

Commercialization Skills: *Necessity for High Technology Entrepreneurs in Digital Era*

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Abstract—As Fourth revolution evolves, digitalization enables development and diffusion of new high technologies. Hence, it is essential to have knowledge on commercialization competence, which assists entrepreneurs to transform their inventions / innovations into consumable products / services. Therefore, this study investigates commercialization skills and their importance for entrepreneurs in digital era. A qualitative method was used via interview. Business advisors and developers in Finland were interviewed. The results revealed that presentation / pitching, regulatory, information analysis, social media, and negotiation skills are necessary for high technology entrepreneurs. The results also affirmed that entrepreneurship, marketing, and business management skills, which are previously discussed by scholars and practitioners, are also needed. With these results, this study contributes to the discourse of commercialization and entrepreneurship education.

Keywords—commercialization skill, high technology, entrepreneur, digitalization, entrepreneurship education

I. INTRODUCTION

With advent of digitalization, every aspect of human activities is changing [1], [2], [3]. Hence, new technologies emerge, and existing technologies are improved. Consequently, scientists and technologists are keen on breakthrough with their new inventions, but they seem to ignore that transforming them into consumable products/services is a necessity for their success. The transformation is known as commercialization [4], [5]. Meanwhile, commercialization process is complex, complicated, tedious, and sometimes, expensive. It is even, more complicated when the process is concerned with a high technology [6]. High technology (henceforth, high-tech) is described as a “*technology that is at the cutting edge and is usually associated with strong economic growth and advanced technological development*” [7]. It composes of process and product complexities [8]. Examples of high-tech in digital era are artificial intelligence (AI), robots, automation, internet of things (IoT), and big data. Therefore, certain skills are essential for commercializing these digital technologies.

There have been discussions on commercialization skills among scholars. However, many of these scholars, such as [9], [10], [11], [12], and [13], focused on entrepreneurship, marketing, intellectual property (IP), entrepreneurship trait

development, and relationship/social skills. Similarly, available information from practitioners revealed that commercialization skills consist of business management, capital raising, collaboration and networking, sales and marketing, and communication [14] and [15]. However, considering commercialization process of high-techs in digital age, needed skills might be more than aforementioned list. To explore commercialization skills for the digital technologies, the study asks this question: *what are commercialization skills, and are they necessary for commercializing high-techs?*

For the exploration, a qualitative research method was employed. The method often provides an in-depth knowledge on a phenomenon [16], [17]. Twelve business advisors / business development managers were interviewed. Their data were analyzed with content analysis. The results showed that previously discussed skills, like marketing, business management, technology management and entrepreneurship, are important. Meanwhile, the results revealed further that presentation/pitching, regulatory, information analysis, social media, and negotiation are necessary skills for high-tech entrepreneurs in digital era.

Thus, this study contributes to the discourse of commercialization of high-tech and entrepreneurship education. Presently, there are limited studies, which examined essential skills for high-tech commercialization. Most of the previous studies focused on commercialization factors (e.g. [18], [19], [20], [21]), challenges (e.g. [22], [23]), and other aspects of commercialization like patenting, licensing, and commercialization methods (e.g. [24], [25], [26] respectively). Some studies also focused on technology-based companies (e.g. [27], [28], [29]). However, this study focused on commercialization skills in relation to digitalization. Additionally, there are many studies on technology entrepreneurship, but most of them focused on development of entrepreneur traits (e.g. [11], [9]). Meanwhile, this study focused on certain skills which entrepreneurs or potential entrepreneurs need to acquire for their new businesses. Therefore, this study makes a theoretical contribution to commercialization of high-tech and entrepreneurship education. The rest of the article is structured as follows: theoretical background, methodology, findings and discussion, and conclusion.

II. THEORETICAL BACKGROUND

A. Digitalization

In a simpler form, digitalization is an application of the digital technologies into every aspect of life [30]. In a business sense, it is the use of those technologies to create added value, new business model, and generate income for enterprises [31]. In a society perspective, it is an integration of those technologies for better use of other systems [32]. Meanwhile, in a scholars' view, it is structuring of those technologies across: infrastructural, terminal, functional and rhetorical, and market convergence dimensions [33], process, organization, business domain, [2], [34], industries [1], society levels [2], [34], and entire economy [34], [35].

