the government of mainland China rolled out a series of policies, which were understood as the Chinese version of

the Bayh-Dol Act, designed to encourage universities to transfer research outputs in business applications after 2000. This has accelerated the establishment of TTOs to cater the ever-increasing demands of industry-university interactions (Yi & Long, 2021).

Most of the research universities worldwide have established their technology transfer offices. In 2014, there were over 150 TTOs in the US. This figure appears to be saturated as most research universities in the country had already established such an office by then (Link and van Hasselt, 2019). A European Commission report quoted there were over 1,400 TTOs in Europe among the 2,000+ research universities in 2009 (European Commission, 2009; uniRank, 2020). In Hong Kong, the Lingnan University established its TTO in 2020 to catch up with the technology transfer establishments of the other seven government-funded universities, namely the City University of Hong Kong (CityU), Hong Kong Baptist University (HKBU), The Chinese University of Hong Kong (CUHK), The Education University of Hong Kong (EdUHK), The Hong Kong Polytechnic University (PolyU), The Hong Kong University of Science and Technology (HKUST) and The University of Hong Kong (HKU) (Lingnan University, 2020; University Grants Committee, 2022).

A TTO is a part of the organisation structure in a university to support research and development, intellectual property and commercialization, and entrepreneurship and spin-off activities. Universities have been eager to enrich the function and performance of their TTOs to conduct efficient technology transfer activities (Brescia, Colombo and Landoni, 2016). On top of the conventional knowledge dissemination through teaching, publishing and fundamental research, TTOs facilitate the translation of resources in the universities into society meanings in terms of economic growth and entrepreneurship development (Daniela Baglieri, *et al*., 2018). TTOs determine the criteria for success in university-industry collaborative research and technological initiatives from an academic perspective. They identify five mechanisms for research collaboration: Consultancy and Technical Services Provision, Cooperative R&D Agreement, Licensing, Contract Research, and the creation of Spin-off Companies (Rast, *et al*., 2012). These collaboration methods offer various ways for universities and industries to work together, potentially resulting in innovative solutions and advancements in technology. TTOs are an essential link in the education, technology and economy triangle. The success of universities as research institutions depends, at least in part, on the creation and commercialization of new knowledge and know-how embedded in new technologies (Markman, *et al.* 2004). Global university ranking bodies have adopted technology transfer as one of the key indicators in the ranking methodology (Duncan, 2020).

Generally, the primary responsibilities of TTOs encompass managing intellectual property, which includes invention disclosures, patent applications, and patent grants. They also oversee the

commercialization process, such as executing licenses, establishing spin-offs, and generating gross license revenue. Additionally, TTOs facilitate joint collaborations between universities, industries, and government entities, which involve networking, business negotiations, and agreements. (European Commission, 2009). Among the eight government-funded universities in Hong Kong, the TTOs also oversee continuing professional development courses, professional workshops and corporate training for the industry, contract research, consultancy, community and cultural engagement, and entrepreneurial talent development and seed funding (University Grants Committee, 2022).

In recent years, TTOs in Hong Kong have been putting heavy resources into fostering the transfer, realization and commercialization of research-based technology applications in industry-specific settings, such as ArtTech, FinTech, HealthTech, SportTech, FoodTech, etc., and indeed EdTech (University Grants Committee, 2022). These industry-specific technologies require technological invention as the tools to improve the domain area knowledge as the application content. EdTech, the focus of this study, involves using technology to enhance the effectiveness of education, which it achieves by virtue of the functionality provided by the material of new technologies (An, 2021). Education is an important core of the development of EdTech and EdTech businesses. It is recorded that 14% of startups are in the education and learning industries and 9% are in the information, computer and technology industries in Hong Kong (InvestHK, 2023). The educational advancements made by researchers can support the growth of these startups. TTOs have the incentive to evaluate the educational value derived from university research to enhance the success of education startups and facilitate the transition of technology startups into the vast education market.

1.3. Research Problems

Technology transfer professionals described technology transfer activities as the management of knowledge assets and related intellectual properties to seek the fair market value of the university's intellectual property using best business practices for the benefit of the university, staff, students, and the outer community (AUTM, 2014). Technology transfer activities have been established into knowledge transfer activities as a broader and more encompassing concept that technology is not the only field of knowledge for which transfer is considered important; commercialization and economic impacts are complemented by social, cultural, and personal benefits on the output side (European Commission, 2009). Knowledge transfer activities included networks, continuing professional development, consultancy, collaborative research, contract research, licensing, spin-off company formation, teaching, entrepreneurial development, and more others (European Commission, 2009; Fernandez-Alles, *et al*., 2019; Markman *et al*. 2005; Holi, *et al.,* 2018). Knowledge capital encompasses the scientific information, technological knowledge, and professional practices that

firms produce, acquire, combine, and systematize for productive and value-creation purposes. This accumulated knowledge is embedded within individual know-how, operation mechanisms, technologies, and organizational system routines. Continuously enriched by information flows, knowledge capital is utilized in the commercial process and, more broadly, in the value creation process (Laperche, 2021). To establish knowledge capital, a company has to acquire and assimilate knowledge stock via strategic partnerships with partners, including research institutions, in terms of intangible capital, organizational capital and social capital (Laperche, 2021; Li and Hou, 2019). SMEs have to tailor their knowledge capital investment or accumulation plan as they often face stringent financial constraints during their development stages (Li and Hou, 2019; Ortega-Argilés *et al*., 2009). Scholars illustrated that a company can improve its internal knowledge capital by adopting new innovations and value in knowledge transfer collaborations with universities (AUTM, 2014; Markman, *et al*. 2005; Lam, *et al*., 2013; Martínez-Cañas, *et al*., 2012; Sharif and Baark, 2008). Entrepreneurship capabilities focus on the reconfiguration of resources, which are the knowledge capitals owned or controlled by the startup, to prospect, develop and exploit opportunities (De Massis, *et al*., 2018). Scholars also described entrepreneurship capability as the freedom to pursue and develop business opportunities, contingent on a set of combined and internal conditions (Wilson and Martin, 2015). The consequences of building up knowledge capital in a company include the economic benefits of original innovation, a unique dynamism in commercial activities, fostering innovation networking and fruitful supplier-user relationship, and the enhanced power of accumulating knowledge across multiple firms, which generates strong future growth (Laperche, 2021; Li and Hou, 2019; Ortega-Argilés *et al*., 2009). In addition to the hard knowledge and intellectual properties, entrepreneurs need to develop a combination of skills, aptitudes, insights, and favourable circumstances to effectively capitalize on opportunities for commercializing and profiting from the new knowledge through economic innovations (Audretsch & Caiazza, 2015).

As the designated units handling the third mission of universities, TTOs are eager to push their researchers' innovations and technologies to the industries. Conversely, EdTech companies are mostly start-ups that need external input to support their passion and visions with technological and educational capabilities. The EdTech industry is facing the situation that the start-up teams commonly have either subject knowledge of education or hard-care knowledge of technology. Among the top-ranking universities in education in Asia, only about 30% are with undergraduate programs in education technology, while approximately 50% are conducting research projects on education technology. Both universities and start-ups need support from each other in EdTech development. There can be synergy. However, are they a match? Furthermore, more importantly, how to match them? Thus, the research questions can be summarised as follows.

1. *How does university knowledge assist an EdTech business in the start-up stage?*
2. *What are the differences in the effects of a university's technology invention and intervention innovation on EdTech start-ups?*

The focus of TTOs in universities is to manage intellectual property and complete good business deals with startup ventures and other licensees (AUTM, 2014). TTOs are the innovation intermediaries in transferring new knowledge from labs and faculties to startups (Markman, *et al*., 2005). The origin of TTO activities is the university's knowledge and technology. Therefore, research question 1 focuses on university-industry collaborations in the situation that universities are the knowledge and innovation generators while EdTech startups are the recipients. As a combination of education and technology, EdTech, like other subject-specific technology, requests the best-fit fusion of both sides. The inclusion of educational elements brought by intervention innovations in this study is especially important, as it represents the subject-specific knowledge essential for operating within the EdTech industry (An, T. 2021). Many scholars have studied the importance of technological inventions in traditional technology-driven industries (Bercovitz, Janet and Maryann, 2006; Daniela, *et al.*, 2019; Lam, *et al*., 2013; Lee and Win, 2004; Markman, *et al*., 2005; Sharif and Baark, 2008; Wang, and Liu, 2022). This study included the measurement of the importance of universities' research-based intervention innovations, i.e. the education elements, in addition to the technologies in research question 2.

1.3.1 Significance of the Research Questions

The education technology business is a market of trillions of dollars. Both academic and business studies agree there is a hundred billion global education technology market, whose growth is non-stoppable, especially under the boosting of the COVID-19 pandemic. The market is expected to witness a compound annual growth rate of 19.9% from 2021 to 2028 (Grand View Research, 2021; Markets and Markets, 2020; Holon IQ, Aug 2021; Renz, A., 2020). The IBIS Capital's measures the global market for educational technology products and platform services valued at USD 228 billion in 2019. Without considering the boosting effects of the COVID-19 pandemic, the market's growth rate was projected to be at least 15% each year. The HolonIQ Global EdTech Funding 2021 – Half Year Update indicates that venture capital investment in EdTech increased over 14 times during the period 2010 to 2019. Within only the first half of the year 2021, the global EdTech venture capital investment reached USD 10 billion. There are 27 EdTech unicorns at the end of June 2021, 53 mega-rounds (US$100M+) and more than 3,000 funding rounds over US$5M with a total of US$26B deployed in the last 18 months (Holon IQ, 2021).

No traditional big names were dominating the EdTech market; start-ups are the primary driving force (Knee, 2016; Ramiel, *et al.*, 2019; Grand View Research 2021; Markets and Markets, 2020; Holon IQ, Aug 2021; Renz, 2020). In these few decades, Israel has become the world's research and development centre for innovation and technology. The country was ranked the most successful showcase of the high-tech development model. It is an event on top of Silicon Valley (De-Fontenay and Carmell, 2004). The country established the research and development centre cum start-up accelerator for EdTech, called the MindCet, under The Center for Educational Technology. This is a platform fusing researchers, teachers, entrepreneurs and technologists to shape the discursive and interpretive practices of EdTech (Ramiel, *et al.*, 2019). The Isreal case demonstrates the potential for successful fusion of research-based technologies with pedagogical settings.

In the US, the Stanford University's report also proposed establishing a start-up acceleration centre focused on analytic-driven translational research for EdTech, including personalized learning and the teaching methodologies needed to support the development of the education sector and EdTech industry. The initiative would equip research teams with all the necessary tools to successfully develop and launch funding proposals for a diverse range of sources. The report recommends launching the EdTech start-up accelerators on a worldwide scale to offer comprehensive assistance, from crafting a grand vision and narrowing interests to handling the practicalities of running a successful university-based research lab, as well as fostering and maintaining partnerships between research and industry for long-term sustainability. Another critical responsibility of the centre would be to identify the most effective methods of training individuals in the field to utilize software applications (Pae, 2014).

As advancements in computer science and technology have progressed, so has the evolution of EdTech. EdTech has transitioned from its early stages, where it heavily relied on behaviourist computer-assisted instruction systems, to now featuring platforms that encourage and facilitate self-directed learning. Examples of such platforms include concepts like 'Bring Your Own Device' (BYOD) and 'Flipped Classroom'. BYOD allows students to use their personal devices for learning, promoting a sense of familiarity and comfort that can enhance the learning experience. The 'Flipped Classroom' model, on the other hand, reverses the traditional learning environment by delivering instructional content, often online, outside of the classroom and moving activities, including those that may have traditionally been considered homework, into the classroom. Moreover, EdTech now incorporates maker spaces and wearable technology. Makerspaces provide hands-on, creative ways to encourage students to design, experiment, build and invent. Wearable technology, such as smartwatches or fitness trackers, can be used to enhance learning experiences and gather data on student performance and engagement. The latest advancements also involve adaptive learning

technologies and the Internet of Things (IoT). Adaptive learning technologies use AI and machine learning algorithms to personalize learning content for individual students based on their learning pace and style. Meanwhile, IoT in education could involve connected devices that make classrooms smarter or the use of data from connected devices for personalized learning. These developments in EdTech not only reflect the dramatic changes in technology but also indicate a shift in the educational paradigm towards more personalized, interactive, and learner-centred approaches (Pinkwart, 2016; Johnson, *et al*., 2015; Pea, 2014).

Chinese have emphasised the importance of education for thousands of years. There are eight world-class universities in Hong Kong, where hundreds of education research projects plus thousands of cutting-edge technological developments are ongoing every day. Ironically, there is a lack of a research centre with a primary focus on EdTech research and development, let alone a business incubation unit. Innovation and technology are indispensable in upgrading the competitive advantages of a business and industry in a nation, contributing to wealth creation (Kahlil, 2000). The two biggest start-up incubators, the Hong Kong Science Park and the Hong Kong Cyberport, accommodate about two hundred EdTech start-ups. In parallel, The Education University of Hong Kong incubates about 20-30 EdTech ventures each year (The Education University of Hong Kong, 2022). However, only a tiny portion of the pool is doing business with a proper combination of evidence-based pedagogical innovations and technological inventions.

According to the statistics of the HKSAR Government, there are 340,000 Small-to-Medium-sized Enterprises (Small and Medium Enterprises or SMEs) in Hong Kong, which constitute over 98% of the city's business establishments and provide job opportunities to about 45% of the workforce in the private sector. The statistics tell entrepreneurs are important locomotives for the international city. Their vitality and business performance are crucial to the development of the city's economy (HKSAR Trade and Industry Department, 2021). Scholars also explain SMEs have a reputation as boosters of employment, economic growth and economic dynamics (Ahlin *et al*., 2014; Keizer *et al*., 2002). As an advantage of the company size, SMEs are flexible and feasible for initiating and realising innovations. However, SMEs have limited organisational resources and are eager to adopt new knowledge, innovation, and technology. It is common for SMEs to formulate technological collaboration with universities or research institutes to carry out the R&D and product development as an economical and safer strategy compared to doing all innovation development activities in-house (Keizer *et al*., 2002). Chesbrough (2007) indicates that it is common for SMEs to build up inter-organisational partnerships and technological capital beyond their own boundary by assessing external sources of knowledge and technological expertise. Industry-University Collaboration has been adopted as a strategic approach for advancing the process of innovation by universities and

SMEs, which results in notable enhancements in product differentiation and profitability (Lam, *et al.,*2013). University knowledge can upgrade the enterprises' capabilities, in terms of both technology and education, to catch the new waves in the marketplace.

Typical modes of industry-university collaboration to transfer existing research outcome into business implementations cover patenting and commercial licensing, forming joint ventures and spin-off companies. Besides, knowledge transfer can be in the form of close co-development between academic and industrial contexts, like research partnerships, collaborative research, contract research and consulting (de Wit-de *et al*., 2019; European Commission, 2009; Holi *et al*., 2008; Tsui *et al*. 2020). The relationship between EdTech startups and universities varies according to the types of technology transfer collaboration engaged. In patenting and licensing, the university is the provider of intellectual properties while the startup is the user. A startup established via joint venture and spin-off is a subsidiary of the university. The resulting startup-university relationship of a co-development research partnership can be provider-user, university-subsidiary or a mix of two in accordance with the ownership sharing of the resulting intellectual properties of the partnership. A startup can also be an incubating company, which does not necessarily directly adopt any intellectual properties of the university but is incubated under the university's entrepreneurship development schemes (University Grants Committee, 2022).

Universities possess research results that can benefit markets and learners, while startups require innovation capital to accelerate their growth and keep up with international competition. Effectively matching university knowledge with startup ventures is crucial for advancing the industry and generating significant returns on the city's investment in university research and development (Wahl *et al.*, 2022).

1.3.2 Research Objectives

The primary objective of this study is to examine the effects of the transfer of university knowledge on building up the business innovation capability of start-ups in the EdTech industry. Universities conduct various types of research and development. Technology invention provides new technology as the media to deliver educational value to the learners. Intervention innovations are learning sciences, including novel pedagogies and new practices that create new educational value for learners. They can create different values in different aspects of an EdTech start-up. Scholars explained that the transfer of knowledge and technology from universities can overall improve the entrepreneurial performance of a startup in traditional technology sectors (de Wit-de Vries *et al.,* 2019; Perkmann & Walsh, 2007; Wang *et al*., 2022; Wang and Liu, 2022). This study aims to validate that this principle

holds true also in the EdTech industry, suggesting that university-driven innovation and expertise knowledge can play an essential role in the sustainable success of EdTech entrepreneurs.

The composition of an EdTech start-up team creates a different profile of knowledge capital. "There are different drivers of entrepreneurship in different types of firms", stated Millar (2011). The needs for a technology-based entrepreneur team and those for an education-based team are different. The effects of different types of university knowledge can bring contrasting effects on EdTech start-ups. A model guiding the mix-and-match can practically benefit EdTech start-ups. This study seeks:

> *O1: Identify the types of knowledge and technology which universities can transfer to EdTech entrepreneurs*
>
> *O2: Identify the aspects of an EdTech entrepreneur that university knowledge can advance*
>
> *O3: Validate the positive impact of knowledge and technology from universities on the performance of EdTech Entrepreneurs*
>
> *O4: How do different types of university knowledge affect the entrepreneurship capability of an EdTech entrepreneur in the start-up life cycle?*

Emerging technologies in both the research world and business sectors are evolving at a rapid pace. While scholars have long validated the positive impact of university-industry technology transfer, new questions arise about whether theories applicable to conventional technology sectors can also be extended to new technological frontiers. This study aims to address this research gap by examining the effects of university knowledge transfer activities on emerging technologies within domains that are not inherently technology-based, such as education. Research creates knowledge specialization in "scientific" and "artistic" (Bloch and Verchère, 2019). This study would provide valuable insight to guide future research in similar emerging technology sectors, for instance, ArtTech, Sports Tech and Female Tech, etc., not only in the academic theory development but also for managerial contribution on having human sciences and arts to uphold the technological development in content design, contexts improvement and system compliance (Bloch and Verchère, 2019; Mehrnezhad *et al.*, 2024; Ratten, 2020).

Chapter 2. Literature Review

This study mainly focuses on the EdTech startups that adopted knowledge from universities via knowledge transfer activities. It is crucial for a company to build up connections with non-business partners to access valuable intangible knowledge as the resources fitting the company's mission and interests (Sinthupundaja *et al*., 2020). When a startup decides whether to get engaged in an industry-industry knowledge transfer partnership, she has to conduct pre-competitive research, which can be time- and resources-consuming, to analyse the potential market risk, compliance with local, regional and international rules and policies, the potential impact on pricing and marketplace constraints, etc. These are not only the internal commercial and ethical considerations of the entrepreneur team, but also of the group of investors behind (Laperche, 2021). Such considerations are often eliminated in university-industry knowledge transfer collaborations, as a university is not a commercial player in the market (AUTM, 2014).

The integration of technological and non-technological innovation processes establishes variation of new innovative activities (Geldes *et al*., 2017). A startup, as a commercial entity, can enter into a collaboration with a university via research programs, research consortiums, tender projects, researcher schemes, joint ventures or technology commercialisation (Laperche, 2021). Besides, it can be a spin-off or incubating company established by university staff or students and as a subsidiary of the university (Boh *et al*., 2016). Eventually, all these types of collaboration often end up with a licensing agreement with the university to officially adopt the commercial use of the university's pre-developed intellectual property or of the co-developed intellectual property from the knowledge transfer collaboration (AUTM 2014; European Commission, 2009; Holi *et al*. 2008).

This chapter covers a literature review on the knowledge and knowledge transfer activities in universities; EdTech and EdTech industry in the market; knowledge capital, entrepreneurship capability and absorption capacity of EdTech startups.

2.1 About Knowledge

In the economic field, knowledge spillover is used to describe the process of innovation diffusion. Knowledge has become the nature of industrial research and product development (Ahrweiler *et al.*, 2011). In recent years, there has been a trend of research on the knowledge spillover of entrepreneurship in technology-based industries. New start-ups are established by *employees turned entrepreneurs* to commercialise knowledge stocks developed in university research and incumbent company technology development, which are unadopted and underutilised by the mother organisation (Tsvetkova and Partridge, 2021). Knowledge is the core of knowledge transfer. Knowledge can be "captured" by or embodied into "objects" such as databases, software routines, patents, publications,

public presentations and know-how. Knowledge can be classified according to the status of codified knowledge, excludable knowledge, and prospective knowledge (OECD/Eurostat, 2018).

- Codified knowledge is usually systematically organized and is readily transferrable through articles, books, formulas, models, materials, databases, and IP rights such as patents. This kind of knowledge is inexpensive to copy and with low resistance to others' uses (OECD/Eurostat, 2018).
- Excludable knowledge is by intension preventing the uses by others. Patents and other forms of registered intellectual property rights are typical cases of excludability. The situation also applies to other means, such as secrecy, agreements or social norms (OECD/Eurostat, 2018).
- Prospective knowledge refers to what is yet to be developed. Agreements to jointly produce new knowledge, for example, through collaboration, will typically entail a pledge for active participation in the production of new knowledge and the exchange of existing knowledge required to achieve that goal (OECD/Eurostat, 2018).

"Knowledge is a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information", defined by Davenport, Thomas & Prusak, Laurence (1998). They mentioned in another article that an organisation has no way to grow healthily without proper utilization of knowledge. Organisations interact with their surrounding ecosystem, absorbing information, turning it into knowledge, integrating it with their experience, values and rules, and converting it into management decisions and actions (Davenport & Prusak, 1998).

Scholars categorise knowledge into three types: technical knowledge, market knowledge and international knowledge. Technical knowledge enables a firm to improve production and deliver the right products and services with a competitive advantage. Market knowledge provides a firm with a good understanding of its own advantages and professional social networks. International knowledge helps the firm to reach international standards and reduce operating uncertainty for the firm as a whole (Mejri, *et al*., 2018). The utilization of knowledge in an organisation has to undergo three development phases: 1) adoption of explicit knowledge via learning and knowledge transfer; 2) rendering of tacit knowledge into explicit knowledge and its effective and efficient implementation; 3) realization of the role of potential knowledge and creation of new knowledge in day-to-day business operation (Smedlund, 2008; Nonaka, 1994).

Knowledge is a meaningful resource for individuals, companies, organisations and economic bodies today. It is now being applied systematically and intentionally (Drucker, 1993). Knowledge is enlarged, amplified and justified in an organisation to create value (Nonaka, 1994). In the current

knowledge-based economic environment, knowledge is a crucial capital for an organisation to build up its competitive advantage (Tsvetkova and Partridge, 2021; Mejri *et al*., 2018; Ahrweiler *et al.*, 2011; Smedlund, 2008; Yli-Renko *et al.*, 2002; Davenport and Prusak, 1998;). An organisation's knowledge builds up its intellectual capital and is now more valuable than conventional tangible assets, such as land, real properties and product stocks (Barão *et al.*, 2017; Cowan *et al.*, 2000; Nonaka, 1994; Drucker, 1993).

2.2 Knowledge Transfer in University

"Knowledge transfer", "technology transfer" and "knowledge exchange" all are terms referring to the translation and evolution of innovation and technology from the place of its fundamental research and applied research and development to the marketplace as a product, service or daily routine practice (European Commission, 2009; Grosse, 1996). Technology transfer activities have evolved into knowledge transfer activities, which encompass a wider range of fields beyond technology. This broader concept recognizes the importance of transferring various types of knowledge, with the output not only leading to commercialization and economic impacts but also offering social, cultural, and personal benefits (European Commission, 2009). Knowledge Transfer is frequently described as the third mission by the higher education sectors of many advanced economies. Knowledge transfer activities are defined as the systems and processes by which knowledge, including technology, know-how, expertise and skills are transferred between higher education institutions and society, leading to innovative, profitable or economic or social improvements (University Grants Committee, 2022). The professional knowledge transfer activities in universities aims for managing knowledge assets and related intellectual properties to ensure the university's intellectual property is valued fairly in the market, using best business practices for the benefit of the university, its staff, students, and the broader community (AUTM, 2014). Universities implement technology and knowledge transfer activities as the tools to transform themselves from a research university to an entrepreneurial university with strong ties to industry, then disseminate their newly produced knowledge to the industry and society (Kalar and Antoncic, 2015). Some of the knowledge transfer activities are more structured than others. Many previous studies have focused on formal activities related to intellectual property rights, such as patenting, licensing, and the creation of spin-offs, as primary outcomes for universities. However, it is measured that many industries and universities, less formal, informal, and non-commercial activities are at least as important, if not more so, than formal activities and agreements (D'Este *et al.*, 2007). Scholars described formal knowledge transfer activities are more for supporting startups in developing proof-of-concept model and prototype of products, while informal knowledge transfer activities contribute to the marketing and social capacity of the startups (Heisey and Adelman, 2011).

Previous studies have not sufficiently addressed the distinction between knowledge transfer and technology transfer. This gap in research is primarily due to the interchangeable use of these terms in both technology transfer and knowledge transfer literature. Most studies have treated the two concepts as synonymous, contributing to the prevailing ambiguity. Based on definitions sourced from various research disciplines and backgrounds, researchers have agreed that technology transfer is closely linked with the conveyance of information, expertise, and technical knowledge. This knowledge is typically embodied in products, processes, and management systems (Wahab *et al.*, 2012). It is closely related to the transfer of useful know-how and practical innovations among organisations (Lord & Ranft, 2000). Scholars describe innovation activity depicts the process as non-linear and characterized by multiple interactions, system integrations and complex networks (Bessant and Rush, 1995). The literature increasingly describes university-industry technology transfer and knowledge exchange collaboration is considered as a crucial locomotive of the society's economy and innovation growth (de Wit-de Vries *et al*., 2009; Passaro *et al*., 2020; Cheng, 2021). This diffusion can occur through market transactions, strategic alliances, joint ventures, licensing or else (Grosse 1996). Many universities established industry liaison offices and developed services to support the commercialisation of research results. Over time, the offices developed their specialist staff and services for assessing disclosed inventions, patenting, licensing, and incubating and funding spin-offs and start-ups, but also for actively approaching firms for contract-based arrangements. Recently, the term knowledge transfer has been more broadly used as a slightly larger meaning of technology transfer. Technology is not the only field of knowledge concerned. The knowledge can be social, cultural and personal benefits on the output side, creating essential economic and economic impacts (European Commission, 2009). Most universities in Hong Kong set up designated units, which are usually named Knowledge Transfer Offices or Technology Transfer Offices, to facilitate and foster internal researchers' and scholars' participation in knowledge transfer (University Grants Committee, 2022; Tsui, *et al.* 2020). The offices in universities in Hong Kong have evolved their role in the patenting and licensing of university inventions in Hong Kong since the late 1980s (Sharif *et al*., 2008). Their activities create new values and parameters in the fields of intellectual property, technology development and practical innovations (Beltran-Morales *et al.*, 2020).

Universities and tertiary education institutions have an obligation to transfer their research outcome, innovations, and technologies into real businesses and daily life applications. Even the giants of various industries, those vast and resource-rich companies, at multiple stages, find themselves turning to external sources to gather input for enhancing their technological competencies to improve their operations and develop new establishments. This is all the more true for SMEs and start-ups (Bessant and Rush, 1995). These smaller entities, which often lack the vast resources of their larger

counterparts, frequently need to rely on external expertise or resources to build and improve their technological capabilities. It underscores the point that no company can operate in a vacuum, irrespective of its size or market position. Interdependence and collaboration are key to driving technological advancement and innovation in the business world. The knowledge transfer offices are platforms designed to bridge the interactions and collaborations between universities, researchers and industries (Brennenraedtset *et al*., 2006; Sharifiet *et al*., 2014; O'Reillyet *et al*., 2019). Universities, research institutes, and tertiary education establishments are responsible for developing original knowledge and technological advancement to drive the tendency of economic growth of the city while benefiting the wider community. In parallel, they want to leverage knowledge transfer to enhance the research and development funding return on investment. While research and teaching are institutional activities comparable among universities, knowledge transfer activities are influenced by several strategic goals at the university level, ranging from having a positive impact on society to increasing economic income (D. Baglieri *et al*. 2018). They help create and nurture help companies to be innovative, which is the research and development findings of universities. Enhancements of the industry's innovation and technology capabilities and cultivation of creation are the main objectives of the knowledge transfer offices. Knowledge transfer offices are the key vehicles for commercialisation, which disclose inventions and evaluate patentability, valid technology, and volarise commercialisation potential. They are not only the dual agents of a faculty, the overall university and the information exchange and integration hub with industry (Pitsakis & Giachetti, 2020).

Nowadays, universities are more and more deeply committed to interactions with external partners to commercialise or adopt their research results to accomplish their third mission (Huyghe *et al*., 2014; Etzkowitz, 2003; Rasmussen *et al*., 2006). In Hong Kong, universities have conventionally conducted knowledge and technology transfer to industries and social sectors, mainly through channels like research publications, consulting, and presentations at professional conferences (Sharif, N., *et al*. 2008). All the eight government-funded universities in Hong Kong set up designated units under the research and development branches, which are usually named Knowledge Transfer Offices or Entrepreneurship Centers, to facilitate and foster internal academics' participation in knowledge implementation via commercial licensing or entrepreneurship development activities (Tsui *et al*., 2020; Cheng, 2021). They aim to foster the growth of entrepreneurship and economic development. Knowledge transfer is also a channel to boost start-up activities. The eco-system of early-stage investments is yet to mature. Some success stories will help inject a sense of confidence into young people and nurture social attitudes and support towards entrepreneurship (Tsui *et al.,* 2020).

Technology Transfer activities of universities create value in the larger society. This transfer of knowledge can exist in a myriad of formats, all of which contribute to the advancement and development of a company's technological capabilities. The technology and knowledge being transferred can take one of many forms, from a tangible form of a new piece of process equipment or embodied in a prototype product to the form of a piece of knowledge and information codified via a patent license or a set of design specification (Bessant and Rush, 1995). Technology empowers start-ups and SMEs with inadequate and limited resources to capitalize on market advantages in terms of managing and valuating customer knowledge and smoothly implementing digital transformation (Kaoud & El Dine, 2022). A university-industry collaboration raises the knowledge and competence levels of a company, increases their dynamic and variety of knowledge, and increases the frequency and efficiency of innovation diffusion. Companies partnering with universities are more attractive to other companies when they are considering getting into a collaboration (Ahrweiler *et al.*, 2011). The activities cover the management, including creation, protection, implementation, dissemination and commercialisation, of intellectual properties. The European Commission indicated that the key types of technology transfer activities are invention and patent management, research collaboration, licensing, and spin-off or start-up company formation (European Commission, 2009). TTOs are market-oriented units in universities balancing high levels of patents, contracted R&D, licenses and academic spin-offs, with a competency mix of non-academic experts to facilitate the development of the broader eco-system of academia-industry-and-government collaborations (Fernandez-Alles *et al.*, 2019; Sharif *et al.,* 2008).

Although innovation necessitates exchange via knowledge transfer, this process carries significant risks. These include the potential failure of collaboration and the possible loss of competitive advantage if crucial information is shared with rival organizations (Hurmelinna, 2011). Indeed, like any other collaboration, there are risky factors in university-industry knowledge transfer collaborations, especially since a university is usually commercially neutral and open (AUTM 2014). For instance, potential knowledge leakages during transfer, potential knowledge leakages during internal adoption by staff, empowering competitors in the market, and internal ability to absorb and utilizing the knowledge efficiently (Cannice *et al.*, 2003; Coadour *et al.*, 2019). Improper or impossible intellectual property protection, especially for non-technology-based innovation, is another challenge in negotiating and concluding an agreement on the transfer of knowledge (Bloch and Verchère, 2019; Geldes *et al*., 2017; H.W.D., 1948).

2.2.1 Formal Technology Transfer Activities

In general, technology transfer is not a quick, one-time event but rather a process that unfolds over time and involves multiple steps and stages. These steps and stages can include the initial

identification of an opportunity or need, followed by the search, comparison, selection, acquisition, implementation, and ultimately, the long-term use of the technology, which involves continuous learning and development. This process is intricate, involving numerous participants and elements and various patterns of interrelationships (Bessant and Rush, 1995). Each stage of the process may be influenced by a different set of participants and issues, adding to the complexity of the technology transfer process. The metrics for technology transfer can be classified as informal and formal knowledge-sharing activities, create new values and parameters in the fields of intellectual property, technology development and practical innovations (Stankevičienė *et al*., 2007; Beltran-Morales *et al*., 2020; Taminiau, *et al.* 2009; Nonaka, 1994) to nurture companies to be innovative with the research and development findings of universities.

Formal technology transfer is a critical catalyst for economic development, fostering the growth of firms and creating new job opportunities. This process can amplify the economic impact of universities, making them more appealing to state and local politicians, as well as other key stakeholders associated with the university. Moreover, these activities also offer numerous benefits to students. For instance, students get the opportunity to participate in practical research, gaining firsthand experience in the realm of innovation and technological advancement. They are also educated about patenting and licensing processes, which are critical components of the innovation ecosystem. These experiences can significantly enhance their job prospects, preparing them for future roles in the industry. Furthermore, universities engaged in technology transfer activities can gain recognition for addressing global issues in health, environmental sustainability, and technology. This not only raises the institution's profile but can also attract philanthropic donations and research grants (Waldman *et al.,* 2022).

In essence, formal technology transfer serves as a multi-faceted tool that can stimulate economic growth, enhance the university's reputation, provide practical learning experiences for students, and contribute to solving global challenges. In a bid to maintain their significant roles in the knowledge-based economy, universities are actively seeking innovative avenues to secure adequate funding. This is essential in order to manage the substantial expenses associated with research endeavours. Concurrently, industrial firms are striving to stay updated with technological advancements amidst an unpredictable, competitive, and rapidly evolving environment (Rast *et al*., 2012). In this context, universities emerge as vital allies for the industry, providing a critical link between academic research and practical applications. This partnership can yield mutual benefits, with universities gaining the necessary funding and industries accessing cutting-edge research and technological innovation. Nonaka (1994) defines the formal technology transfer mechanism as one that comprises a procedure, a formal language and an exchange of materials to ensure that people can exchange and combine their

explicit knowledge. This mechanism can be in the form of official procedures, formal languages, and the exchange of handbooks. Formal knowledge exchange is a process of leverage and extension. Leverage is, as described, the process of making individual knowledge available for organisational needs, while extension is the transfer of knowledge through shared knowledge. Martinez-Canas *et al*. (2012) express that an organisation can acquire new knowledge and skills via inter-organisational alliances to reinforce innovation activities and build up their key knowledge capital to support continuous development. Specialised organisations engaging in knowledge-based activities can use their close social interactions to enhance both knowledge acquisition and innovation, which helps compensate for their internal resource constraints, especially in the knowledge economy era. In typical technology transfer activities, the formal activities involve an official contract between the university and the external partners, such as consultancy, collaborative research, contract research, licensing and venturing activities (Holi *et al.* 2008). The industry and university usually enter into formal agreements, joint ventures, or strategic alliances to collaborate on product development, intellectual property commercialisations, fund bidding partnerships, business incubations and market explorations in formal knowledge sharing (Tsui *et al*., 2020; de Wit-de Vries, E. *et al.* 2019; Etzkowitz 2003; Rasmussen *et al*., 2006). Rast (2012) concluded five common types of university-industry technology transfer collaboration mechanisms, which are consultancy and technical services provision, cooperative R&D agreement, licensing, contract research, and spin-off companies. These collaborations advance the inter-organisational joint R&D efforts, information exchanges, marketing trend updates and collective knowledge sharing, which are conducted under formal organisational structures and mechanisms.

Contract research, collaborative research and consultancy are all channels involving a high level of commitment and interaction between the university and industry, i.e. external partners, whether it is a commercial firm, government unit, organisation, charity body or any public entity. Contract research refers to research activities that lead to the delivery of a product or process tackling particular industrial needs and settings. Contract research between a university researcher and a corporation involves applied research of specified formal knowledge. Contract research leads to the joint creation of further tacit knowledge (Wright *et al*., 2008). In all cases of contract research, academics perform all research works (European Commission. 2009). The industry provides funds; the university provides brains with a time frame ranging from a few months to years. Through contract research, the industry wants to utilize the unique capability of the university that works for commercial benefit (Lee *et al*., 2004). Contract research provides companies with access to new technology and advancement of R&D, while universities receive revenue (Markman *et al*., 2008).

Collaborative research is, in principle, similar to contract research, but the outcome intellectual properties are jointly owned by the university/researcher and the external partner. The boundary between collaborative research and contract research varies in different universities. In general, the joint ownership of intellectual properties is the result of (1) funds received cannot fully cover the total research and development costs of the university, but the projects are of significant interest to the university; (2) both sides contribute valuable patents and knowledge to the projects. Both academics and firms participate in the design of research projects, contribute to the implementation, and share the project outputs (EU Commission. 2009).

In consultancy projects, academics provide expert advice without conducting new research. Contract research and collaborative research are subsets of research, whereas consultancy is not (EU Commission. 2009). University or research centers provide advice, information, or technical services (Lee *et al*., 2004). Consultancy is the interaction between academia and industry to find the best and most appropriate solution to a problem. The engagement of the end-user is involved in utilizing the knowledge generated in a university (Wright *et al*., 2008). Consultancy work is commissioned by industry, not involving original research (D'Este and Patel, 2007).

Scholars' research supported that TTOs are the critical players in the evaluation of invention disclosures, marketing innovation and technology to potential licensees, patent registration, and negotiation and conclusion of licensing (Boh *et al.,* 2015). Centralising the licensing of patents resulting from research is described as the original objective of TTOs back to the 1980s. In commercial licensing, a TTO assembles and discloses university innovations and negotiates and enforces licenses with users of these innovations. TTOs spend, on average, about 74% of their staff man hours in preparing licensing and commercialisation activities, such as soliciting ideas, evaluating inventions and assessing the economic potential of inventions (Castillo *et al*., 2016).

2.2.2 Informal Technology Transfer Activities

The informal activities can refer to networking, dissemination of / access to academic publications and talent development (Holi *et al.* 2008). Taminiau *et al.* (2009) expressed the view that informal knowledge transfer refers to informal communication and the conceptualisation of an informal network. The interactions relate to resources, services, and activities, which are used to facilitate knowledge exchange but are not necessarily designed for that purpose. The occasions taking place can be casual coffee breaks, social gatherings, conferences, workshops, events, phone calls, email conversations and even parties. Boh 2007 also suggests that informal knowledge transfer relies on the relationship between people. The transfer of knowledge can also take place via informal and unstructured interactions and communications, even where there is no specific intention to do so.

Scholars explained that the university-business interface and university-community relationship are equally critical for the success of knowledge transfer activities. The knowledge transfer activities have to characterize the surrounding community as well as the culture, organisation and incentive structures in the universities themselves (Carlsson *et al.,* 2002). TTOs have to create a mutual relationship with the community to develop an innovation system in society (Sharif *et al*, 2008).

Informal knowledge sharing plays a significant role in the development of Silicon Valley as a centre of innovation and technology businesses (Bresnahan & Garfield, 2004). The successful clusters there are characterised by frequent interpersonal social interactions such as informal inter-people interactions and social gatherings (Saxenian, 1994). Informal knowledge networks within organisations share expertise, solve problems together, communicate and collaborate effectively with each other, and eventually generate new knowledge (Davenport and Prusak, 1998). In Hong Kong, the universities and science parks are holding more and more informal knowledge-sharing events to enhance inter-industrial conversations and knowledge diffusion (University Grants Committee, 2022; Tsui *et al.,* 2020). Back in 2010, all the universities in the city had co-organised the Knowledge Transfer Conference to build up the industrial network and social eco-system for government-industry-university knowledge transfer. In this study, informal knowledge sharing under knowledge transfer refers to casual activities, such as breakfast talks, luncheons, dinners, coffee chats, happy-hours gatherings, conferences, and seminars, which are social networking opportunities for establishing interpersonal contact and sharing knowledge.

2.2.3 Entrepreneurial Activities for Technology Transfer

The European Commission integrated technology transfer into the definition and development of the strategy of building the Europe of Knowledge 2020. Start-ups are committed to the economy's transmission and development in terms of job creation, promoting innovation, introducing new products, opening new markets, and driving technological evolution (Tsvetkova & Partridge, 2021). TTOs were the key players as the drivers of the processes of valorisation of technology, innovation, invention, and intellectual property arising within the academic entities, while they have also been identified as a core part of the mechanism supporting the creation and growth of academic spin-offs/start-ups (Fernandez-Alles *et al.*, 2018).

Incubating university-based start-ups is one of the primary commercial mechanisms of university knowledge transfer. TTOs promote and support the entrepreneurial spinoff firms and start-ups of universities via financial support in terms of the banking system and venture capital funding as part of their commitment to the transformative process of the innovative system in the knowledge-based economy (Sharif *et al.*, 2008). TTOs contribute to entrepreneurial activities in terms of the allocation of diversity resources as a stimulus for researchers and student entrepreneurs and, more importantly,

the social networks connecting to the market actors (Fernandez-Alles *et al.*, 2018). Entrepreneurship and start-up incubation are the processes for TTOs to accelerate the commercialisation of research-based knowledge (Sutopo *et al.*, 2022). The creation of new ventures is a consistent outcome of the entrepreneurship activities. They provide a new way of experiential and experimental learning to equip and transform students into entrepreneurs. The activities act as the basis for utilizing the on-going creation of real-life ventures as primary learning vessels, including an intention to incorporate (Lackéus *et al*., 2015). Development of technology-based new ventures significantly contributes to the economies in terms of exploiting technological advancement to expand new market for conventional business, to create new industries, and to provide new employment and wealth opportunities (Daniela *et al*., 2019).

Graduate and postgraduate students are active participants in universities' entrepreneurial development activities. They are heavily involved in the earliest phase of the technology commercialisation process in terms of idea generation, commercialisation decision, prototype generation, commercial and technological validation, and fundraising. TTOs play the role of business incubators, allowing students and faculty members to meet, form teams, and experiment with the ideas of bringing technology form research labs to the market. The services and expertise of TTOs help the student entrepreneur teams to develop their technology and business plans and eliminate the start-ups' potential risk in the marketplace and technology failure. Students are provided with a safe zone in the initial stages of the start-ups without opportunity costs as part of their university-life and under calculated risk shielded by the TTOs (Boh *et al.,* 2015).

Type of Entrepreneurial Activities Organised by TTOs

Project-based classes on technology commercialisation. In case study research among Harvard University, Massachusetts Institute of Technology, Stanford University, University of Arizona, University of Maryland, University of North Carolina, and University of Utah, nearly half of the 100+ participating start-ups originated from project-based classes. Some start-up teams also make use of project-based classes to recruit the necessary competency to strengthen the team mix (Boh, *et al.,* 2015). Universities are using their inventions in project-based classes as a new trend of experiential learning, in parallel involving students in technology evaluation and promoting the technology transfer for intellectual-based entrepreneurship among students (Lackéus *et al*., 2015).

Mentoring Programs - Offering student entrepreneur teams with business networks and expertise support from industry executives and specific professionals, for instance, lawyers, engineers, potential suppliers / users / buyers, licensees and investors (Boh *et al.,* 2015). Viewed from the perspective of small business growth and entrepreneurial support programs, there is a long-

established tradition of offering mentorship to budding entrepreneurs. It's also seen as a best practice for educators in entrepreneurship to ensure that student teams involved in business plan competitions have access to experienced mentors. Mentorship is a highly effective educational tool that encourages the transmission of knowledge, skills, and abilities through shared experiences. It not only enhances and fortifies the mentee's self-confidence and belief in their entrepreneurial capabilities but also aids in their personal and professional development (Wilbanks, 2013).

Incubation Programs - TTOs provide seed funds and training to support entrepreneur teams intensively over the incubation period. The incubation usually also covers advanced mentorship, office space and business matching (Boh *et al.,* 2015). The seed fund is important in driving innovation and technology ventures because of the reluctance of the banking industry to provide support to start-ups. Technology and innovation-related start-ups rely heavily on personal savings in lieu of readily available business loans. In practice, large firms are typically better able to demonstrate creditworthiness and are therefore favoured in terms of loan disbursement (Sharif *et al.*, 2008). In recent decades, bank financing has been more open to support research-based start-ups in terms of business account opening and loan disbursement, especially for start-ups from university incubation programs.

Business Case Competitions - serve as an exceptional method for educational institutions to inspire and cultivate entrepreneurial thinking and innovation among students (Wilbanks, 2013). Business case competitions are more likely in the ideation stage of entrepreneurship development and promoting innovative entrepreneurship (Li *et al.*, 2019). They help student entrepreneurs form their teams and develop technology invention ideas, business plans and strategic roadmaps for venturing. Winner teams in prominent competitions would also gain publicity and credibility advantages (Boh *et al.,* 2015). Business case competitions serve as platforms for interdisciplinary cooperation, encouraging students to form start-up teams and prototype solutions for real-world business environments. These competitions allow students to apply their academic knowledge to practical situations, promoting collaboration and innovative thinking (Li *et al.*, 2019).

