

Skills Development for Industry 4.0 of Thai SMEs

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Abstract—This research is aimed at assessing the skills development requirements for Industry 4.0 by Thai small and medium sized enterprises (SMEs). The skills platform for Industry 4.0 is investigated across four domains: 1) Knowledge about ICT; 2) Ability to work with data; 3) Technical know-how; and 4) Personal skills. A questionnaire was utilised to collect the data from nine SMEs in the service sector and 47 students studying a Bachelor of Business Administration degree from top five universities in Thailand. The descriptive statistics with average scores were calculated to describe the situation regarding skills in Industry 4.0. The results show that the highest level of required skills for SMEs was personal skills, followed by knowledge about ICT and ability to work with data. The findings also revealed that knowledge about ICT and technical know-how were the most valued by business administration students for their improvement regarding Industry 4.0. The results could be used to identify what skills SMEs and students need most from higher education institutes for skills development in preparation for Industry 4.0.

Keywords— Education, Industry 4.0, SMEs, Skills, Thailand.

I. INTRODUCTION

Thailand has developed a major economic system over the past 20 years, with its GDP (Gross Domestic Product) and employment rate relying heavily on small and medium sized enterprises (SMEs) [1]. In 2015, SMEs represented 2.76 million enterprises, 99.7% of the total, which generated 41.1% of total GDP. Given these facts, it is clear that SMEs will continue to play an important role in the country's future development. That is, SMEs are considered as the key drivers in the economy of Thailand. Accordingly, government agencies have been launching campaigns and policies aimed at promoting and supporting SMEs to become more competitive, to create higher value-added, and providing guidelines for SME growth.

Notably, Thailand has established a 20-year national strategic plan, to be implemented between 2017 and 2036, focusing on technology and the knowledge base to meet the demands of Industry 4.0. Clearly SMEs will need to equip themselves with the appropriate skills so as not to be left behind in the context of this development. Hence, it will be necessary for Thai higher education (HE) institutes to support Thai SMEs by teaching the skills that these businesses require to ensure that they are ready to cope robustly with the challenges that arise in this context [2]. At present, there are some doubts about the level of skills development for Industry 4.0 in HEs being raised by Thai SMEs. Therefore, this research is aimed at identifying the skills required by SMEs and students in HEs. It is anticipated that the findings will prove useful for HEs in terms of informing them about the required skills for Industry 4.0, which they could teach in order to enhance SME growth and development.

II. INDUSTRY 4.0 AND SMEs

A. Background of Industry 4.0

The German government was an early adopter of the Industry 4.0 concept, with a high technology centric strategy being proposed in 2011. At the time, Industry 4.0 was known as the fourth stage of industrialisation and was widely discussed among many industries and researchers. Germany, as one of the world's most advanced manufacturing countries, wanted to consolidate its manufacturing clout and advance from Industry 3.0 to 4.0 by integrating information and communication technologies with industrial ones. The main objective of Industry 4.0 is to increase the ability of the production process by creating an extremely flexible production model of personalization with real-time exchanges between people, products and devices [3].

In order to advance to Industry 4.0, a firm needs access to advanced technologies, such as Cyber-Physical Systems (CPS), the Internet of things (IOT), the Internet of services (IOS), Big Data, and smart manufacturing systems [4-5]. Some researchers have pointed out that CPS efforts have been mainly focused on measurement of data from physical devices based on utilizing the internet as a method of communication to ensure that physical devices operate in a secure, smart and high-efficient manner [6]. Furthermore, others have also pointed out that the introduction of the IoT and IoS in manufacturing processes mark the starting point of the fourth industrial revolution [7]. Industry will use cloud computing and networks of sensors to facilitate communication between all entities, which can be people or things. Through engaging with these new systems, industry can benefit by providing value-added services to meet customer demand in a more timely and bespoke manner. Moreover, real-time communication between customers and suppliers is available through standard tools and applications, which has brought in a new dynamic in the exchange. [4]. In terms of coping with demands of Industry 4.0 researchers stress the need to be able to handle the technical aspect, which is a big challenge for SMEs. From a management perspective, Industry 4.0 will allow for an enterprise to work in close collaboration with multiple parties within the same value creation network, as well as coordinate between different levels of the hierarchy (management, corporate planning, production scheduling) within the firm [8].