Furthermore, the digitalization technologies consist of AI, robots, automation, IoT, big data, 3D printing, driverless cars, drones, cyber-weapons, surveillance [33], [36], [34], nanotechnology, biotechnology, material science, energy storage, and quantum computing [37], [38], [36]. Deductively, in this article, digitalization associates with high-techs. Therefore, blockchain, smart cities, brain inspired computing, quantum computing, social computing, cloud computing, smart grids, digital circuits, factory automation, fuzzy logic, expert systems, agents and multi-agent systems, natural language processing, data mining, sentiment analysis, human computer interaction, image processing, geographic information systems, video analysis, medical diagnosis, segmentation techniques, augmented reality, virtual reality, satellite communication systems, 5G network evolutions, biometrics, electronic data interchange, cryptocurrencies, e-learning, e-business, digital marketing, and virtual organizations are digital high-techs.

B. Commercialization Skills

For any new technology to be successfully commercialized, there should be a team. This team must possess some skills [39], [11]. Lack of the skills has been a challenge for technology commercialization [11], [9], [40]. It is undeniable that innovators/inventors have technical competence, but they often lack business skills, which is essential for commercialization of their discoveries [41]. Nonetheless, commercialization skills is one of neglected topics [42].

Commercialization skills are regarded as an entrepreneurship skill [11], [12], [13], because entrepreneurial traits are essential for business creation [39], [11], [10], [9]. Additionally, entrepreneurs are expected to be risk-taker, innovator, and manager [39], [11], [10]. Thus, they need determination and self-confidence [39], [42]. However, commercialization skill seems to be more than entrepreneurship skills, because developing a commercialization pedagogy revealed that commercialization education has to be real, intensive, interdisciplinary, and iterative [11]. Therefore, many scholars have proposed different commercialization skills, based on their various studies. Their proposed skills are summarized and presented in the following Table I.

TABLE I.

<i>Commercialization Skills</i>	
<i>Scholars</i>	<i>Skills</i>
Chandler (2005) [43]	technical knowledge, marketing, relationship, learning, strategy
Fletcher and Bourne (2012) [44]	business, marketing,
Slater and Mohr (2006) [45]	marketing, strategy
Nevens et al (1990) [46]	communication, project management
Andersson et al (2007) [09]	entrepreneurship, project management, technical, analysis, business,
Wright et al (2009) [10]	entrepreneurship
Barr et al (2009) [11]	entrepreneurship, motivations, self-efficacy, marketing, financial, intellectual property
Abd Rahim et al (2015) [39]	risk taking, braveness, knowledge, values, self-confidence
Zahra and Nambisan (2011) [12]	marketing, social/relational
Magnusson et al (2008) [42].	business, entrepreneurship
Hsu and Wakeman (2013) [13]	technical, commercial

The above Table 1 shows that technology, business / commercial, marketing, strategy, financial, management, relationship, communication, and analysis are key commercialization skills. Are these skills sufficient for high-tech entrepreneurs in digital age? The answer to this question is provided in the findings and discussion section.

III. METHODOLOGY

To achieve the goal of this study, a qualitative research method was employed. This method is useful when an issue needs to be explored. It allows researchers to understand the issue deeply [16]. The method is highly relevant for empirical study [47], [17]. Its strength includes use of many evidences such as documents, observations, interviews and artifacts [48]. However, a systematic procedure must be used when applying the method [17] so that credibility can be established, which is essential for validity and reliability of a study [47], [49]. In order to ensure systematic process, methodological process of this study is detailed in the following subsections.

A. Interview Questions and Selection of Study Participants

Firstly, interview questions were developed from literature review and the research question. The question consisted of background, ethical, and research questions. The background questions pertained to academic information, and working experience of study participants (telling brief story about their previous projects/advisory services). The ethical questions

related to confidentiality and the research question focused on commercialization skills.

After the above step, selection criteria were outlined. They include: a study participant must have more than 10 years working experience on high-tech commercialization, and the person must versatile with digitalization development. Based on these criteria and research questions, different business advisors/developers were identified, and contacted. Twelve people responded positively to the interview request. The following Table 2 shows the details of the participants.