Entrepreneurship Education - Entrepreneurship education in higher education institutions necessitates the contribution and networking of diverse individuals and units, both within and outside the academic setting. These educational activities can take various forms, including extracurricular activities, comprehensive academic programs and courses, and multidisciplinary research projects (Liu, 2021). Entrepreneurship education aims to bolster entrepreneurial competencies and positively influence entrepreneurial behaviours. This is achieved through teaching about entrepreneurship, fostering entrepreneurial skills, and promoting active learning through entrepreneurship projects

(Wahl *et al.*, 2022; Bell & Bell, 2023). Nurturing talent is crucial in encouraging students and researchers to embark on and remain committed to their entrepreneurial pursuits. Entrepreneurship education bolsters innovation by cultivating entrepreneurial skills, competencies, attitudes, and mindsets at both practical and technical levels (Bell & Bell, 2023). Moreover, these educational activities not only provide requisite knowledge and skills but also offer a glimpse into the potential for successful entrepreneurial development (Boh *et al*., 2015).

2.3 EdTech and The EdTech Industry

For kids, knowledge is about the contents of their textbooks and sharing with school teachers. For companies, scholars describe knowledge as the acts, opinions, ideas, theories, principles, models, experience, values, contextual information, expert insight, and intuition that provides a framework for evaluating and incorporating new experiences and information to improve business values (Popadiuk *et al.,* 2006; Mitri, 2003; Davenport and Prusak, 1998). The European Union defined four specific objectives of education in their strategic framework for European cooperation in education and training – the Education and Training 2020: to make lifelong learning and mobility a reality; to improve the quality and efficiency of education and training; to promote equity, social cohesion and active citizenship; and to enhance creativity and innovation, including entrepreneurship, at all levels of education and training (Marcella, 2020).

Investors, entrepreneurs, educators, researchers and policy makers joined hands in the late 1990s to realise the idea that education could be dramatically improved by implementing radical new business models, while technologists came later to fuel the field with new big ideas (Knee, 2016). Education is categorized as an industry world-wide. This industry affects students, parents, employees, employers, and citizens, i.e. almost all of us. Education and learning science development are not isolated but closely related to other scientific, medical, and technological advancements in the academic and commercial ecosystems (Mebratu & Ma, 2011). Alongside the development of computer science and technology, EdTech also evolved from early behaviourist computer-assisted instruction systems to platforms that feature self-directed learning, for instance, bring your own device and flipped classroom, maker spaces and wearable technology, and adaptive learning technologies and the Internet of Things (Pinkwart, 2016). Major international organizations such as the OECD, World Bank, and UNESCO have played a crucial role in expanding EdTech worldwide to ensure continuity in education. Their efforts have been bolstered discursively by influential think tanks and consultancies. The global landscape of the EdTech industry has also undergone significant transformation. The most valuable EdTech companies, now worth billions, are based in China and India, reflecting, at least in part, the geopolitical interests in harnessing digital resources and artificial intelligence in education (Williamson, 2021). The industry has established the concept of a learning

society in this knowledge-based economy era, where the economic forces should be demanding instant continual acquisition of knowledge and skills for raising competition and creativities for individuals and the whole society (Wu *et al*., 2011).

The education industry is massively dominated by the public players. Statistics in the US show that nearly 90% of the education spending in the country in 2015 was from the government, including the local governments, state governments and the federal government (Knee, 2016). The party paying for the educational products or services is not the selectors or users. For instance, the schoolteachers select the learning kits for students, while the parents or government units pay the bills. Scholars described an academic entity in the current era as having to fulfil five responsibilities: academic leadership for rendering and transferring international advances into domestic content; capacity building for raising the professional competencies, attitude and technical skills of the target audiences; technological support for developing new technology-enabled pedagogies or practices for teaching and training; research and evaluation for devising systems and mechanisms to address operational and market needs; and dissemination partnerships for creating a collaboration network among related partners and social communities (Chao, 2020). Kodama (2000) described virtual education businesses as a knowledge-based industry for including educational content with multimedia technology. It offered significant business expansion and innovation advancement to education, from domestic education to international education, from general lifelong learning to specialized social welfare education, etc. The extension of education development is grounded in the right integration of knowledge, technology, applied research, learning diversity, and various business management competencies (Scheer *et al.* 2006).

Alongside the retitling from an institute to a university in 2016, The Education University of Hong Kong launched its "education-plus" approach to re-frame the scope of teaching education and education research and development across a multidisciplinary aspect. They started with the integration of teaching training with arts, culture, language, environment, policy and society, and psychology. In addition to nurturing competent teachers, the university's scope has been extended to include innovative pedagogies and practices, education leadership, social progress, and human betterment. After several years of evaluation, the University has re-defined education as a topic relevant to people of all ages and socio-economic circumstances, covering lifelong learning and training, children 's development and environmental health, with the integration with artificial intelligence, environment science, scientific validations, sports science, and social enterprises. Eventually, education-plus is a solution to solve complex problems in the society (The Education University of Hong Kong. 2017; 2022).

EdTech means educational technology. It is an integration of two elements: the practical educational pedagogies and the technological inventions (An, 2021). EdTech is not only limited to e-learning materials and smart classroom equipment. The development of new technologies in parallel evolves the advancement of the frontier of EdTech possibilities. The hundred billion global education technology market is non-stoppable and is expected to witness a compound annual growth rate of 19.9% from 2021 to 2028. EdTech is not only limited to e-learning materials and smart classroom equipment. It covers interactive displays for replacing blackboards, learning management systems, student record systems, mobile collaboration systems, automatic assessment systems, personalised learning systems, job-talent matching platforms, employability advisory platforms, as well as gamification and edutainment solutions. Advancements in technologies have, in parallel, evolved the advancement of EdTech solutions. Augment Reality, Virtual Reality, Internet of Things, together with the new ABCD "Artificial Intelligence, Blockchain, Cloud Computing and big Data," are reforming the way of teaching and learning. Digital technologies are making access to education cheaper, easier and faster than ever before. Learners are more willing to shift towards electronic books without the boundaries of time and location. The digitalisation of educational materials also reduced the difficulties in translation, not only for written words but also for those with physical disabilities who can listen to the educational content in an audio format. As of August 2021, the market is enormous, and there are 30 EdTech start-up Unicorns with a valuation of USD1 billion or above. (Grand View Research 2021, Markets and Markets 2020, Holon IQ, Aug 2021).

Ever since the rise in popularity of personal computers and the internet in the 1990s, the field of educational technology, also known as EdTech, has seen the introduction of numerous new terms, each representing different areas of application. For instance, the term 'wikis' has been introduced to represent the spirit of optimism and philosophy that underpins the open web. The term 'e-learning', on the other hand, has been used to set the framework for the technological advancements and approaches that would dominate the next decade. 'Learning objects' is another term used in the EdTech field to refer to digitised entities that aid in technology-supported learning. Similarly, 'open educational resources' have come to denote the open context in which self-guided learning can take place. The term 'learning management system' is used to refer to the comprehensive solutions offered to e-learning providers. 'Web 2.0' refers to the gathering of user-generated content, while 'second life and virtual worlds' represent an entirely new platform for the delivery of courses. 'E-portfolios' are used to store all the evidence of learning that a learner has gathered throughout their life, both formally and informally. 'Social media' refers to platforms that facilitate powerful and meaningful discussions at any time of the day. The term 'personal learning environment' has been introduced as a result of the proliferation of services during the web 2.0 boom. Meanwhile, 'MOOCs' (Massive Open Online

Courses) represent on-demand learning, and 'learning analytics' refers to the data-driven analysis of learning activities on MOOCs and Learning Management Systems. 'Digital badges' provide proof of achieving a combination of key educational technology challenges. The terms 'AI', 'blockchain' and 'Web 3.0' represent emerging areas of the EdTech field, the impacts of which are still too early to fully comprehend (M. Weller, 2018).

EdTech is a young industry. Education is declared as one of the last sectors that innovate with technology (Romy Hilbig. *et al*. 2019). On top of the traditional topics of medicine, science, engineering, information and communications, EdTech is a new keyword of the innovation and technology industry. It involves the knowledge flow that a company adopts new knowledge to develop a new way of knowledge delivery to learners with enhanced effectiveness of teaching and learning (Esperanza, 2020; Ramiel *et al*., 2019). The Association for Educational Communications and Technology suggests educational technology is the study and ethical practice of facilitating teaching and learning and improving performance by creating, using and managing appropriate technological processes and resources (Januszewski *et al*., 2013). Although new teaching and learning formats have already been introduced, they still do not fully utilize the full range of technical possibilities available (Romy *et al*., 2019). EdTech has enabled the advancement of adult education, lifelong learning, and language education, which is a new form of virtual, multidisciplinary, multimedia, interactive, individual, and diversified experience. EdTech brought to the learners and trainees new meanings and manners of "lectures", which will eventually render sustainable economic growth, a personal sense of fulfilment, quality and value in life (Kodama, 2000). Apart from multimedia, gamification is another hot term in EdTech innovation. Some scholars classified educational games as "serious games", which is an accepted term for games with an educational intent. With the adoption of new technologies, serious games are not only with educational subject content but also make learning becomes interesting. The games appear not only in the form of mobile apps on smartphones, but also with specific professional purposes for management training program, teaching new techniques under simulations, and conducting research and game studies (Blazic & Blazic, 2015).

Adopting technology in education is neither as simple as the introduction of the usage of computer equipment in teaching and learning nor bringing electronic devices to school and home. There is a more complex and ambitious achievement of seamless technology implementation as a catalyst for a shift toward new learning models in remote and hybrid settings (Osorio-Saez *et al*., 2021). The International Society for Technology in Education launched the framework that leveraging technology for learning should aim to improve the equitability among people in terms of access to knowledge, assessment and evaluation, engagement and experience. EdTech inspires learning and

creativity, trains digital citizens, improves employability, and engages professional growth and leadership (ISTE 2000; 2008; 2009). Technology, as the tool, fueled the development of education and the education industry with customer captivity. Technology enabled education businesses to build up their only barrier or protection against competitors, just like engineers, scientists, and technologists patented their innovations against copy-cats. This created a health environment for the development of enterprise in the education business (Knee, 2016)

2.4 Performance Measurement of Educational Technology Start-ups

Start-ups are new progressive ventures which are tracing the quick adaptation to new technologies and marketplace changes. Thanks to the rapid development in innovation and technology, the business environment and various business models undergo rapid and continuous changes. These create a competitive advantage for start-ups compared with traditional large enterprises (Sekliuckiene *et al.,* 2018). By taking an effective approach to management and making good use of knowledge, EdTech start-ups and SMEs can harness the power of data science to their advantage, particularly in the areas of marketing and customer relationship management (Kaoud & El Dine, 2022). However, start-ups have to continuously advance themselves to survive and grow along the start-up life cycle. This life cycle of an entrepreneurial business involves several milestones, from idea generation to global expansion (Osnabrugge & Robinson, 2000). That means the development of start-ups starts from the ideation, entrepreneur team formation, evaluation of business models and products, prototyping, and scaling up, until the establishment of a global market business different. Statistics show that at least six out of ten start-ups end up going bankrupt in their first three to five years of business (Passaro *et al.,* 2020). The ventures need to formulate strategies and solutions to tackle the challenge at various stages of the life cycle of start-up development. The success of a start-up depends on its availability of commercializing innovations, its resource capability and the dynamic convention to competitive advantages in terms of intangible and tangible assets (Paradkar *et al.*, 2015).

The OSLO manual described the measurements of innovation ventures as follows. The targets and outcomes that mould a corporation's business arrangement encapsulate the repercussions of innovative changes in business processes on the corporation's proficiency. These innovative changes can bolster the corporation's aptitude in absorbing, processing and scrutinizing valuable knowledge. This absorption and processing of knowledge can lead to better decision-making, enhanced business strategies, and ultimately, improved business performance. In addition, some of these innovative changes can also significantly influence the corporation's adaptability to shifts in the business environment. This adaptability is crucial in today's rapidly changing business world as it ensures the corporation can quickly respond to market changes, customer demands, and competitive pressures. Moreover, these innovative changes can enhance working conditions within the corporation. This

could be through improved workflows, better use of technology, or the introduction of more flexible working arrangements. Improved working conditions can lead to greater employee satisfaction, increased productivity, and lower staff turnover. Lastly, these innovative changes can ensure the long-term survival and viability of the corporation. By continually innovating and adapting, the corporation can stay ahead of competitors, meet the evolving needs of customers, and successfully navigate the challenges of the business environment (OECD/Eurostat, 2018).

A start-up's unique knowledge indeed presents a distinct set of challenges and opportunities when it comes to establishing a sustainable competitive advantage, particularly for technology-based ventures. On one hand, it is this unique insight and comprehension of market opportunities that often sparks the creation of a new technology venture. Founders typically possess a wealth of technical knowledge garnered from their previous experiences. This knowledge forms the basis of the company's unique value proposition and can be a critical factor in gaining an early competitive edge. This knowledge allows them to perceive the intersection between what new technology can achieve and the unfulfilled needs in the market and to map out the optimal configurations yielding the maximum organizational benefits in terms of innovation and market performance outcome (Hussinki *et al*., 2017; West *et al*., 2009). This unique perspective can lead to the development of innovative products or solutions, providing them with a competitive edge in the market. However, on the other hand, this technical mindset can also create significant organizational challenges as the venture evolves. A focus on technical aspects may overshadow the importance of other critical areas such as marketing, sales, customer service, or human resources. Also, the emphasis on technical innovation can sometimes lead to a disconnect between the product and the actual needs of the market. Moreover, founders with a technical background may struggle with aspects of business management and leadership. This can hinder the venture's growth and even lead to internal organizational conflicts (West *et al*., 2009; Ge and Zhao, 2022). The decision-making rationale of entrepreneurs plays a significant role in shaping their actions during the entrepreneurship process. Academic researchers introduced the idea of effect, and further incorporated this effect logic into management studies. Essentially, this concept pertains to the active engagement of entrepreneurs with related entities. This engagement is based on the evaluation of available tools and resources, understanding their own abilities, and ultimately achieving a progressive growth of resources. Therefore, while a start-up's unique knowledge, particularly in technical aspects, can drive innovation and create a competitive advantage, it's crucial for the founders to balance this with a strong understanding of other business areas to achieve a proper integration of opportunity and resources and entrepreneurial performance (Ge & Zhao, 2022). They must ensure that their technological capabilities align with market needs and that their organization is equipped to manage the challenges that come with business growth (West *et al*., 2009).

Passaro *et al.'s (2020)* start-up business development model classifies the life cycle into four stages: ideation, intention, start-up, and expansion. Ideation is about potential idea generation. It requires the entrepreneur team to be creative in order to discover ideas and identify market opportunities. The intention stage covers market validation and product prototyping. In the start-up stage, the entrepreneur team establish a new venture to practice its business plan and launch its products. The venture needs to be capable of massive market acquisition and industrialisation of products to expand its business to the global market. All the stages required the entrepreneur team's business innovation capability. The innovation capability reflects the performance of a start-up in terms of (i) product innovativeness for problem-solution fit products and the ability to improve and launch a new product to respond to the changes in market and customer needs, (ii) market innovativeness for product/market fit strategies based on its ability in following and understanding the changes in the marketplace environment and innovation, and (iii) scaling up the business as a combination of both product and market innovativeness, which also indicates of their ability to succeed (Sekliuckiene *et al.,* 2018).

The performance measurement of start-ups is also usually explained by the entrepreneurship theories. J.A. Schumpeter propunded a theory of entrepreneurship associates entrepreneurship are both with organisations of businesses and with innovations or continuous business development. The Schumpeterian entrepreneurship theory defines entrepreneurship as varied business activity-planning, organisation of financing and production, all of which as a whole determinating the business success and failure. The core of Schumpeterian entrepreneurship is innovation, with the roles of innovator-to-be, innovator, developer and promoter, which eventually reward the entrepreneur as profits (Mehmood *et al*., 2019). Schumpeterian entrepreneurship emphasizes that the importance of motives and behaviours of individuals. Schumpeterian entrepreneurship sheded light on the role of innovation in spakling economic development by the entrepreneurs via the process of (1) launching a new or updated product/service; (2) implementing novel production or sales methods; (3) entering an unrepresented market; (4) sourcing new raw materials or semi-finished products: (5) changing the industry/market structure, such as forming or dissolving a monopoly; (6) applying a new organizational structure to the industry (Becker *et al*., 2012; Śledzik *et al*., 2023). Moreover, R.S. Burt pointed out the importance of social networks, stating that individuals, organisations, or markets can gain competitive advantages by linking up disconnected groups. This is Burt's Structural Holes theory for the social structure of competition. Entrepreneurs have to take advantage of opportunities and are unencumbered by structural constraints to connect the holes between social groups to access and control information and dominate coordination (Burt, 2004; Krackhardt, 1995). Entrepreneurs have to have beliefs and behaviour, knowledge and practice, and characteristics to be homogeneous

within clusters relative to the heterogeneity between clusters (Burt, 2004). Their core factor for being successful and having better meditate risk is access to heterogeneous and diverse knowledge and resources from disparate parts of a social network structure (Aarstad, 2014; Burt, 2004). A well-structured entrepreneurial network is the social capital that enables more creativity and innovation (Burt, 2000).

2.5 Knowledge Capital of EdTech Start-ups

Knowledge capital is the collective expertise, technological know-how, and professional practices that organizations develop, acquire, merge, and systematize to drive production and create value. It is inherent in individual skills, operational methods, technologies, and routine organizational systems. Continually enhanced by incoming information, knowledge capital plays a pivotal role in commercial endeavours and the broader spectrum of value generation (Laperche, 2021). Establishing knowledge capital requires companies to absorb and integrate knowledge assets through strategic alliances with entities like research institutions, encompassing intangible, organizational, and social capital (Laperche, 2021; Li and Hou, 2019). Knowledge capital is at the core of the ability of an organisation to practice innovation and render it into wealth (Schiuma and Lerro, 2008). A company's knowledge capital is primarily linked to its internal R&D capabilities and its resource allocation proficiency (Yam, *et al., 2004*). It focuses on all the intangible resources that a startup can use to achieve competitive advantages, covering the well-observed and hidden value of knowledge among individual staff and the company and the social capital (Hussinki *et al*., 2017; Schiuma and Lerro, 2008). Collaboration and networking can be seen as antecedents of knowledge capital building (Hussinki *et al*., 2017). SMEs must customize their strategies for investing in or building knowledge capital, as they often encounter financial limitations during growth phases (Li and Hou, 2019; Ortega-Argilés *et al*., 2009). Research indicates that firms can bolster their internal knowledge capital by embracing new innovations and valuing knowledge-sharing partnerships with academic institutions (AUTM, 2014; Markman *et al*. 2005; Lam *et al*., 2013; Martínez-Cañas *et al*., 2012; Sharif *et al*., 2008).

Industry-University Collaboration is considered a form of open innovation. Industries, especially SMEs, look to university collaborators for the needed innovation competence that they lack through partnership (Schienstock & Hämäläinen, 2009; Lam *et al*., 2013). Because of constantly expanding the technology and knowledge pool, the business environment and various business models undergo rapid and continuous change. Companies and organisations are forced to be flexible and quick to adapt to innovations and the changing environment. Organisational learning, a process of knowledge adoption and sharing, is vital at all development stages in a business development cycle, especially for start-ups and SMEs (Sekliuckiene *et al*., 2018). Knowledge is a valuable asset for any

organisation and serves as the main competitive advantage that differs one organisation from the other (Pradana, 2015). To be able to transform into a Do Well Do Good sustainable enterprise, a start-up cannot ignore the importance of innovations other than technology, for instance, economic innovation, which includes the introduction of novel concepts, creative means of utilising readily available resources for economic advantage, or applying differentiation to convert changes into opportunities. This approach not only provides personal benefits but also contributes to societal welfare. Therefore, to truly embody sustainable entrepreneurship, start-ups must seek to innovate beyond technology and consider economic and social dimensions as well (Potjanajaruwit, 2018). Thanks to digitisation, the EdTech industry multiplied with the development of new technologies and expansion of the marketplace that led to novel learning and teaching in classrooms in schools, lecture theatres in universities, and offices in companies. Education entities, both academic institutions or EdTech enterprises, cannot get rid of various aspects of business functions. For instance, marketing of programs and services to students, teachers, and parents; recruitment of quality talents; day-to-day operational expenses and execution (Mebratu & Ma, 2011). They must apply the concept of business operation and management practice to acquire continuous sustainable development and survival (Wu *et al*., 2011). Education and technology are the dual drivers of businesses. EdTech companies must bring teaching and learning together in the design of their technological products and services. The EdTech developers have to ensure teachers and trainers are involved in securing their proper understanding of pedagogical contents and practices. In parallel, EdTech developers must play the role of trainers to ensure the educators understand EdTech solutions and the value created by new teaching and learning (Romy *et al.* 2019). EdTech companies have to invest time and resources to develop their understanding of teaching and learning before the EdTech application can be implemented and fully adopted by educators (Luckin & Cukurova, 2019). On the other hand, they have to develop their technology capability to leverage technologies to create more efficient, effective and individualised modes of education.

2.5.1 Technology Value

The technology value of a company or organisation is about its capabilities to create technological innovations. It is not only about the internal research and development capability on technology but also includes productization, process, knowledge, user experience and organizational structure (Guan & Ma, 2003; Yam *et al.*, 2004). The technological value of an organisation can be immediately visible in its products, processes, and support areas. Technology value is an important asset that the organisation can claim as competence. It enables the organisation to reliably reproduce its goods and services while building up the barrier for competitors to replicate (Adler & Shenhar, 1990). Liao *et al.* (2007) discuss innovation is about the changes in an organisation's products and services and the

process and operation enabling their creations and deliveries. Technological innovation is a critical activity for organisations to prevent being eliminated from the market. The Oslo Manual 2018 (OECD/Eurostat, 2018) echoes that:

> *An innovation is a new or improved product or process (or combination thereof) that differs significantly from the unit's previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process). Knowledge is a basis for innovation, novelty and utility, and value creation or preservation as the presumed goal of innovation. The requirement for implementation differentiates innovation from other concepts such as invention, as an innovation must be implemented, i.e. put into use or made available for others to use.*

The Oslo Manual 2018 defines two main types of innovation: product innovation and business process innovation. Product innovation is about how an organisation offers a new or improved good or service with technology that differs significantly from its previous ones and that has been introduced on the market. Business process innovation is the organisation's ability to develop new or improved business processes for one or more business functions that differ significantly from its previous practices under the adoption of technological advancement. The business process innovation covers the elements of supporting operations and sales and marketing (OECD/Eurostat, 2018).

Research on university-industry collaboration in Hong Kong indicates innovative and unique business models, technology complexity and integration, and product innovations top the list of key drivers for companies to come into technology transfer collaboration with universities. The technology value gained enables a firm to build up a competitive business advantage, integrate internal technology competence with external technology development, and deliver products and services that fit customer demands (Lam *et al.*, 2013). Despite the choice of wordings, scholars (Liao *et al*., 2007; Yam *et al*., 2004) use product innovation, process/operation innovation and marketing innovation as the dimensions to measure the innovation capability of knowledge-intensive industries. Their studies introduce frameworks for innovation auditing and examine the relevance among various types of innovation capabilities, discussing the effects on organisational performance.

2.5.2 Education Value

An (2021) raised the issue that people have to ask new questions when measuring EdTech about the purpose in education. Educators today are navigating an increasingly complex landscape when it comes to the adoption and use of technology in schools. The number of available technological innovations is growing, with many still in their developmental or beta stages (Hughes, 2019).

Furthermore, most of these innovations have not been subject to educational research to determine their instructional or learning effectiveness. This raises the challenge of identifying which technologies will truly enhance the educational experience and contribute to improved learning outcomes. Therefore, it is crucial for educators to stay informed and be discerning when integrating these new technologies into their classrooms (Bull, *et al.*, 2017). Education is not only limited to childhood development and in-school learning. Since 1850, the Cambridge University has introduced the concept of extension education, which is now widely existing in the global education systems and social environment. Extension education frames education to cover lifelong education, education for sustainability, continuing education, liberal arts education, adult education, recurrent education, lifelong learning, learning society, etc. (Wu *et al*.,2011). Education is also closely related to the growth of small businesses. Research indicated CEOs' or business owners' industry-specific knowledge acquired before gaining leadership of small and medium-sized enterprises and business operation and management knowledge acquired after gaining the leadership were both positively related to the enterprises' performance in terms of profitability and productivity (Soriano and Castrogiovanni, 2012). Education is multicultural, integrating teaching, human relations, and interpersonal interaction, and it is social reconstructionist, addressing social inequalities (Mebratu & Ma, 2011). Education value in a community setting is about the engagement of more citizens in acquiring knowledge about, forming ethical values about, and taking action for the particular subject of interest. It has a fundamental impact on shifting the rational mind and daily action, which eventually changes society's future (Chao, 2020; Mebratu & Ma, 2011). Technology has enabled novel and more complex activities for education (Pierson, 2001). Nowadays, technology can demonstrate educative processes and systems on social dynamics and interactions, as mentioned by Mebratu & Ma (2011). Scholars in 2005 introduced the term technological pedagogical content knowledge as a conceptual framework to describe the knowledge base for teachers to effectively teach with technology (Voogt *et al.,* 2013; Koehler and Mishra, 2005). EdTech is an integration of technological development and teaching and learning knowledge to address the advancement of knowledge development directly related to the subject matter in education (Voogt *et al.,* 2013).

EdTech is ready-to-hand in the service of people's educational needs (An, 2021). On top of the technology, Koehler and Mishra's knowledge framework described pedagogical knowledge and content knowledge as the measurements of education value (Koehler and Mishra, 2005; Pierson, 2001). When compared with computer science and technology development, learning science and educational practices have changed much more slowly. The educational development trends were observed in behaviourism, cognitivism, and constructionism (Pinkwart, 2016). Effective adoption of technology in education is based on the levels of transparency and ubiquitous of technology in

educational practice and how well it tackles the learning difficulties and student conceptions related to the transfer of specific subject knowledge (Voogt *et al.,* 2013). Learning scientists framed the primary focus of integrating technology with education is about content and effective instructional practices. The technology involves the tools with which we deliver content and implement practices in better ways. Its focus must be on curriculum and learning (Earle, 2002). The measurements of the education value in an EdTech setting cover four areas: the advancement of learning environments or manners; the improvement of the learning experience; the new standard of assessment; and the enhancement of productivity and practice of teaching or training (Niess *et al.,* 2009; Voogt *et al.,* 2013).

2.5.3 Social Network

Knee (2016) described that a network is critical for the success of a good education business. A social network system involves a group of actors who are connected to each other via various relations or ties. The network hosts channels to facilitate the flow of communication, knowledge, innovation, and resources between actors. Social systems embed social capital, which can be operationalised as an essential resource for new development and strategic change in an organisation (Daly, 2020). Social networks connect the innovation diffusion and knowledge flow between different actors in an industry to achieve innovation advancement (Ahrweiler *et al*., 2011). Social networks provide an organisation with knowledge of market opportunities, market trends, cultural value, products, and technological developments (Sinthupundaja *et al.*, 2020; Yli-Renko, Autio & Tontti, 2002; Loane & Bell, 2006). Networks act as critical conduits for innovative thinking and add new knowledge to organisations (Davenport and Prusak, 1998). Social capital and social networks provide useful information, methods, and directions to actors formally and informally (Daly, 2020). Leveraging social networks, entrepreneurs connect with a wide range of stakeholders to access and exchange valuable knowledge and resources (Sinthupundaja, *et al.*, 2020). They empower SMEs and start-ups to access necessary external competency and complementary resources to enhance the firms' operational capabilities (Paradkar *et al.*, 2015). Therefore, the possibility of learning from knowledge-sharing partners can result in successful product and service diversification, consistent growth of competitive advantage and forward-looking international marketing strategies (Sekliuckiene *et al.*, 2018).

The number of academic studies on social networks and social capital recorded an exponential increase in recent decades, from less than a hundred in the mid-1990s to over 1500 publications in 2010, while the fields of studies have also been broader from pure social science to science and technology, and businesses management (Daly, 2020; Bougrain and Haudeville, 2002; Almeida & Kogut, 1999; Powell, Koput, & Doerr, 1996). A network serves as a locus of innovation by providing

timely access to knowledge and resources among the networks and beyond the boundaries of an organisation, which are otherwise unavailable. In fields of rapid intellectual development, the social networks and social capital effects have been well observed at the person-, organisation- and industry-level to achieve positive-sum relationships (Powell, Koput, & Doerr, 1996). Social network is a crucial element for the access to and absorption of knowledge and its creation (Almeida & Kogut, 1999). The social capability enables a technology firm to leverage both external knowledge and internal competency to create marketable and profitable innovations (Chesbrough, 2007). Nowadays, knowledge networks contain knowledge elements, repositories and agents that search for, transmit and create knowledge. These interconnections empower participants, individuals or organisations, to receive, shape, supply, transfer or co-create knowledge (OECD/Eurostat, 2018).

> *"All firms and organisations are engaged in knowledge interactions with each other. A knowledge network consists of the knowledge-based interactions or linkages shared by a group of firms and possibly other actors. It includes knowledge elements, repositories and agents that search for, transmit and create knowledge"* (OECD/Eurostat, 2018).

Firms and their executives are involved in two distinct networks: one is an informal managerial network consisting of connections among the firm's executives, and the other is a formal institutional network involving official ties between different firms (Bell, 2005). The scholar described the first one is an internal, managerial network, which is characterized by informal connections among the executives within the same firm. This network is typically built on personal relationships, shared experiences, and mutual trust. It facilitates communication, cooperation, and decision-making processes within the firm. The second network is an inter-organisation tie network. This network consists of formal, often contractual relationships between different firms. It could include partnerships, joint ventures, supplier relationships, or customer relationships. This network extends beyond the boundaries of the firm and connects it to the broader business environment. It is crucial for the firm's access to resources, information, and markets. Both networks play a significant role in shaping the firm's strategies, operations, and performance. Effective management of these networks can contribute to the firm's competitiveness and success (Bell, 2005).

Structural relationships are an important dimension of social capital. It refers to the relationship characterised by close and regular social interactions between organisations. It results in norms and repeated practice of information exchange and resource sharing based on trust (Martínez-Cañas *et al*. 2012). Another dimension is network centrality. Social networks provide informal channels to foster the dissemination and sharing of knowledge and resources among members of the network. Centrality ensures the central position to connect to these knowledge channels. It is a crucial measurement of a

firm's social capable (Li *et al*., 2013). As start-ups rarely have renowned brand names, personal contact networks are critical assets for promotions and sales. The social networks of the firm directly influence the identification of new opportunities and business expansion (Yli-renki *et al.*, 2002).

2.6 Absorptive Capability

Absorptive capability is a company's capacity to find, capture, fuse, adopt and transform external knowledge into an internal innovation ability. It is the ability of an entrepreneur to understand new knowledge, recognize its value, and subsequently commercialize it by creating a business (Qian & Acs, 2013). It is the organisational mechanism describing the company's ability in (i) knowledge acquisition and assimilation, called the potential absorptive capability; and (ii) knowledge integration and evolution, called the realised absorptive capability (Zahra *et al*. 2002; Cohen *et al.* 1990). Knowledge may not be transferred easily from one actor to another but instead requires a certain absorptive capacity on the part of the incumbent in order to absorb and use it for commercialization and, ultimately, innovative activity (Audretsch and Caiazza, 2015).

Most of the EdTech start-ups in Hong Kong are supposed to be with their niche knowledge advantage in their domain fields, given that this is the common criteria among the entry requirement of the incubators, for instance, the Hong Kong Science Park and the Hong Kong Cyberport, and the universities' entrepreneurship development schemes. However, their competence or organisational resistance in making changes and capturing, integrating and evaluating new knowledge to advance their businesses will be examined and evaluated. A start-up can begin with great innovation and technology, but the ability to capture new knowledge to fuel their continuous innovation and business advancement. Previous studies suggest measuring the percentage of the company's research and development workforce out of their total workforce as the indicator of their performance in absorptive capability (Leahy *et al.* 2007; Zahra *et al.* 2008).

2.7 Entrepreneurship Capability

The empirical conception of entrepreneurship is about the activities that an organisation makes use of for identifying and exploiting opportunities, the process of realising and arbitraging unmatched supply and demand, which is exiting but yet well utilized by players in the market, and the creation and exploitation of un-existing marketplace and businesses by foreseeing the possible future demands and supplies that is not yet existing (Al-Aali and Teece, 2014). Entrepreneurs have to acquire a set of skills, aptitudes, insights and circumstances in order to make good use of the opportunities of commercializing and profiting new knowledge into economic innovations (Audretsch and Caiazza, 2015). Entrepreneurs must acquire critical capabilities to manage, control and deploy various tangible and intangible resources in the ecosystem economically, socially, and environmentally to establish

the capacity of their enterprises to attain the necessary competitive advantages to accomplish their business missions (Sinthupundaja *et al.*, 2020).

Entrepreneurship capability in startups from university knowledge transfer activities impacts venture success: product-market matching, claiming and protection of intellectual properties, attracting and mentoring the founding team, and strategic timing (Thomas *et al.*, 2020). Entrepreneurship capability centers on the reorganization of resources, specifically the knowledge assets that a startup owns or controls, to identify, develop, and capitalize on opportunities (De Massis *et al*., 2018). It is the set of attitude and behavioral tendencies that empower an individual to foster and enhance their capacity for achieving entrepreneurial milestones professionally (Kuratko *et al*., 2018; Lee *et al.,* 2018). Additionally, scholars have described entrepreneurial capability as the autonomy to pursue and cultivate business opportunities, dependent on a combination of internal conditions (Wilson and Martin, 2015).

In technology-pushing start-ups, knowledge created by the internal competency of the founding members is sufficient to fulfil their technological needs for building and testing their prototypes with end users (Ayna Yusubova *et al.*, 2020). Knowledge creation offers sufficient opportunities to increase the rate of entrepreneurship and promote the growth of the economy (Audretsch and Caiazza, 2015). Knowledge creation enables the start-ups to earn high returns with their strong intellectual property pools (Kwak, 2002). However, the start-ups would commonly need to leverage complementary assets, knowledge, coaching, information and resources of the external environment to further advance their development and enter into necessary business alliances (Audretsch and Caiazza, 2015; Kwak, 2002). When they enter the commercialization stage, the start-ups need non-top management employees' commercial vision and entrepreneurial attitude to commit to making their products and services work well (Audretsch and Caiazza, 2015). The degree to which the start-ups integrate their internal creation, knowledge from external environments, and the firms' commercial attitude as a whole enables them to generate sustainable revenues to support the spillover of innovations as the formation of new business activities (Audretsch and Caiazza, 2015; Ayna Yusubova, *et al.*, 2020). Scholars' study on venture capitalists and cooperative start-up commercialization strategies indicate that venture capitalists favour start-ups with a strong ability to be a knowledge factory, significant social connectivity in business alliance formation, and radical innovating strategies to create new technological products (Hsu, 2006).

2.7.1 Innovativeness

Knowledge fuels the journeys of entrepreneurs. Entrepreneurs discover, create and exploit knowledge to proactively generate new possibilities (Al-Aali and Teece, 2014). Innovation is the process that transforms an invention into a marketable product. It extends beyond mere invention; it

encompasses the commercialization of ideas, implementation, and modification of existing products, systems, and resources. Therefore, innovation is a comprehensive process that marries creativity with practical application and market viability (Mueller *et al.*, 2001). Entrepreneurs, who act as the creators or incumbents, create and transfer new knowledge internally and cooperatively. Meanwhile, new entrants join in to perceive unexploited opportunities by leveraging the un-adopted knowledge of other organisations to start-up new ventures. In addition to an entrepreneurial climate, the creation of new ventures and entrepreneurial activity depends upon the availability of prospective entrepreneurs, i.e. individuals possessing personality traits combined with personal circumstances, which are likely to lead them to form a new venture (Mueller *et al.*, 2001). Intentionally or un-intentionally, knowledge capital directs the formation of a new venture to boost the growth of the knowledge-based society (Audretsch and Caiazza, 2015). A start-up can utilise its knowledge capital as its operating capabilities and the ability to enhance and reconfigure its operating capabilities. It is about the capability for routinising the development and adaptation of operating routines (Arend, 2014). The start-ups' ability to create, transfer, transform, adopt and spill over knowledge develops its knowledge capital (Arend, 2014; Yam *et al*., 2004). The learning capability of external knowledge is their ability to identify, integrate, and utilise knowledge from the environment and partners. The research and development capability of in-house knowledge reflects the start-ups' ability to formulate research and development strategy, project implementation, and knowledge inventory. Resource allocation capability refers to the start-ups' ability to acquire external resources and combine them with internal resources to form innovations (Yam *et al*., 2004).

2.7.2 Entrepreneurial Attitudes

The essential step on the entrepreneur journey is to start a business, during which a person transforms from the previous identity to the new identity as an entrepreneur. The entrepreneurial identity centrality indicates the intention and readiness to commercialise knowledge to start up a business and to take risks and manage uncertainty in the business environment (Wang *et al*., 2022). Entrepreneurs should foster innovation, risk-taking, and proactivity to facilitate the exploration and utilization of creative ideas. Furthermore, entrepreneurs should have confidence in their ability to construct, which aids in achieving specified performance objectives (Khedhaouria *et al.*, 2015). Attitudes are predispositions to respond to a stimulus, such as a situation, a person, or an object, in a specific way and entail cognitive, affective, and conative components. Entrepreneurial attitudes are the specific attitudes toward new ideas, practical solutions, and organizational operation processes which open up opportunities for new businesses and novel ways of problem-solving (Schierjott *et al.*, 2018). Start-ups have to share the culture of creating entrepreneurial attitudes among their small team to effectively utilize their resources and abilities and eventually characterise the whole organisation

(Ayna Yusubova *et al.*, 2020; Lackéus *et al.*, 2015; Al-Aali and Teece, 2014; Arend, 2014; Soriano, and Castrogiovanni, 2012; Boh, 2007; Liao *et al.*, 2007). Entrepreneurial attitudes are the strong connections with a person's entrepreneurial intention and behaviours. They refer to the personal driver towards enormous development and commitment to interdisciplinary achievements and innovation (Lackéus *et al*., 2015). Gibb (2002) concluded that these attitudes reflect the commitment to life learning, the integration of disciplines and knowledge, and the adaptation of various approaches to continuous deliverables to benefit the personal individual, the serving organization, the particular industry, and the wider community. In a firm, employees' individual attitudes that drive their personal engagement and commitment to entrepreneurial acts are the entrepreneurial attitudes. The entrepreneurial attitudes, which appear to be the infrastructure and framework for corporate entrepreneurship, influence individual members' performance in job-related tasks and their perceptions of the start-ups. The chemical reaction of individual members' entrepreneurial attitudes results in the corporate-wide entrepreneurship performance of the start-up that purposefully and continuously recognizes and exploits business development opportunities (Liu *et al.*, 2020). Liu (2020) also classified entrepreneurial attitudes as venturing attitudes and innovation attitudes. Venturing attitudes refer to the emphasis on creating new ideas for business and embanking new operations to improve business performance, while innovation attitudes refer to the emphasis on ideation and research and development work towards creating new knowledge for continuous product development (Liu *et al.*, 2020; Arend, 2014; Yam, *et al*., 2004; Guth & Ginsberg, 1990). Schierjott (2018) supplements entrepreneurial attitudes also cover perceived personal control, need for achievement, self-esteem and the inter-connection in between. Different configurations of knowledge capital with managerial approaches could yield equally good performance outcomes for the ventures. In practical terms, start-ups should empower their team members with the freedom and liberty to explore and innovate beyond their assigned roles and responsibilities, given that innovation is a strategic priority. However, they should also direct their focus towards efficiency and effectiveness when it's time to utilize the accumulated knowledge to sustain competitiveness (Hussinki *et al*., 2017).

2.7.3 Co-creation

Scholars described innovation and technology development is a process involving multi-dimensional commodities and a particular package which probably might not be available form a single source of supplier but from a combination of them (Bessant and Rush, 1995). Inter-organizational co-creation is clearly an essential element to facilitate the development and adoption of technologies. In order to foster a dynamic and successful innovation ecosystem, organisations have to collaborate with external entities such as research promotion agencies, suppliers, and consumers to achieve common benefits. By forming these strategic alliances, organizations can create a network of innovations that facilitates

the exchange of knowledge and the mutual sharing of benefits derived from the development of new products and operational processes. This co-creation approach not only accelerates innovation but also ensures a wider distribution of its benefits, thereby promoting a more inclusive and sustainable innovation advancement (Potjanajaruwit, 2018). The concept of co-creation explains the interplaying and interacting activities among stakeholders of a particular operational activity of an organisation, which involves internal employees, customers, suppliers, distributors and every market competitor. Promotion of the concept of co-creation eliminates the circumstance of unproductive or destructive organizational performance (Klein *et al*., 2013). The co-creation movement is the series of activities and processes for organizational transformation for attaining new growth towards the next paradigm of value creation to advance the level of competitiveness (Ramaswamy, 2009). Co-creation is put into action by a mix of various players with diverse backgrounds, who eventually all obtain benefits from their investment of time, knowledge, and resources in the partnership (Karami & Read, 2021). All entrepreneurs, including social entrepreneurs, have created shared value as their sustainable competitive advantages to follow through with their missions and to attain their economic goals (Sinthupundaja, *et al.*, 2020). Klein (2013) describes value and market co-creation as the requisite capabilities in modern strategic entrepreneurship and business management.

Market co-creation, involving partners in networks and alliances, is a hard but crucial process for market-entry start-ups. Market co-creation activities are more often carried out in pursuit of the vision of a market that has yet to emerge. They dictate the start-ups' development and determinate their business sustainability (Al-Aali and Teece, 2014). Re & Magnani (2022) describe co-creation outputs impacting the firms' conventional market mix as: co-production, co-promotion, co-pricing, co-distribution, co-maintenance, co-outsourcing and co-disposal. Market co-creation also describes the entrepreneurs-customers collaboration - a market is a platform for start-ups and customers to join hands for co-creating (Karami & Read, 2021). Large firms' strategic business development usually requires new partnerships and opening up new eco-system. Start-ups can take advantage of co-creating a new marketplace and eco-system. Market co-creation creates motivations for entrepreneurs and entrepreneurs-to-be and is the new nature and essence of the innovation and entrepreneurship ecosystem in the knowledge-based economy (Pitelis & Teece, 2010).

Co-creation is a generator of value that can output repeatedly repeatably to increase productivity, reduce operating costs, and increase worker engagement in an organisation. The co-creation movement is poised to advance and transform organizations towards cost reduction, efficiency enhancement, and quality assurance while reducing business risk–increasing the ability to deal with uncertainty and high-return risk. Most importantly, co-creation is also a sustainable growth engine that enhances strategic capital, increases returns, and expands market opportunities in new ways

(Ramaswamy, 2009). Re & Magnani (2022) further conclude that value co-creation is a series of business operations for entrepreneurs to achieve joint development within the organisation, among organisations and their stakeholders. There are various types of co-created value: co-conception, co-meaning, co-design, co-consumption and co-experience. Value co-creation empowers start-ups' performance and competitiveness holistically in the dimension of products, services, and experiences (Re & Magnani, 2022). The EdTech industry highlights the importance of expanding the scope of educators' roles to include technological innovation and integration in classroom settings, which should also take into account EdTech innovators and their advancements. This expanded ecological viewpoint can be regarded as an EdTech ecosystem, where educators now find themselves positioned (Hughes, 2019; Kurshan, 2016).

Chapter 3. Research Model and Hypotheses

This chapter outlines the research model of this study, which provides a conceptual framework that steers the research processes. It further delineates the primary variables, relationships, and assumptions that form the foundation of this research study. This model is integral to the research as it aids in the understanding and interpretation of the data collected, ensuring that the study's findings are reliable, valid, and applicable to the topic at hand. It is a blueprint for the study, providing direction and structure to the research process. Scholars define a research model as a theoretical framework that functions as a predetermined set of guidelines, delineating the steps and providing a structure for analyzing and interpreting the data in a specific research study (Earl, 2016). This framework serves as the backbone of the research, assisting the researcher in understanding the relationships between various variables and concepts. It provides a comprehensive perspective of the research problem, aiding in the formulation of research questions, hypotheses, and, eventually, the interpretation of the research findings. A research model deploys evaluation of statistical analysis and analysis of research literature as the theory base (Palvia *et al*., 2006). A research model should consider research questions, study design, and data analysis in an interactive and iterative process. When designing the research model, a researcher has to be open to emergent findings, emphasize the importance of rigour and trustworthiness, and develop strategies for enhancing the credibility and transferability of findings (Maxwell, 2005).

The aim of this study is to construct a research and evidence-based model that scrutinizes the influence of technology transfer on the enhancement of EdTech start-up's entrepreneurship capabilities. Figure 4A portrays the conceptual model describing the transition of technology transfer activities in universities into the knowledge capital of EdTech entrepreneurs. The model also depicts the contribution of this knowledge capital and absorption capability towards the entrepreneurship capability in EdTech start-ups. This conceptual model aims to illustrate how the transfer of technology from universities can provide a significant source of knowledge for EdTech entrepreneurs, which, when combined with their ability to absorb and utilize this knowledge, can enhance their entrepreneurial capabilities. This could potentially lead to the development and success of their EdTech start-ups. According to Maxwell (2005), the research model is constructed using four primary sources that make up a conceptual research framework: experience, prior theory and research, pilot studies, and thought experiments. The previous sector of the literature reviewer explains the model's background. This study will seek to clarify the correlations between university technology transfer, knowledge capital, absorption capability and entrepreneurship capability of an EdTech start-up.