B. SMEs and Skills in Industry 4.0

All enterprises irrespective of size will have to overcome many challenges in order to survive in Industry 4.0. These include the customers' requests for improved product-service innovations, greater product variety, increased quality standards, support services and immediacy of satisfaction. To meet these challenges from the customer, organizations will be required to be capable of managing their whole value-

chain in a responsive manner [9]. In preparing to embrace Industry 4.0, large organizations may have fewer issues due to the availability of their resources, such as financial, technological and human ones. However, SMEs lack these for dealing with these issues arising from Industry 4.0 [10].

Despite SMEs having limited financial and human resources, they are driven by a continual need to improve their organization in order to survive. The authors in [11] listed the many competencies that are required for organizations in Industry 4.0, such as personal ones, referring to the ability to engage in self-reliant problem-solving and interdisciplinary activity, out-of-the-box thinking; social/interpersonal competencies, pertaining to the ability to communicate, cooperate and establish social connections, structures with other individuals and groups; action-related competencies, referring to the ability of an individual to integrate concepts into his/her own agenda and to transfer plans into reality successfully; and domain-related competencies, pertaining to the ability to access and use domain knowledge for a job or a specific task. Other researchers have also listed specific IT skills, such as data analytics, computer information technology, software, and human-machine interaction [12]. The authors in [13] calls for the need for non-IT skills required by SMEs, in particular, people management and communication skills.

III. BA CURRICULUM

Regarding Thai education in the past, teacher-centered practice was deeply rooted in society, in accordance with traditional cultural values Teachers' mission was not only about the transfer knowledge, but also, teaching morality and instructing their students in how to be good citizens The image that was generally assigned to the teacher was "righteous philosopher" with good knowledge. Thailand's learning environment in the past was, therefore, a model of "one-way communication", which an emphasis on memorizing what was being taught. Students who used this method might not understand the whole lesson, only remembering the parts that would help them to pass an exam or assignment [14].

Nowadays, the focus in Thai education is on process modification, whereby the education of the country is now geared towards meeting the country's innovation requirements. There is an integrated management of education in science, technology, engineering, and mathematics (STEM) to solve or create something according to the students' interests, with a strong focus on creativity and innovation [15]. Regarding teaching in the 21st century and curriculum development with skills, the interest lies in the learning content and methods pursued according to learning ability. The fundamental aim is to integrate knowledge for innovation and technology with a range of skills.

Regarding the top five universities in Thailand, ranked by QS Asia University Rankings 2019 [16], these are: 1) Chulalongkorn University 2) Mahidol University 3) Chiang Mai University 4) Thammasat University and 5) Kasetsart University. For the curriculum of the Business Administration (BA) program, there are many courses with two main categories, namely general education studied by all and optional core courses, which the students can choose.

Based on the BA program, we summarized the subjects with skills required by Industry 4.0 in Table I. It shows there are many courses on BA programs for providing skills development, including hard skills, soft skills and meta-skills to students in HE institutes.

TABLE I. SUBJECTS IN SKILLS DEVELOPMENT FOR INDUSTRY 4.0

Top Five Universities	General Education	Core Courses	
		General	Major
Chulalongkorn University	Science and Mathematics, Interdisciplinary	Quantitative Business Analysis, Business Statistics	Business Information Systems, Analysis and Design, Data Communication for Management, Change and Innovation, Statistical Analysis for Decision Making, Database and Application in Business Designs of Experiment
Mahidol University	Thai Language in Communication, Mathematics and Statistics		Management Information Systems, Entrepreneurship, Management Information System
Chiang Mai University	Technology Development and Global	Communication for Business Results	Creativity and Innovation Management
Thammasat University	Creativity and Communication	Development of Creativity and Creation of Innovation, Persuasive and Negotiation Skills, Management of Innovative Organizations	Business Intelligence and Analytics, Artificial Intelligence, Tools for Data Analytics, Cloud Application Development
Kasetsart University	Thai Language for Communication	Business Statistics, Quantitative Analysis for Decision Making in Business, Management for Information System	Business Analytics, Business Systems Analysis, Organization Communication, Creativity and Innovation, Business Negotiation, Management Simulation Technique

IV. SKILLS DEVELOPMENT FOR INDUSTRY 4.0

Regarding the platform of skills development for Industry 4.0, the authors used a framework from this reference [17] that contained four domains including 1) Knowledge about ICT 2) Ability to work with data 3) Technical know-how and 4) Personal skills. A questionnaire was applied to survey the data according to objectives of this research. The questionnaire involved 3 parts, with the first probing each profile of response, name of SME, and type of business. The second part was aimed at investigating the level of required skills by SMEs in the four domains. The

respondents were required to rate statements on a five-point Likert scale, where 1 indicated the least requirement and 5 the most. The level of importance of the different skills that students needed to improve was evaluated in the third part. The respondents were required to rate statements on a five-point Likert scale too, where 1 represented the least important skill that needed to be improved and 5 the most important skill that needed to be so. The average scores were divided into five equal-sized groups: 1) very low level [1.00-1.80] 2) low level [1.81-2.60] 3) moderate [2.61-3.40] 4) high level [3.41-4.20] 5) very high level [4.21-5.0]. The average scores of these two parts as descriptive statistics were used to explain the skills development.