TABLE II.

	The Study Participants		
	Academic Qualification	Working Experiences	Year of Exp.
SP 1	MSc	Purchasing manager, R&D leader, Marketing & Communication Manager, and Business developer manager.	25
SP 2	PhD	A surgeon and business developer	20
SP 3	PhD	Clinical instrument developer, Quality assurance manager, Innovation process manager, and E-health consultant	20
SP 4	PhD	R&D manager, Business development advisor, and International marketing manager	44
SP 5	PhD	R&D manager, Marketing and sales manager, and Business development manager	30
SP6	PhD	A Consultant for regional development companies, R&D manager, and Internationalization and marketing manager.	30
SP7	PhD	Business development director, and Innovation and Strategy director.	25
SP8	MSc	Quality manager, R&D manager, Production manager, and Head of business development	40
SP 9	PhD	R&D director, and Business development directors	20
SP 10	PhD	R&D Manager, and Innovation manager	13
SP 11	PhD	R&D Manager, and Innovation manager	12

	The Study Participants		
	Academic Qualification	Working Experiences	Year of Exp.
SP 12	MSc	R&D Manager, and Innovation manager	11

B. Data Collection and Data Analysis

The data were collected by face-to-face interviews. They were collected between September and November 2017. They were recorded and transcribed. The collected data were analyzed with content analysis. This method is defined as a process of deriving main knowledge from qualitative data. The process contains codification of data, theme development from codes, and summarization of themes [17], [50]. Following the process, the data were coded after collected data were read several times. Afterwards, the codes were summarized to develop themes. Thereafter, the themes were collated to produce final results of the study. The following diagram shows the details of this study methodological process.

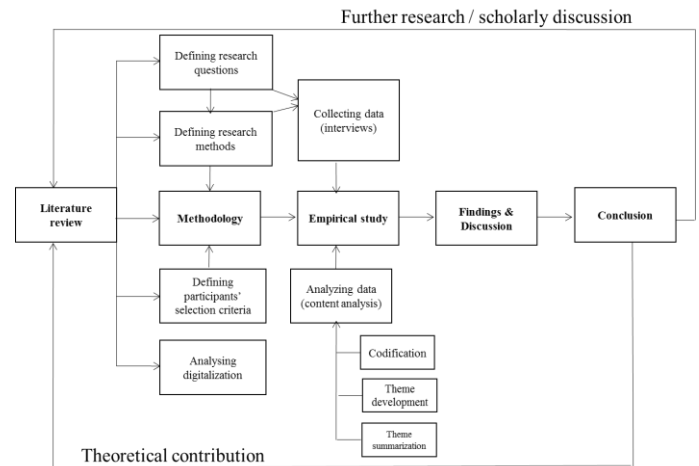


Figure 1. Research Process

IV. FINDINGS AND DISCUSSION

According to [39] and [11], commercialization skills are necessary because new technologies need to be diffused. These new high-techs are problem-solver, and they make life comfortable and livable. Thus, the study participants confirmed that commercializing these technologies require certain competences. The participants advised universities to inculcate commercialization skills into their academic curricula. Summary of commercialization skills from the study participants is presented below.

(a) **Presentation/Pitching Skill:** this skill topped the list of skills which participants of this study believed to be the most essential skills for any high-tech entrepreneurs in digital age. They cited an example that new high-techs often require more resources like money, materials and people. These resources can be acquired by a good presentation of the new high-tech to individuals and organizations, who possess them (e.g. venture capitalists, financial institution, and incubation centers). The

study participants made it known that a good presentation is needed sometimes in filing patents so that legal practitioner and university technology transfer officers (TTO) could understand what to patent. This skill is associated with communication which was mentioned by [46] and marketing as [43], [44], [45], and [11] explained. Meanwhile, this skill focuses on communicating benefits or uses of the new high-techs for purpose of getting support and necessary resources to take the technology further. Thus, this skill is a necessity for high-tech potential entrepreneurs, who mostly and likely to be scientists or engineers.