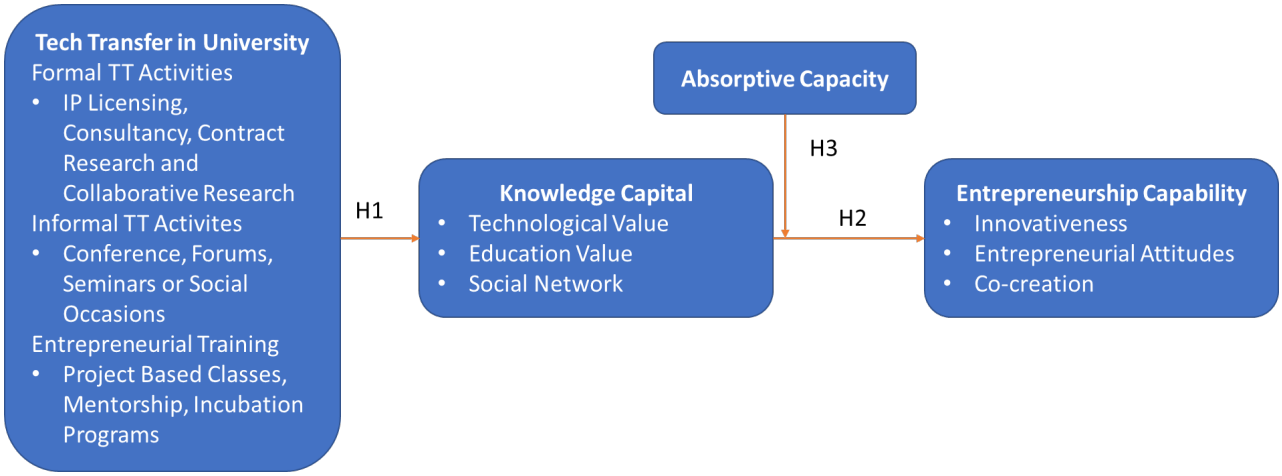


Figure 3A: Conceptual model illustrating the contributions of university technology transfer to knowledge capital of an EdTech start-up and how the capital is translated into entrepreneurship capability with the interference of absorption capability.

3.1 Technology Transfer in University Informing Knowledge Capital in a Company

In Hong Kong, 50.4% of research and development activities were conducted in universities (Tsui, *et al.*, 2020). University research indeed offers a significant reservoir of knowledge and technological expertise to the community and commercial sector. This wealth of information often results in a pool of innovations and inventions. However, without active exploration and utilization by potential users, these breakthroughs often only manifest as academic presentations and journal papers. Therefore, it's essential for potential users, such as entrepreneurs and businesses, to tap into this rich source of knowledge. By doing so, they can translate academic research into practical applications, driving innovation and growth in the commercial sector. This process of technology transfer allows academic research to make a direct impact on society and the economy, further emphasizing the importance of strong ties between universities and the commercial sector. Technological inventions are fundamental for economic growth locally, nationally, and internationally. Each case of technology transfer is unique and company specific, involving a particular process of modification and adoption of technologies fitting a particular time frame of the external environment for business and social development (Bessant and Rush, 1995). However, in order to actually create impact and value for society and generate measurable profits for the participating companies, the research-based innovations and inventions need to be successfully transferred to the market. Therefore, newly developed knowledge, practical interventions and technologies need to be integrated into products or services which are actually pushed to the marketplace (Joshua *et al.,* 2005; Kirchberger & Larissa, 2016). Translational research activities and technology commercialisations at research-intensive universities have helped to develop regional and national economies, resulting in university start-ups, the growth of other new companies and associated employment (Hamilton & Philbin, 2020).

Nowadays, there are many channels to get access to the hub to explore valuable knowledge and technologies. The external partners of universities can either act as developers of technologies and/or the organizations bringing these technologies to the market through the interactive channels of technology transfer (Kirchberger *et al.,* 2016). The outsiders can be considered in the context of enabling the adoption of intellectual properties in the commercial marketplace effectively (Hamilton & Philbin, 2020). As commercially neutral entities, universities are also effective facilitators of gathering cross-field stakeholders for information exchange for the best benefit of them (Nsanzumuhire, and Groot, 2020).

Based on the abovementioned reasoning, the following hypothesis is presented.

H1: Technology Transfer from University activities is positively related to the EdTech start-ups' knowledge capital.

Formal technology transfer activities refer to the structured processes by which scientific knowledge and technological innovations are transferred from research institutions to industry, with the aim of creating new products and services (Mowery, 2010). This process involves a range of activities, including licensing agreements, patenting, spin-offs, and research partnerships (Siegel *et al.,* 2003). Companies and organisations can adopt ready-to-use intellectual properties in the university through commercial licensing, which is well dictated and protected by formal agreements (Nsanzumuhire and Groot, 2020). Licensing agreements can generate revenue for research institutions, while industry partners can benefit from access to new technologies and expertise (Mowery, 2010). The external parties can engage suitable experts in universities to further develop or customer-make solutions for particular market-fit products or services by adopting their background intellectual properties on-hand or utilizing their professional knowledge and academic thinking (Yoshioka & Takahashi, 2022).

Formal technology transfer activities can play an important role in facilitating the commercialization of scientific knowledge and technological innovations. There is a growing trend in the establishment of formal technology transfer activities as a means of promoting innovation and economic growth, while government bodies and funding agencies have been increasingly actively engaged in technology transfer initiatives, and research institutions have been developing new models and policies to facilitate the ease for collaboration with industry partners (Tsui, *et al.,* 2020; Mowery, 2010; Siegel *et al*., 2003). Companies and organisations pay universities to outsource their research and development work for technological solutions and non-technical interventions, especially for start-ups with limited manpower and highly advanced skills. Licensing and commercializing new technology can be better than building it in-house. The development of new technologies by competing firms has the potential to destabilise an industry's competitive landscape. Leveraging the

research-based knowledge and expertise in universities allows companies to reduce the risk factors of developing new technologies in-house and provide access to complementary assets that are technically and resource-wise costly to develop internally (Moreira *et al.,* 2020). Studies have indicated that formal technology transfer activities can create significant economic benefits for both research institutions and industry partners, notwithstanding the process of technology transfer can be time-consuming and resource-intensive and may require significant investment in infrastructure and personnel (Debackere & Veugelers, 2005).

Moreover, the formal technology transfer collaborations enhance the credibility and recognition of the products and services of the start-ups by leveraging the technological and marketing value of the participating university and the involvement in academic research-related activities (Yoshioka & Takahashi, 2022). Such kinds of paid services can be in the forms of consultancy, contract or collaborative research depending on the portions of input, investment, contributions, and outcome sharing of each party in the project. A significantly larger proportion of academic researchers are practising consultancy, contract, or collaborative research types of technology transfer than licensing. Collaborations result in creating new intellectual properties and practical solutions for the industry side to attract new resources, obtain new knowledge and building capital (Perkmann *et al*., 2013).

Formal technology transfer can also be an accelerator of a company's social network development. In a study examined the impact of formal technology transfer activities on a company's social network, formal technology transfer can lead to increased knowledge sharing among employees, which in turn strengthens the company's social network. Additionally, scholars suggested that the implementation of formal technology transfer can help to identify knowledge gaps (Grimpe and Hussinger, 2013) and facilitate communication between different departments within the company and a vast social network of academic entrepreneurs on campus and in the surrounding regions of the universities (Waldman *et al.,* 2022). When zooming out to the inter-organisation situation, formal technology transfer activities can help to strengthen relationships between firms and increase the amount of knowledge exchanged between them. Additionally, formal technology transfer collaboration is a concrete building block for establishing trust between firms, which can lead to future partnerships (Gilsing & Nooteboom, 2005). Technology transfer can help companies connect with a broader network of experts, researchers, and industry partners, which can enhance their long-term collaborative social network development.

Based on the abovementioned reasoning, the following sub-hypotheses are presented.

H1a: Formal Technology Transfer from University activities is positively related to the EdTech start-ups' technology value.

H1b: Formal Technology Transfer from University activities is positively related to the EdTech start-ups' education value.

H1c: Formal Technology Transfer from University activities is positively related to the EdTech start-ups' social network.

Before going into these kinds of formal technology transfer collaborations, informal technology transfer activities usually serve as the doors and windows for outsiders to learn about the resources, potential and possibilities of innovation in universities. Informal technology transfer activities play a critical role in facilitating knowledge and technology diffusion, particularly in contexts where formal mechanisms are not readily available or accessible. Universities often organize conferences, seminars and networking occasions to promote the output and expertise of their research centres and individual faculty members. The primary results of the activities are the formation of social relationships and collaborative networks (Perkmann & Walsh, 2007). Informal technology transfer focuses primarily on interactions of the individuals involved, i.e. academic researchers and industry personnel (Grimpe and Fier, 2010; Perkmann & Walsh, 2007). Although informal technology transfer activities are the kind that sometimes takes place "going out the back door", outsiders can make use of the platforms to access the pool of knowledge and technology in universities to kick start their collaborations (Vega-Gomez & Miranda-Gonzalez, 2021; Löfsten & Lindelöf, 2002). Formal and informal technology transfer can be events in sequence or in parallel (Grimpe. and Fier, 2010). The informal technology transfer activities also gather players across industries that they can make good use of and to expand their social networks (Grimpe & Fier, 2010; Perkmann & Walsh, 2007). SMEs rely heavily on informal networks and personal relationships to access knowledge and expertise that they cannot, or are too costly to, acquire through formal mechanisms. Informal technology transfer activities build up their reputation, reciprocity and social capital (Ali & Birley, 1998). The study also highlighted the importance of trust, reciprocity, and social capital in facilitating informal technology transfer activities. Ranga and Etzkowitz (2013) advised informal technology transfer brings to an organisation the informal network of personal relationships, trust and mutual learning, which is a critical element in the early stages of the innovation process. The community dynamics facilitate members in the collaboration to be innovative, to improve their dynamic capabilities, to adapt evolution of the business environment, and to encourage the development of the inertia for constantly looking for new partnerships to increase mobility (Wang and Liu, 2022). The informal interactions between companies and TTOs are important facilitators of technology transfer in the education business, to overcome social-cultural factors, to figure out the possible transfer process, and eventually to foster the commercialization and dissemination of educational technologies and innovations (Klauss, 2000).

Based on the abovementioned reasoning, the following sub-hypotheses are presented.

H1d: Informal Technology Transfer from University activities is positively related to the EdTech start-ups' technology value.

H1e: Informal Technology Transfer from University activities is positively related to the EdTech start-ups' education value.

H1f: Informal Technology Transfer from University activities is positively related to the EdTech start-ups' social network.

Entrepreneurial teams must face the transition between phases of the entrepreneurial life cycle and the venture life cycle. They must experience entrepreneurial team formation, collaboration, and dissolution embedded within the phases of venture inception, development and decline (Patzelt *et al.*, 2021). Back in the early 2000s, the involvement of university students in knowledge transfer was typically about the recruitment of students from the university who demonstrated outstanding performance in corporate-sponsored projects (Bercovitz and Maryann, 2006). In an entrepreneurial society, the mandate of universities is to contribute and provide leadership to create entrepreneurial thinking, actions, institutions, and entrepreneurship capital. The entrepreneurial universities create new interdisciplinary learning and experience to equip people thriving in the emerging entrepreneurial society, who will eventually spillover new knowledge from the universities to the commercial firms and non-profit organisations, with the skills, knowledge, mindsets and human capital to generate solutions to specific societal problems and challenges. (Audretsch, 2014). To prepare the entrepreneurial teams, comprehensive entrepreneurial programs in universities provide one-stop-shop opportunities for start-uppers to equip their technology capabilities, domain knowledge of the market segment and social network to support their business development and operations. Entrepreneurial education programs provide benefits to individual participants benefits in terms of knowledge learning, idea inspiration, and business incubation resources and network, which results in the rise of participants' intentions and attitudes towards personal entrepreneurial behaviours and the success of the future ventures (Souitaris *et al*., 2007; Wesley II *et al*., 2022). Typically, universities' entrepreneurial development programs cover an entrepreneurial journal's early stages: talent training, ideation, and business incubation (AUTM, 2014; Boh *et al*., 2015; Audretsch and Caiazza, 2015). The programs aim to promote entrepreneurship, cultivate mindsets and talents in the universities' community, and foster the growth of the start-up ecosystem both locally, regionally and globally (Knowledge Transfer, EdUHK, 2022). The inspiration of attitude and opportunities eventually results in the increase of students' attempts to the entrepreneurial career (Souitaris *et al*., 2007).

In the transition to entrepreneurship, a student faces first an attitude–intention-related personal challenge and then a number of 'implementation' challenges such as acquiring knowledge, finding and evaluating an opportunity and assembling the resources (Souitaris, *et al*., 2007). Talent training programs usually aim to prepare students with learning resources and attitudes in starting up a business. They include elements to motivate, empower, and cultivate trainees, enabling them to create innovative solutions for commercial and societal issues, utilizing university research, IP, knowledge, technology, and expertise. The attainment of knowledge and effective utilization of resources provided by the training can assist in addressing implementation obstacles of student entrepreneurs (Souitaris, *et al*., 2007). Furthermore, they aspire to establish a dynamic ecosystem dedicated to encouraging collaboration within the start-up community and promoting entrepreneurship across the institutes. Embarking on the journey of starting a business opens opportunities for establishing a non-profit organization or launching a new venture within an established business (Winkel *et al*. 2013).

Creation of a new venture often builds on a venture community of individuals' support, including financial (investment) and social resources (advisory and recommendation) that entrepreneur teams use to develop their products and services for the marketplace and support their continuous evaluation (Wesley II *et al.*, 2022). The seed fund programs in universities provide opportunities for start-uppers to leverage universities' research-based technology and knowledge innovation on their business proposals in addition to the seed fund money. Collaboration and funding opportunities are considered to be valuable resources and essential elements in the further implementation, development and support of participants in entrepreneurship programs (Winkel *et al*. 2013). Those entrepreneurial activities involving the participation of industry experts, such as mentorship programs and project-based classes, allow students and start-uppers to establish connections with the industry in an early stage. They attempt to forecast forthcoming results, such as achieving significant milestones, demonstrating a proof of concept, securing their initial customer, or attaining a revenue target (Wesley II *et al.*, 2022; Elango *et al.*, 1995). This is a solid foundation for business social networking.

Scholars described the success of entrepreneurial development programs as an effective university-based entrepreneurship ecosystem which can provide strong local, regional, national, and global relationships. The relationship network has to cover the business commercial sector, investment community, other institutions, government units, and also non-government and non-profiting organisations (Winkel *et al*., 2013) and, more importantly, the experienced founders (Wesley II *et al.*, 2022). In incubation programs, one common approach is to set up an office centre or innovation hub as the incubator to house the start-ups from the university (O'Meara, 2020; Rothaermel & Thursby, 2005; Kolympiris & Klein, 2017; AUTM 2014; Lee & Win, 2004; Mowery & Sampat, 2004).

University-affiliated start-up incubators are designed to enable the transfer of knowledge from the university to the firms housed within the incubator (Rothaermel & Thursby, 2005). The goal is to support the development and commercialization of innovative ideas and technology by providing office space in a renowned office space, mentoring services, technical support, and business assistance to eligible teams towards further investment and business scale up. The effect of a venture club is to connect new entrepreneurs with previous founders, investors, and other suppliers of social resources to maintain the level of sustainability and self-evolution of the ecosystem (Wesley II *et al.*, 2022). These connections should be pursued with gusto as the increased resources enhance the students' learning experiences and develop stronger linkages between students and their surrounding community, which can have enormous implications for local and regional economic development (Winkel *et al*., 2013). Engagement in activities with other entrepreneurs in their business community is also essential for founders. Entrepreneurs should focus on targeting resource providers who have both investing and founding experience when seeking financial assistance. In addition to financial support, entrepreneurs also need non-financial support. Research has revealed that resource providers with founding experience are more likely to offer social support to entrepreneurs, including advice, regardless of the evaluation of their venture (Wesley II *et al.*, 2022). It is essential to actively pursue these connections since they can greatly enrich students' learning experiences and foster stronger ties between them and their local community. This, in turn, can have significant implications for the economic development (Winkel *et al*. 2013).

Based on the abovementioned reasoning, the following sub-hypotheses are presented.

H1g: Entrepreneurial Training from University activities is positively related to the EdTech start-ups' technology value.

H1h: Entrepreneurial Training from University activities is positively related to the EdTech start-ups' education value.

H1i: Entrepreneurial Training from University activities is positively related to the EdTech start-ups' social network.

3.2 Knowledge Capital informing Entrepreneurship Capability in a Company

This section investigates the relationship between knowledge capital and the entrepreneurship capabilities of EdTech start-ups, with the aim of determining the impact of technology transfer activities in universities. Numerous academic scholars have stressed the importance of knowledge, technology and innovation for international competitiveness, particularly for technology-based firms. Entrepreneurs and start-up founders use new opportunities, entrepreneurial knowledge, social

networks, and empirical evidence, which are acquired via various experiential and cognitive processes, to develop their intellectual capital, constant entrepreneurial attitudes and co-creation intention (Sekliuckiene *et al*., 2018; Hussinki *et al*., 2017; Noel, 2009). Potjanajaruwit (2018) straightly concluded that inter-organisation collaboration and knowledge capability have a direct positive effect on the performance of new technology-based ventures. Lawson *et al.* (2001), for instance, contend that innovation capability involves the capacity to apply knowledge and ideas to novel products, processes, and systems to benefit the firm and its stakeholders. Noke & Hughes (2010) argue that SMEs can strategically employ new knowledge to develop a capability for creating new products and, thus, upgrade their position in the value chain. Zarzewska-Bielawska (2012) suggests that innovation- and technology-based firms' R&D capacity and business performance can be strengthened via knowledge transfer and sharing. By expanding and deepening relation-specific knowledge, knowledge acquisition accelerates product development, reducing product development cycles and, in turn, increasing the rate of product rollout (Yli-Renko, Autio & Sapienza, 2001).

Wang and Yang (2004) propose that knowledge integration and innovation have a positive impact on new product performance, marketing competence, and knowledge acquisition. Technological innovation has two essential dimensions: product and process innovation. Process innovation concentrates on the effectiveness of internal mechanisms and the process of successfully launching products. While technological innovation capability involves various elements, high-tech SMEs prioritize product and market innovation, with process innovation mostly relevant to efficient manufacturing and production, while organizational innovation is more significant for larger firms (Fores & Camison, 2011). As such, SMEs' technological innovation is primarily measured by product and market innovation. Many innovation and technology firms have attempted to become innovative leaders by developing their R&D capability (Zarzewska-Bielawska, 2012). Strategic planning is a valuable contributor to establishing technology firms' core competencies, which can be described by attributes of "unique," "distinctive," "difficult to imitate," and "superior to competition on resource deployment or skills" (Chen & Wu, 2007). Yang, Rui & Wang (2006) suggest that a technology firm's innovation capability in China is closely linked to the knowledge they acquire, particularly tacit technological knowledge, which is challenging to access during an exchange due to its non-codified nature and often recognized serendipitously. This type of knowledge capital and co-creation collaboration are typically improved through face-to-face interpersonal communication, an informal form of knowledge transfer (Desrochers, 2001). In the creation start-up stages, entrepreneurs' knowledge, available social contacts and skills have to be transferred from them to the members of the enterprise (Sekliuckiene *et al*., 2018). Technological knowledge assets, especially tacit technological knowledge resources, are critical to enhancing a firm's innovation capability

(Díaz-Díaz *et al.*, 2006), as knowledge can create a competitive advantage for a company (Conner & Prahalad, 1996).

Based on the abovementioned reasoning, the following sub-hypotheses are presented.

H2: EdTech start-ups' knowledge capital is positively related to their entrepreneurship capability

A company can enhance their technology value not only through internal research and development but also by acquiring externally developed technologies and subsequently disseminating, integrating, conveying, and incorporating them within their organizations (Yam *et al.*, 2004). Internal knowledge collection and translation are the input of product innovation, process innovation and management innovation of a company (Liao *et al.* 2007). The accumulation of knowledge resources at its inception also lays a foundation for the new venture's sustainability. Having accumulated knowledge through their own idiosyncratic experiences and processes, founders will have a unique view of opportunity in the market that cannot be appropriated by potential competitors (West *et al*., 2009). The ability of a company to generate innovation can be defined as the interactive system to create, spread, and employ economically valuable innovations, which are commonly referred to as the firm's technological innovation capabilities (Yam *et al.*, 2004). A company's performance in innovativeness is a special asset and is correlated closely with interior technology and experience. Innovativeness is also closely related to technology, as it represents the company's capacity to develop new products, apply new technology, improve its operational process, and react to the rapidly changing market (Guan & Ma, 2003).

Scholars found that technology knowledge was positively related to entrepreneurial attitude, as entrepreneurs who possessed a deeper understanding of technology were more likely to identify and pursue new opportunities in the market (Hussain *et al.*, 2018; Ferreira *et al*., 2022; Aljanabi, 2018; Liu *et al.*, 2020; Yam *et al*., 2004). Additionally, technology knowledge was found to mediate the relationship between environmental uncertainty and entrepreneurial attitude. Companies with higher abilities to carry out technological transition have a higher tendency towards making good use of the new environmental challenges with entrepreneurial approaches (Ferreira *et al*., 2022). A firm's innovation capability should simultaneously exhibit product, procedure, and management innovations (Liao *et al.* 2007). Entrepreneurship attitudes are contributed by technology value that entrepreneurs who were better equipped to deal with technological change were more likely to have a positive attitude towards entrepreneurship and to commercialise the technology (Aljanabi, 2018). The disposition of an entrepreneur is closely associated with their propensity for taking risks. Those who are more willing to take risks tend to be more successful in identifying and pursuing new

opportunities. Caliendo and Kritikos (2018) conducted a study that revealed a positive correlation between technology value and risk-taking behavior among entrepreneurs. Individuals with a better understanding of technology were more inclined to take calculated risks when pursuing new opportunities. The study further indicated that risk-taking behaviour played a partial role in mediating the relationship between technological knowledge and entrepreneurial success. This implies that entrepreneurs who are more willing to take risks are more likely to achieve their goals. The technology value's endeavour to innovate new products fosters the company's internal dynamic transformation to adapt to environmental changes (Aljanabi, 2018). Knowledge and intellectual resources provide the initial foundation of new ventures for competitive advantage and lead to the development of other important resources, which are two of the greatest challenges confronted by new ventures (West *et al*., 2009).

Co-creation entails collaboration between companies and their stakeholders, including customers, employees, and partners. Technology knowledge is a crucial element in facilitating successful co-creation as it enables companies to design and implement new products and services that cater to the needs of their stakeholders. The idea of creating value through collaborative efforts between markets and utilizing unique capabilities can offer an understanding of the development of the public domain and its relationship with the private sector (Klein, 2013). Prahalad and Ramaswamy (2004) suggest that co-creation is a means of generating value by engaging customers as active participants in the process of product development and innovation. Scholars have examined the role of technology knowledge in co-creation and that technology knowledge is a critical factor in the success of co-creation initiatives, as it enables companies to develop and implement new products and services that understand and meet the needs of their stakeholders to co-create new values to everybody in the value-chain (Lusch & Vargo, 2014). Co-creation in terms of user involvement forces a rethink of many of the traditionally-accepted strategies when a company attempts to utilize the value of its technology value (Kristensson *et al*., 2008).

Based on the abovementioned reasoning, the following sub-hypotheses are presented.

H2a: Technology value is positively related to the EdTech start-ups' innovativeness.

H2b: Technology value is positively related to the EdTech start-ups' entrepreneurial attitudes.

H2c: Technology value is positively related to the EdTech start-ups' co-creation.

Education value is about the pedagogical know-how of the company. It is essential for the success of any educational technology company. According to Mishra and Koehler (2006), pedagogical knowledge refers to "an understanding of how teaching and learning can change when particular technologies are used in particular ways". In other words, it is the knowledge of how technology can be effectively integrated into the teaching and learning process. In the context of new ventures, innovation embraces high complexity due to the rapid, continual development of innovations in terms of technology advancement as well as the capability to capture competitive advantage in the target market to fulfil consumers' changing needs and preferences. They need domain subject knowledge and technology to transform into innovative enterprises (Potjanajaruwit, 2018). Putting in the setting of EdTech start-ups, the technological and educational elements are equally important. A study by Karpicke and Blunt (2011) highlighted the importance of pedagogical knowledge in the development of educational technology that supports retrieval practice. The study found that EdTech companies that incorporated pedagogical knowledge into the design of retrieval practice tools were more successful in creating products that were effective in enhancing long-term memory. Pedagogical knowledge is critical for the development of effective educational technology products in EdTech companies. Education value issues that are relevant and need to be considered in order to successfully apply technology to teaching and learning (Okojie *et al*., 2006). Companies that prioritize pedagogical knowledge are more likely to create products that align with educational goals, support student learning, and are engaging and effective in promoting long-term memory. Education value and technology value are equally important to EdTech start-ups. Studies indicated that EdTech fund raisers tend to consider learning context, performance evaluation and system of rewards (Antonenko *et al*., 2014). In an EdTech start-up team, the value of learning sciences and practice encourages the co-design and co-creation along an inter-stakeholder approach. Educators, trainers and technology developers' co-creation frameworks are structured to deliver the cores for prioritizing human intelligence, tackling educational challenges and educating everyone with technologies (Luckin & Cukurova, 2019). Research has shown that EdTech companies that prioritize pedagogical knowledge in their product development have a higher chance of success. For example, a study by the University of Wisconsin-Madison found that EdTech products developed with a focus on pedagogical knowledge were more likely to have positive impacts on student learning outcomes (Koehler & Mishra, 2009).

Based on the abovementioned reasoning, the following sub-hypotheses are presented.

H2d: Education value is positively related to the EdTech start-ups' innovativeness.

H2e: Education value is positively related to the EdTech start-ups' entrepreneurial attitudes.

H2f: Education value is positively related to the EdTech start-ups' co-creation.

The importance of a company's social network in influencing its innovativeness cannot be understated. Research has consistently shown that social networks play a critical role in facilitating knowledge sharing, collaboration, and access to external resources, all of which are essential for fostering innovation within organizations. Innovations are not only determined by factors internal to firms but also by an interactive process involving relationships between firms and different actors (Yam *et al.*, 2004). A company's social network refers to the relationships and interactions among individuals and groups both within and outside the organization. These networks can be formal, such as organizational structures and hierarchies, or informal, such as personal relationships and informal communication channels. The structure and composition of these networks significantly impact the flow of information and ideas, which ultimately affects the company's innovativeness. Scholars' study indicates in today's business environment, network connections and co-creation play a crucial role. In innovation networks, innovation is no longer a standalone activity that takes place solely within a firm's organizational boundaries. The firm that is innovating must now focus more on the resources and capabilities of other firms within the network and determine how to effectively combine its own resources with those of other firms. A company's technology competence and capability directly influence the inter-enterprise interactions (Fan *et al*., 2023).

In the developmental stage of a start-up, managers of an enterprise should take the lead in the group learning activities and create a shared learning culture in the workplace. One key aspect of social networks that influences innovativeness is the diversity of network ties. Start-ups with diverse social networks, characterized by connections to individuals and groups from different backgrounds, industries, and knowledge domains, tend to be more innovative. These diverse ties provide access to diverse knowledge, perspectives, and expertise, which can lead to the generation of novel ideas and solutions. Burt (2004) advised people connected across diverse groups have a stronger tendency to think and behave in alternative, unconventional ways. Individuals with diverse social networks were more likely to produce innovative ideas compared to those with homogeneous networks. Inter-organisational learning and networking ensure the fast growth of a start-up in the scale-up and international growth phase when it starts rapidly growing in foreign markets. In this phase, it is crucial to establish employees' recognition among the interested parties, such as investors, business partners, and clients (Sekliuckiene *et al*., 2018).

Moreover, the strength of network ties also impacts innovation. Strong ties refer to close relationships characterized by frequent interactions and high levels of trust, whereas weak ties refer to more distant relationships with less frequent interactions. While strong ties are valuable for sharing knowledge

and maintaining social support, weak ties are particularly important for innovation. Weak ties provide access to novel information and resources that are not readily available within one's immediate network (Granovetter, 1973). A social network provides networks linked by a common language. The strongest network helps the creation and delivery of the best products (Knee, 2016). Granovetter's seminal work on the strength of weak ties (1973) highlighted that weak ties serve as bridges to new information and can lead to the discovery of innovative opportunities. Good ideas emerged from the intersection of social networks but spread in a way that would continue segregation between the networks. There is a brokerage advantage in producing ideas, and company systems of start-ups are working correctly to reward brokers who produce good ideas. However, the potential value for integrating operations across the company was dissipated in the distribution of ideas (Burt, 2004).

In addition to tying diversity and strength, the network structure itself affects innovativeness. Research has shown that companies with more decentralized networks, where information and decision-making are spread across multiple individuals and groups, tend to be more innovative. Network centrality, tie strength, and tie stability strengthened the relationship between in-cluster ties and performance (Li *et al.*, 2013). Decentralized networks promote information diffusion, foster collaboration, and enhance the ability to integrate diverse knowledge and perspectives. On the other hand, companies with highly centralized networks may suffer from information silos, limited knowledge sharing, and reduced innovativeness. Both internal and external social capital play significant roles in influencing the acquisition and creation of knowledge within start-ups in terms of the resources embedded in social relationships, such as trust, shared norms, and mutual obligations. (Yli-Renko *et al*., 2002). The characteristics of network ties underwent a weakening process, which altered the relationship between ties outside the cluster and performance. Research findings indicate that firms within a cluster should actively foster distant connections in their network ties to counteract the risks of being locked into existing patterns and to prevent the decline of their clusters due to entropy (Li *et al.*, 2013). Public-private social networks' interactions push digital transformation, services innovation and business model development in EdTech start-ups, for instance, when considering the coordination between private and public activities, the speed at which complementary resources are developed by both sectors for innovation, as well as the timing of their interaction during the intertwined innovation process, are important factors to consider (Mattsson & Andersson, 2019).

Overall, a company's social network plays a crucial role in shaping its innovativeness, entrepreneur attitudes and co-creation tendency. The diversity of network ties, the strength of ties, and the network structure all contribute to the flow of knowledge, collaboration, and access to external resources necessary for innovation. By cultivating a social network that promotes information exchange,

collaboration, and diverse perspectives, companies can enhance their ability to generate and implement innovative ideas.

Based on the abovementioned reasoning, the following sub-hypotheses are presented.

H2g: Social network is positively related to the EdTech start-ups' innovativeness.

H2h: Social network is positively related to the EdTech start-ups' entrepreneurial attitudes.

H2i: Social network is positively related to the EdTech start-ups' co-creation.

3.3 Absorptive Capacity moderating Entrepreneurship Capability in a Company

According to various studies in the field of knowledge management, knowledge is typically composed of explicit and tacit components (Lang, 2004). When knowledge is exchanged between individuals or organisations, there is a possibility of knowledge spillover, where knowledge unintentionally leaks and benefits other firms. This spillover of knowledge can contribute to the innovation processes of other companies. Different types of knowledge, such as information about innovative products developed by competitors, patent data, and insights gained from product display exhibitions, can potentially spill over and be utilized by other firms. Innovation and technology companies have the intension to utilize external sources of innovation as the bridge to transfer innovative technologies and increase internal innovation ability (Yam *et al.*, 2004).

Absorptive capacity enables the firm to access both local as well as distant sources of knowledge (Li *et al.*, 2013). The absorptive capacity of start-ups refers to their ability to recognize, assimilate, and apply external knowledge. Cohen and Levinthal (1990)'s concept of absorptive capacity highlights the importance of a firm's ability to recognize, assimilate, and exploit external knowledge in order to enhance its innovation capability. For the start-up venture founders start to source or develop new resources to facilitate their business to go into the market or to level up their market competitive barriers, they have to have the capability to understand the hard core types and configurations of resources that the opportunities call for (West *et al*., 2009). By actively seeking and effectively integrating external knowledge, firms can strengthen their innovation processes and remain competitive in dynamic and changing environments via the processes for better equipped to access and make use of knowledge obtained from external sources, such as collaborations with other organizations, participation in industry networks, or engagement with research institutions. Liu, Hu, & Kang (2021) examined the impact of formal technology transfer on the innovation performance of firms. They found that formal technology transfer can help to increase a firm's innovation output, as it provides access to new knowledge and expertise. Additionally, they found that formal technology

transfer can help to increase a firm's absorptive capacity, which is the ability to identify, assimilate, and apply new knowledge.

Research on the moderating effect of absorptive capacity is helpful in promoting the transformation of enterprise interaction to innovation capability. Internally, firms can foster innovation by investing in research and development efforts conducted by their own staff. These internal processes can generate valuable knowledge and contribute to the firm's innovation capability. External knowledge sources play a crucial role in complementing and enhancing internal capabilities. External knowledge refers to knowledge that exists outside the boundaries of the firm, including knowledge generated by other companies, research institutions, customers, suppliers, and industry experts. (Fan *et al*., 2023). While firms can generate new technological knowledge internally through their R&D staff and related activities, the innovation process often relies on external knowledge sources, as highlighted by Pierce and Delbecq (1977).

Absorptive capacity has a significant positive impact on innovation performance and the innovative culture of a company (Liu *et al*., 2021). For start-ups and SMEs, it is crucial to recruit an adequate competency of R&D in order to tap into new external knowledge through external networks. The gathering of knowledge resources, intellectual capital, and knowledge management skills at the initial stages of a start-up venture is crucial for its long-term sustainability. Founders and top management team, through their unique experiences and domain skillsets, acquire a wealth of knowledge or intellectual capital. This distinctive accumulation of knowledge gives the founders a unique perspective on market opportunities, something that cannot be easily replicated or seized by potential competitors. This specialized knowledge provides a competitive edge and helps shape the venture's unique business approach, essentially setting it apart in the industry (Hussinki, 2017; West *et al*., 2009). It also aids in anticipating industry trends, understanding customer behaviours, and responding to market dynamics effectively. Moreover, this accumulated knowledge forms a strong foundation upon which the business can grow and prosper. It helps create robust strategies for the venture's growth and make informed decisions about scaling up operations or venturing into new markets. In essence, the unique insights gained from the founders' accumulated knowledge not only contribute to the venture's initial success but also ensure its sustainability in the long run. This is because such knowledge forms an invaluable resource that can't be easily duplicated or taken over by others, thereby providing a lasting competitive advantage (West *et al*., 2009).

Thus, if the companies possess a high absorptive capacity, which is reflected in having a sufficient competency scale for R&D, they can effectively absorb new knowledge shared through inter-organizational networks. In this context, knowledge sharing becomes beneficial for enhancing their

technology innovation capability. In contrast, if the companies lack the absorptive capacity, indicated by a shortage of competency for R&D, needed to effectively absorb external knowledge, the impact of inter-organizational knowledge sharing on improving their technology innovation capability becomes questionable. This is specially crucial for the EdTech industry because start-ups have to get used to the public-private interaction, revealing tensions between the private actors' business model and the public actors' services provision model (Mattsson & Andersson, 2019). Consequently, the effectiveness of knowledge capital in enhancing the start-up's entrepreneurship capability is contingent on the firm's level of absorptive capacity. Building upon the aforementioned insights, we propose the following hypothesis.

H3: The effect of knowledge capital on an EdTech start-up's entrepreneurship capability is positively moderated by the start-up's absorptive capacity.

The following sub-hypotheses are also presented:

H3a: The effect of technological value on an EdTech start-up's innovativeness is positively moderated by the start-up's absorptive capacity.

H3b: The effect of technological value on an EdTech start-up's entrepreneurial attitudes is positively moderated by the start-up's absorptive capacity.

H3c: The effect of technological value on an EdTech start-up's co-creation is positively moderated by the start-up's absorptive capacity.

H3d: The effect of education value on an EdTech start-up's innovativeness is positively moderated by the start-up's absorptive capacity.

H3e: The effect of education value on an EdTech start-up's entrepreneurial attitudes is positively moderated by the start-up's absorptive capacity.

H3f: The effect of education value on an EdTech start-up's co-creation is positively moderated by the start-up's absorptive capacity.

H3g: The effect of social network on an EdTech start-up's innovativeness is positively moderated by the start-up's absorptive capacity.

H3h: The effect of social network on an EdTech start-up's entrepreneurial attitudes is positively moderated by the start-up's absorptive capacity.

H3i: The effect of social network on an EdTech start-up's co-creation is positively moderated by the start-up's absorptive capacity.

3.4 Research Model

Figure 4B below presents the proposed model of technology transfer in university, knowledge capital, entrepreneurship capability and absorptive capability. We use the model to understand the technology transfer activities in universities, the knowledge capital of EdTech start-ups, and how they influence the start-ups' entrepreneurship capability. Technology transfer activities happen in universities. EdTech startups make use of the activities to acquire necessary knowledge, information and resources in other forms to build up their knowledge capital and then utilize them as value in entrepreneurship capability. Absorptive capability is described and studied as the moderating variable.

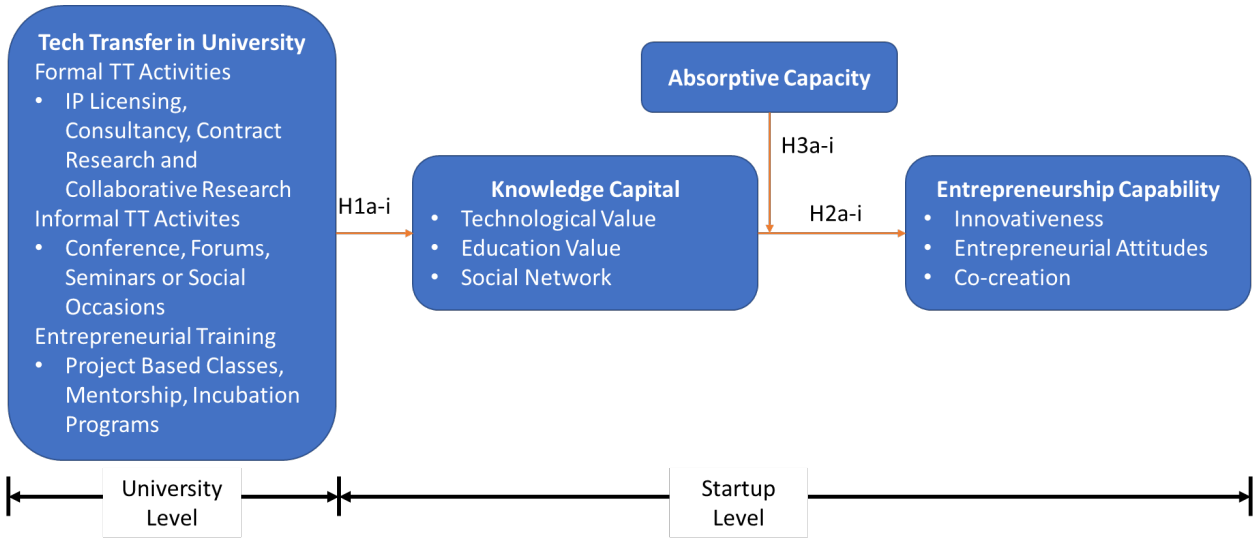


Figure 3B: Research Model Including Hypotheses

The study investigates how technology transfer in universities affects the entrepreneurship capability of start-ups in the EdTech industry in Hong Kong. It argues that technology transfer in universities indirectly influences entrepreneurship capability via the EdTech start-ups' knowledge capital. The three hypotheses are listed as follows:

H1: Technology Transfer from University activities is positively related to the EdTech start-ups' knowledge capital.

H2: EdTech start-ups' knowledge capital is positively related to their entrepreneurship capability.

H3: The effect of knowledge capital on an EdTech start-up's entrepreneurship capability is positively moderated by the start-up's absorptive capacity.

Chapter 4. Methodology

This study aims to investigate the contribution of university knowledge to business innovation capability via building up the knowledge capital of an EdTech start-up. It adopts a two-step approach: in-depth interview and quantitative survey.

Entrepreneurship is a multifaceted process, shaped in part by its context and purpose and influenced by a multitude of other factors. Given its complexity, it is beneficial to dedicate significant time to deeply understand the specifics of start-ups and their ecosystem. This understanding can be effectively achieved through qualitative research, which allows for an in-depth exploration of the varying dynamics and intricacies that define the entrepreneurial landscape in a given context (Miller, 2011). In the initial phase, an exploratory research design was employed to gain a deeper understanding of the business factors and refine the conceptual framework. This involved conducting in-depth interviews with industry practitioners, experienced professionals, and academia. The insights gathered from these interviews provided initial support fidelity for the proposed conceptual framework and research instrument (Onwuegbuzie, *et al.,* 2010).

Moving on to the second stage, a confirmatory research design was adopted, and survey data was collected to empirically test the hypotheses derived from the conceptual framework. The data for the survey was obtained through online questionnaires answered by EdTech start-ups' management. The research model, including the formulated hypotheses, was analyzed using a quantitative research methodology to further examine and evaluate the studies in a comprehensive analytical setting (Fetters *et al.,* 2013).

The results obtained from testing the hypotheses have important managerial implications. By scrutinizing the statistical analyses, valuable insights can be drawn regarding the relationships and effects proposed in the research model. These insights can offer guidance to managers and decision-makers in understanding the impact of various factors on business performance, strategy formulation, or innovation processes.

4.1 Research Design

The conceptual research framework is preliminarily designed based on literature and personal expertise in the field. The resulting survey instrument, a questionnaire, will be evaluated with the consultation of industrial practitioners. We will invite five senior practitioners of the EdTech industry to conduct in-depth interviews, which aim to validate the research design and conceptual framework structure. The survey instrument will be refined. The later step will involve a quantitative survey to collect primary research data from EdTech start-ups or new entries to the EdTech industry in Hong

Kong. We target to invite 200 companies, which are mostly incubating start-ups in the Hong Kong Science Park, the Hong Kong Cyberport or supported by entrepreneurship development schemes of local universities. So, the pool of respondents has a similar knowledge background. We collected real-time survey data in the network (Wesley II *et al.*, 2022). A pre-test will be carried out with 10 EdTech start-ups to check the clarity, appropriateness, and reliability of the survey instrument. In the main research, we expect 100 out of the 200 companies will respond to the survey. The data collected will be used to test the hypotheses under a quantitative research approach. Managerial and practical implications will be drawn from the results.

The study is cross-sectional research to investigate the correlations between university knowledge and the business innovation capability of an EdTech start-up mediated by the knowledge capital and moderated by the absorptive capability. This will provide a holistic view of various variables in a single time point. The business innovation capability is the dependent variable of the conceptual research model. The company level is the unit of analysis.

A sequential exploratory mixed method design is adopted to ensure the quality of the data collected. Mixed methods research offers powerful tools for investigating complex processes and systems, draws upon the strengths of quantitative and qualitative approaches, and provides an innovative approach for addressing contemporary issues in complex, multi-level industries (Fetters *et al.,* 2013). In an exploratory sequential design, the researcher first generates a hypothesis concerning the research issues, then collects and analyzes qualitative data to initially test the hypothesis and research framework, and these findings inform subsequent quantitative data collection (Onwuegbuzie *et al.,* 2010; Fetters *et al.,* 2013).

4.2 Sample, Data Collection and Analysis

The study targets EdTech start-ups in Hong Kong. All the samples must be in the education technology industry and started their business in the field with no longer than five years. The number of full-time employees is not expected to be over 50 people. The figures provided by the Hong Kong Science and Technology Park Corporate and the Hong Kong Cyberport Management Company Limited indicate that there are a total of about 200 EdTech start-ups in Hong Kong, while most of them are incubating in the Park sites (Tracxn, 2023; Esperanza *et al*., 2022; Wong, 2021). The Education University of Hong Kong is another major incubator of EdTech ventures. They are nurturing about 20~30 social enterprises each year, half of which are in the EdTech field (The Education University of Hong Kong, 2022).

Top management of the EdTech start-ups will be invited as the respondents in the main round of research. At the beginning, it is the top management that first identifies an entrepreneurial

opportunity and makes the decision to pursue it in a new business venture. This person must then proceed to establish the initial vision and objectives for the emerging companies. It is crucial that this individual effectively persuades others to embrace his or her vision and become partners, employees, investors, suppliers, consumers, and so forth in the industry environments (Enslev. *et al.*, 2006; Hmieleski *et al*., 2007). They are founders, co-founders, chief executive officers, chief technology officers, chief education officers, research directors, and key managers who have solid involvement in the operation, strategic planning, research, product development and decision-making of the ventures. They empower their teams to be self-rewarded, self-led, self-motivated, and self-developed towards opportunity thinking and participative goal setting (Hmieleski *et al*., 2007). More importantly, they have an obligation to develop new technology and innovation and influence their employees to buy into their dreams and develop the ventures together (Enslev. *et al.*, 2006; Passaro *et al.*, 2020).

In the second stage of this study, an online questionnaire survey was conducted to gather information about the EdTech start-ups in Hong Kong. Mail, email, or social media invitations will be sent to the targeted companies to explain the objective of the study and provide the path to access the online survey. The research findings will be shared with the respondents, whose identifications will be kept confidential.