A questionnaire was devised to collect the data at Digital Job Fair, Bangkok, in April 2019. The data were gathered from nine SMEs in the service sector, including digital marketing, logistics and transportation, medical equipment, education and an event's organizer. 47 BA students from the top five universities in Thailand were also surveyed (just the third part of the survey). The descriptive statistics, as shown in Table II, provide the average scores of skills development for Industry 4.0. The results indicate that the most important skill in term of domain of skills development for Thai SMEs in the Industry 4.0 is personal skills (4.664), followed by knowledge about ICT (4.142), ability to work with data (4.064), and technical know-how (3.429), respectively. Amongst these personal skills, communication skills, working in a team, adaptability and ability to change, and mindset change for lifelong learning are the top four priorities reported by SMEs regarding what they want from their employees. In addition, basic information technology knowledge, understanding visual data output and making decisions were considered to be the most important skills in the domain of knowledge about ICT. They particularly mentioned the ability to work with data that would contribute to Thai SMEs.

TABLE II. SKILLS FOR INDUSTRY 4.0

Skills for Industry 4.0	Average Scores	
	Thai SMEs	BA Students
1. Knowledge about ICT	4.142	4.007
1.1 Basic information technology knowledge	4.455	4.062
1.2 Ability to use and interact with computers and smart machines like robots, tablets etc.	4.106	3.955
1.3 Understanding machine to machine communication, IT security & data protection	3.864	3.908
2. Ability to work with data	4.064	3.773
2.1 Ability to process and analyze data and information obtained from machines	4.015	3.924
2.2 Understanding visual data output & making decisions	4.364	3.833
2.3 Basic statistical knowledge	3.727	3.727
3. Technical know-how	3.429	3.965
3.1 Inter-disciplinary & generic knowledge about technology	3.833	3.955
3.2 Specialized knowledge about manufacturing activities and processes in place	3.303	3.939
3.3 Technical know-how of	3.277	3.848

Skills for Industry 4.0	Average Scores	
	Thai SMEs	BA Students
machines to carry out maintenance related activities		
4. Personal Skills	4.664	3.934
4.1 Adaptability and ability to change	4.561	3.864
4.2 Decision making	4.515	4.030
4.3 Working in a team	4.615	3.848
4.4 Communication skills	4.758	4.185
4.5 Mindset change for lifelong learning	4.561	4.045
Total	4.159	3.923

Regarding skills development for Industry 4.0 for each domain for the surveyed BA students, the findings also reveal that they needed to improve skills in knowledge about ICT (4.007), technical know-how (3.965), and personal skills (3.939), respectively, in terms of importance from their perspective. Notably, communication skills was considered the most important ability that BA students needed to improve, followed by basic information technology knowledge and mindset change for lifelong learning, respectively.

V. CONCLUSIONS

For this research, the authors investigated the level of skills development in preparation for Industry 4.0 for Thai SMEs. A questionnaire was used to collect the data from nine SMEs and 47 BA students from the top five universities in Thailand. The results show the average scores for skills development requirement for Industry 4.0 in four domains: 1) Knowledge about ICT 2) Ability to work with data 3) Technical know-how and 4) Personal skills. The findings indicate that personal skills and knowledge about ICT are the top priorities that SMEs need from their employees. While regarding higher education institutes, BA students would like them to provide more knowledge regarding ICT and technical information.

The contribution of this study is to inform higher education institutes on the skill requirements of SMEs as well as to understand what skills BA students need to improve. In addition, higher education institutes could modify their existing curriculum based on the findings, thus responding calls from these firms. In sum, they need to provide teaching and learning approaches for skills development that will make SMEs competitive in Industry 4.0. For further research, the authors suggest researchers should survey a much larger sample of SMEs and BA students so as to allow for generalization of the findings regarding skills development for Industry 4.0.

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