(b) **Regulatory Skill:** with digitalization and its technologies, much information is available online which include laws and regulations. Thus, as a high-tech entrepreneur, familiarization with target industry, field, market and country is essential. As the study participants shared, most of the high-techs are regulated, and they need certain certification to ensure safety, efficacy and quality for users. Having basic knowledge on related regulations enables potential entrepreneurs to speed-up their commercialization process. This skill is not yet discussed by scholars though [9] and [11] laid emphasis on IP knowledge. This skill does not focus on IP issues only, but it also focuses on certification and quality control processes. Because, IP issues are often managed by TTO officers and there are several consultants on that it. Of course, regulatory service can be bought, but from experience, the study participants emphasized that having basic regulatory knowledge facilitates IP, innovation, and commercialization processes.

(c) **Information Analysis Skill:** digital age is highly connected with information. Hence, high-tech entrepreneurs need to develop their information analysis skill. The experts, study participants, affirmed that there are so much information out there, but ability to select relevant ones and analyze them is one of keys to successful commercialization. This message corresponds to [3] who stated that application of digitalization to commercialization process of high-techs has positive influence on information management. This skill is also not yet discussed by scholars though [43] explained that having ability to learn enables commercialization activities. Similarly, [9] explained that analysis skill is important, but these scholars added the skill to their academic curriculum. Therefore, it would be good if the scholars can elaborate information analysis skill further by focusing on how it can facilitate commercialization process.

(d) **Social Media Skill:** the previous works, like [43] and [12], elucidated that social or networking skill is important in technology commercialization. The study participants agreed with their notion, but these experts noted that social media skill plays important role in collaboration, marketing, and networking. They advised that potential high-tech entrepreneurs need to acquire it because these entrepreneurs would need the skill to get resources like funding and to promote their product/service (digital marketing).

(e) **Negotiation Skill:** in digital age, collaboration, partnership, and outsourcing, are common means of doing business. These means facilitate commercialization process as [3] noted. However, ability to negotiate with collaborators or partners is a necessity. The study participants revealed that they

have seen many high-tech entrepreneurs sold their businesses cheaply due to their negotiation incompetence. The participants noted that this skill deals with information analysis skill. Due to importance to business management, this skill has been discussed by scholars [33], [11]. Meanwhile, the scholars explained the skill as a management skill; hence, it is under-discussed as a unique skill.

The above skills are the most essential skills for high-tech entrepreneurs, though some of them are not yet discussed by scholars and practitioners. The study participants also mentioned common skills like entrepreneurship, marketing, project management, business management, funding acquisition, selling, and IP knowledge. These experts stated that high-tech entrepreneurs do not need to be an adept in these skills, but they should have basic knowledge in them. These skills are widely discussed by [43], [44], [45], [46], [11], [10], [39], [12], [42] and [13].

V. CONCLUSION

Having commercialization skilled person in a team of technology commercialization project improves success of the new technology [51]. Similarly, having business people or experienced entrepreneurs in a technology commercialization facilitates the process [39], [11]. Therefore, commercialization skill is a necessity for high-tech entrepreneurs. However and mostly, commercialization skills are discussed with entrepreneurship, marketing, and business management competences. The skills have not been explicitly discussed, in relation to digitalization by the scholars. Therefore, this study filled the gap by presenting commercialization skills, which high-tech entrepreneurs should possess. Thus, the study contributes to theoretical discourse of commercialization and entrepreneurship education.

Although the study had a theoretical contribution, it also has limitations. The first limitation is its methodology. According to study [16], [48], [47] and [17], qualitative method lacks generalization, especially if it focused on a case or specific segment. In this study, high-techs and business advisors/developers were focused. In the same vein, the study participants were selected from a country (Finland); this can limit generalization of the study though Finland is one of the best countries in the world. Nevertheless, these limitations provide research opportunities for scholars. For example, testing of identified commercialization skills could be done quantitatively. The skills can also be tested across different countries and industries, so that influences of culture and other factors could be ascertained.

Most importantly, the findings of this study hopes to call attention of scholars and practitioners to issue of commercialization skills and how they should be developed. Because, the need for commercialization is increase due to limited funding for research and development, job insecurity for scientists and engineers, and survival of companies [52], [26].

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