EdTech startups in Hong Kong are the target samples of this study. The market statistics indicate that there were about 200 EdTech startups in the Hong Kong market (Tracxn, 2023; Esperanza *et al*., 2022; Wong, 2021). One hundred and ninety-three of them were in the business network of the researcher, who is one of the most well-connected professional executives in the field. Therefore, this group of 193 EdTech startups is very similar to the whole population of EdTech startups in Hong Kong and can be considered a representative sampling frame. The researcher sent research invitations and questionnaires to all these 193 EdTech startups. The invited startups covered in-park companies in the Hong Kong Science Park and Hong Kong Cyberport and the incubating companies of local universities. A total of 93 startups agreed to participate in the research and returned their questionnaire survey. The response rate was 48.19%. This study had a specific sampling frame, and the target samples were from a specific niche of industries. Simple random sampling is best used under such a sampling frame that the target population is accurately defined and easily accessible (Saunders *et al.*, 2019). Simple random sampling ensures that every person in the population has an equal probability of being chosen as a response, eliminating bias. This sampling method also fits the study's cost consideration. However, it is also prone to sampling error, involves a cumbersome process, and poses challenges when dealing with diverse and widely scattered populations (Noor *et al*., 2022).

The entrepreneurs received a direct invitation to participate in the study. To a certain extent, the snowball approach was also adopted because the invitation encouraged recipients to disseminate the invitation further. This aimed to eliminate the un-reached population sharing the same specific characteristics and relevant professionals, i.e. entrepreneurs in EdTech (Saunders *et al.*, 2019).

This study attempts to clarify the relationship between university technology transfer activities and entrepreneurship capability mediated by knowledge capital and moderated by the absorptive capacity of the EdTech start-up. Hypotheses are formulated to investigate the connections between the relevant constructs, which are then tested using survey data through statistical analysis. A research instrument is developed to measure these constructs accurately. The survey approach utilized in this study focuses on quantitative analysis to explore the relationships between variables. To gather the necessary data, online self-administered surveys were conducted within a targeted group of EdTech start-ups. This approach allowed for direct engagement with the participants, ensuring accurate and reliable responses. The survey participants were selected from a representative sample of EdTech companies, providing a comprehensive understanding of the relationships between variables specifically within the Hong Kong local universities and EdTech industries.

The collected data will be analysed with the statistical program R software to assess the reliability and validity of the constructs - Factor loading, Cronbach's α, and Composite reliability.

4.3 Measurement Items

In this study, the constructs and underlying variables outlined in *Figure 4A* of the research conceptual model will be measured. Notably, the focus is on the entrepreneurship capability of EdTech start-ups in Hong Kong, which is considered the dependent variable in the research model. Consequently, it is necessary to adopt a company-level unit of study and analysis.

To capture a snapshot of the population at a single point in time, a cross-sectional approach was chosen for this study. This approach offers practicality and directness in examining multiple variables simultaneously. By collecting data from different companies within the EdTech sector in Hong Kong, researchers can gain insights into the entrepreneurship capability and related factors within this specific context.

However, it's important to note that a cross-sectional study design has limitations. It primarily provides a snapshot of the current state of affairs and does not consider the temporal sequence of events. As a result, it may not provide definitive information about cause-and-effect relationships or account for what occurs before or after the data collection point (Wolf 2011; Creswell *et al.*, 2018).

Future research with longitudinal or experimental designs could explore these dynamics in greater depth.

By carefully selecting the unit of analysis and applying a cross-sectional approach, this study aims to provide valuable insights into the entrepreneurship capability of EdTech start-ups in Hong Kong. While the limitations of the chosen approach should be acknowledged, the findings can contribute to a better understanding of the factors influencing entrepreneurial success in the EdTech industry. The survey instrument will adopt a seven-point scale ranging from '1 – Strongly Disagree' to '7 – Strongly Agree'. *Table 5A* describes the measuring items in detail. Data of company size, the position of respondents, the experience of respondents will also be collected as descriptive statistics.

The OSLO Manual 2018 highlighted that evaluation in the innovation sector should encompass the quality of a venture's product, the product's market presence, the production and delivery mechanisms of the product, the business structure and operations, and the improvements brought about to the broader industries and society (OECD/Eurostat, 2018). This comprehensive measurement approach ensures that all aspects of innovation, from product development to market impact, are adequately assessed, contributing to the overall growth and advancement of the industry and society at large. We adopt from Martínez-Cañas *et al*. 2012 that *Technology Transfer in University measures Formal Technology Transfer Activities - IP Licensing, Consultancy, Contract Research and Collaborative Research* and *Informal Technology Transfer Activities – Conferences, Forums, Seminars or Social Occasions*. These two measures influence start-ups' knowledge on education and pedagogies, technology knowhows, customer needs and market trends. Following Boh, W. F., *et al.* 2015, *Entrepreneurial activities – Project Based Classes, Mentorship, Seed Fund Program, entrepreneurship classes, and Incubation Programs* are other measures for Technology Transfer at University. The four items measure the degree to which the start-up reaches useful university technologies and knowledge via entrepreneurial activities of the university; the degree to which the start-up received funding and facility support from entrepreneurial activities of the university; the degree to which the start-up obtains professional services support, such as legal, business advisory and investment, via entrepreneurial activities of the university; and the degree to which the start-up earns practical entrepreneurship knowledge via entrepreneurial activities of the university.

This study adopts technology value as a measure of *knowledge capital* from Yam *et al.,* 2004 and Liao *et al*., 2007. The items measure the degree to which the start-up regularly monitors technology development trends; the degree to which the start-up is capable of conducting in-house product development; and the degree to which the start-up has good knowledge of different market segments. Following Koehler & Mishra 2005, Niess, *et al.*, 2009, Wu *et al.*, 2011, and Chao 2020 that

knowledge capital also measures the *education value* of the EdTech start-ups. The items measure the start-ups' original pedagogies or educational practices; their capability of validating the education value of their products and services content; their capability of evaluating the quality of knowledge delivery; their capability of assessing users' receipts of knowledge and performance; and how they are capable to the creation of new learning environments. Moreover, we adopt from Martínez-Cañas, R., *et al.* 2012 that the *knowledge capital* of an EdTech start-up measures the *social network* coverage of the company. We adopt the measurement item of Martínez-Cañas *et al.* 2012 and Yli-Renko *et al.* 2002 measure the close relationship between the start-up to search for information, resources and new contacts. Yli-Renko *et al.* 2002 also measure the coverage of personal contact networks for target customers and target distribution channels. We also adopt the measures on the readiness to share knowledge externally and the accessibility for knowledge exchanges with outsiders, Li *et al*. (2013)

Bessant and Rush (1995) illustrated the capability of an organisation in the field of technology and innovation can be described as the recognition of requirements for technology through a systemic and regular audit of its current competencies and comparison of those which it needs to develop and acquired to fit the market change; exploration of the range of technological options available to get a food fit with their internal environment and needs; and the capability of selection, acquisition, implementation and operation of the technology and learning about how best to use it. Following Arend (2014) and Yam *et al*., (2004), the *entrepreneurship capability* of start-ups measures *innovativeness*. This study adopts from the two groups of scholars that *innovativeness* measures the ability of start-ups to integrate new knowledge as well as resources in product and business development. We also adopt the measure of the start-ups' accumulation of knowledge from Arend (2014) and the accessibility of the start-up to new knowledge relevant to your business from Yam *et al*., (2004). Arend (2014) and Yam *et al*., (2004) also measure *entrepreneurial attitudes* as the start-ups' *entrepreneurship capabilities*. We adopt their measures of good internal communication and coordination and timely responds to market changes/opportunities. We also follow Yam *et al*. (2004)'s measure of cross-functional teamwork within start-ups. Besides, we adopt the measures of the degree to which your start-up encourages employees to suggest ways for new lines of business and favours strong in-house R&D, technological leadership and innovation from Liu *et al.* (2020). Daniela Nuscheler *et al.* (2019) mentioned that the management team's entrepreneurship capabilities facilitate the transformation of new product introductions that help new ventures' growth. The start-up teams should have the ability to work cross-functionally so that members can fill gaps in each other in terms of their skills and experience. Following Klein *et al.* (2013), Co-creation is another measure of the start-ups' *entrepreneurship capabilities*, which covers measurement items of co-creation of new value to target customers and a new market with an external party(s).

For the moderating factor, we adopt Li *et al*. (2013)'s measures of absorption capability in terms of accurate evaluation of knowledge acquired externally; competitive advantage against competitors for acquiring knowledge for future use; ease of obtaining market information; acquisition of original and pioneering knowledge from external; and ability to lowering operation costs.

Table 4A: Measurement Items for Studying the Value of Technology Transfer on the Development of Entrepreneurship Capabilities

Constructs	**Variables**	**Measurement Items**	**Adopted from**
Technology Transfer in University There are formal and informal types of technology transfer activities, which are often linked. Formal technology transfer transfer activities are those university-industry collaborations via formally established channels and well-structured regulations. They are blended with agreements for contract services, intellectual property licensing, and the creation of new companies. Informal technology transfer activities involve collaborating, contacting, and exchanging information and knowledge among universities and companies without signing any agreement or contract. The activities promoting the creation of startups and enhancing students' entrepreneurial skills and employability are also essential activities of technology transfer (Markman *et al* 2004; Vega-Gomez *et al.*, 2021). The Cronbach's alpha of formal technology transfer and informal technology transfer (including entrepreneurship development activities) counts as 0.668 and 0.613, respectively, in a previous study (Vega-Gomez *et al.*, 2021). Other scholars classify entrepreneurial activities as a type of technology transfer activities separately from the formal and informal ones (Boh *et al*., 2015; Markman *et al.,* 2004, 2005).			
	Formal Technology Transfer Activities - IP Licensing, Consultancy, Contract Research and Collaborative Research	The degree to which your start-up obtains knowledge on education and pedagogies via formal technology transfer activities of university	Martínez-Cañas *et al*. 2012
		The degree to which your start-up obtains technological	Martínez-Cañas *et al*. 2012

		knowhow via formal technology transfer activities of university	
		The degree to which your start-up obtains information about customer needs and market trends via formal technology transfer activities of university	Martínez-Cañas *et al.* 2012
	Informal Technology Transfer Activities – Conferences, Forums, Seminars or Social Occasions	The degree to which your start-up obtains knowledge on education and pedagogies via informal technology transfer activities of university	Martínez-Cañas *et al.* 2012
		The degree to which your start-up obtains technological knowhow via informal technology transfer activities of university	Martínez-Cañas *et al.* 2012
		The degree to which your start-up obtains information about customer needs and market trends via informal technology transfer activities of university	Martínez-Cañas *et al.* 2012
	Entrepreneurial activities – Project Based Classes, Mentorship, Seed Fund Program,	The degree to which your start-up reaches useful university technologies and knowledge via entrepreneurial activities of university	Boh *et al.* 2015; Vega-Gomez *et al.*, 2021.

	entrepreneurship classes, Incubation Programs		
		The degree to which your start-up received funding and facility support from entrepreneurial activities of university	Boh *et al.* 2015
		The degree to which your start-up obtains professional services support, such as legal, business advisory and investment, via entrepreneurial activities of university	Boh *et al.* 2015
		The degree to which your start-up earns practical entrepreneurship knowledge via entrepreneurial activities of university	Boh *et al.* 2015; Vega-Gomez *et al.*, 2021
Knowledge Capital A firm's knowledge capital is dominantly associated with elements of in-house R&D capability and resource allocation capability. R&D capability pertains to a company's proficiency in combining R&D strategy, executing projects, managing project portfolios, and allocating R&D expenditures. Resource allocation capability is the firm's competence in acquiring and suitably distributing capital, expertise, and technology throughout the innovation process. The Cronbach's alpha values read 0.64-0.93 for variables of R&D capability and 0.79-0.83 for resource allocation capability in a previous study of other scholars (Yam *et al.,* 2011).			
	Technology Value	The degree to which your start-up regularly monitors technology development trends	Yam *et al.,* 2004
		The degree to which your start-up is capable of conducting in-house product development	Yam *et al.,* 2004 ; Liao *et al*., 2007

		The degree to which your start-up has good knowledge of different market segments.	Yam *et al.,* 2011
		The degree to which your start-up transfers/adopts technology into products or services.	Yam *et al.,* 2011 ; Liao *et al*., 2007
	Education Value	The start-up is with original pedagogies or educational practices	
		• We are thinking and working a lot on the pedagogies of the products or services we designing	Koehler & Mishra, 2005
		• We are thinking and working a lot on the content of the products or services we designing	Koehler & Mishra, 2005
		The start-up is capable of validating the education value of its products • We are considering how content and pedagogies influence one another	Niess *et al.*, 2009
		• We have been modifying our products' or services' content to adapt to the technology platform	Niess *et al.*, 2009
		• We have the mechanism to evaluate the quality of teaching or training	Wu *et al*., 2011

		The start-up is capable of developing new methods of assessment	
		• We are investigating new measurements of user performance	Niess *et al.*, 2009 ;
		• We are developing innovative assessment tools	Niess *et al.*, 2009 ; Chao, 2020
		The start-up is capable of creating new learning environment or experience • We are integrating technology to the development of our educational content • We are using technology as a tool for learning / training	Niess, *et al.*, 2009 ; Chao, 2020 Niess *et al.*, 2009 ; Chao, 2020
	Social Network	The degree to which your start-up has a close relationship for searching for information, resources and new contacts	Martínez-Cañas *et al.* 2012 ; Yli-Renko *et al.* 2002
		The readiness of your start-up in sharing knowledge with other firms	Li *et al*. (2013)
		The degree to which your start-up is accessible for other firms and organisations for knowledge exchange when needed	Li *et al*. (2013)
		The individual contact networks of your start-up cover your target customers	Yli-Renko *et al.* 2002

		The individual contacts of your start-up cover your target distribution networks	Yli-Renko *et al.* 2002
Absorption Capability The absorption capability of a firm positively influences its performance. Scholars have noted that absorption capability provides advantages over competitors, including the ability to evaluate externally acquired knowledge, acquire knowledge for future use, recognize market changes and information, assess the originality and pioneering nature of external knowledge, and reduce the costs associated with adopting and implementing innovations. In a previous study conducted by other scholars, the Cronbach's alpha value for entrepreneurship capability was found to be 0.95 (Li *et al*., 2013).			
		Compared with major competitors, your start-up can accurately evaluate knowledge that is acquired externally	Li *et al*. (2013)
		Compared with major competitors, your start-up has a stronger ability to acquired knowledge for future use	Li *et al*. (2013)
		Compared with major competitors, your start-up can easily obtain market information	Li *et al*. (2013)
		Compared with major competitors, your start-up has acquired original and pioneering knowledge from external	Li *et al*. (2013)
		Compared with major competitors, your start-up has the advantage in lower the operation costs	Li *et al*. (2013)
Entrepreneurship Capability Entrepreneurship capability is a multi-variable construct that assesses a firm's competitiveness, aggressiveness, risk-taking, boldness, and other related attributes. It encompasses a startup's ability to handle competitors, the competency of its staff, the capability to enhance product or service			

lines, and its commitment to innovation development. In a previous study conducted by other scholars, the Cronbach's alpha value for entrepreneurship capability was found to be 0.923 (Arend, 2014). Scholars described co-creation partnerships raises fundamental issues about alternative means of social interaction and their interrelationship. Firms co-create as a means and outcome of efficient interest alignment, accelerate innovation and opening new markets (Klein *et al.* 2013).			
	Innovativeness	The degree to which your start-up accumulate knowledge	Arend (2014); Bessant, and Rush (1995)
		The degree to which your start-up integrates new knowledge in product and business development	Arend (2014) ; Yam *et al*., (2004)
		The degree to which your start-up integrates resources for product and business development	Arend (2014) ; Yam *et al*., (2004)
		The degree to which your start-up has good access to new knowledge relevant to your business	Yam *et al*., (2004)
	Entrepreneurial Attitudes	The degree to which your start-up encourage employee to suggest ways for new lines of business	Liu *et al.*, (2020)
		The degree to which your start-up has good communication and coordination	Arend (2014) ; Yam *et al*., (2004)
		The degree to which your start-up has a cross-functional teamwork	Yam *et al*., (2004) ; Daniela Nuscheler, *et al.*, (2019)
		The degree to which your start-up timely responds to market opportunities	Arend (2014); Yam *et al*., 2004
		The degree to which your start-up favor strong in-house R&D,	Liu *et al.*, (2020)

		technological leadership and innovation	
	Co-creation	The degree to which your start-up co-create new value with external party(s) to your target customers.	Klein *et al.* (2013)
		The degree to which your start-up co-create new market with external party(s)	Klein *et al.* (2013)

4.4 Pilot Studies and Design of Research Instrument

An initial survey was formed mostly based on the literature. An industry veteran well versed in EdTech innovations and five industry practitioners were consulted to improve the survey instrument and ensure a high level of content validity. The modified survey was sent to some EdTech start-ups for their comments. The survey was dispatched to about three hundred EdTech start-ups via the researcher's professional network.

This study adopted the sequential exploratory mixed method of research design to enrich the study's depth as well as breadth of understanding and widen the spectrum of viewpoints. Scholars described the most straightforward mixed method is the exploratory design in the meaning that the different types of data are collected in two separate phases and each type is collected one at a time (Kettles *et al*., 2011). The qualitative study was used for hypothesis generation and the quantitative step was adopted for hypothesis testing that mixed methods enable the researcher better to simultaneously answer a combination of exploratory and confirmatory questions (Lund, 2012). Within this sequential exploratory mixed method design, a literature search followed by a framework analysis of the conceptual research model using the qualitative data was conducted (Wess *et al*., 2022). The researcher searched literature on how knowledge transfer activities in universities and research institutes inform the advancement of technology start-ups and the development of the emerging EdTech industry. The research framework presented as the conceptual model was explored in a qualitative interview study of EdTech practicians. Then, the intermediate data and analysis were converted into a questionnaire as the research instrument for the final third phase, where quantitative data was collected and analysed (Creswell & Creswell, 2018). Approximately one hundred EdTech start-ups participated in the quantitative part of the study.

Chapter 5. Analysis and Results

5.1 Sequential Qualitative Analysis

This study was a sequential exploratory mixed-method analysis. Research interviews were conducted with five EdTech start-ups actively involved in technology transfer collaborations with universities. For each EdTech start-up, we provided a brief profile description, type of technology transfer collaborations with universities, and sector of business in Table 5A.

The qualitative part of studies identifies previously unknown issues and explores the range of their effects. The qualitative part of this study aimed to validate and inform the development of the survey instrument, which was an integration of several scholars' previous studies (Creswell *et al.*, 2011). Other scholars' studies proved the constructs and correlation of university-industry technology transfer, firms' knowledge capital and entrepreneurship capability with the moderating effect of their absorptive capability in other traditional deep tech fields. This qualitative part of the study verified the applicability of similar models and our hypothesized relationships among the startups in the EdTech industry in Hong Kong.

All five participants in the in-depth interviews were experienced practitioners from various EdTech start-ups, with extensive involvement in multiple technology transfer collaborations with universities. These individuals hailed from diverse backgrounds, including business executives, research team members, faculty members, university teaching staff, and serial education entrepreneurs. Their academic qualifications were equally diverse, ranging from doctorate degrees in science and technology to postgraduate degrees in business and education and undergraduate degrees in language and music teaching. Their business sectors and products spanned a broad spectrum of EdTech aspects. Start-up A specialized in creating electronic devices designed to serve as teaching and learning tools. These tools were specifically aimed at assessing and monitoring the performance of students with special educational needs. The development of these products was the result of collaborative translational research with universities, backed by funding amounting to millions of Hong Kong dollars. The project team was comprised of experts from various fields, including engineering technology, computing programming, special education, and product design. This start-up represented the commercialization of the outcomes of the translational research, manifesting as a real-world venture in the business sector. Start-up B developed a system that integrates artificial intelligence and the Internet of Things to support self-regulated learning for students with special educational needs, both at home and in schools. The system enables parents and teachers to develop individualized education plans for each student, complete with performance assessments and comprehensive lifelong learning records stored in the cloud. This start-up exemplifies the

transformation of conventional education centers into EdTech ventures. The development of Start-up B's system resulted from collaborative research with a Hong Kong research institute, followed by a series of research and development partnerships with universities for system refinements and implementations. Start-up C's product originated from a prototype developed by a university teaching staff member for use in his own lessons. This product is a blockchain-based learning management and student reward system. The project received substantial funding, amounting to millions of Hong Kong dollars, which supported its widespread application in university and school classrooms. Eventually, the teaching staff member decided to establish a start-up to commercialize the project. Start-up D's product is a music education and learning mobile app that operates in tandem with a patented music notation system to offer a platform for music learning and playing. As a gamification and edutainment solution for music teaching and learning, this product significantly reduces barriers for learners in terms of technical know-how, skills, and economic factors. Learners can play music without understanding traditional music notation or mastering physical musical instruments, thereby providing equal opportunities for people of diverse backgrounds to learn, experience, and enjoy music. One of the original project team members commercialized the intellectual properties of the research project by entering into a licensing agreement with the university. The founder of Start-up E is a serial education entrepreneur specializing in the field of language study. This start-up represents a new extension of the founder's original education business, transitioning from traditional face-to-face teaching to an AI and EdTech-based online learning platform. In response to the constraints imposed by the COVID-19 pandemic, this start-up launched an online lesson streaming platform that connects students with foreign teachers. Additionally, the start-up offers an AI-empowered platform that recommends academic programs to students based on their input information. In essence, this platform serves as a valuable tool for students looking to identify overseas institutions and academic programs that align with their individual needs and goals.

The founders of the five start-ups involved in the initial phase of this study came from a diverse array of backgrounds. Each brought unique levels of professionalism, expertise, and experience to their ventures at the time of establishment. Despite their varied backgrounds, they all shared one common experience: they all participated in incubation programs either at universities or in incubation parks within Hong Kong. Out of the five start-ups, four were heavily involved in all facets of the universities' tech-transfer activities. This included not only formal technology transfer activities but also informal ones. These could range from structured workshops and seminars to casual discussions and brainstorming sessions. In addition to these, these four start-ups also participated in the universities' entrepreneurial training activities. These activities are designed to equip start-up founders with the necessary skills, knowledge, and mindset to successfully run and grow their

businesses. In conclusion, the founders' diverse backgrounds and the start-ups' active involvement in a wide range of technology transfer and entrepreneurial training activities at universities have contributed to their growth and success.

The major questions used in the in-depth personal interviews are:

i. Please give a brief introduction of your startup.
ii. What kind of collaboration did you have with universities?
iii. Apart from what you experienced, what else do you want universities can help your business?
iv. When you are going to develop/advance your products, what is your first step?
v. How do you enhance the technology value of your products?
vi. How do you validate the educational performance of your products?
vii. How do social networks contribute to the development of your business?
viii. How do knowledge/technology capabilities and entrepreneurship mindset affect your business, respectively?
ix. What does the term "Co-creation" mean to your business?
x. What are the challenges for your company to adopt new knowledge and information from this fast changing world?

From in-depth interviews with these start-ups, we gained insights into how they engaged with and sought support from technology transfer activities within universities. We also learned how they were able to build and enhance their knowledge capital, and how this knowledge capital influenced the establishment and development of their entrepreneurial capabilities. Through comprehensive interviews conducted with the five start-ups, we gained valuable insights into their involvement in technology transfer activities in universities, and how they sought valuable resources during the collaborations tangibly and intangibly. These activities could range from formal business agreements, deals and investments, towards the informal side of attending and conducting workshops and seminars to business team matching, brainstorming sessions, and discussions. Unlike established, large-scale corporations, start-ups, and SMEs often require sustained partnerships and a series of collaborations. These collaborations often involve more intimate involvement in various aspects, such as product development, project implementation, and strategic planning. This close cooperation is typically more critical for smaller organizations, as it can provide the support and resources necessary for them to grow and thrive (Bessant and Rush, 1995). In the agreement types of collaborations, start-ups mentioned,

> "*We can have an enterprise with the professors and work more closely together so that we can turn our research into a profitable venture that will have a significant positive impact on society…*", "*We negotiated the equipment rental model with the supplier, under the name of this collaborative research project, which was similar to payment by instalments. This significantly reduced the financial pressure of the project…*"

and

> "*We outsource some of the work to the universities in some cooperations and form a trilateral collaboration…*".

Through these activities, the start-ups were provided with the platform, opportunities and interpersonal connections for acquiring new knowhow, technologies, skills, or market information that could be implementable in their daily operation and business developments. Scholars described technological competence, which refers to the package of technological resources, skill and experience, as the internal value that supports the business with a source of distinctive competitiveness edges both at the level of the company but also aggregating to the advancement of an industry (Bessant and Rush, 1995). Some examples captured by the interviewed start-ups about advancing their knowledge frontier included utilising unique expertise in the teams –

> "*There was a professor in the field of chip development. The professor in HKUST was one of the top three experts in Hong Kong on radio frequency applications…*"

and

> "*We paid the universities to hire professors on a contract basis, and we collaborated on research projects together, and the universities also hired/employed us to work for them…*".

In terms of keeping up to date with the market information, some points mentioned by the start-ups were

> "*KT Office once suggested that I attend a weekend seminar…*"

and

> "*I agree KT Office is good… offering various opportunities for knowledge exchange…*".

Most of the start-ups that took part in the in-depth interview described the technology transfer collaboration with universities advanced their ventures in terms of reaching new funding resources, for instance,

> "*We invested HK$3 million to match another HK$3 million from the Hong Kong government…*",
>
> "*We get the grant via the university to develop prototypes of three technology products…*"

and

> "*We get new money via KT Office, which goes toward helping us teach and acquire instruments…*".

Another common comment heard from the five start-ups was that knowledge transfer offices or technology transfer offices in universities were valuable and supportive in their development of entrepreneurial journeys. The OSLO Manual 2018 indicated that the goals and results that shape a venture's business structure encapsulate the impact of business and innovation processes on its abilities. On the one hand, some of these impacts can enhance the venture's capabilities in assimilating, processing, and examining knowledge and technology. On the other hand, others can affect the company's adaptability to marketplace changes and technological evolution to improve working conditions and ensure the company's sustainability (OECD/Eurostat, 2018). The technology transfer activities in universities thereby strengthen their knowledge capital.

Knowledge capital, which includes the skills, knowledge, and expertise within an organization, is a valuable asset for any start-up. Knowledge capital, also known as intellectual capital, of a new venture, refers to the intangible value of an organization's collective knowledge, expertise, proprietary technologies, and information. It's an essential asset for a new venture and can often be a key differentiator in competitive markets for firm performance and value creation (West *et al*., 2009; Hussinki *et al*., 2011). The strategies and subsequent performance of a new venture are fundamentally rooted in the knowledge capital the company possesses about its target market. Understanding the opportunities available within that market, as well as the best approach to seize these opportunities, are crucial factors. Therefore, a firm's market insights, identification of opportunities, and strategic planning to leverage those opportunities significantly influence its overall performance (West *et al*., 2009). There are various ways these start-ups underwent to build and strengthen their knowledge capital. Some did it through getting connected with and absorbing talented individuals from university collaborations, others through continuous learning and training, for instance, and some through active participation in research projects and collaboration with universities. Regarding the advancement of their technology value, the interviewed start-ups mentioned,

> "*The collaborative research projects enabled us to build an interdisciplinary team, so we can leverage on each one's expertise to cover the works which are elementary to the final products…*",
>
> "*Specific professors plan and develop the product for various categories…*"

and

> "*We were fortunate to meet a very talented team who helped us develop some products to aid our students in participating in these hard science classes*".

Apart from the technology value, education value is another crucial knowledge element for EdTech businesses. The start-ups described in the interview,

> "*A professional in special education, advised to have a device assisting her students. Eventually, the team came up with the proposals on developing a tuneable headset for children with special educational…*",
>
> "*With the education experts, the product can be developed better. Without them, the technical people wouldn't know how to get the opinions and support of teachers…*",
>
> "*For educational elements, when we promote our product to non-governmental organizations, professors would join us to explain the products to our clients, including schools or users in the education fields, on how the product may benefit or support them…*"

All the conversations with five start-ups in the in-depth interview also reflected the importance and influence of social network in their ventures, for instance

> "*Collaborations with universities give us more opportunities to connect with NGOs that are hard to reach or are not in our network before…*",
>
> "*Universities could help us get in touch with such organizations and search for opportunities to collaborate…*",
>
> "*At that time, one developer introduced me to another developer…* ",
>
> "*Customers will have developed a trust in us as a result of our high social engagement…*"

and

> "*Experience and relationships were the key benefits to my company. It opened up more follow up research collaboration between us, and new opportunities…*"

In the initial stage of the ventures, the knowledge is deemed to be critical for them to understand the industry where the ventures are set to compete, to set the business approach that the ventures plan to adopt and to revolve around the creation, development and harvesting of new ventures or business functions (West *et al*., 2009). The knowledge can significantly increase the chances of a start-up's success, as it provides the fundamental insights and skills required to navigate the complex landscape of entrepreneurship (Hussinki *et al*., 2011).

Moreover, we explored how their accumulated knowledge capital influenced the establishment and enhancement of their entrepreneurial capabilities. This could be seen in their ability to identify and seize opportunities, innovate, make strategic decisions, manage resources, and navigate through challenges and risks. Companies set themselves apart from their competitors in the market not just through their knowledge and technological competence but also through their ability to be innovative. This innovation stems from their capacity to absorb and assimilate new inputs of technology and innovative ideas. Therefore, a company's competitive edge is not only determined by what it already knows or the technology it currently possesses but also by how effectively it can integrate and apply new technological and innovative inputs. (Bessant and Rush, 1995). The five start-ups interviewed in the study explained how they built up their ability of innovativeness. Some of their points were:

> "*a closer communication and regular progress review among the commercial side and academic side would help bridge the gap in between both sides' expectations*…",
>
> "*My start-up was created and is being developed through collaboration because our team lacks the knowledge and expertise to do it internally*…",
>
> "*This collaboration opened the window for us to leverage engineers in the university to finetune the detail technological specifications and settings, and understand the application environment in special education and rehab science*…",
>
> "*The entire technological foundation and backdrop are related to working together with outsourcing businesses to complete the project*…",
>
> "*if there's no education team to help them sell and secure resources, then the tech team won't have resources to develop new technologies, so it's a team effort*…",
>
> "*I work on music and my partner does engineering*…",

and

> "*Our staff has been working very hard to keep up with the most recent technological developments*…"

In the aspects of the entrepreneurial attitude of the start-ups, the interviewees said,

> "*I changed my role from engineer, technical design to business operation…*",
>
> "*A start-up needs to have a solid idea, a team to carry it out, and the ability to clearly communicate and oversee the entire process…*",
>
> "*A in-house technical person keeps meeting with companies, especially leading ones, to learn about both their offers and their needs. He/she gets information of the market trend as well as the data sheets from the market leaders…*",
>
> "*It's hard to bring a team together because it requires the combination of resources and partners from all sides to work together, and my job is to unite the team and keep moving forward…*",
>
> "*Our staff has been working very hard to keep up with the most recent technological developments…*"

and

> "*I seldom do marketing research on only one stakeholders. I would usually do both sides, which is factual statistics market research, separate to qualitative or quantitative research...*".

Co-creation is an important dimension introduced in the entrepreneurship capability of start-ups (Klein *et al.*, 2013). SMEs and start-ups often lacked the technological, technical, and managerial capability to get reach to the new and risky, as well as the conventional and robust fields (Bessant & Rush, 1995). From the five EdTech start-ups, we heard in the dialogues how importance is co-creation in their business, product development and operational breakthrough:

> "*You are certain of the project's goals, but you might not have the team to achieve it, so you manage the outside team through a contract…*",
>
> "*When we had the ideas, we sought outside assistance and consulted with various firms to complete the project…*",
>
> "*There are three different types of connections, including university teachers and middle school teachers, which is a very important group because we are teachers. Then there are teachers who help guide our product, help us do research, and make people believe that our product is valuable…*",
>
> "*I would have a group of students and parents, teachers and principals that I could discuss with them about my ideas of developing a new product…*",

> "*Since I know I have to create a product prototype, test the market, and produce the item, I normally outsource the initial stages of these tasks in order to reduce costs and increase profits…*"

and

> "*Co-creation led to developing the required technology with a well discounted cost…*"
>
> "*We should always do the right thing with the right people at the right moment…We have no control over environmental conditions but do have control over how we approach problems, how disciplined we are, and how we think…*",

an interviewed start-up representative described. In essence, the richer the knowledge capital, the stronger their entrepreneurial capability, which is crucial for the survival, growth, and success of their start-ups.

In general, it is possible to underline that technology transfer activities in universities were critical resources for the companies' knowledge capital and entrepreneurial capability for all the interviewed starts for their establishment and development. To enter the EdTech field, the considered start-ups either brought the market with a technological product to their customers or adopted a technological tool or platform to technologise the conventional education steps. Technology, education value, team competency and market information were all important elements. The qualitative study informed that EdTech startups, like the firms in traditional technology industries, underwent and got value-added from formal technology transfer, informal technology transfer and entrepreneurship development activities in universities. It was validated that technology value and social networks are essential for EdTech startups and support the hypothesis that education value is another critical element for knowledge in EdTech startups. Innovativeness, entrepreneurial attitudes and co-creation were supported as the entrepreneurship capability of the EdTech startups, while co-creation was emphasized by all the interviewed startups as EdTech involved more than one domina knowledge. The interview results informed the hypothesized relationship and reinforced the importance of co-creation and education value as measurement items in the research model. In conclusion, the interviews provided a deeper understanding of the start-ups' engagement with universities, the building and strengthening of their knowledge capital, and the impact of this knowledge capital on their entrepreneurial capability. According to the results derived from the in-depth interview, the conceptual model of the research framework was supported.

Table 5A: Descriptive data about the Interviewed EdTech Start-ups

	Brief Profile	Sector of Business	EdTech Product / Services	Founder	Technology Transfer Activities with Universities
A	EdTech Start-up A was founded by an engineer with a doctoral degree. The founding team comprised technical staff from a research institute, academic researchers, and commercial executives. The start-up was established under a multimillion-dollar translational research grant from the HKSAR government. The start-up represents the successful commercialization of the outcomes of this translational research.	Teaching and Learning Tools and Textbooks - Electronics and Computer Engineering	Electronic devices for performance assessment and monitoring	Technical profession in science and engineering with a PhD	Contract research, Collaborative research, Various Informal Technology Transfer Activities (not specified)
B	EdTech Start-up B was founded by an experienced professional executive in the field of accounting and finance. The start-up developed a distance-learning system designed to support the therapeutic learning of students with special educational needs, both at home and in schools. The system leverages artificial intelligence and the Internet of Things to assist parents and teachers in developing individualized education plans for each student.	AI for Teaching, Learning, Training and Assessment - Education Centre and Information and Communication Technology	AI and IoT systems for students with special educational needs	Experience business executive with limited technical background	Various Formal Technology Transfer Activities (not specified), Various Informal Technology Transfer Activities (not specified), Mentoring, Incubation Program
C	EdTech Start-up C was founded by a faculty member of a university. The start-up developed a blockchain-based system for managing learning profiles, which rewards and accredits learning. The project originated from a multimillion-	Learning and School Management System -	Blockchain learning management and student rewarding system	Teaching staff in a university with technical background	Various Formal Technology Transfer Activities (not specified), Various Informal Technology Transfer Activities

	dollar grant awarded to a university by the government.				(not specified), Project Based Class, Incubation Program
D	EdTech Start-up D was founded by a member of a university research project team. The start-up commercialized a music education and learning mobile app, which utilizes a patented music notation system. This app offers a music learning and playing platform that significantly lowers the entry barrier in terms of cost and technical skill, compared to traditional music learning methods.	Gamification and Edutainment Solutions – Mobile App and Cloud Computing System	Mobile app and cloud platform for music playing, learning and performance	Research project team member in a university, who involving in the development of the commercialised EdTech projects	Licensing, Collaborative Research, Various Informal Technology Transfer Activities (not specified), Mentoring, Incubation Program
E	EdTech Start-up E was founded by a serial entrepreneur in the education sector, specializing in school enrollment and study tours. Amid the COVID-19 pandemic, this start-up launched an online learning platform that connects students with foreign teachers for live streaming lessons. Additionally, it provided an artificial intelligence data platform to assist students in finding suitable schools and programs overseas.	In-School Services and Support, Nurturing Employment – AI System	Online lesson streaming platform and AI schools and programmes recommendation platform	Serial education entrepreneur, with limited technical background	Various Informal Technology Transfer Activities (not specified), Mentoring, Incubation Program

Table 5B: A Summary of the Statements of the Interviewed EdTech Start-ups

Technology Transfer in University	Knowledge Capital of the Start-up	Entrepreneurship Capability of the Start-up
1. We negotiated the equipment rental model with the supplier, under the name of this collaborative research project, which was similar to payment by instalments. This significantly reduced the financial pressure of the project… (A)	21. The team was capable of structuring all research and development works. I admitted it as the best practice on technology development…(A) 22. Experience and relationships were the key benefits to my company. It opened up more	50. I changed my role from engineer, technical design to business operation…(A) 51. a closer communication and regular progress review among the commercial side and academic side would help bridge the

2. There was a professor in the field of chip development. The professor in HKUST was one of the top three experts in Hong Kong on radio frequency applications…(A)
3. We hired several good students of his team…(A)
4. We invested HK$3 million to match another HK$3 million from the Hong Kong government... (A)
5. The contract research allowed us, the commercial party, to get access to the facilities in a reasonable price while the researchers get new materials and topics for their research…(A)
6. We paid the universities to hire professors on a contract basis, and we collaborated on research projects together, and the universities also hired/employed us to work for them…(B)
7. We outsource some of the work to the universities in some cooperations and form a trilateral collaboration…(B)
8. Collaborative research was good, good for start-ups to build up the technology profile and technological creditability in the market. It reduces the product development costs significantly, while resources are highly limited in start-ups…(A)
9. We get the grant via the university to develop prototypes of three technology products…(C)
10. I'm grateful for the support that KT Office has given us…(C)

follow up research collaboration between us, and new opportunities…(A)

23. We had no particular goals, or even ideas, about what they project should be. We opened up the discussion with researchers and experts, to collect the views from different parties to shape the project…(A)
24. A professional in special education, advised to have a device assisting her students. Eventually, the team came up with the proposals on developing a tuneable headset for children with special educational…(A)
25. It involved several academic departments in universities, involving mechanical engineering, electronics engineering and rehab science. The University provided rare, or even unique, research facilities and expertise in the city to support the project. It provided a one-stop-shop of all-round support for the technology development…(A)
26. The collaborative research projects enabled us to build an interdisciplinary team, so we can leverage on each one's expertise to cover the works which are elementary to the final products…(A)
27. The customer told the story with his/her friends and referred us. Social network developed a chain of business opportunities for the company's sustainable growth… (B)
28. Involve multi-universities in stages to enrich the spectrum of experts endorsing the project…(A)

gap in between both sides' expectations…(A)

52. This collaboration opened the window for us to leverage engineers in the university to finetune the detail technological specifications and settings, and understand the application environment in special education and rehab science…(A)
53. Our communications were very close and frequent…(A)
54. We weighed the regular connections with the academic world. This can be for regular update on technology development, and more importantly, the marketing and public relation value of the university…(A)
55. The press opportunities and international awards arranged by universities would help us opening up new markets (schools, non-government organisations) and building up the brand…(A)
56. I spent much of my time in meeting researchers in universities to explore new technologies and business opportunities…(A)
57. Co-creation led to develop the required technology with a well discounted cost…(A)
58. To educate the users, create the interest among users and work out the commercial business model for our companies…(C)
59. A in-house technical person keeps meeting with companies, especially leading ones, to learn about both their offers and their needs. He/she gets information of the market trend

11. KT Office once suggested that I attend a weekend seminar… (C)
12. I agree KT Office is good, offering various ed-tech funds and opportunities for knowledge exchange…(C)
13. We get new money via KT Office, which go toward helping us teach and acquire instruments for the Music Children Foundation, which will benefit some needy students. We will also assist with some research projects… (D)
14. We need the initial capital to pay for suppliers to update and fix the products…(D)
15. These funding made me take the initiative…(D)
16. since the open of institutions and funding schemes to support the tech start-up, there are more connections with the universities…(E)
17. Start-up founders who have experiences to share with the students about the phenomenon and give suggestions on their path and journey… (E)
18. I worked as the organising committee or secretary for the symposium or conferences held by the universities…(E)
19. The educational technology and educational companies would prefer to have more interactions and collaborations with universities…(E)
20. We can have an enterprise with the professors and work more closely together so that we can turn our research into a
29. The university partner has already covered the technical development…(A)
30. I believe that technological development has an impact on new products…(B)
31. Specific professors plan and develop the product for various categories… (B)
32. By publishing papers and gaining help by the professors in developing, the product will gain more credibility and reputation… (B)
33. For educational elements, when we promote our product to non-governmental organizations, professors would join us to explain the products to our clients, including schools or users in the education fields, on how the product may benefit or support them… (B)
34. Collaborations with universities give us more opportunities to connect with NGOs that are hard to reach or are not in our network before… (B)
35. We were fortunate to meet a very talented team who helped us develop some products to aid our students in participating in these hard science classes… (C)
36. I think a lot of good ed-tech products are developed by teaching staff… (C)
37. At that time, one developer introduced me to another developer…(C)
38. We also get a lot of support from the education sector…(C)
39. With the education experts, the product can be developed better. Without them, the as well as the data sheets from the market leaders… (A)
60. We share concepts and ideas in addition to our strengths to advance the field of interest…(B)
61. The majority of what we accomplished was working together with other units to co-develop… (B)
62. A start-up needs to have a solid idea, a team to carry it out, and the ability to clearly communicate and oversee the entire process…(B)
63. We need a team of people to assist you when you start to build the entire thing, rather than doing it alone at first…(B)
64. If we have the team to do it internally, it would be the most ideal method as we can oversee the entire process…(B)
65. You are certain on the project's goals, but you might not have the team to achieve it, so you manage the outside team through a contract… (B)
66. My start-up was created and is being developed through collaboration because our team lacks the knowledge and expertise to do it internally… (B)
67. When we had the ideas, we sought outside assistance and consulted with various firms to complete the project… (B)
68. The entire technological foundation and backdrop are related to working together with outsourcing businesses to complete the project… (B)

profitable venture that will have a significant positive impact on society…(E)	technical people wouldn't know how to get the opinions and support of teachers…(C) 40. We don't know much about marketing or accounting. If universities could offer mentorships on these topics, it would be fantastic, especially for accounting, which can be disastrous if it is out of control… 41. Universities could help us get in touch with such organizations and search for opportunities to collaborate…(D) 42. I believe that the university's branding is its most beneficial part…Second is the facilities and resources…(D) 43. A faculty member is usually a key influencer in his / her field, so when people saw his / her name or the name of the university, they knew it had to do with technology or music… (D) 44. We would never be totally satisfied about our social networks… (D) 45. If we have the support from the universities, the impact and influence we could brought out could be very significant…(E) 46. What I can do is to understand the entire user experience…(E) 47. Customers will have developed a trust in us as a result of our high social engagement…(E) 48. Regarding various funding schemes, the technological component is regarded relatively important…(E) 49. I need assistance with creating the website and on other technical aspects…(E)	69. There are three different types of connections, including university teachers and middle school teachers, which is a very important group because we are teachers. Then there are teachers who help guide our product, help us do research, and make people believe that our product is valuable… (C) 70. It's hard to bring a team together because it requires the combination of resources and partners from all sides to work together, and my job is to unite the team and keep moving forward… (C) 71. For the sustainable development of the company, the team is the most important…(C) 72. if there's no education team to help them sell and secure resources, then the tech team won't have resources to develop new technologies, so it's a team effort…(C) 73. I work on music and my partner does engineering…(D) 74. The most challenging aspect is making it possible for teachers who lack basic computer literacy to quickly pick up these abilities and pass them on to their students… (D) 75. They should have the professional knowledge necessary to know what could be implemented in schools, whether it is successful, and whether there are any issues…(D)

		76. Our staff has been working very hard to keep up with the most recent technological developments…(D) 77. A fresh norm would be how to utilise these two distinct modes in order to accomplish goals in the most practical and economical ways… (D) 78. I seldom do marketing research on only one stakeholders. I would usually do both sides, which is factual statistics market research, separate to qualitative or quantitative research...(E) 79. I would look at the foreign end user cases to search for market demands, as they are more developed in this industry…(E) 80. I would look at the market reactions when they launch this product, and see if we could made some changes and apply to local market…(E) 81. I would have a group of students and parents, teachers and principals that I could discuss with them about my ideas of developing a new product…(E) 82. We would find a balance between our end users and the market, create a prototype and to check on the reactions of the market…(E) 83. Since I know I have to create a product prototype, test the market, and produce the item, I normally outsource the initial stages of these tasks in order to reduce costs and increase profits…(E) 84. We can test the market after creating the prototype, and then I'll hire employees to work in-house…(E)

		85. I couldn't do anything myself, but I could interact with the parties involved to make sure the result was what I desired…(E) 86. Most importantly is to understand the concept and explain how the thing works out clearly…(E) 87. We should always do the right thing with the right people at the right moment…(E) 88. We have no control over environmental conditions but do have control over how we approach problems, how disciplined we are, and how we think…(E)
Remark: The (A), (B), (C), (D) and (E) after each quote indicate the corresponding interviewed startup		

5.2 Sequential Quantitative Analysis

According to Miller (2011), researchers conducting entrepreneurship studies often face challenges such as low response rates, low response numbers and limited sample size. These challenges stem from the boundaries of the target industries and the limited scope of the available sample in the market. In the comprehensive quantitative questionnaire survey conducted, a total of 93 EdTech start-ups in Hong Kong participated by responding to the survey. Each of the start-ups provided complete responses for all the 48 variables included in the questionnaire, ensuring that there were no missing values in the collected data. However, during the data review process, one set of responses was flagged as abnormal. This was due to the observation that all responses from question 3 through to question 46 were identical, a pattern that is highly unlikely in such a diverse set of variables. This uniformity suggested a potential error or anomaly in the data collection or input process. To maintain the integrity of the analysis, it was decided to exclude this potentially erroneous set of data from the overall evaluation. As a result, the number of valid data sets used in the final analysis was adjusted to 92, rather than the initial 93. This step ensured that the analysis was conducted with the most accurate and reliable data, free of any potential anomalies or inconsistencies that could skew the results.

5.2.1 Descriptive Statistics

This report outlines the characteristics of the sampled EdTech start-ups in Hong Kong. The characteristics examined include the company size of the start-up, the position of the respondent within the company, and the geographical distribution of their EdTech business operations.

As detailed in Table 5C, the majority of the sampled EdTech start-ups are relatively small in size. Only a few of the responding companies reported having more than 30 employees. This is not unusual in the start-up landscape, as top management in such companies often assume multiple roles and control all aspects of the company's operation. This allows the company to function effectively, even on a personal basis, in its early days (Davila *et al*., 2010). National and regional statistical studies provide a specific range of figures regarding the average size of start-ups, measured in terms of the number of employees. For instance, Furlan (2019) reports an average of 2.09 employees, Audretsch & Acs (1994) report an average of 9.55 employees, while Chung *et al*. (2007) report a higher average of 20.6 employees. In the context of this study, a significant majority of the respondents (72.8%) reported that their company size was smaller than 20 employees. This statistic aligns with the generally accepted notion that start-ups tend to be smaller in size, particularly in their early stages of operation.

Table 5C: Company size of the EdTech Start-ups in Hong Kong Participated in the Online Questionnaire Survey of this study

Company Size (No. of Employees)	Number of Companies (Percentage)
Over 30 People	7 (7.61%)
20 to 30 People	18 (19.56%)
10 to 20 People	19 (20.65%)
5 to 10 People	27 (29.35%)
Less than 5 People	21 (22.83%)
Total	92 (100.00%)

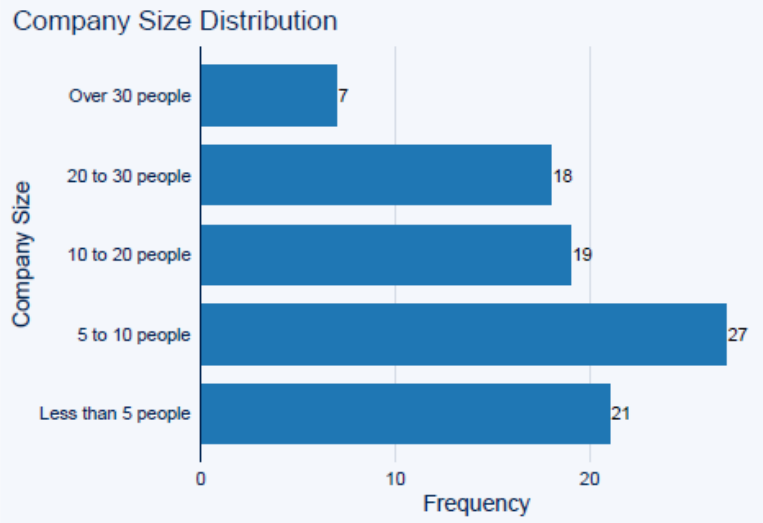
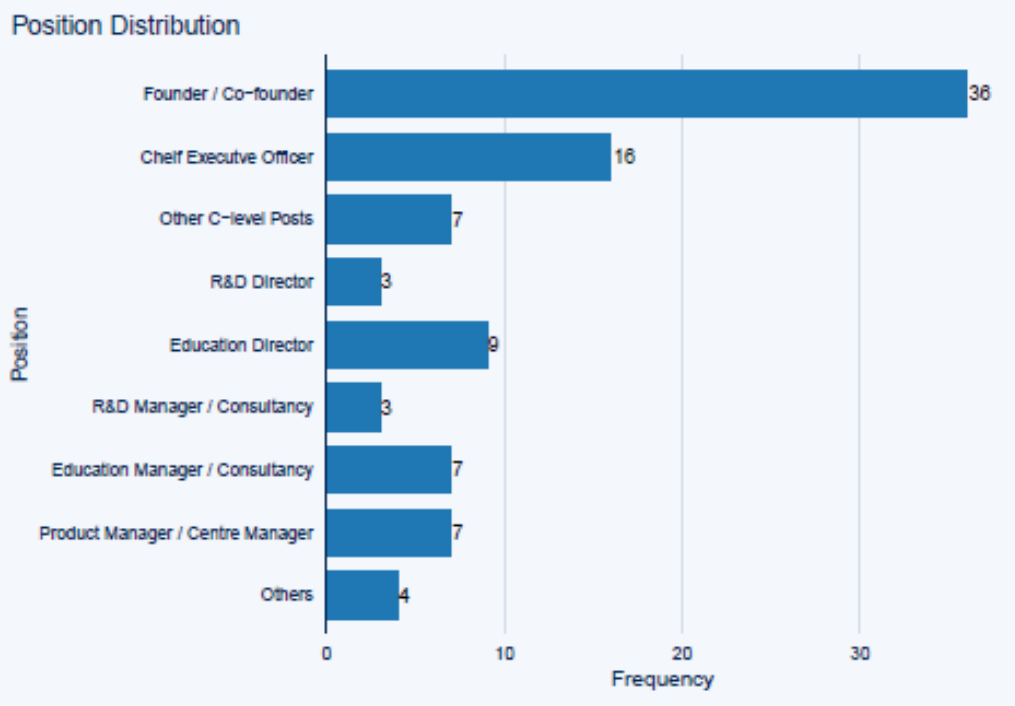


Table 5D shows that 77.17% of the respondents were in the position of director and above (including founder, co-founder, chief executive officer, chief technical officer, other C-level officers, R&D director and education director, etc.) and that the other respondents held managerial positions (including education manager, education consultancy, R&D manager, R&D consultancy, product manager, centre manager, etc.).

Table 5D: Positions of the Respondents in the EdTech Start-ups in Hong Kong Participated in the Online Questionnaire Survey of this study

Position	Number of Respondents (Percentage)
Founder / Co-founder	36 (39.13%)
Chief Executive Officer	16 (17.39%)
Other C-Level Posts	7 (7.61%)
R&D Director	3 (3.26%)
Education Director	9 (9.78%)
R&D Manager / Consultancy	3 (3.26%)
Education Manager / Consultancy	7 (7.61%)

Product Manager / Centre Manager	7 (7.61%)
Others	4 (4.35%)
Total	92 (100.00%)



In the education sector over the past decades, technology has become an ever more basic input into the provision and growth of education services, including access to technology, technology-enable behavioural interventions, improvements to instruction and self-led learning (Rodriguez-Segura, 2022). Since the acceleration of popularity of personal computers and the internet in the 1990s, new terms of areas of applications have been introduced in the EdTech field, for instance, wikis, e-learning, learning objects, web 2.0, e-portfolios, social media, personal learning environment MOOCs, learning analytics digital badges AI, blockchain and Web 3.0 (Weller, 2018). The QS Reimagine Education Award and Conference, which was organised annually by the QS and the University of Pennsylvania, categorise EdTech into access-diversity-inclusion, AI in education, best use of generative AI, blended & presence learning, ICT tools, EduApp, instructional technologies, developing emerging skills, e-learning, immersive experiential learning, innovation in business education, learning assessment, lifelong learning, nurturing employability, nurturing values and ethics, nurturing wellbeing & purpose, science of learning, sustainability education and empowering partnerships (QS, 2023).

Chapter 2.3 reviews the literature on EdTech areas. The areas of EdTech businesses of the respondent start-ups were classified as AI for Teaching, Learning, Training and Assessment; Art and Culture; Business Education and Professional Training; Early Childhood Education; Equity, Social Cohesion

and Inclusion; Gamification and Edutainment Solutions; Immersive Experiential Learning; In-School Services and Support; Learning and School Management System; Nurturing Employment; Nurturing Values and Ethics; Rehabilitation and Nurturing Wellbeing; Sports and Health Education; Teaching and Learning Tools and Textbooks; Vocational Education and Training; and Others.

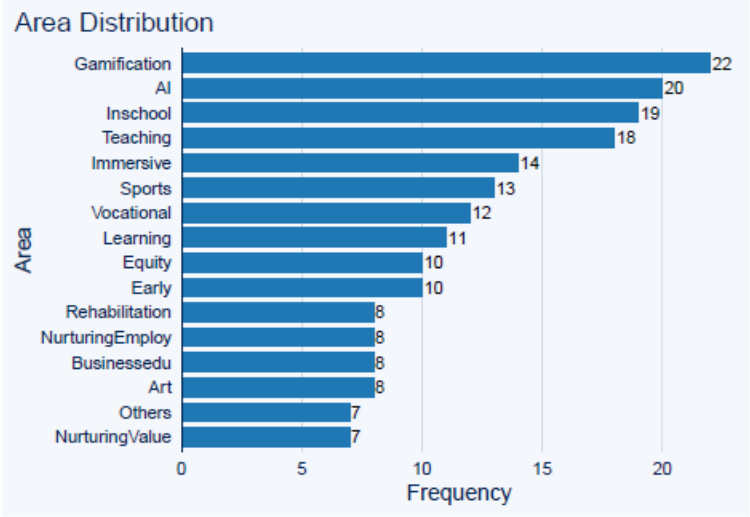
In this study, the surveyed EdTech start-ups were allowed to indicate multiple fields in which they provide their products, services, and solutions. This flexibility resulted in a comprehensive representation of the various areas of EdTech business in which these start-ups are engaged. As detailed in Table 5E, the highest proportion of respondent start-ups reported operating in the field of Gamification and Edutainment Solutions. This field was represented by 22 start-ups, which constitutes 24% of the total 92 respondents. This area of business involves the application of game-design elements and principles in non-game contexts to improve user engagement, learning, and problem-solving. The second most represented field was AI for Teaching, Learning, Training, and Assessment, with 20 start-ups indicating business operations in this area. This field involves the use of artificial intelligence technologies to facilitate and enhance various aspects of the learning process. Both of these top-ranking fields have a strong requirement for technological elements. This demonstrates the increasingly prominent role that advanced technology plays in the EdTech sector. This trend aligns with the broader evolution of the education industry, which is increasingly leveraging technology to enhance teaching and learning outcomes. (Weller, 2018; IBIS Capital and EdTech Global Limited, 2019; Blazic & Blazic, 2015).

In-school Services and Support and Teaching and Learning Tools and Textbooks were also major business fields of the EdTech start-ups that participated in this study, which recorded 21% and 20%, respectively. 11% to 15% of the start-ups were within reach in the fields of Immersive Experiential Learning; Sports and Health Education; Vocational Education and Training; Learning and School Management System; Equity, Social Cohesion and Inclusion; and Early Childhood Education. The figures are the same 9% for these four areas of EdTech businesses: Rehabilitation and Nurturing Wellbeing; Nurturing Employment; Business Education and Professional Training; and Art and Culture. Seven out of the 92 start-ups were providing EdTech products and services in Nurturing Values and Ethics. Another seven start-ups were offering solutions in EdTech fields other than the ones listed.

Table 5E: Field of EdTech Businesses of the Respondents in the EdTech Start-ups in Hong Kong Participated in the Online Questionnaire Survey of this study

Field of EdTech Business	Number of Respondents (Percentage, out of 92 respondents)

Gamification and Edutainment Solutions	22 (24%)
AI for Teaching, Learning, Training and Assessment	20 (22%)
In-School Services and Support	19 (21%)
Teaching and Learning Tools and Textbooks	18 (20%)
Immersive Experiential Learning	14 (15%)
Sports and Health Education	13 (14%)
Vocational Education and Training	12 (13%)
Learning and School Management System	11 (12%)
Equity, Social Cohesion and Inclusion	10 (11%)
Early Childhood Education	10 (11%)
Rehabilitation and Nurturing Wellbeing	8 (9%)
Nurturing Employment	8 (9%)
Business Education and Professional Training	8 (9%)
Art and Culture	8 (9%)
Nurturing Values and Ethics	7 (8%)
Others	7 (8%)
Remark: Each respondent can select more than one answer for this survey question.	



5.2.2 Reliability and Validity Analysis

Table 5F provides an overview of the constructs and variables utilized in this questionnaire survey. The collected data was subsequently analysed using the R programming language, a powerful tool that is widely recognized for its capabilities in statistical analysis and data visualization (Crawley, 2012). In this study, R was specifically employed to perform a range of statistical analyses. These included data exploration to understand the basic properties and characteristics of the data, pattern

analysis to identify trends and relationships within the data, and hypothesis testing to draw conclusions about the data. The specific procedures and results of these statistical analyses conducted using R will be further detailed and discussed in the following sections of this report. This approach will offer a comprehensive understanding of the survey data and facilitate a robust interpretation of the findings.

Table 5F: Overview of the Constructs, Variables, the corresponding indicators and Questions in the Questionnaire Survey

Constructs	Variables	Indicators	Questions
Technology Transfer in University	Formal Technology Transfer Activities	TTIU_formal_edu	Your start-up obtains knowledge on education and pedagogies via formal technology activities of university.
		TTIU_formal_tech	Your start-up obtains technological knowhow via formal technology transfer activities of university.
		TTIU_formal_market	Your start-up obtains information about customer needs and market trends via formal technology transfer activities of university.
	Informal Technology Transfer Activities	TTIU_informal_edu	Your start-up obtains knowledge on education and pedagogies via informal technology transfer activities of university.
		TTIU_informal_tech	Your start-up obtains technological knowhow via informal technology transfer activities of university.
		TTIU_informal_market	Your start-up obtains information about customer needs and market trends via informal technology transfer activities of university.
	Entrepreneurial Activities	TTIU_ent_tech	Your start-up reaches useful university technologies and knowledge via entrepreneurial activities of university.
		TTIU_ent_funding	Your start-up received funding and facility support from entrepreneurial activities of university.
		TTIU_ent_prof	Your start-up obtains professional services support, such as legal, business advisory and investment, via entrepreneurial activities of university.
		TTIU_ent_know	Your start-up earns practical entrepreneurship knowledge via entrepreneurial activities of university.
Knowledge Capital	Technology Value	KC_tv_monitor	Your start-up regularly monitors technology development trends.

		KC_tv_develop	Your start-up is capable of conducting in-house product development.
		KC_tv_market	Your start-up has good knowledge of different market segments.
		KC_tv_transfer	Your start-up transfers/adopts technology into products or services.
	Education Value	KC_ev_ped	Your start-up thinks and works a lot on the pedagogies of the products or services you designing.
		KC_ev_content	Your start-up thinks and works a lot on the content of the products or services you designing.
		KC_ev_influence	Your start-up considers how your products' or services' content and pedagogies influence one another.
		KC_ev_adapt	Your start-up modifies your products' or services' content to adapt to the technology platform.
		KC_ev_evaluate	Your start-up has the mechanism to evaluate the quality of teaching or training.
		KC_ev_measure	Your start-up investigates new measurements of user performance.
		KC_ev_innassess	Your start-up develops innovative assessment tools.
		KC_ev_inttech	Your start-up integrates technology to the development of your educational content.
		KC_ev_techtool	Your start-up uses technology as a tool for learning / training.
		KC_ev_information	Your start-up has a close relationship for searching for information, resources and new contacts.
	Social Network	KC_sn_share	Your start-up is ready to sharing knowledge with other firms.
		KC_sn_access	Your start-up is accessible for other firms and organisations for knowledge exchange when needed.
		KC_sn_covercust	The individual contact networks of your start-up cover your target customers.
		KC_sn_coverdis	The individual contacts of your start-up cover your target distribution networks.
Absorption Capability		AC_evaluate	Compared with major competitors, your start-up can accurately evaluate knowledge that is acquired externally.

		AC_know	Compared with major competitors, your start-up has a stronger ability to acquired knowledge for future use.
		AC_market	Compared with major competitors, your start-up can easily obtain market information.
		AC_original	Compared with major competitors, your start-up has acquired original and pioneering knowledge from external.
		AC_low	Compared with major competitors, your start-up has the advantage in lower the operation costs.
Entrepreneurship Capability	Innovativeness	EC_inn_acc	Your start-up accumulate knowledge.
		EC_inn_intknow	Your start-up integrates new knowledge in product and business development.
		EC_inn_intres	Your start-up integrates resources for product and business development.
		EC_inn_access	Your start-up has good access to new knowledge relevant to your business.
	Entrepreneurial Attitudes	EC_ea_sug	Your start-up encourage employee to suggest ways for new lines of business.
		EC_ea_com	Your start-up has good communication and coordination.
		EC_ea_cross	Your start-up has a cross-functional teamwork.
		EC_ea_res	Your start-up timely responds to market opportunities.
		EC_ea_inn	Your start-up favor strong in-house R&D, technological leadership and innovation.
	Co-creation	EC_cc_value	Your start-up co-create new value with external party(s) to your target customers.
		EC_cc_market	Your start-up co-create new market with external party(s).

In this study, we assessed the reliability of the constructs and variables using Cronbach's alpha, a statistical measure of internal consistency that is widely used in social science research. This measure was then used to test the construct validity and reliability. Cronbach's alpha is particularly useful in a specific situation: when examining the variance of individual items in a unidimensional test. In essence, it provides a measure of the extent to which all the items in the test measure the same concept or construct. Hence, a high alpha value suggests that a substantial proportion of the test's variance can

be attributed to general and group factors, indicating a high level of internal consistency (Cortina, J. M., 1993). By using Cronbach's alpha, we can ensure that the constructs and variables in our study are not only reliable but also valid in measuring the intended attributes. This increases the confidence in our findings and allows for more robust conclusions to be drawn from the data. The reliability of a construct is typically determined by Cronbach's alpha coefficient, which should ideally fall in the range of 0.6 to 0.8, as agreed upon by many scholars (Cortina, 1993; Rossiter, 2002; Hair *et al*., 2014; Cheung *et al*. 2023). In this study, the R analysis yielded a Cronbach's alpha of 0.97 for the entire data set, with a 95% confidence interval (0.941, 0.982). This score far exceeds the minimum threshold of 0.6, indicating a high degree of reliability. In fact, an alpha of 0.97 suggests that the items in the survey are highly correlated, meaning they measure the same underlying construct very consistently. Therefore, we can confidently conclude that the overall survey results are highly reliable.

Confirmatory factor analysis (CFA) was conducted to demonstrate the unidimensionality and validity of the constructs. CFA relies on theoretical assumptions and a predetermined factor structure model to determine if the data fits the proposed structure. It posits that a set of latent common factors can explain the correlations among observed variables. CFA creates a measurement model to assess the relationship between observed variables and these latent factors, and tests whether this relationship aligns with the theoretical model. It validates theoretical assumptions: CFA can confirm whether the theoretical assumptions made by researchers align with the actual data (Preedy *et al.*, 2010).

To demonstrate unidimensionality, we need to focus on the following criteria and their respective cut-offs:

RMSEA (Root Mean Square Error of Approximation): This fit index assesses how well a proposed model fits the data, with lower values indicating a better fit.

Good fit: $RMSEA \leq 0.06$

Acceptable fit: $0.06 < RMSEA \leq 0.08$

Poor fit: $RMSEA > 0.10$

(Hu *et al.*, 1999)

b) CFI (Comparative Fit Index): This measure evaluates model fit and is less sensitive to sample size compared to other indices, making it a popular choice (Tabachnick *et al*., 2007).

Good fit: $CFI \geq 0.95$

Acceptable fit: $0.90 \leq CFI < 0.95$

Poor fit: $CFI < 0.90$

(Hu *et al.*, 1999)

c) TLI (Tucker-Lewis Index): Also known as the Non-Normed Fit Index (NNFI), this index assesses model fit, with higher values indicating a better fit.

Good fit: TLI ≥ 0.95

Acceptable fit: 0.90 ≤ TLI < 0.95

Poor fit: TLI < 0.90

(Hu *et al.*, 1999)

d) SRMR (Standardized Root Mean Square Residual): This index measures the average of the absolute values of residual correlations, with lower values indicating a better fit.

Good fit: SRMR ≤ 0.08

Acceptable fit: 0.08 < SRMR ≤ 0.10

Poor fit: SRMR > 0.10

(Hu *et al.*, 1999)

e) Factor Loadings: These indicate the strength and direction of the relationship between an item and its underlying factor. Higher absolute values suggest stronger relationships.

Acceptable: ≥ 0.50

Good: ≥ 0.70

Excellent: ≥ 0.80

(Hair *et al.*, 2010)

To prove construct validity, we focus on these criteria:

a) AVE (Average Variance Extracted): This represents how much variation in items is explained by the latent construct. An AVE of 0.50 or higher indicates that the construct explains 50% or more of the variance in its indicators (Hair *et al.*, 2010).

b) CR (Composite Reliability): CR represents the ratio of true score variance to total score variance. Generally, CR values above 0.7 are considered acceptable, while values above 0.8 or 0.9 indicate good reliability (Hair *et al.*, 2010).

Table 5G: Summary of Measurement Scales

Constructs	Variables	Indicators	Factor Loading	Cronbach's Alpha	Composite Reliability	CFA Models				AVE	CR	$\chi 2$ value
						RMSEA	CFI	TLI	SRMR			
Technology Transfer in University	TTIU_formal	TTIU_formal_edu	0.633	0.762	0.533	0.124	0.924	0.893	0.079	0.550	0.767	77.165
		TTIU_formal_tech	0.682	--	--	--	--	--	--	--	--	
		TTIU_formal_market	0.847	--	--	--	--	--	--	--	--	
	TTIU_informal	TTIU_informal_edu	0.861	0.859	0.679	--	--	--	--	0.680	0.861	
		TTIU_informal_tech	0.736	--	--	--	--	--	--	--	--	
		TTIU_informal_market	0.860	--	--	--	--	--	--	--	--	
	TTIU_ent	TTIU_ent_tech	0.655	0.884	0.717	--	--	--	--	0.666	0.891	
		TTIU_ent_funding	0.763	--	--	--	--	--	--	--	--	
		TTIU_ent_prof	0.958	--	--	--	--	--	--	--	--	
		TTIU_ent_know	0.869	--	--	--	--	--	--	--	--	
Knowledge Capital	KC_tv	KC_tv_monitor	0.768	0.853	0.670	0.131	0.822	0.793	0.078	0.611	0.863	338.919
		KC_tv_develop	0.888	--	--	--	--	--	--	--	--	
		KC_tv_market	0.729	--	--	--	--	--	--	--	--	
		KC_tv_transfer	0.706	--	--	--	--	--	--	--	--	
	KC_ev	KC_ev_ped	0.785	0.923	0.801	--	--	--	--	0.550	0.926	
		KC_ev_content	0.731	--	--	--	--	--	--	--	--	
		KC_ev_influence	0.771	--	--	--	--	--	--	--	--	

		KC_ev_adapt	0.771	--	--	--	--	--	--	--	--	
		KC_ev_evaluate	0.799	--	--	--	--	--	--	--	--	
		KC_ev_measure	0.769	--	--	--	--	--	--	--	--	
		KC_ev_innassess	0.692	--	--	--	--	--	--	--	--	
		KC_ev_inttech	0.743	--	--	--	--	--	--	--	--	
		KC_ev_techtool	0.656	--	--	--	--	--	--	--	--	
		KC_ev_information	0.689	--	--	--	--	--	--	--	--	
	KC_sn	KC_sn_share	0.635	0.866	0.684	--	--	--	--	0.627	0.87	
		KC_sn_access	0.742	--	--	--	--	--	--	--	--	
		KC_sn_covercust	0.920	--	--	--	--	--	--	--	--	
		KC_sn_coverdis	0.842	--	--	--	--	--	--	--	--	
Entrepreneurship Capability	EC_inn	EC_inn_acc	0.870	0.901	0.753	0.066	0.977	0.969	0.038	0.696	0.903	57.213
		EC_inn_intknow	0.796	--	--	--	--	--	--	--	--	
		EC_inn_intres	0.900	--	--	--	--	--	--	--	--	
		EC_inn_access	0.787	--	--	--	--	--	--	--	--	
	EC_ea	EC_ea_sug	0.835	0.887	0.725	--	--	--	--	0.612	0.886	
		EC_ea_com	0.846	--	--	--	--	--	--	--	--	
		EC_ea_cross	0.670	--	--	--	--	--	--	--	--	
		EC_ea_res	0.794	--	--	--	--	--	--	--	--	
		EC_ea_inn	0.782	--	--	--	--	--	--	--	--	
	EC_cc	EC_cc_value	0.850	0.871	0.694	--	--	--	--	0.772	0.871	
		EC_cc_market	0.909	--	--	--	--	--	--	--	--	

Absorption Capability		AC_evaluate	0.908	0.879	0.698	0.172	0.948	0.896	0.055	0.584	0.857	18.603
		AC_know	0.862	--	--	--	--	--	--	--	--	
		AC_market	0.678	--	--	--	--	--	--	--	--	
		AC_original	0.820	--	--	--	--	--	--	--	--	
		AC_low	0.580	--	--	--	--	--	--	--	--	

Remark: p-values of all measured items are smaller than 0.05.

Table 5G shows the measurement items for each construct, factor loadings, Cronbach's alpha coefficients and composite reliability. In this study, we check Cronbach's alpha coefficients as a measurement of the reliability of the construct to tech whether the constructs used are in a significant degree of measuring the same underlying concept. The Cronbach's alpha coefficients are measured as follows: Technology Transfer in University – Formal Technology Transfer Activities is 0.762; Technology Transfer in University – Informal Technology Transfer Activities is 0.859; Technology Transfer in University – Entrepreneurial Activities is 0.884; Knowledge Capital – Technology Value is 0.853; Knowledge Capital – Education Value is 0.923; Knowledge Capital – Social Network is 0.866; Entrepreneurship Capability – Innovativeness is 0.901; Entrepreneurship Capability – Entrepreneurial Attitude is 0.887; Entrepreneurship Capability – Co-creation is 0.871; and Absorption Capability is 0.874. All the measured Cronbach's alpha coefficients are higher than 0.7, which indicates the constructs are reliable.

Apart from Cronbach's alpha coefficients, the factor loadings are measured to examine the correlation coefficient on the relationship and the impact of the observed variables on the corresponding constructs. Hair *et al.*, (2014) suggested a table of factor loading coefficient values that is considerable to be practically significant in corresponding to the sample size of a particular study. The scholars mentioned the factor loading value should be 0.55 for a sample size of 100 respondents and 0.60 for a sample size of 85 respondents, which ideally, all factor loading values should be at least 0.7 (Hair *et al.*, 2014). Some other scholars accept a factor loading of more than 0.30 to be significant in indicating a moderate correlation between the item and the factor (Tavakol & Wetzel, 2020), while Steven J.P. 2002 suggested the significant value for interpretation purposes should be great than 0.4. In this study, the indicator TTIU_formal_edu under the variable "Formal Technology Transfer Activities" recorded the lowest value of factor loading, which is 0.633, except for the moderating variable absorption capability. The second lower value of factor loading is recorded as 0.635, for KC_sn_share, which is under the variable "Social Network" of knowledge capital. A few other variables with factor loading smaller than 0.7 are TTIU_ent_tech, KC_ev_techtool, EC_ea_cross, TTIU_formal_tech, KC_ev_information, and KC_ev_innassess. Two items under the moderating variable absorption capability also record a factor loading smaller than 0.7, which are AC_low and AC_market. All the factor loadings measured in this study are greater than 0.55. The factor loadings are classified to be practically significant. 34 out of the 44 measured indicators are with factor loadings greater than 0.7.

Scholars also mentioned composite reliability, or called construct reliability, as an appropriate reliability measurement taking into account the factor loadings to give weights to the items that contribute more to the latent variable (Hair *et al.*, 2014; Cheung *et al.*, 2023). Composite reliability

is a measure of internal consistency in scale items (Netemeyer *et al.,* 2003; Shrestha, 2021). A composite reliability score above 0.7 is generally considered acceptable, indicating that the items have relatively high internal consistency. Some scholars adopted composite reliability scores of 0.6, given the Cronbach Alpha coefficient measures greater than 0.7 (Anis Suryani, Fatwa Tentama, 2020; Shrestha, N., 2021). Like Cronback's alpha coefficient, the closer the value is to 1, the more reliable the scale (Raykov, 1997; Hair *et al.*, 2014; Cheung *et al*., 2023). Table 5G shows the composite reliability of all the variables under the three constructs. When converting to three decimal places, the composite reliability values are measured as follows: Technology Transfer in University – Formal Technology Transfer Activities is 0.533; Technology Transfer in University – Informal Technology Transfer Activities is 0.679; Technology Transfer in University – Entrepreneurial Activities is 0.717; Knowledge Capital – Technology Value is 0.670; Knowledge Capital – Education Value is 0.801; Knowledge Capital – Social Network is 0.684; Entrepreneurship Capability – Innovativeness is 0.753; Entrepreneurship Capability – Entrepreneurial Attitude is 0.725; Entrepreneurship Capability – Co-creation is 0.694 and Absorption Capability is 0.874. Five out of the ten composite reliability read over 0.7. Considering all the measured Cronbach's alpha coefficients are higher than 0.7, composite reliability in the range of 0.6 can also be accepted. Thus, except for Formal Technology Transfer Activities', all other variables are measured with acceptable composite reliability, which indicates the constructs are reliable.

The outcomes of the study largely indicate that the measures utilized demonstrate adequate reliability and validity. In other words, the "reliability" of the measures indicates that they are consistent and stable over time, meaning if the same measurement is taken again under the same conditions, it would produce the same results. On the other hand, the "validity" of the measures refers to how well they accurately capture or measure the concept that they are intended to measure. If a measure is valid, it means it's measuring what it's supposed to measure and not something else. Therefore, the statement implies that the methods or tools used in this study to collect data are both reliable (providing consistent results) and valid (accurately measuring what they are intended to measure), insuring the credibility and applicability of the study's findings.

The CFA model for the Technology Transfer in University scale resulted in RMSEA = .0124, CFI = .924, TLI = .893, SRMR = .079, and $\chi 2 = 77.165$, $p < .001$; the CFA model for the Knowledge Capital scale resulted in RMSEA = .131, CFI = .822, TLI =.793, SRMR = .078 in SRMR, and $\chi 2 = 338.919$, $p < .001$; the CFA model for the Entrepreneurship Capability scale resulted in RMSEA = .066, CFI = .977, TLI = .969, SRMR = 0.038, and $\chi 2 = 557.213$, $p < .001$; and the CFA model for the Absorptive Capability scale resulted RMSEA = .172 , CFI = .948, TLI = .896, SRMR = 0.055,

and $\chi 2 = 118.603$, $p < .001$. Although the RMSEA and TLI indicate that the CFA model is not adequate, the CFI suggests that the model is acceptable. Given the relatively small sample size, the CFI serves as a dominating reference point (Tabachnick *et al*., 2007). The AVE value of the measuring items is recorded in the range of 0.55 to 0.772, which are all above the cut-off of 0.50. The CR value of TTIU_formal measures as 0.767, which is in the acceptable range, while other items' CR values are above 0.8 indicating the good reliability. Therefore, the actual data and the theoretical assumptions align in this model.

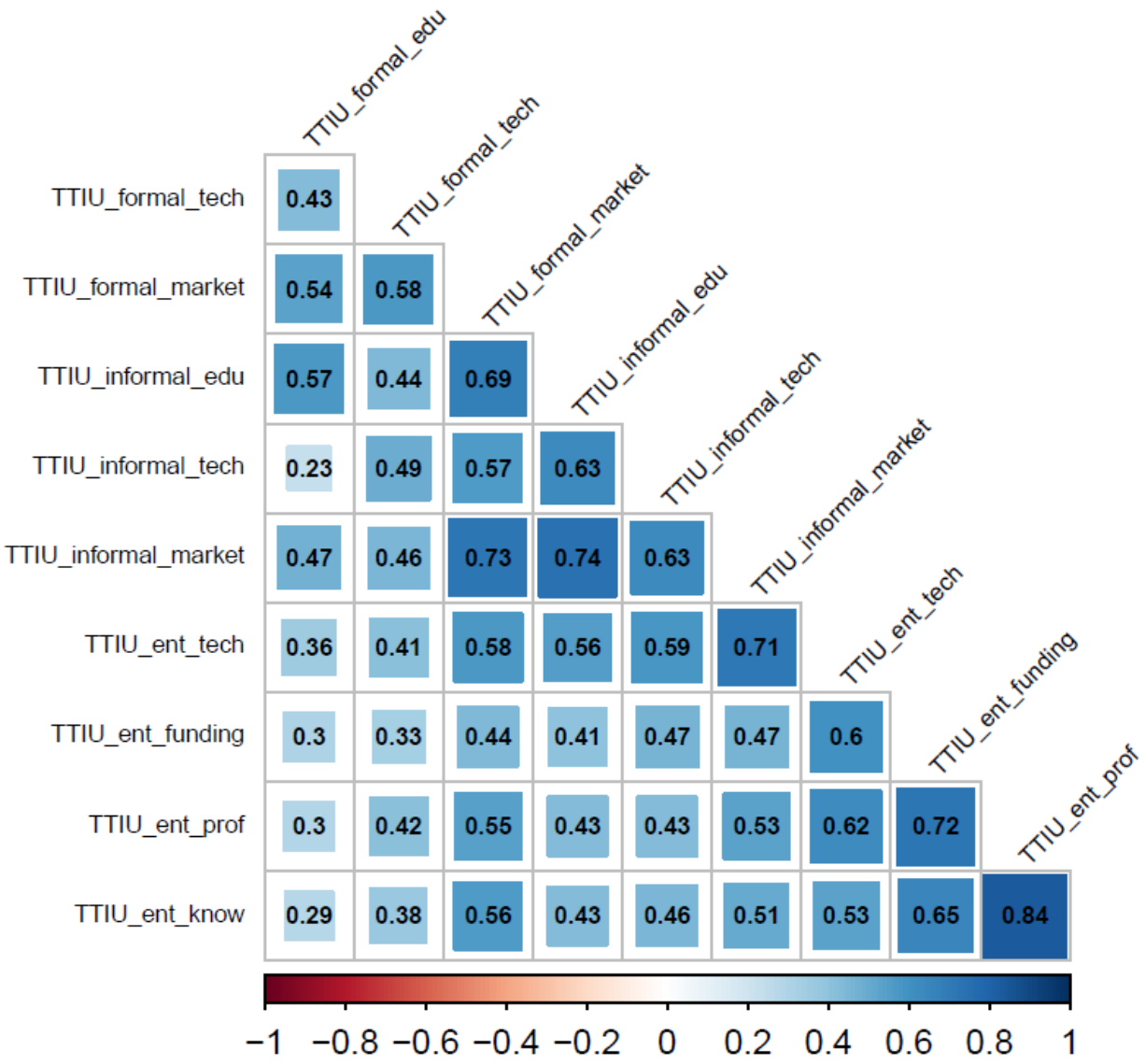
5.2.3 Multivariable Correlation Analysis

Correlation analysis is the statistical test used to evaluate the strength and direction and assess discriminant validity by evaluating whether a correlation between two constructs is statistically significantly less than unity (Cheung *et al*., 2023). In this study, the correlation coefficient is measured using the Pearson correlation coefficient.

In this part of the analysis, the strength and direction of the relationship between two variables are quantified using the Pearson correlation coefficient. This specific coefficient is widely used in statistical analysis due to its ability to measure the degree of linear association between two variables. The Pearson correlation coefficient is a unitless measure that can range from -1 to +1, with statistics closer to an absolute value of 1 reflecting a more robust relationship (Hahs-Vaughn, 2023). This scale provides a way to understand the relationship between the two variables. If the correlation coefficient yields a positive number, it signifies a positive correlation between the variables. In other words, as one variable increases, the other variable also increases. On the other hand, if the correlation coefficient is negative, it indicates a negative correlation between the variables. This implies an inverse relationship where an increase in one variable corresponds to a decrease in the other. It's important to note that the Pearson correlation coefficient only measures the linear relationship between variables. It does not imply a cause-and-effect relationship or guarantee that a strong correlation will result in a predictive model (Sedgwick, 2012; Shaun, 2023). Hahs-Vaughn (2023) indicated the commonly accepted interpretation of the Pearson correlation coefficient to be 0.10 is a weak correlation, 0.30 is a moderate correlation, and 0.5 is a strong correlation.

Tables 5H, 5I, 5J and 5K show the correlation figures and correlation plots of items and variables in construct Technology Transfer in University, Knowledge Capital Entrepreneurship Capability and Absorption Capability, respectively. In the correlation plots, the blue colour represents a positive correlation, while the red colour means a negative correlation. The correlations in figural values are indicated if the correlation is significant with 95% confidence (Olivoto *et al.*, 2018).

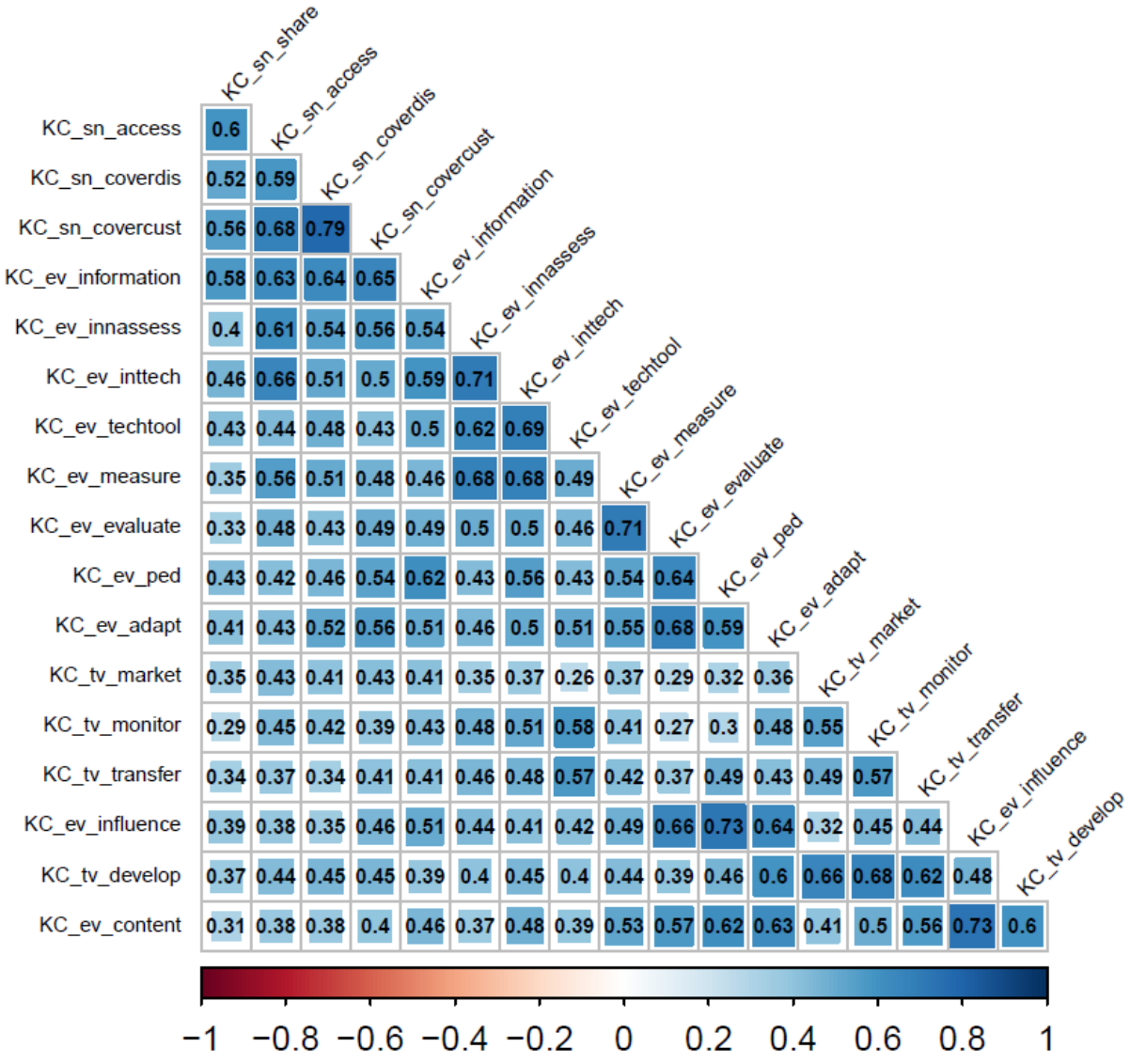
Table 5H: Correlation Figures and Plots of items in the Construct "Technology Transfer in University"



The correlation plots referenced under Table 5H indicate that all responses related to the construct of "Technology Transfer in University" have a positive correlation with each other. This means that as one variable increases, the other does too, demonstrating a direct relationship between them. In this instance, some of these correlation coefficients are within the moderate correlation range, marked by a value of 0.3. This moderate correlation is predominantly seen with the item TTIU_formal_edu. The correlation coefficients were specifically 0.23 for TTIU_formal_edu with TTIU_informa_tech, 0.29 for TTIU_formal_edu with TTIU_ent_know, 0.3 for TTIU_formal_edu with TTIU_ent_funding, 0.3 for TTIU_formal_edu with TTIU_ent_prof, and 0.36 for TTIU_formal_edu with TTIU_ent_tech. Out of the total 45 Pearson correlation coefficients measured, more than half, specifically 23, were

greater than 0.5, indicating strong correlations. The highest Pearson correlation coefficients is recorded in TTIU_ent_prof and TTIU_ent_know. There is not any item with the Pearson correction coefficients that fell into the weak correlation range, which is defined by a value of 0.1. In general, the items categorized under "Technology Transfer in University" exhibit a high positive correlation. This means that these items typically increase or decrease together, indicating a significant relationship between them.

Table 5I: Correlation Figures and Plots of items in the Construct "Knowledge Capital"



The correlation plots found in Table 5I show that all the responses associated with the "Knowledge Capital" construct positively correlate with each other. There are four instances where the correlation coefficients are below the moderate correlation range, indicated by a value of 0.3. The specific coefficients are: 0.26 for KC_ev_tech with KC_tv_market; 0.27 for KC_ev_evaluate with

KC_tv_monitor; 0.29 for KC_ev_evaluate with KC_ev_market; and 0.29 for KC_sn_share with KC_tv_monitor. Out of the 153 Pearson correlation coefficients that were calculated, 57 were greater than 0.5, and six were exactly 0.5, indicating strong correlations. The Pearson correlation coefficient measures the linear correlation between two variables, and a value of 0.5 or above represents a strong correlation. The strongest correlation, with a Pearson coefficient of 0.79, was between KC_sn_coverdis and KC_sn_covercust. Other Pearson correlation coefficients greater than 0.7 included: 0.71 for KC_ev_infomration with KC_ev_inttech; 0.71 for KC_ev_measure with KC_ev_evaluate; 0.73 for KC_ev_ped with KC_ev_influence; and 0.73 for KC_ev_influence with KC_ev_content. None of the Pearson correction coefficients fell into the weak correlation range, defined by a value of 0.1. Overall, the items under the "Knowledge Capital" category demonstrate a high positive correlation.

Table 5J: Correlation Figures and Plots of items in the Construct "Entrepreneurship Capability"

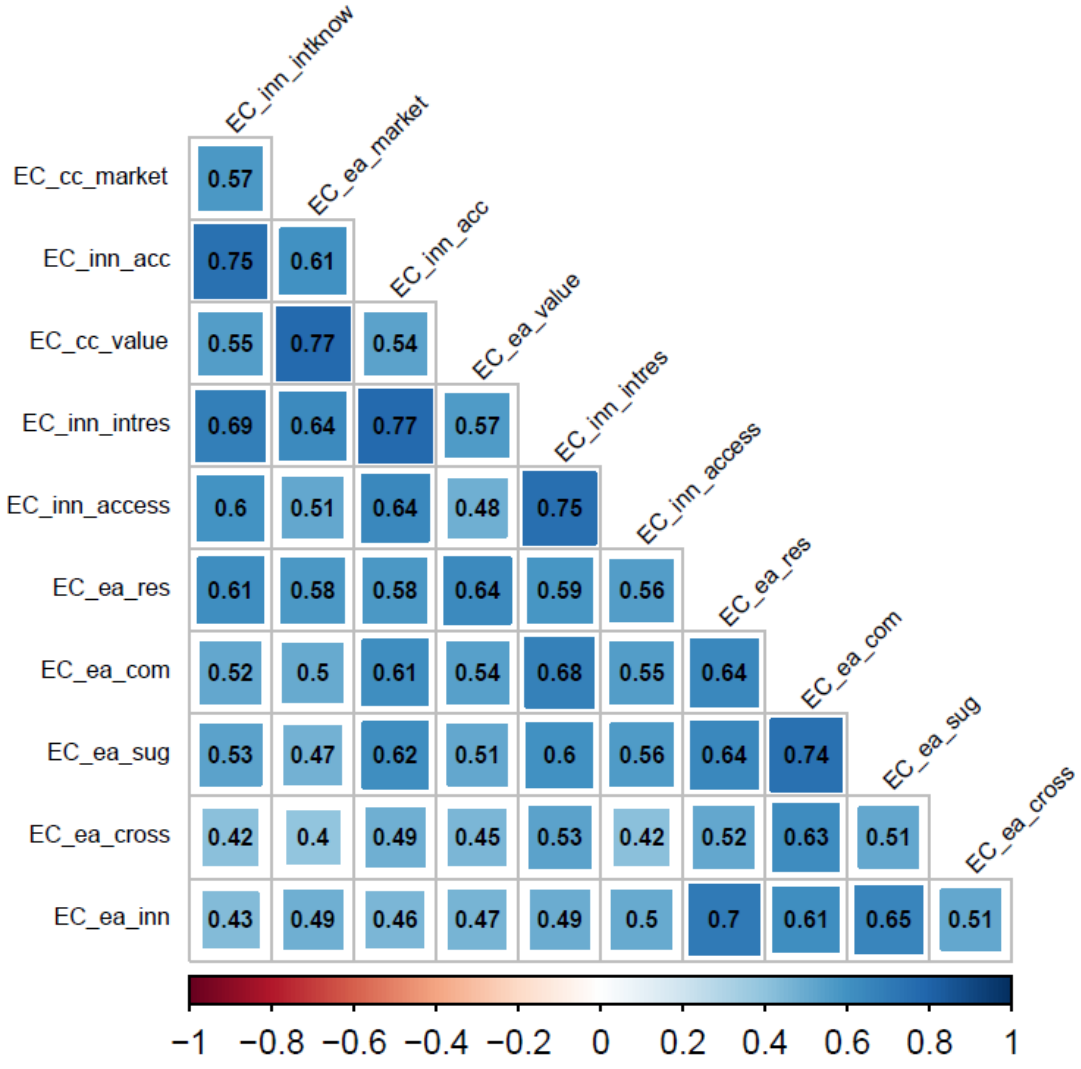


Table 5J shows the correlation figures and plots of the construct "Entrepreneurship Capability". All the responses associated with the "Entrepreneurship Capability" construct demonstrate positive

correlations. All the measured Pearson correlation coefficients are greater than 0.3. Out of the 55 Pearson correlation coefficients that were calculated, 12 are smaller than 0.5. Among them, the lowest measured value is 0.40 for EC_ea_market with EC_ea_cross. Forty-one are greater than 0.5, and two are exactly 0.5, indicating strong correlations. The Pearson correlation coefficient measures the linear correlation between two variables, and a value of 0.5 or above represents a strong correlation. The strongest correlation, with a Pearson coefficient of 0.77, is between EC_ea_market with EC_cc_value; and EC_inn_acc with EC_inn_intres. Other Pearson correlation coefficients greater than 0.7 included: 0.74 for EC_ea_com with EC_ea_sug; 0.75 for EC_inn_intknow with EC_inn_acc; 0.75 for EC_inn_intres with EC_inn_access; 0.77 for EC_ea_market with EC_cc_value; and 0.77 for EC_inn_acc with EC_inn_intres. None of the Pearson correction coefficients fell into the weak correlation range, defined by a value of 0.1, or the moderate correlation range, defined by a value of 0.3. Overall, the items under the "Entrepreneurship Capability" category demonstrate a high positive correlation.

Table 5K: Correlation Figures and Plots of items in the Construct “Absorption Capability”

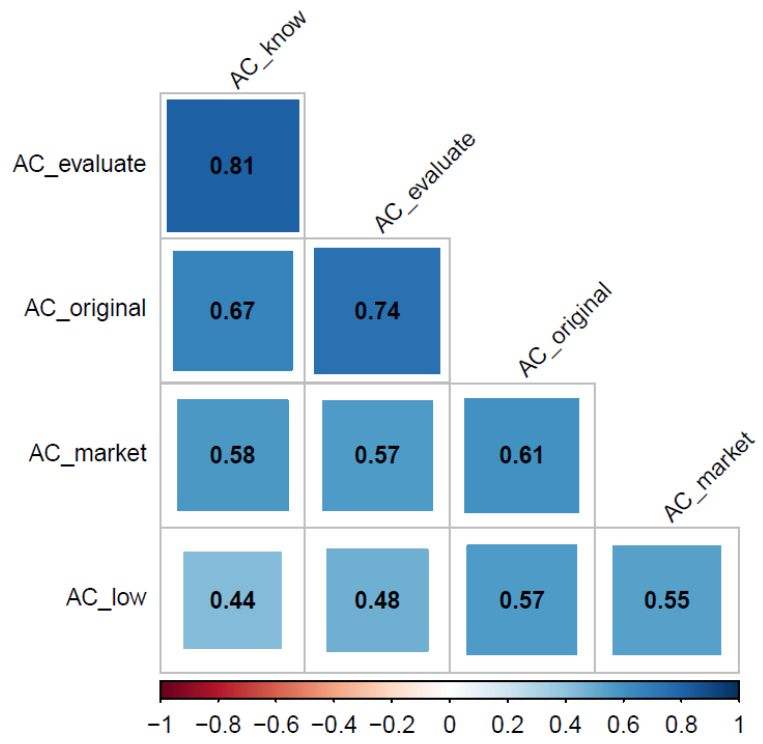


Table 5K displays the correlation figures and plots for the "Absorption Capability" construct. All the responses related to this construct show positive correlations, with all measured Pearson correlation coefficients exceeding 0.3. Out of the ten calculated Pearson correlation coefficients, two are less

than 0.5, while all other eight figures are larger than 0.5. The Pearson correlation coefficient is a measure of linear correlation between two variables, with a value of 0.5 or above indicating a strong correlation. The highest correlation, represented in terms of the Pearson coefficient, is 0.81. It is found between AC_evaluate and AC_know. Anther Pearson correlation coefficients exceeding 0.7 include 0.74 for AC_evaluate and AC_original. None of the Pearson correlation coefficients fall into the weak correlation range (defined by a value of 0.1) or the moderate correlation range (defined by a value of 0.3). Overall, the elements within the "Absorptive Capability" category display a high degree of positive correlation.

Table 5L: Correlation Figures and Plots of all items in the “Technology Transfer in University”, “Knowledge Capital”, “Entrepreneurship Capability” and “Absorptive Capability”

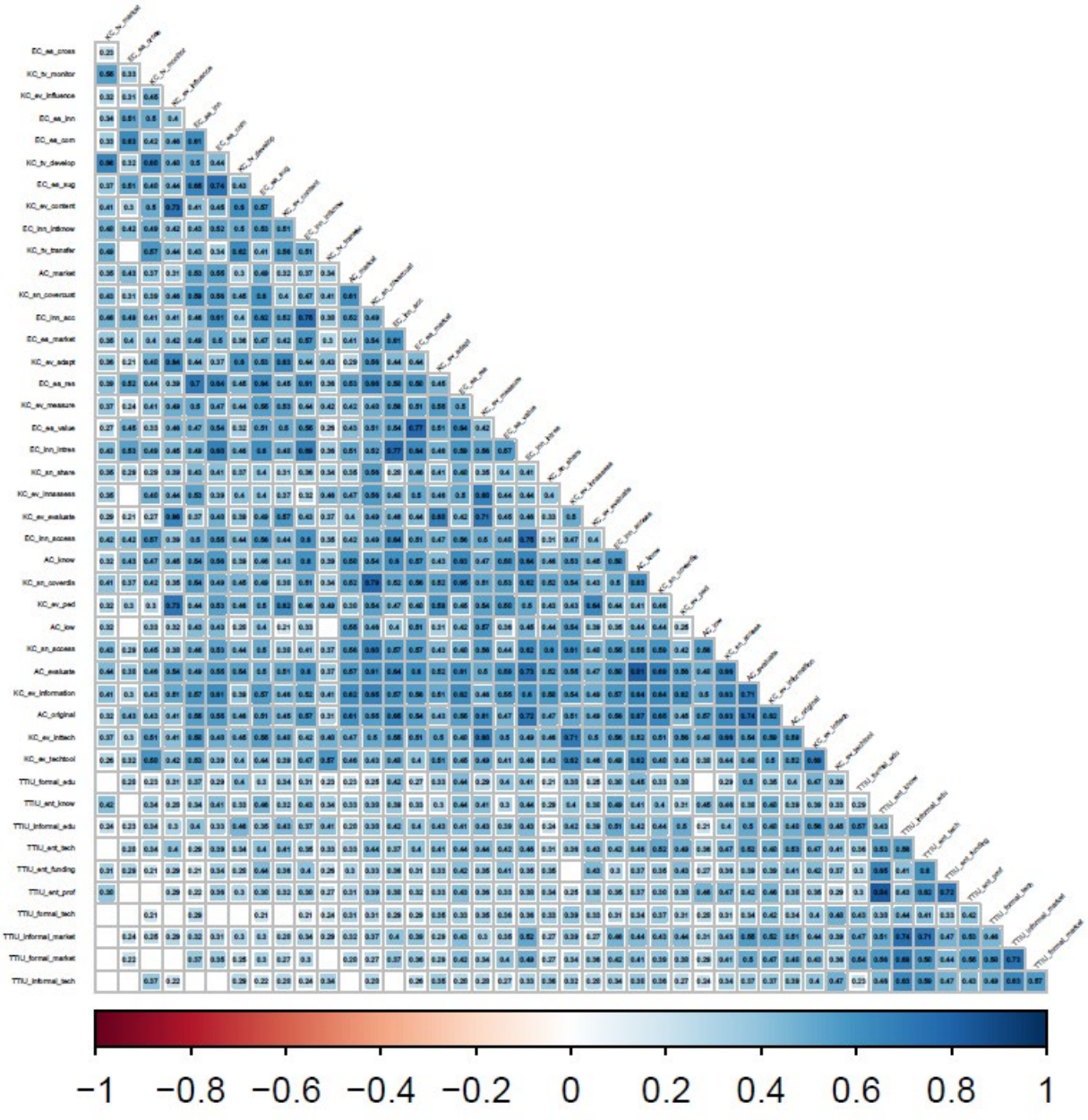
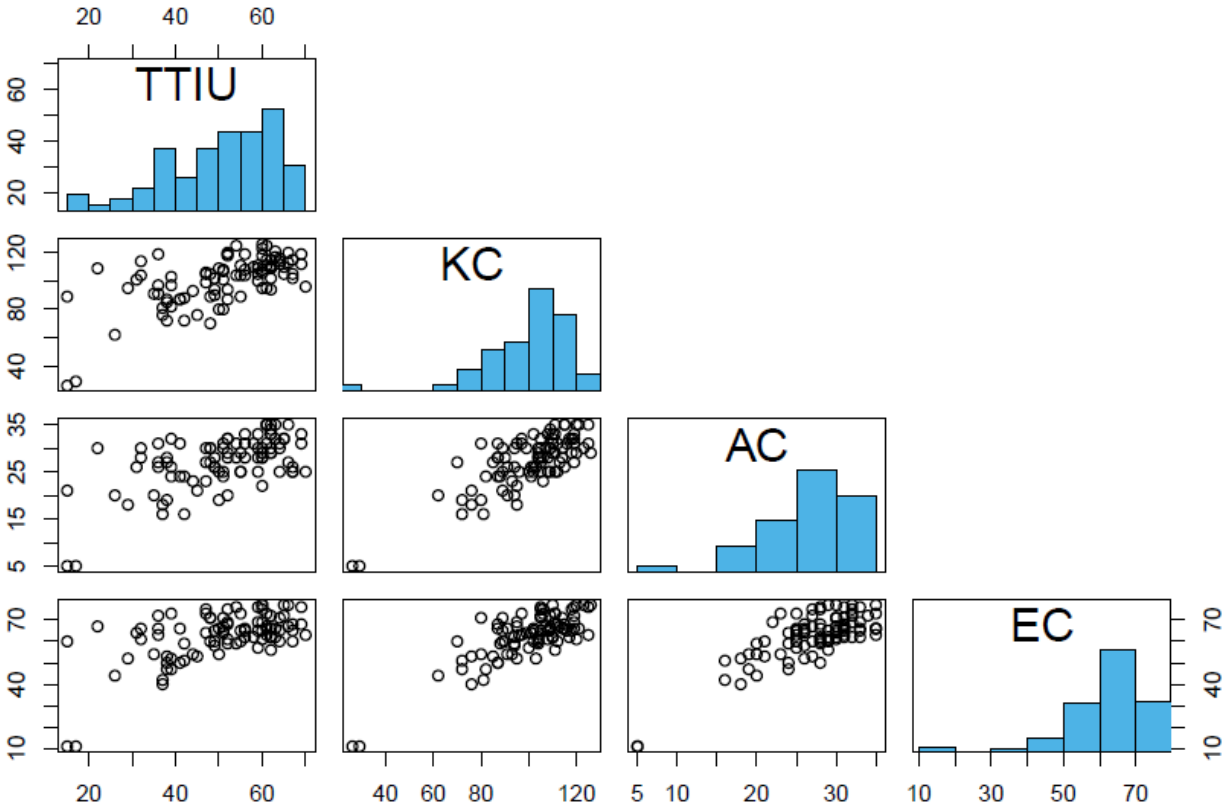


Table 5L summaries the Pearson correlation coefficients of all items in the "Technology Transfer in University", "Knowledge Capital", "Entrepreneurship Capability" and "Absorptive Capability". All the responses related to this construct show positive correlations, but 22 out of the 946 measurements are less than 0.2 in the range of weak correlation. Eight hundred and seven of the measurements are greater than 0.3, which implies they are moderately positively correlated. Among the 807 measurements, 252 are greater than 0.5, which indicates they are strongly positively correlated.

Table 5M: Histogram of Correlations Analysis of the Measuring Constructs



Here, we use a histogram for correlation analysis to plot the Pearson correlation coefficient's numerical measurement, as shown in Table 5L. The table serves as a graphical representation that organises the sum of numbers answered in each part to get the score for the corresponding part. It gives an estimation for the probability distribution of the measured variables and shows the distribution of correlation coefficients among the constructs: TTIU for "Technology Transfer in University", KC for "Knowledge Capital", EC for "Entrepreneurship Capability" and AC for "Absorption Capability".

"Technology Transfer in University" TTIU = TTIU_formal_edu + TTIU_formal_tech + TTIU_formal_market + TTIU_informal_edu + TTIU_informal_tech +

TTIU_informal_market + TTIU_ent_tech + TTIU_ent_funding + TTIU_ent_prof + TTIU_ent_know

"Knowledge Capital" KC = KC_tv_monitor + KC_tv_develop + KC_tv_market + KC_tv_transfer + KC_ev_ped + KC_ev_content + KC_ev_influence + KC_ev_adapt + KC_ev_evaluate + KC_ev_measure + KC_ev_innassess + KC_ev_inttech + KC_ev_techtool + KC_ev_information + KC_sn_share + KC_sn_access + KC_sn_covercust + KC_sn_coverdis

"Entrepreneurship Capability" EC = EC_inn_acc + EC_inn_intknow + EC_inn_intres + EC_inn_access + EC_ea_sug + EC_ea_com + EC_ea_cross + EC_ea_res + EC_ea_inn + EC_cc_value + EC_cc_market

"Absorption Capability" AC = AC_evaluate + AC_know + AC_market + AC_original + AC_low

From the histogram in Table 5L, we observe that all the plots of TTIU, KC AC and EC all lean towards +1. They demonstrate clear positive correlations. Compared to TTIU, KC, EC and AC show higher scores.

Table 5N: Correlation Figures and Plots of the Constructs: "Technology Transfer in University", "Knowledge Capital", "Entrepreneurship Capability" and "Absorption Capability"

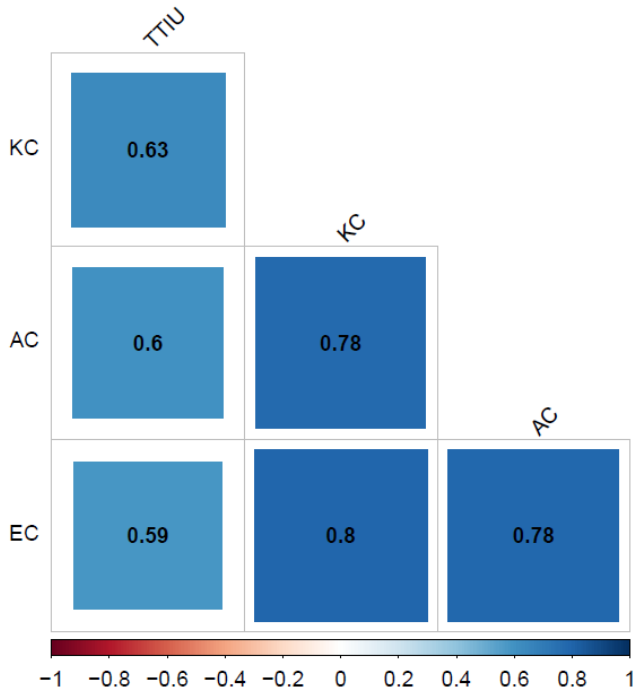


Table 5N displays the correlation figures and plots among the four constructs: "Technology Transfer in University", "Knowledge Capital", "Entrepreneurship Capability" and "Absorption Capability".

All the responses related to this construct show positive correlations, with all measured Pearson correlation coefficients exceeding 0.5. This indicates the four constructs are strongly correlated with each other. The highest correlation, represented in terms of the Pearson coefficient, is 0.80. It is found between KC and EC. Other Pearson correlation coefficients exceeding 0.7 include 0.78 for KC and AC, and the same value for AC and EC. TTIU and KC also demonstrate a strong correlation, in terms of the Pearson correlation coefficient is 0.63. None of the Pearson correlation coefficients fall into the weak correlation range (defined by a value of 0.1) or the moderate correlation range (defined by a value of 0.3). Overall, the constructs are strongly correlated with each other, but EC and KC, EC and AC are slightly stronger than EC and TTIU.

5.2.4 Regression Analysis and Results

In this study, we use regression analysis to statistically investigate the relationships between the variables and constructs. This aims to figure out the causal effect and test the hypotheses. Scholars described regression techniques have long been central to the fields of economic statistics to social sciences to engineering (Arkes, 2019; Sykes, 1993). Arkes (2019) explained regression analysis helps towards eliminating the influence of other factors to get closer to the true and average causal effect of something. It measures how a set of actors explains an outcome and how the outcome moves with each factor. It concludes causality, quantities how one factor causally affects another.

Regression analysis is a statistical technique used to estimate the relationships among variables that have a cause-and-effect or reason-and-result relationship. The main focus of univariate regression is to analyze the relationship between a single dependent variable and one independent variable, formulating a linear equation that represents this relationship. Regression models that involve one dependent variable and multiple independent variables are referred to as multiple linear regression (Uyanik *et al.*, 2013). Linear regression is a statistical technique used to model the linear relationship between a dependent variable and one or more independent variables. The linear regression model is typically expressed as:

$$\hat{y} = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_p x_p + \varepsilon$$

where $\hat{y}$ is the dependent variable, $x_1, x_2, \ldots x_p$ are the independent variables, β_0 is the y-intercept, β_1, β_2, … β_p are the regression coefficients, and is the error term. A fitted linear regression model can be utilized to identify the relationship between a specific predictor variable and the response variable while holding all other predictor variables in the model constant (Freedman *et al.*, 2009).

5.2.4.1 Depending Variable: Knowledge Capital

Table 5O: Results of Regression Analysis for Knowledge Capital

Independent Variable	Dependent Variable	Coefficient	P-value	R-squared	F-statistic
TTIU_Formal	KC_tv	0.3491	0.0038	0.08949	F1,90 = 8.845, p < .0001
TTIU_Formal	KC_ev	1.3593	<0.0001	0.2929	F1,90 = 37.28, p < .0001
TTIU_Formal	KC_sn	0.4778	<0.0001	0.1993	F1,90 = 22.4, p < .0001
TTIU_Informal	KC_tv	0.42356	<0.0001	0.1729	F1,90 = 18.81, p < .0001
TTIU_Informal	KC_ev	1.212	<0.0001	0.3056	F1,90 = 39.6, p < .0001
TTIU_Informal	KC_sn	0.4476	<0.0001	0.2296	F1,90 = 26.82, p < .0001
TTIU_ent	KC_tv	0.34913	<0.0001	0.1719	F1,90 = 18.68, p < .0001
TTIU_ent	KC_ev	1.0238	<0.0001	0.319	F1,90 = 42.16, p < .0001
TTIU_ent	KC_sn	0.4133	<0.0001	0.2864	F1,90 = 36.12, p <.0001

Table 5O presents the regression results. The dependent variable is Knowledge Capital, while the independent variable is Technology Transfer in University. Technology Transfer in University - Formal Technology Transfer Activities have a significant positive effect on Knowledge Capital – Technology Value (Regression Coefficient = 0.3491, $p < 0.01$), Knowledge Capital – Education Value (Regression Coefficient = 1.3593, $p < 0.0001$) and Knowledge Capital – Social Network (Regression Coefficient = 0.4778, $p < 0.0001$). Based on the abovementioned regression analysis results, the following hypotheses H1a, H1b and H1c are respectively supported.

H1a: Formal Technology Transfer from University activities is positively related to the EdTech start-ups' technology value.

H1b: Formal Technology Transfer from University activities is positively related to the EdTech start-ups' education value.

H1c: Formal Technology Transfer from University activities is positively related to the EdTech start-ups' social network.

Table 5O also presents a significant positive effect of Technology Transfer in University - Informal Technology Transfer Activities on Knowledge Capital – Technology Value (Regression Coefficient = 0.4236, $p < 0.01$), Knowledge Capital – Education Value (Regression Coefficient = 1.212, $p < 0.01$) and Knowledge Capital – Social Network (Regression Coefficient = 0.4476, $p < 0.01$). Based on the abovementioned regression analysis results, the following hypotheses H1d, H1e and H1f are respectively supported.

H1d: Informal Technology Transfer from University activities is positively related to the EdTech start-ups' technology value.

H1e: Informal Technology Transfer from University activities is positively related to the EdTech start-ups' education value.

H1f: Informal Technology Transfer from University activities is positively related to the EdTech start-ups' social network.

When we measure Technology Transfer in University - Entrepreneurial Activities as the independent variable, the regression analysis records Knowledge Capital – Technology Value (Regression Coefficient = 0.34913, $p < 0.01$), Knowledge Capital – Education Value (Regression Coefficient = 1.0238, $p < 0.01$) and Knowledge Capital – Social Network (Regression Coefficient = 0.4133, $p < 0.01$). Technology Transfer in University - Entrepreneurial Activities demonstrates a significant positive effect on all three variables of Knowledge Capital. Based on the abovementioned regression analysis results, the following hypotheses H1g, H1h and H1i are respectively supported.

H1g: Entrepreneurial Training from University activities is positively related to the EdTech start-ups' technology value.

H1h: Entrepreneurial Training from University activities is positively related to the EdTech start-ups' education value.

H1i: Entrepreneurial Training from University activities is positively related to the EdTech start-ups' social network.

Table 5O also presents the statistics of R-squared and F-statistic. R-squared is a value between 0 and 1 that indicates how well the independent variables in a model explain the variability of the dependent variable. An R-squared value of 0.5 indicates that the model explains 50% of the variability in the dependent variable, meaning that the independent variables account for 50% of the observed variation in the dependent variable. However, R-squared does not indicate whether the coefficients are statistically significant or whether the regression model is the best fit for the data (Chicco *et al.*, 2021). The F-statistic helps determine whether the linear regression model as a whole is statistically significant. It tests the null hypothesis that all regression coefficients are equal to zero against the alternative hypothesis that at least one coefficient is not zero (Alabi *et al.*, 2022).

The F-statistic and the R-squared value are related but serve different purposes. The F-statistic tests the overall significance of the regression model, while the R-squared value measures the proportion of the variance in the dependent variable explained by the independent variables. Therefore, the F-

statistic has similar limitations as R-squared; it does not provide information about the individual significance of the regression coefficients if there are multiple variables in the regression. If the p-value associated with the F-statistic is less than the chosen significance level (usually 0.05 or 5%), then the null hypothesis is rejected, indicating that at least one of the regression coefficients is significantly different from zero (Chicco *et al.*, 2021; Alabi *et al.*, 2022).

In this linear regression, TTIU is the independent variable and KC is the dependent variable. The R-squared recorded in Table 5O range from 0.08949 to 0.3056. The highest value is in TTIU-Informal – KC_ev, which means that TTIU_Informal can explain 30.56% of the variability in the dependent variable. Most of the P-value of the F-statistic <0.0001 means that the null hypothesis is rejected and TTIU's coefficient is significantly different from zero.

Table 5P(i): Regression analysis with Independent Variables (TTIU) and Dependent Variables (KC) on Statistical Program R

```
##
## Call:
## lm(formula = KC ~ TTIU, data = df_num)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -43.289  -7.616   0.439   7.105  33.622
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  56.2416     5.8566   9.603 1.91e-15 ***
## TTIU          0.8698     0.1116   7.793 1.09e-11 ***
## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 13.77 on 90 degrees of freedom
## Multiple R-squared: 0.4029, Adjusted R-squared: 0.3963
## F-statistic: 60.73 on 1 and 90 DF, p-value: 1.088e-11
```

Item responses are typically aggregated to form composite scores, i.e. sum scores, to facilitate the rank-ordering of respondents and analyses of relationships between constructs under the assumption of unit weighting (Jenkins *et al*., 1977; Kelley *et al*., 2016; McClure *et al*., 2024). That is, TTIU is the sum of TTIU_Formal, TTIU_Informal and TTIU-ent, while KC is the sum of KC_tv, KC_ev and KC_sn. The scores of the corresponding questions for smaller-order constructs are summed to obtain composite scores for these constructs. This approach is often justified when the correlation coefficients and Cronbach's alpha among these variables are high and significant. In such cases, a large portion of the variance in the test is attributable to general and group factors, with very little item-specific variance (Cortina, 1993). This indicates a strong correlation between the variables.

When variables within a construct are highly correlated, summing their scores can effectively represent the overall meaning of the construct.

This approach assumes that each variable contributes equally to the construct (Nunnally et al., 1994). There may be an issue with unequal variable importance. The CFA model indicates that the variables exhibit unequal factor loadings, suggesting they contribute differently to the overall construct. Consequently, using a simple sum may not accurately reflect these varying levels of importance (Bandalos, 2018). Additionally, this approach can result in a loss of information, as combining multiple variables into a single composite score can obscure the nuanced information contained in the individual variables (Diamantopoulos & Winklhofer, 2001). Other scholars also described the potential errors of this approach as dimensionality assumption, sensitivity to outliers, ignoring measurement error, ordinal data issues and multicollinearity (Dormann et al., 2013; Hattie, 1985; Joreskog, 1994; Kline, 2023)

Therefore, the CFA model has been analysed to prove the appropriateness in using the sum score for the first-order constructs to get the second-order constructs:

F_TTIU =~ TTIU_formal + TTIU_informal + TTIU_ent

Table 5P(ii): Confirmatory Factor Analysis of TTIU

CFA model		Factor Loadings	P-value	AVE	Cronbach's alpha	CR
TTIU	TTIU_formal	1	<0.0001	0.653	0.839	0.853
	TTIU_informal	1.234	<0.0001			
	TTIU_ent	1.319	<0.0001			

Table 5P(ii) indicates that the average variance extracted (AVE) is 0.653 and the composite reliability (CR) is 0.853. The factor loading coefficients are high, when are all greater than 0.7 (Hair *et al.*, 2014). Here the AVE exceeds 0.50 while the CR surpasses 0.70, the sum or average of the items can serve as a reliable indicator of the latent variable (Bandalos & Finney, 2001).From the regression analysis illustrated in Table 5P(i), we can read the result of the regression as:

KC = 0.8698 * TTIU + 56.2416

And the p-value of the coefficient is $1.09 * 10^{-11}$, which is less than 0.05.

So, we have enough confidence to conclude that TTIU is positively related to KC. Technology Transfer in University demonstrates a significant positive effect on Knowledge Capital. Based on the abovementioned regression analysis results, the hypothesis H1 is respectively supported.

H1: Technology Transfer from University activities is positively related to the EdTech start-ups' Knowledge Capital.

5.2.4.2 Depending Variable: Entrepreneurship Capability

Table 5Q: Results of Regression Analysis for Entrepreneurship Capability

Independent Variable	Dependent Variable	Coefficient	P-value	R-squared	F-statistic
KC_tv	EC_inn	0.57467	<0.0001	0.3715	F1,90 = 53.2, p <.0001
KC_tv	EC_ea	0.60966	<0.0001	0.3069	F1,90 = 39.85, p <.0001
KC_tv	EC_cocreation	0.22626	<0.0001	0.1713	F1,90 = 18.61, p <.0001
KC_ev	EC_inn	0.30682	<0.0001	0.4906	F1,90 = 86.7, p <.0001
KC_ev	EC_ea	0.346	<0.0001	0.4579	F1,90 = 76.03, p <.0001
KC_ev	EC_cocreation	0.16631	<0.0001	0.4289	F1,90 = 67.58, p <.0001
KC_sn	EC_inn	0.6539	<0.0001	0.4046	F1,90 = 61.16, p <.0001
KC_sn	EC_ea	0.80705	<0.0001	0.4523	F1,90 = 74.33, p <.0001
KC_sn	EC_cocreation	0.3742	<0.0001	0.3941	F1,90 = 58.54, p <.0001

Table 5Q presents the regression results. The dependent variable is Entrepreneurship Capability, while the independent variable is Knowledge Capital. Knowledge Capital – Technology Value has a significant positive effect on Entrepreneurship Capability – Innovativeness (Regression Coefficient = 0.575, $p < 0.0001$), Entrepreneurship Capability – Entrepreneurial Attitude (Regression Coefficient = 0.610, $p < 0.0001$) and Entrepreneurship Capability – Co-creation (Regression Coefficient = 0.226, $p < 0.0001$). Based on the abovementioned regression analysis results, the following hypotheses H2a, H2b and H2c are respectively supported.

H2a: Technology value is positively related to the EdTech start-ups' innovativeness.

H2b: Technology value is positively related to the EdTech start-ups' entrepreneurial attitudes.

H2c: Technology value is positively related to the EdTech start-ups' co-creation.

Table 5O also presents a significant positive effect of Knowledge Capital – Education Value on Entrepreneurship Capability – Innovativeness (Regression Coefficient = 0.307, $p < 0.0001$), Entrepreneurship Capability – Entrepreneurial Attitude (Regression Coefficient = 0.346, $p < 0.0001$) and Entrepreneurship Capability – Co-creation (Regression Coefficient = 0.166, $p < 0.0001$). Based on the abovementioned regression analysis results, the following hypotheses H2d, H2e and H2f are respectively supported.

H2d: Education value is positively related to the EdTech start-ups' innovativeness.

H2e: Education value is positively related to the EdTech start-ups' entrepreneurial attitudes.

H2f: Education value is positively related to the EdTech start-ups' co-creation.

When we measure Knowledge Capital – Social Network as the independent variable, the regression analysis records Entrepreneurship Capability – Innovativeness (Regression Coefficient = 0.654, $p < 0.0001$), Entrepreneurship Capability – Entrepreneurial Attitude (Regression Coefficient = 0.807, $p < 0.0001$) and Entrepreneurship Capability – Co-creation (Regression Coefficient = 0.374, $p < 0.0001$). Technology Transfer in University - Entrepreneurial Activities demonstrates a significant positive effect on all three variables of Knowledge Capital. Based on the abovementioned regression analysis results, the following hypotheses H2g, H2h and H2i are respectively supported.

H2g: Social network is positively related to the EdTech start-ups' innovativeness.

H2h: Social network is positively related to the EdTech start-ups' entrepreneurial attitudes.

H2i: Social network is positively related to the EdTech start-ups' co-creation.

Table 5Q also presents the statistics of R-squared and F-statistic to indicate the overall significance of the regression model and the proportion of the variance in the dependent variable explained by the independent variables. In this linear regression, KC is the independent variable and EC is the dependent variable. The R-squared recorded in Table 5Q range from 0.1713 to 0.4906. The highest value is in KC_ev – EC_inn, which means that KC_ev can explain 49.06% of the variability in the dependent variable. All p-value of the F-statistic <0.0001 means that the null hypothesis is rejected and KC's coefficient is significantly different from zero.

Table 5R(i): Regression analysis with Independent Variables (KC) and Dependent Variables (EC) on Statistical Program R

```
## Call:
## lm(formula = EC ~ KC, data = df_num)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -15.1078  -5.3148  0.0575  3.3568  18.8914
##
## Coefficients:
##             Estimate Std.  Error  t value  Pr(>|t|)
## (Intercept)  11.32301      4.11766   2.75   0.00721 **
## KC            0.50982      0.04036  12.63   < 2e-16 ***
## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 6.822 on 90 degrees of freedom
## Multiple R-squared: 0.6394, Adjusted R-squared: 0.6354
## F-statistic: 159.6 on 1 and 90 DF, p-value: < 2.2e-16
```

Similar to Table 5P(i) and (ii), the scores of smaller-order constructs are summed up to represent the scores of a higher-order construct here. Here, KC is the sum of KC_tv, KC_ev and KC_sn, and EC is the sum of EC_inn, EC_ea and EC_cocreation. Given the high correlation coefficients and Cronbach's alpha, the scores of the corresponding questions for smaller-order constructs are summed to obtain composite scores for these constructs to represent the overall meaning of the construct.

F_KC =~ KC_tv + KC_ev + KC_sn

F_EC =~ EC_inn + EC_ea + EC_cc

Table 5R(ii): Confirmatory Factor Analysis of KC and EC

CFA model		Factor Loadings	P-value	AVE	Cronbach's alpha	CR
KC	KC_tv	1	<0.0001	0.747	0.766	0.873
	KC_ev	2.727	<0.0001			
	KC_sn	1.05	<0.0001			
EC	EC_inn	1	<0.0001	0.708	0.831	0.870
	EC_ea	1.126	<0.0001			
	EC_cc	0.518	<0.0001			

Table 5R(ii) indicates that the average variance extracted (AVE) of KC is 0.747 and the composite reliability (CR) is 0.873, and the AVE of EC is 0.708 and CR of EC is 0.870. The factor loading coefficients for KC_tv, KC_ev, KC_sn, EC_inn and EC_ea are high, when are all greater than 0.7 (Hair *et al.*, 2014). The factor loading coefficient for EC_cc is 0.518, which is acceptable (Hair *et al.*, 2010). Here the AVE exceeds 0.50 while the CR surpasses 0.70, the sum or average of the items can serve as a reliable indicator of the latent variable (Bandalos & Finney, 2001).

From the regression analysis illustrated on Table 5R(i), we can read the result of the regression as:

EC = 0.50982 * KC + 11.32301

The regression coefficient is 0.50982 and the p-value of the coefficient is $2.2 * 10^{-16}$, which is less than 0.05.

So, we have enough confidence to conclude that KC is positively affecting EC with significance. The knowledge capital of an EdTech start-up demonstrates a significant positive effect on their entrepreneurial capability. Based on the abovementioned regression analysis results, the hypothesis H2 is respectively supported.

H2: EdTech start-ups' knowledge capital is positively related to their entrepreneurship capability

5.2.4.3 Independent Variable: Absorptive Capability

Table 5S: Results of Regression Analysis for the Direct Effect of Absorptive Capability on Entrepreneurship Capability

Dependent Variables	Entrepreneurship Capability – Innovativeness (EC_inn)		Entrepreneurship Capability – Entrepreneurial Attitudes (EC_ea)		Entrepreneurship Capability – Co-creation (EC_cc)	
Independent Variable	Regression Coefficient	P-value	Regression Coefficient	P-value	Regression Coefficient	P-value
Absorption Capability	0.601	<0.0001	0.669	<0.0001	0.306	<0.0001

Table 5S presents the regression results of the direct effect of absorptive capability of entrepreneurship capability. The dependent variable is Entrepreneurship Capability, while the independent variable is absorption capability. Absorptive capability demonstrates a significant positive effect on Entrepreneurship Capability – Innovativeness (Regression Coefficient = 0.601, $p < 0.0001$), Entrepreneurship Capability – Entrepreneurial Attitude (Regression Coefficient = 0.669, $p < 0.0001$) and Entrepreneurship Capability – Co-creation (Regression Coefficient = 0.306, $p < 0.0001$). Based on the abovementioned regression analysis results, the absorptive capability positively affects the start-up's entrepreneurship capability.

5.2.4.4 Moderating Variable: Absorptive Capacity

Table 5T: Results of Regression Analysis for the Moderating Effect of Absorptive Capacity on the Effects of Knowledge Capital on Entrepreneurship Capability

Dependent Variables	Entrepreneurship Capability – Innovativeness (EC_inn)		Entrepreneurship Capability – Entrepreneurial Attitudes (EC_ea)		Entrepreneurship Capability – Co-creation (EC_cc)	
Independent Variables	Regression Coefficient	P-value	Regression Coefficient	P-value	Regression Coefficient	P-value
Knowledge Capital – Technology Value (KC_tv)	-0.28155	0.5381	1.32563	0.01783	-0.125289	0.7014
Knowledge Capital – Education Value (KC_ev)	0.84945	0.0059	0.6331	0.08404	0.298959	0.1679
Knowledge Capital – Social Network (KC_sn)	-0.75116	0.2434	-1.2688	0.10319	-0.096413	0.8335
Absorptive Capacity (AC)	0.90564	<0.0001	1.18804	<0.0001	0.3039	0.0179

Moderating Effects of Absorptive Capacity						
KC_tv: AC	0.01577 (H3a)	0.3294	-0.0446 (H3b)	0.02372	0.002171 (H3c)	0.8506
KC_ev: AC	-0.02689 (H3d)	0.0117	-0.01916 (H3e)	0.13086	-0.007281 (H3f)	0.3316
KC_sn: AC	0.02422 (H3g)	0.2902	0.04873 (H3h)	0.07902	0.006782 (H3i)	0.6778
*EC_inn ~ KC_tv + KC_ev + KC_sn + AC + AC * KC_tv + AC * KC_ev + AC * KC_sn* *EC_ea ~ KC_tv + KC_ev + KC_sn + AC + AC * KC_tv + AC * KC_ev + AC * KC_sn* *EC_cc ~KC_tv + KC_ev + KC_sn + AC + AC * KC_tv + AC * KC_ev + AC * KC_sn*						

Moderating variables in linear regression influence the strength or direction of the relationship between an independent and dependent variable. They can enhance, reduce, or alter the impact of the independent variable on the dependent variable. The principle of moderation is often tested through an interaction term in the regression model. This interaction term is created by multiplying the independent and moderating variables. Researchers typically employ multiple linear regression analysis to test for moderation and include the interaction term in the model. If the interaction term is statistically significant, the moderating variable affects the relationship between the independent and dependent variables (Makruf, 2019).

On hypothesis H3, this study is interested in the moderating effect of an EdTech Start-up's absorptive capacity on its knowledge capital's influence on entrepreneurship capability. Table 5T presents the regression results of the moderating effect of the absorption capability on the effect of knowledge capital on entrepreneurship capability in EdTech start-ups. The dependent variable is Entrepreneurship Capability, while the independent variable is knowledge capital and absorption capability.

When measuring EC_inn as the dependent variable and KC_tv as the independent variable, the p-value for the moderating effect of AC (KC_tv:AC) recorded 0.3294, which is greater than 0.05. The moderating effect is not significant. When measuring EC_inn as the dependent variable and KC_ev as the independent variable, the p-value for the moderating effect of AC (KC_ev:AC) recorded 0.0177 which is less than 0.05. The moderating effect is significant. The regression coefficient measured a value of -0.02689. The moderating effect of AC on the influence of KC_ev on EC_inn is negative. When measuring EC_inn as the dependent variable and KC_sn as the independent variable, the p-value for the moderating effect of AC (KC_sn:AC) recorded 0.2902, which is greater than 0.05. The moderating effect is not significant. Absorptive capacity does not positively affect the impact of the knowledge capital on the innovativeness of EdTech start-ups. Based on the abovementioned

regression analysis results, the following hypotheses H3a, H3d and H3g are respectively not supported.

H3a: The effect of technological value on an EdTech start-up's innovativeness is positively moderated by the start-up's absorptive capacity. (No significant effect → Hypothesis Rejected)

H3d: The effect of education value on an EdTech start-up's innovativeness is positively moderated by the start-up's absorptive capacity. (Negative moderating effect → Hypothesis not supported)

H3g: The effect of social network on an EdTech start-up's innovativeness is positively moderated by the start-up's absorptive capacity. (No significant effect → Hypothesis Rejected)

When measuring EC_ea as the dependent variable and KC_tv as the independent variable, the p-value for the moderating effect of AC (KC_tv:AC) recorded 0.02372, which is less than 0.05. The moderating effect is significant. The regression coefficient measured a value of -0.0446. The moderating effect of AC on the influence of KC_tv on EC_ea is negative. When measuring EC_ea as the dependent variable and KC_ev as the independent variable, the p-value for the moderating effect of AC (KC_ev:AC) recorded 0.13086, which is greater than 0.05. The moderating effect is not significant. When measuring EC_ea as the dependent variable and KC_sn as the independent variable, the p-value for the moderating effect of AC (KC_sn:AC) recorded 0.07902, which is greater than 0.05. The moderating effect is not significant. Absorptive capacity does not positively affect the impact of the knowledge capital on the entrepreneurial attitudes of EdTech start-ups. Based on the abovementioned regression analysis results, the following hypotheses H3b, H3e and H3h are respectively not supported.

H3b: The effect of technological value on an EdTech start-up's entrepreneurial attitudes is positively moderated by the start-up's absorptive capacity. (Negative moderating effect → Hypothesis not supported)

H3e: The effect of education value on an EdTech start-up's entrepreneurial attitudes is positively moderated by the start-up's absorptive capacity. (Not significant effect → Hypothesis Rejected)

H3h: The effect of social network on an EdTech start-up's entrepreneurial attitudes is positively moderated by the start-up's absorptive capacity. (Not significant effect → Hypothesis Rejected)

When measuring EC_cc as the dependent variable and KC_tv as the independent variable, the p-value for the moderating effect of AC (KC_tv:AC) recorded 0.8506, which is great than 0.05. The moderating effect is not significant. When measuring EC_cc as the dependent variable and KC_ev as the independent variable, the p-value for the moderating effect of AC (KC_ev:AC) recorded 0.3316, which is greater than 0.05. The moderating effect is not significant. When measuring EC_cc as the dependent variable and KC_sn as the independent variable, the p-value for the moderating effect of AC (KC_sn:AC) recorded 0.6778, which is greater than 0.05. The moderating effect is not significant. Absorptive capacity does not positively affect the impact of the knowledge capital on the co-creation performance of EdTech start-ups. Based on the abovementioned regression analysis results, the following hypotheses H3b, H3e and H3h are respectively not supported.

H3c: The effect of technological value on an EdTech start-up's co-creation is positively moderated by the start-up's absorptive capacity. (Not significant effect → Hypothesis Rejected)

H3f: The effect of education value on an EdTech start-up's co-creation is positively moderated by the start-up's absorptive capacity. (Not significant effect → Hypothesis Rejected)

H3i: The effect of social network on an EdTech start-up's co-creation is positively moderated by the start-up's absorptive capacity. (Not significant effect → Hypothesis Rejected)

Table 5U: Regression Analysis on the Moderating effect of AC on Independent Variables (KC) and Dependent Variables (EC) on Statistical Program R

```
##
## Call:
## lm(formula = EC ~ KC + AC + AC * KC, data = df_num)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -11.5648  -4.1193   0.3144   3.8967  10.8469
##
## Coefficients:
##              Estimate Std.  Error  t value  Pr(>|t|)
## (Intercept) -16.559642   6.661858  -2.486   0.0148 *
## KC            0.632312   0.089481   7.066   3.57e-10 ***
## AC            2.103221   0.327466   6.423   6.62e-09 ***
## KC:AC        -0.014820   0.003273  -4.528   1.86e-05 ***
## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 5.609 on 88 degrees of freedom
## Multiple R-squared: 0.7616, Adjusted R-squared: 0.7535
## F-statistic: 93.71 on 3 and 88 DF, p-value: < 2.2e-16
```

We further analyse the absorptive capacity with the regression analysis to support the moderating effect of AC:

$$EC \sim KC + AC + AC * KC$$

Let me first interpret the "AC*KC". This is called the interaction term in the regression. The interaction term is used in the situation of $A \overset{C}{\downarrow} \rightarrow B$. That is, study the impact of C on the impact of A on B. This is exactly what we want to do with KC, AC and EC.

From the regression analysis illustrated in Table 5T, we can read the result of the regression as:

$$EC = 0.632312 * KC + 2.103221 * AC + -0.014820 * AC * KC - 16.559642$$

And the p-value of the coefficient is $2.2 * 10^{-16} < 0.05$. From the result of the regression, KC and AC positively affect EC with significance.

As statistics only calculate correlations, we can also interpret the situation of $C \overset{A}{\downarrow} \rightarrow B$. From the interaction term's coefficients, AC negatively affects KC's effect on EC with significance, which goes against our intuition. We can interpret it in a different way. KC negatively affects AC's effect on EC with significance, which means the company with a higher KC, the effect of AC on EC will get lower. That is more intuitive.

Based on the abovementioned regression analysis results, the following hypothesis H3 is not supported.

> H3: The effect of knowledge capital on an EdTech start-up's entrepreneurship capability is positively moderated by the start-up's absorptive capacity. (Negative moderating effect → Not supported)

Hierarchical regression is introduced in this analysis to study the moderating effect of absorptive capacity more comprehensively (Lee & Song, 2015; Lukito-Budi *et al.*, 2022; Salam & Bajaba, 2023; Zahra & Hayton, 2008). It is a statistical technique employed to explore the relationship between a dependent variable and one or more independent variables, while also considering the impact of additional variables (Hayes, 2022). Hierarchical regression models can yield stabilization of estimated parameters and may permit evaluation of effect-measure modifiers in settings where such estimates would be excessively unstable if the outcome types were modelled one at a time (Richardson *et al.*, 2015). Hierarchical regression is an appropriate tool for analysis when the variance in a criterion variable is explained by predictor variables that are correlated with each other (Pedhazur,

1982). Hierarchical regression attempts to enhance standard regression estimates by incorporating a second-stage regression into the ordinary model, offering a practical approach for evaluating multiple exposures (Witte & Greenland, 1996). Hierarchical regression is a widely used technique for assessing the impact of a predictor variable while controlling for other variables. This method is valuable for evaluating the additional contributions of predictors beyond those already included, serving as a tool for statistical control, and examining incremental validity (Lewis, 2007). Hierarchical regression is with the assumptions of (i) linearity - the relationship between the dependent and independent variables is linear; (ii) reliability of measurement – all the variables are measured without error; (iii) homoscedasticity - variance of errors is constant, and (iv) normality - errors of the model are normally distributed (Berndt & Williams, 2013).

When investigating the effect of a moderating variable on the relationship between an independent variable and a dependent variable, an interaction term is typically included in the regression model (Hayes, 2022; Zahra & Hayton, 2008). In the EC_inn model, all independent variables are included , entering the main effects and two-way interactions, without the moderation as the step 1 model (Hayes, 2022; Luk, *et al*., 2008; Zahra & Hayton, 2008):

EC_inn ~ KC_tv + KC_ev + KC_sn + AC

Then in the second step in each model, the moderating variables joined together with one independent variable and one dependent variable in different equations, i.e. the relevant three-way interactions (Luk, *et al*., 2008; Lukito-Budi *et al.*, 2022; Zahra & Hayton, 2008). That is AC*KC_tv, AC*KC_ev and AC*KC_sn are added separately to form step 2 models and used ANOVA to compare with the primary model to check the F-values and changes in R-squared (Hayes, 2022; Luk, *et al*., 2008; Zahra & Hayton, 2008).

Similarly, the step 1 model for EC_ea is:

EC_ea ~ KC_tv + KC_ev + KC_sn + AC

AC*KC_tv, AC*KC_ev and AC*KC_sn are added separately to form step 2 models.

The step 1 model for EC_cc is:

EC_cc ~ KC_tv + KC_ev + KC_sn + AC

AC*KC_tv, AC*KC_ev and AC*KC_sn are added separately to form step 2 models.

Under the null hypothesis that the moderating variable AC does not linearly moderate the effect of independent variable KC on dependent variable EC, the secondary model should not fit better than the original one. That is, if the null hypothesis is true, adding the product term will not produce a

model that provides any new information about individual differences in dependent variable EC provided by the original model. The difference in the squared multiple correlations, ΔR^2, is a descriptive measure of how much better the secondary model fits in relative to the original model. The F-statistic is used to test whether the addition of the interaction term significantly improves the model (Hayes, 2022). A p-value less than 0.05 suggests that the interaction term significantly enhances the model fit. This implies that the interaction term plays a crucial role in explaining the variability of the dependent variable (Zahra & Hayton, 2008). This analysis aims to examine the significance and impact of this interaction term in the hierarchical regression.

Table 5V: Hierarchical Regression Analysis on the Moderating effect of AC on Independent Variables (KC) and Dependent Variables (EC) on Statistical Program R

	EC_inn model	EC_ea model	EC_cc model
Constant	3.02912	5.55931*	.73719
Step 1			
KC_tv	.20933*	.14858	-.04754
KC_ev	.09349	.10341	.09508**
KC_sn	-.00149	.23060	.12010
AC	.3764**	.31621**	.12324*
Step 2			
AC*KC_tv	.01577	-.04460*	.002171
AC*KC_ev	-.02689*	-.01916	-.007281
AC*KC_sn	.02422	.04873	.006782
Model Statistics			
R-squared of equation	.6861	.6658	.5227
R-squared change ΔR^2	.0629	.0918	.0186
d.f.s of ΔR^2	3	3	3
F-statistic	5.6062**	7.6921**	1.091
* p < .05; ** p < .01.			

Table 5V presents the results of the moderated regression models analyzed using hierarchical regression analysis. In the EC_inn model, the interaction term AC*KC_ev for related knowledge capital – education value and absorptive capacity is significant (p < .05), but in the negative direction. The other interaction terms AC*KC_tv and AC*KC_sn are not significant. The EC_inn model itself is significant (p < .05), adding 6.29% to the variance explained by the model.

In the EC_ea model, the interaction term AC*KC_tv for related knowledge capital – technology value and absorptive capacity is significant (p < .05), but in the negative direction. The other interaction terms AC*KC_ev and AC*KC_sn are not significant. The EC_ea model itself is significant (P < .05), adding 9.18% to the variance explained by the model.

Conversely, the analyses of all three models of EC_cc in Table 5V do not reach statistical significance. The statistical results of the hierarchical regression analysis also suggest that hypotheses H3b and

H3d are in significant negative direction, i.e. the hypotheses are not supported. In the meanwhile, other sub-hypotheses of H3 are not statistically significant that they are rejected.

5.2.4.5 Importance of Variables of Knowledge Capital

Regression analysis is indeed one of the most commonly used statistical methods in various fields of study. One of the key aspects of the research question that often arises in regression analysis is identifying which predictors (or regressors) are the most important or establishing a ranking of the regressors based on their importance (Bring, 1994; Grömping, 2015). However, most traditional regression models, including linear regression, are not specifically designed to address this question of variable importance (Grömping, 2015). Measuring variable importance for computational models or measured data is an important task in many applications (Wei *et al.*, 2015). To begin with, it's crucial to understand that the importance or significance of a variable in a model cannot be ascertained simply by comparing regression coefficients. The reason behind this is that different variables have different units of measurement, which makes direct comparisons impracticable and misleading. Furthermore, it's also not appropriate to gauge the importance of a variable by comparing p-values (Van der Lann, 2006). p-values are calculated based on a variety of properties as an objective measure of inductive evidence, but the significance or importance of the variable is not one of these properties (Hubbard & Lindsay, 2008). Lower p-values mainly indicate aspects other than variable importance - for instance, they could reflect the precision of estimates or the size of the sample used in the study. Therefore, when it comes to measuring the importance of variables, there are two primary methods that should be considered.

(a) Standardized Regression Coefficients

Standardised Regression Coefficients are one of the frequently adopted measurements of the relative importance of different variables in quantitative studies (Bring, 1994). One of the challenges in comparing regression coefficients to determine the significance of a variable is that they are often on different scales due to the differing units of measurement. This can make direct comparisons misleading or incorrect. However, this issue can be addressed through standardization of the regression coefficients. By bringing them onto the same scale, a fair comparison becomes possible. In this standardized format, the coefficients can be directly compared, which can provide valuable insight into the relative importance of the variables in the model.

Here is the result of the standardized regression:

EC ~ KC_tv + KC_ev + KC_sn + AC

EC ~ -1.422e-16 + 1.338e-01 *KC_tv+ 2.709e-01 *KC_ev+ 1.381e-01 *KC_sn+ 4.062e-01 *AC

According to the absolute values of their standardized regression coefficients, the order of importance from high to low is KC_ev, KC_sn, KC_tv.

(b) Change in R-squared - when the variable is added to the model last

Another way to determine the importance of a variable is to calculate the increase in the R-squared value that occurs when each variable is added to a model that already includes all the other variables (Bring, 1994; Rights J& Sterba, 2020; Jiang & Smith, 2002). The R-squared value, also known as the coefficient of determination, is a statistical measure that shows the proportion of the variance for a dependent variable that's explained by an independent variable or variables in a regression model. In this context, the change in the R-squared value signifies how much unique variance each variable can explain that was not already accounted for by the other variables in the model (Lewis-Beck *et al.*, 1990). The bigger the increase in the R-squared value, the more important or significant the variable can be considered, as it explains a larger amount of unique variance (Rights & Sterba, 2020). This method can help in identifying the variables that contribute most to the model.

The change in R-squared when the variable, KC_tv, KC_ev and KC_sn is added to the model last are 0.009736247, 0.02384014 and 0.006458187, respectively. By comparing the numbers, the order of importance from high to low is KC_ev, KC_tv, KC_sn.

Both calculations of (a) and (b) supported that Education Value (KC_ev) has the highest variable importance among the variables of Knowledge Capital.

Chapter 6. Discussions of Results

Table 5B reports the descriptive information and key points covered in the in-depth qualitative interview of the five start-ups, which are active and experienced in technology transfer collaboration with universities. Table 5G presents the reliability and validity, in terms of coefficients for factor loading, Cronbach's alpha, composite reliability and confirmatory factor analysis, of the constructs Technology Transfer in University, Knowledge Capital, Entrepreneurship Capability, and Absorption Capability and the underlying variables. Table 5H to Table 5N summaries the correlation coefficients of each construct and across the constructs. Table 5O and Table 5P report the regression analysis results. Overall speaking, the quantitative results, which are based on an instrument supported by the qualitative results, support the research model. The overall fit indicates a sufficient degree of support to the hypotheses. The results support a good degree of the main idea on which this study is based: the technology transfer activities in universities enhance the knowledge capital, which then positively affects the entrepreneurship capability of EdTech start-ups in Hong Kong.

Chapter 4 presents three hypotheses and their sets of sub-hypotheses. This chapter discusses further the hypotheses with reference to the research questions in correspondence.

Research questions:

1. *How does university knowledge help an EdTech business in the start-up life cycle?*
2. *What are the differences in the effects of a university's technology invention and intervention innovation on EdTech start-ups?*

6.1 Synthesis of Hypothesis Tests

Chapter 5.2.4 reports the regression analysis results. The results indicate the key findings of this study as follows.

Formal technology transfer in university is positively affecting all the technology value, education value and social network of EdTech start-ups. These strengthen their knowledge capital. Informal technology transfer in university is positively affecting all the technology value, education value and social network of EdTech start-ups. These strengthen their knowledge capital. Entrepreneurial training is positively affecting all the technology value, education value and social network of EdTech start-ups. These improve their knowledge capital. The hypotheses H1a to H1i are supported.

In the correlations of knowledge capital and entrepreneurship capability, the technology value of an EdTech start-up is positively related to the performance of innovativeness, entrepreneurial attitudes, and co-creation. Technology value strengthens the EdTech start-ups' entrepreneurship capability. Besides, the education value of an EdTech start-up is positively related to the performance of

innovativeness, entrepreneurial attitudes, and co-creation. Education value strengthens the EdTech start-ups' entrepreneurship capability. Moreover, the social network of an EdTech start-up is positively related to the performance of innovativeness, entrepreneurial attitudes, and co-creation. Technology value strengthens the EdTech start-ups' entrepreneurship capability.

Hypotheses	Results
H1a: Formal Technology Transfer from University activities is positively related to the EdTech start-ups' technology value.	Supported
H1b: Formal Technology Transfer from University activities is positively related to the EdTech start-ups' education value.	Supported
H1c: Formal Technology Transfer from University activities is positively related to the EdTech start-ups' social network.	Supported
H1d: Informal Technology Transfer from University activities is positively related to the EdTech start-ups' technology value.	Supported
H1e: Informal Technology Transfer from University activities is positively related to the EdTech start-ups' education value.	Supported
H1f: Informal Technology Transfer from University activities is positively related to the EdTech start-ups' social network.	Supported
H1g: Entrepreneurial Training from University activities is positively related to the EdTech start-ups' technology value.	Supported
H1h: Entrepreneurial Training from University activities is positively related to the EdTech start-ups' education value.	Supported
H1i: Entrepreneurial Training from University activities is positively related to the EdTech start-ups' social network.	Supported
H2a: Technology value is positively related to the EdTech start-ups' innovativeness	Supported
H2b: Technology value is positively related to the EdTech start-ups' entrepreneurial attitudes.	Supported
H2c: Technology value is positively related to the EdTech start-ups' co-creation.	Supported
H2d: Education value is positively related to the EdTech start-ups' innovativeness.	Supported
H2e: Education value is positively related to the EdTech start-ups' entrepreneurial attitudes.	Supported
H2f: Education value is positively related to the EdTech start-ups' co-creation.	Supported

H2g: Social network is positively related to the EdTech start-ups' innovativeness.	Supported
H2h: Social network is positively related to the EdTech start-ups' entrepreneurial attitudes.	Supported
H2i: Social network is positively related to the EdTech start-ups' co-creation.	Supported
H3a: The effect of technological value on an EdTech start-up's innovativeness is positively moderated by the start-up's absorptive capacity.	Rejected
H3b: The effect of technological value on an EdTech start-up's entrepreneurial attitudes is positively moderated by the start-up's absorptive capacity.	Not Supported (Negative moderating effect)
H3c: The effect of technological value on an EdTech start-up's co-creation is positively moderated by the start-up's absorptive capacity.	Rejected
H3d: The effect of education value on an EdTech start-up's innovativeness is positively moderated by the start-up's absorptive capacity.	Not Supported (Negative moderating effect)
H3e: The effect of education value on an EdTech start-up's entrepreneurial attitudes is positively moderated by the start-up's absorptive capacity.	Rejected
H3f: The effect of education value on an EdTech start-up's co-creation is positively moderated by the start-up's absorptive capacity.	Rejected
H3g: The effect of social network on an EdTech start-up's innovativeness is positively moderated by the start-up's absorptive capacity.	Rejected
H3h: The effect of social network on an EdTech start-up's entrepreneurial attitudes is positively moderated by the start-up's absorptive capacity.	Rejected
H3i: The effect of social network on an EdTech start-up's co-creation is positively moderated by the start-up's absorptive capacity.	Rejected

The following conclusions are used to respond to the research questions.

Research question one:

1. *How does university knowledge help an EdTech business in the start-up life cycle?*

Table 5N reports significant correlations between technology transfer in university and the entrepreneurship capability of a start-up. The regression analysis supports that formal technology transfer in a university positively impacts the social network of an EdTech start-up, informal technology transfer in a university positively impacts the social network of an EdTech start-up, and entrepreneurship training in a university positively impacts the social network of an EdTech start-up. These are represented in the hypotheses H1c, H1f and H1i.

H1c: Formal Technology Transfer from University activities is positively related to the EdTech start-ups' social network.

H1f: Informal Technology Transfer from University activities is positively related to the EdTech start-ups' social network.

H1i: Entrepreneurial Training from University activities is positively related to the EdTech start-ups' social network.

As one of the key elements of the knowledge capital of a start-up in the EdTech field, social network demonstrates positive advantages on the firm's innovativeness; social network demonstrates positive advantages on the firm's entrepreneurial attitude; and social network demonstrates positive advantages on the firm's co-creation performance. These are represented in hypotheses the H2g, H2h and H2i.

H2g: Social network is positively related to the EdTech start-ups' innovativeness.

H2h: Social network is positively related to the EdTech start-ups' entrepreneurial attitudes.

H2i: Social network is positively related to the EdTech start-ups' co-creation.

Research question 2:

2. *What are the differences in the effects of university's technology invention and intervention innovation on EdTech start-ups?*

Table 5O illustrates the regression coefficients of knowledge capital of EdTech start-ups as the dependent variables against technology transfer in university as the independent variables. All the regression coefficients demonstrate positive values, so technology transfer activities in universities positively inform the knowledge capital of EdTech start-ups. These are represented in the hypotheses H1a to H1i.

H1a: Formal Technology Transfer from University activities is positively related to the EdTech start-ups' technology value.

H1b: Formal Technology Transfer from University activities is positively related to the EdTech start-ups' education value.

H1c: Formal Technology Transfer from University activities is positively related to the EdTech start-ups' social network.

H1d: Informal Technology Transfer from University activities is positively related to the EdTech start-ups' technology value.

H1e: Informal Technology Transfer from University activities is positively related to the EdTech start-ups' education value.

H1f: Informal Technology Transfer from University activities is positively related to the EdTech start-ups' social network.

H1g: Entrepreneurial Training from University activities is positively related to the EdTech start-ups' technology value.

H1h: Entrepreneurial Training from University activities is positively related to the EdTech start-ups' education value.

H1i: Entrepreneurial Training from University activities is positively related to the EdTech start-ups' social network.

In terms of the magnitude of the regression coefficients, the regression coefficients of formal technology transfer activities, informal technology transfer activities, and entrepreneurial activities are significantly higher in education value than those in technology value. The impact of technology transfer in university is positively stronger on education value than on the technology value of the EdTech start-ups. The magnitude of the regression coefficients of formal technology transfer activities, informal technology transfer activities and entrepreneurial activities are all higher on the social network than those on the technology value, but lower than those on education value. The impact of technology transfer in university is positively stronger on social network than on technology value, but not as strong as those on education value.

6.2 Effects of Technology Transfer Activities in Universities on Technology Value of an EdTech Start-up

Universities serve as a rich reservoir of knowledge and technological advancements, all of which are substantiated by scientific research and evidence (Markman *et al*., 2005; Wang and Liu, 2022; Tsui

et al., 2020). From the perspective of public policy, the traditional justification for using taxpayer funds to support basic research in universities is the investment return to society (Markman, G. D., *et al*., 2005). They are societal investments that hold immense potential for validation and the generation of returns, primarily through economic impact and the creation of innovative enterprises (Tsui *et al.*, 2020). Traditionally, commercial entities have utilized technological innovations from universities through formal technology licensing (Markman *et al*., 2005). This approach carries several advantages for businesses. Firstly, it reduces the time and cost associated with research and product development. Secondly, it enables companies to leverage the university's brand recognition and endorsement, which can enhance the credibility of their products in the market and among the public (Markman *et al*., 2005; Martínez-Cañas *et al*., 2012). In instances where the knowledge available in universities does not seamlessly fit into the company's existing framework, companies can collaborate with university researchers to modify and enhance the knowledge to align with their commercial needs. Such collaborations typically take one of two forms. In the first, known as contract research, the commercial entity fully funds the required research and development and retains complete ownership of the intellectual property rights and commercial rights. In the second form, known as collaborative research, the commercial entity partially funds the research and development, resulting in shared intellectual property rights with the participating universities. Such formal partnerships for translational research can also benefit from public funding in the form of matching funds. This potential for financial support makes formal technology transfer an attractive proposition for EdTech start-ups, according to interviews conducted for this study. Companies can also engage universities for consultancy services to assess the effectiveness of their in-house technology (Wright *et al.,* 2008; European Commission, 2009; Holi *et al.,* 2008). For EdTech start-ups, which often face constraints in terms of resources and expertise, these formal technology transfer activities provide a less expensive and faster way to develop their technological capabilities or even launch their first product in the market (Etzkowitz 2003; Markman *et al*., 2005; Tsui *et al*., 2020;).

As technology-based entities, EdTech start-ups must keep pace with global technology trends. SMEs and start-ups are striving for specialization and innovation in small markets in technology-intensive industries for sustainable growth of business (Zakery & Mohammad, 2021). Seminars, conferences, and industry gatherings provide an ideal platform for these start-ups to access current, high-quality information and to access tacit knowledge that surrounds formalized technology transfer for incorporating knowledge into the start-up's research and development processes (Grimpe and Hussinger, 2013). Unlike similar activities organized by a commercial entity, universities' informal technology transfer activities are usually more diverse in terms of sources of technology information, and the background of participating technology experts (University Grants Committee, 2022; Tsui *et*

al., 2020). The involvement of university technologists and scientists can facilitate a clearer understanding of the technology in question and provide an unbiased perspective on commercial technologies. Technology transfer experts at universities can also help match technologies with suitable companies (Grimpe & Hussinger, 2013). This can be particularly beneficial for EdTech start-ups that may not have a deep understanding of the technology landscape.

In this study, a significant proportion of entrepreneurs in the EdTech sector do not come from a technological background. Entrepreneurial training schemes and incubation programs offered by universities can serve as gateways into the world of technology for these individuals. Furthermore, EdTech start-ups often partner with academic programs at universities to offer project-based classes. They use this collaboration model to connect with a pool of talented students in engineering, programming, and scientific disciplines, thereby obtaining the technology puzzle of their internal competency and addressing their technological needs.

Both formal and informal technology transfer initiatives, along with entrepreneurial activities at universities, equip EdTech start-ups with new resources for technological solutions, expertise, and market information, thereby enhancing their overall technological value. However, in the EdTech sector, technology is not the only driver of innovation and business development. EdTech start-ups may not necessarily need the most advanced, cutting-edge technology, as such technology can be expensive and technically challenging for users, trainers, and learners to adopt. The evaluation of EdTech solutions should be broadened to include considerations of the relationships between humans and education, humans and technology, and education and technology. Technology should not be viewed solely as a tool for efficiency. Instead, it should be recognized as a 'handy' resource that caters to people's educational needs. This perspective acknowledges the vital role that technology plays in enhancing learning experiences, facilitating educational access, and meeting diverse educational requirements. (An, 2021). Often, mature, readily available technological solutions can be the best option for EdTech start-ups. As a result, they may not be as eager to adopt the most advanced technologies from universities as businesses in traditional deep-technology industries or emerging technology industries would be.

6.3 Effects of Technology Transfer Activities in Universities on Education Value of an EdTech Start-up

Typically, start-ups turn to universities as a source of advanced technology and scientific knowledge to enhance or facilitate their products or processes. Firms are compelled to augment their R&D capacity by collaborating and sourcing-in (i.e. purchase, license, and co-develop) discoveries, inventions, and innovations (Markman *et al.*, 2008). University science and inventions are considered to be among the most important knowledge sources for innovation activities (Grimpe & Hussinger,

2013). However, in the realm of the EdTech sector, the focus shifts somewhat and the educational elements are as critical, or perhaps even more significant, than technological aspects. Creativity and innovation in fields other than technology are crucial for the development and implementation of business models of SMEs and start-ups in knowledge-intensive industries (Zakery & Mohammad, 2021). In Hong Kong, a majority of university students trained in education gravitate towards professional teaching roles in schools, primarily due to job security and attractive salaries. Consequently, a notable proportion of founders or members of the founding teams of EdTech start-ups hail from non-educational backgrounds. The knowledge gained from informal transfer limits competitors' opportunities for imitation (Grimpe & Hussinger, 2013). This creates a unique demand within the EdTech start-up ecosystem. Specifically, there is a pressing need for these start-ups to seek innovative, evidence-based educational solutions from universities. These solutions serve as the bedrock upon which they build their EdTech ventures. In essence, they rely on the wealth of educational research and innovation within universities to provide the educational foundation necessary to underpin their businesses. In doing so, they ensure their offerings are not just technologically sound but also educationally robust and effective.

Similar to the acquisition of technological value, start-ups can also bolster their educational value through formal technology transfer activities, informal technology transfer activities, and entrepreneurial initiatives within universities. The education sector is the primary market of most start-ups in the field of EdTech in Hong Kong. Education knowledge is the market knowledge for these start-ups. Every company needs to know the market it wants to enter. Market recognition can be rendered as the knowledge and value of a company in understanding the market, communicating with the stakeholders, workforce conditions and relations, supply chain and value chain, and importantly the knowledge brings new products and services, etc (Zakery & Mohammad, 2021). In Hong Kong, for instance, university researchers are actively involved in the research and development of educational materials and pedagogical tools. EdTech start-ups can license these resources, incorporating them into their own offerings to bolster their educational value. In particular, EdTech start-ups whose founding teams predominantly comprise individuals from technological backgrounds often collaborate with scholars specializing in education. These collaborations can serve multiple purposes. They can help validate the educational impact of their technology-based products, refine these products to better align with real-world educational contexts, and develop resources that transform industrial, and scientific applications into tools for educational purposes. Such collaborations are typically governed by formal agreements or contracts (Vega-Gomez *et al.,* 2021). Whether these collaborations involve contract research, collaborative research, or consultancy services, they are always formalized through written agreements. These agreements ensure clarity

and mutual understanding between the parties involved, outlining responsibilities, expectations, and ownership of any resulting intellectual property (Grimpe & Hussinger, 2013).

The success of knowledge transfer and transformation in a company is not solely because of the technological means (Liao *et al*., 2007). EdTech integrates three conceptions and modes: visual instruction, personalized systems, and systematic methods of evaluation. EdTech is considered to be the educational application of technology to improve the efficiency of education, which it achieves by virtue of the functionality provided by the material of new technologies (An, 2021). The educational product market is a complex ecosystem that extends beyond the conventional buyer-seller dynamic (Mattsson and Andersson, 2019). With competing marketing claims and a lack of trust in vendors, it can be difficult for schools and individual end-users to identify the best solutions for their specific needs (Viner, 2023). Decision-makers in a sale can be different from the end-users or the individuals or entities who finance the purchase. In places like Hong Kong, the school market is a blend of private and public funding, further complicating the picture. Informal technology transfer activities such as conferences, seminars, and workshops involving industry and university collaborations provide crucial platforms for EdTech start-ups. These platforms enable start-ups to gather essential market information and gain insights into the interests and concerns of various stakeholders in the EdTech market. These activities provide a space for start-ups to understand the intricate dynamics of the educational product market. They can discern the priorities of different stakeholders – from the educators who use the products, the administrators who decide on the purchases, the students who are the end-users, to the governmental bodies and private entities that may finance these purchases (Dexter *et al.*, (2021). This understanding is vital for start-ups to tailor their products and strategies effectively, ensuring they meet the needs and expectations of this multifaceted market.

Team formation is a crucial aspect of entrepreneurial training. It involves bringing together individuals with diverse skills and backgrounds to create a well-rounded and effective team (Li. *et al.,* 2019). Networking events such as mixers provide an excellent platform for individual entrepreneurs or existing start-up teams to find potential members who can fill skill gaps within their teams. During these networking events, individuals with an educational background can interact with professionals from diverse fields such as business, science, and technology (Bell & Bell, 2023). These interactions offer opportunities for knowledge exchange, collaboration, and the formation of partnerships. Conversely, start-up teams primarily composed of individuals with a technological background can benefit significantly from these events. They can connect with experts in education who can bring a new dimension of understanding and value to their teams. By incorporating educational expertise, these start-ups can enhance their products or services, making them more

effective and relevant in the educational sector. In essence, these networking opportunities facilitate the cross-pollination of ideas and expertise, leading to more innovative and impactful EdTech solutions.

6.4 Effects of Technology Transfer Activities in Universities on Social Network of an EdTech Start-up

Social networking plays a crucial role in the growth and success of a start-up, providing valuable connections to potential clients, business partners, and investors. Many universities have established incubators to foster the creation of start-up companies based on university-owned (or licensed) intellectual properties (Markman *et al.*, 2008). Network relationships are a significant feature of today's business environment (Fan *et al.*, 2023). It enables start-ups to expand their visibility, reach out to prospective customers, and establish relationships with potential business collaborators. Furthermore, it opens up avenues to attract investment by putting start-ups in touch with individuals or entities willing to support their business ventures financially. In essence, social networking can be a powerful tool for start-ups, facilitating essential relationships and opportunities for growth and success. A good social network can expedite market and product development, reducing both the time and costs associated with these processes. However, the social network is usually limited for start-ups that the company's brand or even the innovative products are new to the market. Building up such a network can be challenging, particularly when their brand or innovative products are new to the market. In such cases, their social reach may be limited due to a lack of recognition or trust. However, it can be clear that it is important to build and use social network (Durda & Ključnikov, 2019). Collaborating with universities through technology transfer initiatives can help overcome this challenge. Universities are often trusted institutions with extensive networks and public credibility. By partnering with these institutions, start-ups can leverage this trust and recognition to expand their own network. This collaboration not only provides access to valuable resources and expertise but also helps start-ups build relationships with potential clients, partners, and investors within the university's network. Thus, university collaboration can be a strategic move for start-ups to establish and expand their social network.

EdTech start-ups involved in the in-depth interview of this study described how their partners in universities link up their collaboration with the industries, education sectors and schools. Under formal technology transfer activities, university scholars often serve as the principal investigators of specific projects. Even though they may not always retain the intellectual property rights to their work, which could belong to the university or other entities, these scholars still bear the responsibility of promoting their projects whenever possible. Scholars can showcase the outcomes of their projects in various ways. They can reference them in their research papers, discuss them during conference

speeches, or highlight them in public talks. This promotion helps to increase the visibility and recognition of their work, contributing to its potential impact and application. In addition, TTOs also play a crucial role in marketing these project outcomes. They might feature the projects in exhibitions, media interviews, and seminars, among other marketing channels (University Grants Committee, 2022; AUTM., 2014). These promotional activities help to disseminate the project outcomes to a broader audience, including potential collaborators, investors, and end-users. Through these combined efforts, both scholars and TTOs can effectively promote the outcomes of technology transfer projects, enhancing their potential for success and impact.

Start-ups are frequently invited to participate in informal technology transfer activities hosted by universities, where they can present their collaborative achievements and future plans. These events provide a unique opportunity for EdTech start-ups to engage with stakeholders from both the education and technology sectors at a relatively low cost. Through these platforms, start-ups can reach a diverse audience, including educators, administrators, investors, and other potential partners. This exposure allows them to explain the necessity of their products, demonstrate their functionality, and highlight how their solutions can address specific challenges in the education sector. Moreover, these events provide an excellent platform for start-ups to receive feedback and insights from these various stakeholders. This feedback can be invaluable in refining their products and strategies, ensuring they are effectively meeting the needs and expectations of their target audience. In essence, these informal technology transfer activities can play a crucial role in helping start-ups educate the market about their offerings and ultimately, succeed in the complex education market.

6.5 Effects of Knowledge Capitals on the Innovativeness of an EdTech Start-up

Innovativeness of a company can be at the level of its product innovativeness, process innovativeness and market innovativeness (Rauch, *et al.*, 2009; Miller, 2011). It is the primary motivation to start up a new business (Mueller *et al.*, 2001). For EdTech start-ups, the combination of technology value and education value is the rule of thumb for developing innovative products. This blend allows them to integrate technology effectively in the delivery of educational content, creating unique and impactful learning solutions. In addition, the combination of technology and education value also empowers EdTech start-ups to enhance their business operations (An, 2021). For instance, using AI technology to generate educational materials can significantly reduce the time and costs associated with achieving personalized learning. This process innovation can streamline operations, improve efficiency, and lead to better learning outcomes. Moreover, this mix of technology and education value can also enable EdTech start-ups to be innovative in the market. They can identify and create new markets, cater to underserved segments, and develop unique business models. Ultimately, the

fusion of technology and education value is what equips EdTech start-ups to be innovative on multiple fronts, driving their growth and success in a competitive market.

A robust social network can be a significant asset for a start-up. It can provide a broader understanding of various industries, highlight potential intersections across different sectors, and reveal opportunities for entering new markets. In the context of EdTech, this is particularly valuable due to the unique dynamics of the education market, where the buyer-seller relationship is often indirect or multi-layered, and of the interaction between private business suppliers and public service providers (Mattsson and Andersson, 2019). For example, a charity might fund the purchase of an EdTech start-up's services, which are then provided free of charge to a number of school students during classes, school times or at home. In such scenarios, the start-up's actual 'customer' may be the charity, but the end-users are the schools. Understanding these dynamics is crucial for navigating the market effectively. A good social network can provide insights into these complexities, allowing the start-up to tailor its strategies accordingly and maximize its impact. Hence, building and maintaining a strong social network can be a key factor in an EdTech start-up's success.

Another common scenario in the EdTech industry is that schools may recommend certain educational products, but the financial responsibility often falls on the parents to purchase these for their children's use. This situation introduces another layer of complexity to the buyer-seller relationship, as the decision-makers (schools) and the payers (parents) are different entities. With robust resources in technology, education, and networking, an EdTech start-up can navigate this complex landscape and carve out new markets for its products. They can leverage their technological capabilities to develop innovative solutions, utilize their educational expertise to ensure their products align with educational needs, and rely on their network to understand market dynamics and reach the right audiences. By understanding the unique dynamics of the EdTech market and leveraging their resources effectively, start-ups can create and capture new opportunities, further driving their growth and success in the industry.

6.6 Effects of Knowledge Capitals on the Entrepreneurial Attitude of an EdTech Start-up

The entrepreneurial attitude of a start-up is about more than just the business operations; it encompasses the mindset, the way of thinking, and the belief system of the company. It's about having a vision, being innovative, and not being afraid to challenge the status quo (Schierjott *et al*., 2018). Entrepreneurs are often characterized by their readiness to take calculated risks, their resilience in the face of setbacks, and their relentless pursuit of their goals. They are willing to implement new approaches, adopt new ideas, and constantly seek out ways to improve and grow. This attitude is crucial in driving the success of a start-up. Entrepreneurial attitude plays a pivotal role not only in the establishment of new ventures but also significantly impacts managerial behaviour

within corporate entrepreneurship. Specifically, it is crucial in fostering the creation of knowledge ties within interpersonal networks that extend beyond organizational boundaries (Schierjott *et al*., 2018). It encourages a culture of innovation, fosters a growth mindset, and facilitates the ability to adapt quickly to changing market conditions or customer needs. In essence, an entrepreneurial attitude is about embracing change, pursuing opportunities, and constantly pushing boundaries to achieve business success (Liu *et al.*, 2020). It's about believing in your ideas and having the courage to bring them to life despite the challenges and uncertainties that may lie ahead.

The knowledge capital of the start-ups reflects their ability to calculate the risk well and evaluate the effectiveness of the new ideas. Knowledge capital, the compilation of knowledge and information generated, procured, amalgamated, and systematized by one or more firms, is integral to productive and value-creation endeavours. It forms the bedrock of their ongoing innovation strategy (Laperche, 2021). The knowledge capital encompasses the collective know-how, expertise, innovative ideas, and unique skills possessed by the organization and its employees (Lööf and Heshmati, 2002). In the context of risk management and innovation evaluation, knowledge capital can be a significant enabler. Start-ups with a high level of knowledge capital can more effectively calculate risks associated with new ventures or initiatives due to their deep understanding of their industry, market trends, and business operations. They have the insight to anticipate potential challenges and the expertise to devise strategies to mitigate them. Similarly, when it comes to evaluating the effectiveness of new ideas, start-ups with robust knowledge capital are better equipped. They can draw on their expertise to assess the feasibility of these ideas, predict their potential impact, and determine the best ways to implement them. Possessing a broad knowledge base and a dependable network of experts gives a firm the ability to accurately assess the feasibility and potential of new ideas and suggestions (Laperche, 2021). This fosters an environment that encourages an internal entrepreneurial attitude, as it instils confidence in taking calculated risks and trying innovative approaches. Strong knowledge capital is also indicative of a firm's capacity for in-house research and development. This is a critical asset, as it allows the firm to swiftly respond to market opportunities and adapt to changes in the business landscape. It gives the firm the agility to innovate and evolve in accordance with market demands and to capitalize on shifts in the industry ahead of competitors.

In essence, a robust knowledge profile and a reliable network of experts empower a firm to be more responsive, adaptive, and innovative, thereby creating a strong foundation for sustained growth and success. While entrepreneurs typically place great emphasis on the availability of tangible assets, such as space and financial resources, when launching a new firm, they must not underestimate the substantial and positive impact of intangible assets. These assets, in the form of human, organizational, and relational capital, can contribute significantly to the company's success (Pena, 2002). The

knowledge capital can provide start-ups with a competitive edge, enabling them to make informed decisions, manage risks effectively, and continuously innovate.

6.7 Effects of Knowledge Capitals on the Co-creations Ability of an EdTech Start-up

Co-creation is a key term for start-ups. In its simplest form, co-creation refers to the process of collaborating with different stakeholders, often including customers or users, to create value. Corporate-startup co-creation is an asymmetric collaboration as they have opposite characteristics in terms of strategy, culture, structure, and decision-making, making their world different (Nobari and Dehkordi, 2023). Studies on knowledge spillover and organizational learning indicate that ongoing interactions among those who create, appropriate, and use technology can enhance and broaden the depth and scope of knowledge and discoveries (Markman *et al.*, 2005). Within the context of innovation networks, the process of innovation has evolved from being a solitary activity confined within the boundaries of a single company to a more collaborative and interconnected endeavor. This shift necessitates a change in the way that innovating firms operate. It's not just about what they can achieve with their own resources anymore. There is a heightened emphasis on understanding and leveraging the resources and capabilities of other firms within the network. This is because the collective strengths, resources, and capabilities of various firms can often outmatch those of a single entity, leading to more robust and effective innovation. (Fan *et al.*, 2023). This could mean developing new products, improving existing ones, or even redefining the way a company does business. In the context of a start-up, co-creation can serve as a powerful tool for innovation. It provides the opportunity to gain firsthand insights from those who will be using the product or service, which can lead to more user-friendly designs and higher customer satisfaction. From a digital-output viewpoint, the goal of entrepreneurial co-creation is to streamline the transformation of an idea into a product or service and to maximize the market potential of a digital artefact (Nobari and Dehkordi, 2023).

The active interaction and cooperation of members in an innovation network are critical to the success or failure of technological innovation. An innovative firm must not only focus on developing its own resources but also on how to effectively combine and integrate its resources with those of other firms in the network. This can involve sharing knowledge, technologies, or other resources to create innovative solutions that leverage the unique strengths of each firm. In essence, in today's interconnected business environment, innovation is a collective effort that requires a deep understanding of the broader network's capabilities and resources, as well as strategic collaboration and resource integration (Fan *et al.*, 2023). Co-creation also fosters a sense of ownership and engagement among participants. When customers feel that they have contributed to the creation of a product or service, they are more likely to feel a connection to the company and become loyal, long-

term customers. Furthermore, co-creation can be a cost-effective way for start-ups to innovate. By tapping into the collective intelligence and creativity of a diverse group of individuals, start-ups can come up with innovative solutions without having to rely solely on internal resources. Therefore, co-creation can be seen as a collaborative, inclusive, and value-driven approach to business that can greatly benefit start-ups.

Given the limited resources typically associated with start-ups, co-creation is a strategic way to pool resources, skills, and knowledge. This collaborative approach can lead to the development of products, services, or solutions that are more innovative, effective, and aligned with market needs. Co-creation also enables start-ups to better understand and cater to their customers' needs, as involving customers in the creation process can provide valuable insights into what they truly value. This can help start-ups to create offerings that truly resonate with the market, enhancing their competitive advantage. Furthermore, by involving other stakeholders in the co-creation process, start-ups can also foster stronger relationships and partnerships, which can aid in their growth and success in the long run. In essence, co-creation can be a powerful strategy for start-ups to leverage collective expertise and resources, create innovative solutions, and deliver exceptional value to the market.

However, there is no free lunch in the world. For co-creation to be sustainable and successful, it requires mutual contributions and commitment from all parties involved. Each participant must bring something to the table, whether it's resources, expertise, time, or ideas. Co-creation is not a one-sided process. It's about collaborating and sharing in order to create something of value. If any party fails to contribute to this common goal, the co-creation relationship can be jeopardized (Nobari and Dehkordi, 2023). In this context, contribution doesn't necessarily mean financial resources alone. It could be providing insights, sharing market knowledge, offering technical expertise, or even giving constructive feedback. What's important is that each participant is actively involved and contributing in a meaningful way. If a party consistently fails to contribute, they risk being replaced by others who are willing to invest in the co-creation process. After all, co-creation is about mutual benefit and shared success, and this can only be achieved through active participation and contribution from all parties involved.

In the EdTech industries, a start-up with strong internal knowledge capital in the EdTech industry, which includes a deep understanding of education systems and processes, as well as technological expertise, is well-positioned to engage in and potentially lead co-creation efforts. This knowledge capital enables them to contribute valuable insights and innovative ideas, helping to shape the direction of co-creation initiatives. The start-up can build and strengthen its competitive advantage by being at the forefront of such collaborations. It can influence the development of products, services,

or solutions that align with its strategic objectives and market vision. This can result in unique, high-quality offerings, and more attuned to customer needs, helping the start-up stand out in the crowded EdTech market. Additionally, a robust social network can significantly enhance a start-up's co-creation opportunities. Connections with industry experts, potential partners, investors, and customers can open doors to collaborations that might not have been accessible otherwise. These relationships can also provide diverse perspectives and resources, enriching the co-creation process. A strong internal knowledge capital and social network can empower an EdTech start-up to actively participate in co-creation, guide its direction, and seize more opportunities, ultimately enhancing its market position and competitive advantage.

6.8 Importance of the Effects of Various Knowledge Capitals on the Entrepreneurship Capability of an EdTech Start-up

Universities generate various types of knowledge that can be beneficial for EdTech start-ups. These start-ups can acquire technological innovation, pedagogical intervention, and social networking through technology transfer activities. Previous sessions have indicated that technology value, education value, and social networking have a positive influence on the entrepreneurial capabilities of EdTech start-ups. The standardized regression coefficients and R-squared analysis in Chapter 5.2.4.5 provide insights into the research question concerning the importance of these three types of knowledge for the development of EdTech start-ups. Both standardized regression coefficients and R-squared analysis highlight education value as the most vital form of knowledge capital. While the standardized regression coefficient ranks social networking as the second most important, the R-squared analysis places technological value in the second position. It is normal for the results of different methods not to be completely consistent (Jiang & Smith, 2002). I am more inclined to accept the results derived from the R-squared method. This is because the degree to which variables explain the model tends to more accurately reflect the importance of these variables.

6.9 Moderating Effects of Absorptive Capacity on the Influences of Knowledge Capitals on the Entrepreneurship Capability of an EdTech Start-up

Rauch *et al.* (2009) suggested there are moderating variables that strengthen the entrepreneurship capability performance of a start-up company. Absorptive capacity is a factor reflecting the ability of a company to recognize the value of new, external information, assimilate it and apply it to commercial ends (Cohen & Levinthal, 1990). Scholars' frameworks adopted absorptive capacity as a moderating factor for the innovation and enterprise performance of technology SMEs and start-ups (Cohen & Levinthal, 1990; Yang *et al*., 2022; Fan *et al.*, 2023; Lee, 2008; Zahra & Hayton, 2008). However, the moderating factor is rejected in the condition of this study.

Absorptive capacity is intangible and abstract, and its advantages for the company are indirect, making it hard to quantify compared to tangible assets. Because of such a nature, companies are reluctant to relate their performance with their performance in absorptive capacity for permitting their personnel to acquire the requisite bandwidth of knowledge (Cohen & Levinthal, 1990). Absorptive capacity is a complex, multi-faceted concept that involves various processes and stages. It's not just about acquiring knowledge. It also entails assimilating, transforming, and applying that knowledge. Each of these aspects can be difficult to measure individually, let alone collectively.

Performance indicators, such as the value of assets, sales volume, and stock values, are direct and easy to measure. The interaction between absorptive capacity, knowledge capital and new business performance is complex, and there are no universally accepted metrics or indicators to measure it directly (Yang *et al.*, 2022). The capacity to absorb knowledge can vary greatly depending on the type of knowledge, the source, and the context. What works well in one scenario may not work in another, adding another layer of complexity to the measurement process. It is also influenced by a wide array of factors, including a company's organizational culture, structure, employee skills, and management practices, among others. These factors are all interconnected and can change over time, further complicating the measurement. Other studies also describe the moderating effect of absorptive capacity on the transformation of enterprise interaction and technological innovation capability as not significant statistically (Fan *et al.*, 2023).

Previous studies indicate that absorption capacity influences the effect of technology transfer on enterprise performance, and good absorption capacity is an important strategy for new companies to establish core competitiveness (Yang *et al.*, 2022). The absorptive capacity is described as the mediator to translate the knowledge into internal capabilities which would eventually contribute to the startup's performance enhancement. The absorptive capacity of a startup plays a significant moderating role in the link between a frequently closely connected network, like the startup ecosystems in science parks and universities, and knowledge-related competency building for growth and prosperity (Park and Rhee, 2012). Absorptive capacity is a valuable tool for firms to gather knowledge and resources through networking activities, enabling them to gain a competitive advantage.

The relationship between absorptive capacity, knowledge capital and a new company's performance can be complex in that absorptive capacity drives knowledge capital, and knowledge capital serves as a practical demonstration of absorptive capacity, and together they work to enhance company performance (Yang *et al.*, 2022). Scholars pointed out the worthiness of investigating the moderating effect of absorptive capacity and its consequence and the relationship between absorptive capacity

and its antecedent (Todorova and Durisin, 2007). This study's analysis suggests that there's a positive correlation between an EdTech start-up's absorptive capacity and its entrepreneurial capability. This finding aligns with the research conducted by other scholars, such as Liao *et al*. (2007) and Andrawina and Govindaraju (2009), who also found a direct positive relationship between a company's absorptive capacity and its entrepreneurial capabilities. Laperche (2021) also described absorptive capacity as one of the encompassed items of knowledge capital contributing to the innovation of a company. Moreover, the characteristics of a start-up or SME significantly influence how they penetrate the market, as suggested by Zakery & Mohammad (2021). This implies that the unique traits of these businesses play a crucial role in shaping their market entry strategies. Absorptive capacity can be viewed as a byproduct of successful knowledge-sharing activities within an organization. It has a positive influence not only on product and business innovation but also on the managerial performance of a company, as per the findings of Liao *et al*. (2007). In essence, the ability of a company, particularly start-ups and SMEs, to identify, assimilate, and apply external knowledge effectively can significantly bolster their entrepreneurial attitude, innovation efforts, and co-creation performance. The evolution of absorptive capacity from its inception to the present has been shaped by a range of different viewpoints and approaches (Agostini *et al*., 2017; Haryanti and Subriadi, 2022). Given the wide possibilities of the impact of absorptive capacity, it is suggested to consider absorptive capacity's direct positive impact on the entrepreneurial attitude performance of startups as well as absorptive capacity's moderating role between knowledge capitals and entrepreneurial attitude performance of startups. Scholars described absorptive capacity as dynamic, with a feedback loop and changes from different time points in the market and inside the ventures (Todorova and Durisin 2007). The manner of enhancing and managing absorptive capacity can also be influencing (Park and Rhee, 2012). Discussions in future research opportunities on the exploration of constructs of absorptive capacity have also opened up.

6.10 Relation to the Entrepreneurship Theories

Section 2.4 discussed Schumpeterian entrepreneurship, named after the economist J. Schumpeter, refers to a dynamic and innovative approach to business where the entrepreneur plays a crucial role in driving economic development (Mehmood *et al*., 2019). This study illustrates the EdTech startup field in Hong Kong mostly aligns with Schumpeterian entrepreneurship which involves innovation, encompassing the roles of an aspiring innovator, an active innovator, a developer, and a promoter, ultimately leading to profits for the entrepreneur. The research model of this study posits that individuals can acquire the necessary knowledge for innovation through technology transfer activities at universities, thereby preparing for their entrepreneurial journey. EdTech startups leverage this transferred knowledge and technology from universities to enhance their capacity for developing new

products and services, delivering innovative educational experiences and values by utilizing advanced tools. This technological value also enables EdTech startups to employ data analytics to understand and meet the needs of students and educators, thus realizing personalized learning.

The integration of educational and technological values empowers startups to expand access to education through various technological means and introduce new subject areas. Strengthened social networks resulting from university-industry technology transfer activities assist startups in discovering new sources of supply, such as content creators, other industries, and university resources. Encouraged collaboration between educators, scientists, technologists, and business executives fosters continuous innovation and improvement or reorganization in education through EdTech solutions. By assuming the roles of innovator, developer, and promoter, an EdTech startup can drive significant change and create new value in the education sector. Ultimately, the startup's success and profitability will reward its innovative efforts, aligning with Schumpeterian entrepreneurship principles (Becker *et al*., 2012; Śledzik *et al*., 2023).

Burt's Structural Holes theory, proposed by sociologist Ronald Burt, emphasizes the importance of bridging gaps (or "holes") in social networks where few or no connections exist between different groups. Acting as a bridge between these disconnected groups allows individuals or organizations to access diverse information, resources, and opportunities that are unavailable to those entrenched within a single group (Burt, 2004). The validation of hypothesis H1 in this study supports the notion that technology transfer activities in universities enable EdTech startups to access diverse knowledge and resources, thereby enhancing their capacities in terms of educational value, technological value, and social networks. By bridging the academic sector, education sector, technology providers, content creators, and policymakers, startups can tap into a broader array of knowledge, resources, and innovative ideas.

Building these social networks enables EdTech startups to facilitate the exchange of diverse perspectives and ideas, leading to innovative solutions. This cross-pollination can result in unique educational products and services that address unmet market needs (Burt, 2004). For instance, one interviewed EdTech startup highlighted how technology transfer activities bring together educators who understand classroom challenges with technologists capable of developing AI-driven solutions to personalize learning experiences. By leveraging the diverse information and resources accessed through structural holes, EdTech startups can enhance their knowledge capabilities to develop more comprehensive and effective solutions to complex educational challenges. These competitive advantages, developed through a comprehensive collaborative structure, are difficult for competitors to replicate.

In summary, by applying Burt's Structural Holes theory, EdTech startups can strategically position themselves to access diverse resources, foster innovation, form valuable partnerships, enhance problem-solving capabilities, gain a competitive edge, and build influential networks through technology transfer activities. This approach can significantly contribute to their growth and success in the dynamic EdTech landscape.Conventionally, educational innovations and pedagogical tools have not been a primary focus of technology transfer in universities or profit-making industries due to difficulties in patenting and perceived lower commercial value compared to other deep tech sectors. However, emphasizing the transfer of pedagogical intellectual properties can stimulate business creation among technology-oriented startups, offering new avenues for development and growth. Co-creation and society network are identified as critical entrepreneurial capabilities for EdTech startups, enabling them to collaboratively develop products and carve out markets. Integrating education and technology expertise is essential for these startups to acquire necessary knowledge. Moreover, platforms that facilitate interaction and collaboration between educators, technologists, and entrepreneurs can accelerate the development and success of EdTech startups by fostering innovative ideas and knowledge transfer, ultimately enhancing the quality of education, driving its digitalization and achieving a new driver for economic growth.

Chapter 7. Conclusions

University-Industry-Government collaboration, often referred to as the "Triple Helix" knowledge transfer model, is a concept that emphasizes the interconnectedness and cooperative efforts between universities, industries, and government entities to foster innovation, economic development, and societal progress. In this model, universities are responsible for generating new knowledge. They conduct research, often in partnership with industry, and provide education to students who will become future employees and entrepreneurs. Industries apply the knowledge generated by universities to create innovative products, services, and processes. They also provide feedback to universities about the skills and knowledge needed in the workforce, ensuring that education is relevant to industry needs. Governments create policies and provide funding to support research and innovation. They also regulate industries to ensure ethical practices and create a favourable environment for economic growth. The collaboration between these three entities can lead to more effective innovation systems, driving economic growth and addressing societal challenges. Each entity brings unique strengths and resources to the table, and their interplay can lead to significant synergies.

From the perspective of industries, knowledge transfer collaboration opens the channels for them to get access to and adopt the innovations and technologies from the research of the universities while gaining the platform to get competitive advantages via government policies and funding. For start-ups, such external support facilitates and fosters their development along the entrepreneurial journey. The progression of a start-up can be envisioned through the lens of a life cycle model. This model represents a series of unpredictable stages that a start-up must navigate. However, it is not a linear progression. Each stage presents its unique set of challenges and opportunities, much like the growth stages of a living organism. For start-ups to effectively and sustainably achieve their mission, they must form strategic collaborations. These partnerships are critical for acquiring the necessary knowledge and resources that aid in their growth and development. These collaborative actors could range from investors providing financial resources to mentors offering expertise and guidance to other businesses offering partnership opportunities (Passaro *et al.,* 2020). These relationships are essential for start-ups to navigate the complexities of their life cycle, respond to unforeseen challenges, and ultimately, to survive and thrive in the competitive business landscape.

According to the resource-based view of companies, it is proposed that a company's unique set of resources and capabilities are pivotal in creating a sustainable competitive edge. These resources can be tangible assets such as machinery, financial capital, and physical property or intangible assets like brand reputation, organizational culture, or intellectual property. Capabilities refer to a company's

skills or expertise in utilizing these resources to perform various business activities efficiently and effectively. This could include superior research and development, exceptional customer service, or efficient supply chain management. In other words, the resource-based view suggests that a company's internal environment, in terms of its assets and capabilities, is key to achieving and maintaining a competitive edge in the marketplace (Wernerfelt, 1984; Barney, 1991; Alas & Sun, 2007; Brulhart *et al.,* 2017). Consequently, the major goal of this study is to ascertain whether the value derived from universities' technology transfer activities can enhance the knowledge capital of EdTech start-ups and subsequently impact their entrepreneurial capabilities in Hong Kong. The study yields the following key empirical findings.

- The technology transfer activities of universities can have a positive effect on an EdTech start-up in Hong Kong in the development of its knowledge capital, including technology value, education value and social network.
- The technology transfer activities of universities can contribute to the entrepreneurship capability, including innovativeness, entrepreneurial attitudes, and co-creation, of an EdTech start-up in Hong Kong by building up its knowledge capital.

The subsequent sections of this chapter will primarily elaborate on the contributions made by this study and its implications for management practices. Furthermore, it will also acknowledge the limitations encountered during the study and suggest potential directions for future research in this area.

7.1 Contributions Made by This Study

7.1.1 Technology transfer as the starting point of rendering knowledge in universities to the commercial application in the EdTech Field

This study originates from the concepts of technology transfer and entrepreneurship activities in universities, which create new initiatives to draw the economic growth and propel strong productivity gains in society in Hong Kong (Tsui *et al.*, 2020). Technology transfer is a channel towards knowledge-based economic development and opens the windows for the commercial sector to reach research-based innovations and technologies in universities (Bercovitz & Maryann, 2006). The importance of technology transfer has grown significantly as academics and researchers from universities aim to optimize their research and innovation contributions to the socioeconomic development of Hong Kong. To encourage this, local universities have stepped up their efforts by introducing various new strategies. These include boosting technology transfer activities within the universities, establishing incubators and accelerators, and forming partnerships with industries and the government. Technology transfer activities in universities build-up or open up the intellectual capital for entrepreneurs to make use of the opportunities to commercialise innovations and technologies to create new businesses (Bercovitz & Maryann, 2006; Waldman *et al.*, 2022). This

research aligns with numerous studies in the field of technology transfer, reinforcing the idea that technology transfer initiatives within universities significantly contribute to the enhancement of entrepreneurial skills and start-up development. Various factors drive entrepreneurship, and these can differ significantly across different types of firms. The elements that correlate or connect with entrepreneurship are not consistent across the board; they can vary greatly depending on the specific organizational context in which the entrepreneurship is taking place (Miller, 2011). Social entrepreneurs create value, but not in the same way as commercial entrepreneurs (Saul *et al.,* 2016). For example, the entrepreneurial drivers in a biotech start-up may not be the same as those in a social enterprise taking care of community healthcare services with technology. Thus, it is essential to understand the unique organizational context to fully comprehend the aspects influencing entrepreneurship within that firm (Saul *et al.,* 2016). Despite the abundance of literature on the subject, there's a noticeable lack of research focusing on specific sectors within the technology industry, particularly those that require a deep understanding of the subject matter in addition to technological proficiency (Liu *et al*., 2021). This study takes a step to bridge this knowledge gap by exploring the role of technology transfer in influencing start-ups in the EdTech sector in Hong Kong. It specifically aims to understand the impact of technology transfer on the development of entrepreneurial capabilities in this specific industry. To achieve this, the research employs the theory of knowledge capitals, entrepreneurship capabilities, and absorptive capacity as key theoretical frameworks. It then uses empirical evidence to analyze the benefits that technology transfer brings to the development of entrepreneurial elements within EdTech start-ups in Hong Kong. In essence, this research seeks to provide insights into how technology transfer can be leveraged to foster entrepreneurial abilities, focusing on the EdTech industry in Hong Kong - an area that has been somewhat not yet specified in previous studies.

7.1.2 Technology Transfer Boosting Knowledge Capital of an EdTech Start-up

University research and development is a significant driving force behind the city's innovative initiatives. This process results in an accumulation of knowledge and technologies that hold considerable potential for commercialization. For economies that lie behind the technological frontier, productivity growth may occur as a result of both innovation and technology transfer (Griffith *et al*., 2003). Universities then transform this pool of knowledge and technologies into practical applications in business and everyday life through various methods. These include formal technology transfer, informal technology transfer, and entrepreneurship development activities. In essence, universities play a pivotal role in the innovation ecosystem of the city. They not only contribute to the generation of new knowledge and technologies but also facilitate their transition from the academic realm to the marketplace. This is achieved by deploying their resources through formal and informal technology

transfer mechanisms, as well as fostering entrepreneurial capabilities (Grimpe & Hussinger, 2013; Lackéus & Williams, 2015). As a result, the potential commercial value hidden within university research and development is realized, driving the city's overall innovation and growth (Cheng, 2021; Tsui *et al.*, 2020). This research investigates the correlation between technology transfer activities within universities and the knowledge capital of EdTech start-ups in Hong Kong. It focuses on three key areas: technology value, educational value, and social networking. Both technology value and social networking are often examined in academic literature due to their significant influence on the performance and development of start-ups and SMEs. The inclusion of educational value in this study is particularly important, as it represents the subject-specific knowledge necessary for operating within the EdTech industry (An, 2021). This means that not only does the start-up need to have a strong technological base, but it also needs to understand the educational context in which its products or services will be used and the stakeholders' mindset and logic they have to tackle in the future business operation. The empirical evidence gathered in this study reveals a positive relationship between university-based technology transfer activities and these three determinants of an EdTech start-up's knowledge capital. This suggests that technology transfer initiatives in universities can significantly enhance the technology value, educational value, and social network of EdTech start-ups, thereby improving their overall knowledge capital.

7.1.3 The Effects of Knowledge Capital on Entrepreneurship Capability of an EdTech Start-up

Knowledge capital, in the context of a start-up, embodies the cumulative knowledge, proficiency, technological assets, information, and innovative ideas that the company possesses. This intangible yet crucial asset represents the intellectual potential of the start-up to conceive and implement innovative solutions. In industries centred around technology, the measurement of knowledge capital often involves an assessment of the intellectual properties held by the start-up. These intellectual properties can include patents, which protect the company's unique inventions; trademarks, which safeguard the company's brand identity; copyrights, which protect original works of authorship; registered designs, that protect the visual design of objects; and circuit registrations, which secure the layout of integrated circuits. Additionally, trade secrets - confidential business information which provides a start-up with a competitive edge - also form a part of a start-up's knowledge capital (Lee & Win, 2004; Poticha & Duncan, 2019). Furthermore, the start-up's business development strategies and processes, as well as its social network - the web of relationships and connections that can be leveraged for business advantage - are integral components of its knowledge capital. These elements collectively contribute to the start-up's ability to innovate, compete, and succeed in its industry. This study narrows its focus to the EdTech industry, specifically examining how the educational value imbued within a start-up can aid in its journey through product development, market penetration, and

educating the market while fostering its growth. The knowledge capital, in this context, is of immense significance as it provides the company with a competitive advantage and enhances its overall value. Knowledge capital is not just about accumulating information; it represents the start-up's ability to use that information effectively to innovate and stay ahead of the competition. It's a combination of expertise, skills, intellectual property, and valuable networks that can be used to create new products, enter new markets, and educate potential customers about the value of what the start-up offers. In this context, the study aims to investigate the relationship between the knowledge capital of a start-up and its entrepreneurship capabilities. Specifically, it explores how well-equipped EdTech start-ups in Hong Kong are in terms of transforming their knowledge capital into entrepreneurial successes. The findings of this study could provide valuable insights into the dynamics of entrepreneurship in the EdTech sector and inform strategies for fostering innovation and growth in this industry. The entrepreneurship capability of a start-up encompasses a broad array of skills and characteristics, including but not limited to an eagerness to assume risks, the fortitude to surmount obstacles, and the ability to learn from setbacks and failures. It fundamentally revolves around the capacity to transform innovative ideas into successful business ventures. In this study, we draw upon established types of entrepreneurship capabilities from various literatures. These include innovativeness, which refers to the ability to create and implement novel ideas, products, or processes; entrepreneurial attitudes, which relate to the mindset and approach towards entrepreneurship, including aspects like risk-taking, proactiveness, and competitive aggressiveness; and co-creation performance, which is about working collaboratively with customers, partners, or other stakeholders to create value. Specifically, we investigate these aspects of entrepreneurship capability in the context of EdTech start-ups. By doing so, we hope to gain a deeper understanding of how these capabilities contribute to the performance and success of start-ups in the EdTech sector. Our empirical findings indicate a positive correlation between the three types of knowledge capital - including education value - and the three types of entrepreneurship capabilities. This suggests that EdTech start-ups in Hong Kong can effectively leverage their technological assets, pedagogical innovations, and the social networks gained through technology transfer from universities to enhance their risk-taking ability, seize market opportunities, and stimulate growth and competitiveness. Technology transfer enables start-ups to acquire new technologies and knowledge, which in turn, can significantly contribute to their knowledge capital. Through the accumulation of knowledge capital via technology transfer, an EdTech start-up can fortify its potential for success and growth. This underlines the importance of technology transfer as a strategic tool for start-ups, particularly in the EdTech industry, to build their knowledge capital and enhance their entrepreneurial capabilities.

7.1.4 Effect of Absorptive Capacity on Entrepreneurship Capability of an EdTech Start-up

Absorptive capability refers to a company's ability to identify, assimilate, integrate, and transform external knowledge into its internal innovation capabilities. It is a crucial organizational process that enables a company to adapt, evolve, and innovate in response to changes in its external environment. Absorptive capability is the bridge that connects external knowledge with internal innovation, enabling a company to continuously learn, adapt, and innovate (Zahra *et al*., 2002; Cohen *et al.,* 1990). Scholars have incorporated the concept of absorptive capacity into their frameworks as a moderating variable that influences the innovation and performance of technology-based SMEs and start-ups in determining how effectively these companies can leverage knowledge for their innovation processes and overall performance (Cohen & Levinthal, 1990; Yang *et al*., 2022; Fan *et al.*, 2023; Lee, 2008; Zahra & Hayton, 2008). However, the positive moderating effect of absorptive capacity on the impact of knowledge capital on the entrepreneurship capability of an EdTech start-up is not supported in the findings of this study. In the regression analysis, most of the moderating effects are with high p-values, and the results are not significant that the hypotheses are rejected. The only two with p-values smaller than 0.05 are for the influence of education value on innovativeness and for the influence of technology value on entrepreneurial attitude. The regression coefficients are measured with a negative value. The absorptive capacity negatively moderates the influence of education value on the innovativeness of an EdTech start-up, while it also negatively moderates the influence of technology value on the entrepreneurial attitude of an EdTech start-up.

Founding teams of technology-based startups demonstrate a strong tendency to follow their preferred strategy irrespective of the characteristics of the external environment (Saemundsson & Candi, 2014). The organizational set-up and the people working in the organization influence the managerial practices (Liu *et al*., 2018). Scholars described that the traditional value of educators is teacher-centered learning, which would require years to adopt new ideas and instruments for teaching. There is a humanistic aspect of the change process as experienced by the educators needed for the effective integration of innovation and technology into the educational environment (Hartman *et al*., 2019). Therefore, there can be contradictions between traditional education value / practices and innovativeness. The stronger the startups' absorption capacity in the traditional education practice, the higher the resistance and stronger the boundary for them to be innovative. On the other hand, technological professionals, like engineers, are generally considered as oriented to things rather than fellow humans, with weak inter-human interaction and essential interpersonal skills, and tough-minded (Van Der Molen *et al*., 2007). Technological professionals have the tendency to slight issues apart from technical challenges or can be described in technical terms (Silyn-Roberts, 1998). Therefore, a strong startup's capacity to learn technology value may imply the team's shortfall in

communication skills and high resistance to market changes, which are crucial components of the entrepreneurial attitude of an EdTech startup.

Technology-based startups' founding teams struggle to adapt their innovation strategies to new realities unless they are willing and able to increase the diversity of the management team and acquire the resources needed to pursue both exploration and exploitation (Saemundsson & Candi, 2014). Future studies can explore the influence of the staff composition and business orientation of EdTech startups on these two above-mentioned negative moderating effects of absorptive capacity. This research especially opens up the question of how to balance technological knowledge and educational knowledge in the success of EdTech businesses.

Although the moderating effect of the absorptive capacity of an EdTech start-up is not seen in this study, the regression analysis indicates that the absorptive capacity positively relates to the entrepreneurship capability of the start-up. Absorptive capacity is an important ability of entrepreneurs and new firms. Qian & Acs (2013) pointed out that the absorptive capacity of entrepreneurs and new firms is a measurement of individual ability, which differs from absorptive capacity in the organizational level notion of Cohen and Levinthal (1990). Entrepreneurs are self-efficacy, who may suffer from bias since individuals may exaggerate their confidence level regarding their ability to accomplish entrepreneurial tasks (McGee & Petterson, 2019). The shifting between the entrepreneur personal identity and the representative of a company may affect the data provided by the entrepreneurs in the study.

Griffith *et al.,* (2003) described absorptive capacity is the second face of research and development, which directly positively impacts the performance of a company together with innovation and technology transfer. Qian & Acs (2013)'s dual-conduit model suggests that both knowledge and absorptive capacity are needed directly simultaneously for the success of knowledge-based entrepreneurial activities. This suggested that EdTech start-ups with a high level of absorptive capacity are seen as better equipped to identify, assimilate, transform, and exploit external knowledge, which in turn can enhance their ability to innovate and improve their performance. Our study supported the absorptive capacity's positive impact in the EdTech start-ups in Hong Kong.

7.2 Managerial Implications

The primary concern plaguing EdTech start-ups in Hong Kong pertains to their capacity to conceive, design, and successfully introduce an innovative product or service into the competitive market. Essentially, these start-ups are tasked with the challenge of not only creating a product that is novel and forward-thinking but also ensuring that it is marketable and can meet the specific needs of its target audience. At the core of their operations is the concept of technology invention, which

leverages new technology as a conduit to deliver educational value to learners. This involves the development of cutting-edge tools and platforms that facilitate efficient and effective learning experiences. It's a delicate balance of integrating technological advancements with educational needs to ensure that the end product is both technologically sophisticated and pedagogically sound. On the other hand, universities play a crucial role in this ecosystem by conducting diverse types of research and development. Their work often forms the foundation upon which these EdTech start-ups build their products and services. Universities can provide valuable insights into the latest educational trends, methodologies, and theories that can be incorporated into the design of these new products. Moreover, the concept of intervention innovations is crucial in the realm of EdTech. This involves the application of learning sciences, which includes the development of innovative teaching methods and the implementation of new practices, all aimed at enhancing the educational value provided to learners. These innovations can revolutionize traditional teaching paradigms and enable the creation of more engaging, interactive, and effective learning experiences. These elements can significantly influence different aspects of an EdTech start-up. They can help shape the company's product offerings, define its value proposition, and ultimately determine its success in the market. Therefore, it's imperative for these start-ups to continually innovate and adapt to the evolving educational landscape to ensure their longevity and relevance in the sector.

The technology transfer activities undertaken by universities aim to bolster the knowledge capital, thereby improving the entrepreneurial performance of EdTech start-ups. These activities are crucial as they strive to align the wealth of knowledge and technology resources found within universities with the needs and capabilities of entrepreneurs. The goal is to facilitate the transformation of these innovations into viable new businesses. This study seeks to illuminate the process of technology transfer, providing insights on how universities and entrepreneurs can work symbiotically to foster innovation and drive business growth. It delves into the mechanisms through which academic research and advancements can be translated into commercial applications, thereby contributing to the proliferation of EdTech start-ups. Beyond the insights shared in Chapter 7.1, this study also presents additional findings derived from a series of interviews and surveys conducted. These findings offer a deeper understanding of the dynamics of technology transfer and entrepreneurship within the EdTech sector. They present a comprehensive view of the challenges and opportunities faced by these start-ups, as well as strategies for leveraging university resources to fuel innovation and business development.

- EdTech start-ups require both technological and pedagogical knowledge for their venture development.

- Technology transfer in universities offers start-ups new funding opportunities in addition to knowledge and technology acquisitions.
- Technology transfer creates new businesses which cannot be achieved solely by the stakeholders on the commercial side.
- A start-up in the field of EdTech has to leverage external resources, network and co-creation to obtain all the necessary components for their business.
- Depending on the founder and founding members of the EdTech start-up, the required knowledge and resources in each technology transfer collaboration varies.
- The limited visibility of the market and technology, coupled with scarce internal resources, act as significant constraints on the growth and development of EdTech start-ups.

Innovation and technology development is the driving force of the modern economy, playing a significant role in transforming traditional industries. In the wake of the COVID-19 pandemic, Hong Kong's primary economic drivers and pillar industries – finance, trading business, logistics and real properties - are under considerable strain. They are grappling with intense competition and mounting challenges, factors which are undermining and eroding Hong Kong's overall competitiveness. This situation has accentuated the urgency for the city to identify new growth engines that can help rejuvenate its economy. Hong Kong is in a race against time to regain its economic momentum, particularly with the development of the Guangdong-Hong Kong-Macao Greater Bay Area underway. This initiative presents both opportunities and challenges for Hong Kong. On one hand, it offers the chance to tap into the immense potential of this economic powerhouse. On the other hand, it also means contending with fierce competition from other cities within the Area. Therefore, it is critical for Hong Kong to leverage innovation and technology development as key strategies to bolster its economic resilience and secure a competitive edge in this rapidly evolving landscape.

EdTech is an emerging market in the global world with immense potential for growth and development. Recognizing the transformative power of technology in education, the Chinese Central Government is actively promoting the digitalization of educational processes. This initiative creates a conducive environment for the growth of technology start-ups in the education sector. For Hong Kong, this presents a golden opportunity. It allows the city to capitalize on this trend and foster the growth of its own EdTech start-ups. Hong Kong can leverage its unique strengths - its robust technological infrastructure, skilled talent pool, and strategic location - to carve a niche for itself in this emerging market. By nurturing its EdTech start-ups, Hong Kong can not only enhance its own education system but also make significant strides in its quest to regain economic growth and bolster its competitiveness in the Greater Bay Area. However, the education sector in Hong Kong has traditionally been heavily reliant on non-commercial funding and government directives for many

decades. As a result, experienced educators often lack the business acumen necessary to navigate the dynamic landscape of EdTech start-ups. Moreover, most university students majoring in education tend to prioritize secure and well-paid teaching careers over the inherent risks of entrepreneurship. Considering the present state of Hong Kong's education sector, start-up ecosystem and EdTech industries, and based on the findings of this research, this study proposes the following recommendations to enhance the development of EdTech start-ups via university technology transfer activities. These include:

- Promoting intellectual properties of education innovation and pedagogical interventions as a core aspect of technology transfer in universities;
- Encouraging the introduction of start-up and SME technologies to education researchers to foster new collaborations
- Strengthening the entrepreneurial training for university students and alumni in the fields related to education professionals;
- Developing matching platforms for education and technology talents;

7.2.1 Promoting intellectual properties of education innovation and pedagogical interventions as a core aspect of technology transfer in universities

Traditionally, educational innovations and pedagogical tools have not been a primary focus of technology transfer. This is mainly due to the fact that these innovations can be difficult to patent, and their commercial value often appears lower than patented technologies in sectors such as medicine, civil engineering, biotechnology, and power electronics, among others. However, placing a greater emphasis on the transfer of pedagogical intellectual properties could stimulate business creation among technology-oriented SMEs. These pedagogical innovations represent a new frontier for these companies, offering untapped potential for development and growth. By promoting these intellectual properties, universities could not only contribute to the diversification of the SME sector but also facilitate the advancement of educational technology, thereby enhancing the overall quality of education.

7.2.2 Encouraging the introduction of start-up and SME technologies to education researchers to foster new collaborations

Technology transfer is a two-way communication process between researchers and entrepreneurs that results in the commercialization of research, knowledge, innovation and technology (Markman *et al*., 2008). Going in the opposite direction of the previous point, introducing market-available technologies from SMEs and start-ups to researchers in the education field can provide them with new insights for research and innovation. This study found that education value is the most critical knowledge that the EdTech start-ups acquired from technology transfer. Moreover, technology-

driven SMEs and start-ups often find themselves in a challenging business situation. They may possess cutting-edge science and technology but struggle to transform these into market value and differentiate themselves from similar solutions. By exposing these businesses to potential applications in the education field, new avenues for business development may be uncovered. Encouraging such collaborations can lead to more innovative, effective, and marketable educational technologies. It can bring about a win-win situation where education researchers gain access to new technologies for their work, and SMEs and start-ups find new markets for their products.

7.2.3 Strengthening the entrepreneurial training for university students and alumni in the fields related to education professionals

Human resources is a critical factor for industry development. To catalyze the growth of the EdTech industry, we need to cultivate potential entrepreneurs with the necessary skills and resources. Entrepreneurial training is multifaceted, practically oriented and theoretically oriented to cover topics of new research fields and emerging industries (Piperopoulos & Dimov, 2015). Providing entrepreneurial training to students and graduates in the education field can equip the market with a talent pool possessing subject knowledge and field experience. These individuals are well-versed in the pain points of the education sector, the challenges faced by schools, and the demands of students and parents. This understanding is crucial for developing businesses in the field. Entrepreneurship training can be instrumental in this context by not just providing the technical tools of business, such as accounting, marketing, finance, etc., but also aiding students in cultivating the required skills for self-management and dealing with adversity and uncertainty (Mueller *et al.*, 2001). This holistic approach to entrepreneurial education helps aspiring entrepreneurs to be well-rounded and better equipped to handle the challenges of starting and running a business. As such, strengthening their entrepreneurial skills can lead to the birth of innovative EdTech start-ups that address these issues effectively, thereby promoting the overall growth and advancement of the EdTech industry.

7.2.4 Developing matching platforms for education and technology talents

Co-creation has been identified as a crucial entrepreneurial capability for an EdTech start-up (Kristensson *et al*., 2008; Nobari & Dehkordi, 2023; Re & Magnani, 2022). Start-ups and individual entrepreneurs need to work collaboratively to develop their products and carve out a market. This study also reveals that absorptive capacity is critical for EdTech start-ups to develop their entrepreneurship capability. A competency that integrates education and technology expertise is crucial for EdTech start-ups to acquire the necessary knowledge for their businesses (An, 2021; Dexter *t al.*, 2021; Kaoud *et al.*, 2022). After training the talents, it's vital to have an appropriate platform to facilitate the exchange and interaction between talents and entrepreneurs in both education and technology business fields. These platforms can foster collaborations, stimulate innovative ideas, and facilitate knowledge transfer, thereby accelerating the development and success of EdTech start-

ups. They can serve as a meeting point for educators, technologists, and entrepreneurs, leading to the creation of innovative solutions that effectively address the needs and foster the digitalization of the education sector.

7.3 Limitations and Directions for Future Research

This study is not without its limitations. One significant concern is the potential for self-report bias, which is an inherent risk in this type of research. Specifically, the constructs of knowledge capital and entrepreneurship capability could be particularly susceptible to this bias. This is due to the possibility that individuals might overstate their confidence levels concerning their ability to execute entrepreneurial tasks and their enterprise capabilities (McGee & Peterson, 2019). In this study, no sensitive information was collected. This is significant because, according to Ajzen (2002), self-reports are generally very accurate when the behaviour being examined is not of a sensitive nature. In other words, when individuals are asked to provide information about their own behaviour that is not considered private or delicate, their responses are typically quite reliable and precise. As such, the accuracy of the self-reports in this study can be regarded as high due to the absence of sensitive content. Using self-reported performance measures can be viewed as a limitation thanks to the subjective nature of such data. However, in circumstances where objective data is unavailable, self-reported measures are considered suitable alternatives (Dess & Robinson, 1984; McGee & Peterson, 2019). This is often the case when studying privately held businesses or start-up companies, where access to complex data can be challenging. Furthermore, using self-reported measures from a single individual to evaluate a firm-level construct may not be the ideal method, but it is a practice that is widely accepted within the research community (Ahlin *et al*., 2014; Ahmed *et al*., 2020; Khedhaouria *et al*., 2015; McGee & Peterson, 2019; Poon *et al*., 2006). Despite its potential drawbacks, this approach is often a necessary compromise in order to gather insightful data in these particular contexts.

Data collected through the survey method is often prone to exhibit common method bias (Chaudhary and Batra, 2018). They are difficult to eliminate in behavioral research, arise from factors such as having a common rater, a common measurement context, a common item context, or the characteristics of the items themselves, and are attributable to the measurement method rather than the constructs being measured (Podsakoff *et al.*, 2003). Common method bias is reported to be commonly occur in entrepreneurship research as the business owner group is the only single source of data collection (Tehseen *et al*., 2017; Zhang *et al.,* 2018). Table 5G presents the confirmatory factor analysis that the fix indexes obtained from this study on absorptive capacity revealed a poor to acceptable model fit. The risk of common method bias is not eliminable in this analysis (Podsakoff *et al.*, 2003; Park & Rhee 2012). Although multiple items were adopted in each construct, common

method bias can be a factor in this study for rejecting the Hypothesis H3 about the moderating effect of absorptive capacity between knowledge capability and entrepreneurial attitudes.

In our study, we did not gather data about multiple founders, which means we are unable to evaluate the potential influence founding teams may have had on our results. However, we directly sent the quantitative survey invitations electronically to the founders of the companies we sampled. We have a high degree of confidence that these surveys were completed by the leading entrepreneurs themselves or their most suitable delegates. Given the relatively small size of the EdTech start-ups we sampled, we are similarly confident that the respondent was either a sole proprietor or someone who started a very closely held corporation. In other words, we believe that the information gathered through these surveys is a reliable representation of the perspectives and experiences of the primary decision-makers within these start-up companies.

Although we cannot conclusively determine how respondents interpreted the instructions or what they were considering when comparing their start-ups' knowledge capital and entrepreneurship capabilities to other businesses in their industry, we do not regard this as a significant issue. As supported by Rauch *et al*. (2009), the use of subjective performance data is generally justified in academic literature. However, it's important to acknowledge that the use of such subjective data could potentially introduce perceptual bias. This is because different entrepreneurs may perceive their firms as being either relatively superior or inferior compared to others based on their personal methods of assessment (Ahlin *et al*., 2014; McGee & Peterson, 2019; Liu *et al.,* 2021). These perceptions may not necessarily align with those of other entrepreneurs within the same industry. It's possible that the views and assessments of individual entrepreneurs may diverge from the collective perceptions within the industry. Therefore, while we have strived to gather reliable data, some degree of perceptual variance is inevitable when dealing with subjective performance data.

Our findings may have limited generalizability due to the fact that our samples were taken specifically from the EdTech industries located in Hong Kong city. However, studies conducted within a specific context do have their own merits. As pointed out by Gartner (2008) and Miller (2011), ignoring the context can make it considerably more challenging to derive cumulative results. By concentrating on a restricted geographical area, researchers are able to "fragment the complexity," as Miller (2011) puts it. This approach allows for a more accurate assessment of the implications of specific relationships within particular situations. Therefore, while our study may have a somewhat limited scope, it provides valuable insights into the specific context of EdTech start-ups in Hong Kong.

In the field of management and organizational research, control variables often have a weak relation to the focal variables and seldom impact the interpretation of results. This minimal impact of control

variables on research outcomes can lead to a decrease in vigilance in identifying instances where control variables create issues in interpreting results (Carlson & Wu, 2012). scholars still recommend including control variables (Becker, 2005; Carlson & Wu, 2012; Wang *et al*., 2004). In future studies, we suggest including technological turbulence and market turbulence as control variables. These factors represent the effects of changes in the market environment and technology ecosystem, which are vital factors in technology-based industries. Technological turbulence refers to the rate of technological change and innovation within an industry, while market turbulence refers to the volatility and unpredictability of market conditions. Both can significantly impact a company's strategic decisions, performance, and competitiveness (Wang *et al*. 2004). By controlling for these factors, we can more accurately isolate and examine the effects of the variables of interest in our research.

Moreover, the survey instrument can be finetuned by asking respondents to evaluate the EdTech start-ups' knowledge capital, absorptive capacity and entrepreneurship capability in comparison with the major competitor in the industry as a benchmark indicator to enhance the level of the objective of the answers from the respondents (Ahlin *et al*., 2014). Given that this research was a cross-sectional study, our findings are bound to a specific time frame. Employing a longitudinal design would provide a more comprehensive view of the impact of technology transfer on EdTech start-ups over an extended period. This approach would likely unveil more robust relationships.

In this study, we explore how entrepreneurs in the EdTech startup sector accumulate and establish technology value, educational value, and social networks as integral components of their companies' knowledge capital. This accumulated knowledge capital is crucial as it supports and enhances the development of their entrepreneurial capabilities. We specifically focus on how technology transfer activities within universities contribute to this process. Our findings confirm that both formal and informal technology transfer, along with entrepreneurship development initiatives within academic institutions, significantly bolster the knowledge capital of EdTech startups.

This enhanced knowledge capital subsequently translates into improved entrepreneurial capabilities, characterized by heightened innovativeness, positive entrepreneurial attitudes, and increased co-creation ability. Among the various components of knowledge capital, educational value stands out as the most significant factor influencing entrepreneurial capability. This underscores the importance of educational resources and expertise in fostering effective entrepreneurship within the EdTech sector.

Furthermore, we examined the role of absorptive capacity—the ability of firms to recognize, assimilate, and apply external knowledge—in this model. While absorptive capacity was observed to

have a positive direct impact on entrepreneurial capability, its role as a moderating factor between knowledge capital and entrepreneurial capability was not significant. This suggests that while absorptive capacity is important, its moderating effects may be less critical than its direct contributions.

Future research could delve deeper into the multifaceted roles of absorptive capacity, investigating it as a moderator, a consequence, and a direct influencer of entrepreneurial outcomes, in a nested model. This study also opens a broader discussion on the importance of domain-specific application knowledge in evaluating venture performance within technology industries. It highlights that, alongside technological value, the specific knowledge relevant to the application domain is a crucial factor for success.

Finally, our model and findings can be adapted to studies in various other technology industries with specific applications, such as SportsTech, HealthTech, FemaleTech, and ArtTech. Each of these sectors could benefit from a similar approach to understanding how knowledge capital and absorptive capacity influence entrepreneurial capabilities and overall venture performance. This suggests a versatile framework that can be tailored to different technological contexts to enhance our understanding of technology transfer activities of universities and entrepreneurship in specialized domains.

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Appendix A:

Survey Questionnaire

You are invited to participate in this questionnaire survey for a research study titled "The Value of Technology Transfer on the Development of Entrepreneurship Capabilities: A Study of Educational Technology Entrepreneurs in Hong Kong".

This research is being conducted by Mr Lemon Kwan from the Doctor of Business Administration program at the University of Wales Trinity Saint David. Mr Kwan is also from the Knowledge Transfer Sub-office of The Education University of Hong Kong.

This survey is designed to data on the value of technology transfer on the development of entrepreneurship capabilities in the educational technology "EdTech" industry in Hong Kong. The research's objective is to study the effects of the transfer of university knowledge and technology on building up the capability of entrepreneurs in the EdTech industry, in terms of knowledge capital, entrepreneurship capability and absorption capability. The result of the study can shed light on how to improve the mix-and-match of company-university collaboration elements that can practically benefit the EdTech startups on educational, technological and commercial development. Your participation will greatly contribute to the development of the emerging industry and ecosystem of EdTech in Hong Kong.

The survey would only take you about 10 minutes to complete, and you can choose to terminate the survey at any time without negative consequences. All information collected will remain strictly confidential and individual details will not be disclosed or identifiable from this survey. Your personal data will not be shared but only used in this study. If you have any questions about the research, please feel free to contact me at E: hmkwan@eduhk.hk or T: +852 9765 6119. Thank you for your participation.

我們誠邀您參加是項問卷調查，為一項名為"科技轉移對企業家能力發展的價值：香港教育科技企業家研究"的研究提供數據。

負責是次研究的研究員是 Lemon Kwan 先生，關先生正就讀 University of Wales Trinity Saint David 的工商管理博士課程，並就職於香港教育大學的知識轉移辦公室。

本問卷旨在調查、收集有關於科技轉移對香港教育科技（EdTech）行業中企業家精神發展的數據。本研究的目標是探討大學知識和科技轉移活動對 EdTech 企業的知識資本、創業能力和吸收能力的影響。研究結果希望揭示如何提升企業-大學合作的配對和效率，使教育科技的初創企業能在教育、技術和商業發展方面實際受益。您的參與將對促進香港的新興教育科技行業和生態系統的發展有着重大貢獻。

Section A: Areas of EdTech Business

Please indicate the area(s) of business that your company is involving with the application of technology, i.e. with the use of computers, mobile devices, online platforms, electronics equipment or else.

AI for Teaching, Learning, Training and Assessment

Art and Culture

Business Education and Professional Training

Early Childhood Education

Equity, Social Cohesion and Inclusion

Gamification and Edutainment Solutions

Immersive Experiential Learning

In-School Services and Support

Learning and School Management System

Nurturing Employment

Nurturing Values and Ethics

Rehabilitation and Nurturing Wellbeing

Sports and Health Education

Teaching and Learning Tools and Textbooks

Vocational Education and Training

Others

Section B: Technology Transfer/ Knowledge Transfer in University

Please indicate the degree to which you agree the statements.

On formal technology transfer activities – Collaborations with universities bounded with formal agreements, such as intellectual properties licensing, consultancy, contract research and collaborative research, etc.

TT1: Your start-up obtains knowledge on education and pedagogies via formal technology activities of university.

- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

TT2: Your start-up obtains technological knowhow via formal technology transfer activities of university.

- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

TT3: Your start-up obtains information about customer needs and market trends via formal technology transfer activities of university.

- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)

- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

On informal technology transfer activities – conferences, forums, seminars or social occasions

TT4: Your start-up obtains knowledge on education and pedagogies via informal technology transfer activities of university.

- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

TT5: Your start-up obtains technological knowhow via informal technology transfer activities of university.

- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

TT6: Your start-up obtains information about customer needs and market trends via informal technology transfer activities of university.

- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

On entrepreneurial activities – project based classes, mentorship, seed fund program, entrepreneurship classes, incubation programs

TT7: Your start-up reaches useful university technologies and knowledge via entrepreneurial activities of university.

- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)

- Agree (6)
- Strongly Agree (7)

TT8: Your start-up received funding and facility support from entrepreneurial activities of university.

- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

TT9: Your start-up obtains professional services support, such as legal, business advisory and investment, via entrepreneurial activities of university.

- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

TT10: Your start-up earns practical entrepreneurship knowledge via entrepreneurial activities of university.

- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

Section C: Knowledge Capital

Please indicate the degree to which you agree the statements.

Technology Value

KC1: Your start-up regularly monitors technology development trends.

- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

KC2: Your start-up is capable of conducting in-house product development.

- Strongly Disagree (1)

- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

KC3: Your start-up has good knowledge of different market segments.

- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

KC4: Your start-up transfers/adopts technology into products or services.

- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

Education Value

KC5: Your start-up thinks and works a lot on the pedagogies of the products or services you designing.

- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

KC6: Your start-up thinks and works a lot on the content of the products or services you designing.

- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

KC7: Your start-up considers how your products' or services' content and pedagogies influence one another.

- Strongly Disagree (1)

- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

KC8: Your start-up modifies your products' or services' content to adapt to the technology platform.

- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

KC9: Your start-up has the mechanism to evaluate the quality of teaching or training.

- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

KC10: Your start-up investigates new measurements of user performance.

- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

KC11: Your start-up develops innovative assessment tools.

- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

KC12: Your start-up integrates technology to the development of your educational content.

- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)

- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

KC13: Your start-up uses technology as a tool for learning / training.

- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

Social Network

KC14: Your start-up has a close relationship for searching for information, resources and new contacts.

- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

KC15: Your start-up is ready to sharing knowledge with other firms.

- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

KC16: Your start-up is accessible for other firms and organisations for knowledge exchange when needed.

- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

KC17: The individual contact networks of your start-up cover your target customers.

- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)

- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

KC18: The individual contacts of your start-up cover your target distribution networks.

- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

Section D: Absorption Capability

Please indicate the degree to which you agree the statements.

AC1: Compared with major competitors, your start-up can accurately evaluate knowledge that is acquired externally.

- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

AC2: Compared with major competitors, your start-up has a stronger ability to acquired knowledge for future use.

- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

AC3: Compared with major competitors, your start-up can easily obtain market information

- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

AC4: Compared with major competitors, your start-up has acquired original and pioneering knowledge from external.

- Strongly Disagree (1)

- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

AC5: Compared with major competitors, your start-up has the advantage in lower the operation costs.

- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

Section E: Entrepreneurship Capability

Please indicate the degree to which you agree the statements.

Innovativeness

EC1: Your start-up accumulate knowledge.

- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

EC2: Your start-up integrates new knowledge in product and business development.

- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

EC3: Your start-up integrates resources for product and business development.

- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

EC4: Your start-up has good access to new knowledge relevant to your business.

- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

Entrepreneurial Attitude

EC5: Your start-up encourage employee to suggest ways for new lines of business.

- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

EC6: Your start-up has good communication and coordination.

- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

EC7: Your start-up has a cross-functional teamwork.

- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

EC8: Your start-up timely responds to market opportunities.

- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

EC9: Your start-up favor strong in-house R&D, technological leadership and innovation.

- Strongly Disagree (1)

- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

Co-creation

EC10: Your start-up co-create new value with external party(s) to your target customers.

- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)

EC11: Your start-up co-create new market with external party(s).

- Strongly Disagree (1)
- Disagree (2)
- Somewhat Disagree (3)
- Neither Agree nor Disagree (4)
- Somewhat Agree (5)
- Agree (6)
- Strongly Agree (7)