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The Mismatch of Present and Required Future Workforce Skills of Manufacturing Industry

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ABSTRACT

Manufacturing is one of the vital industries in Malaysia that contributes to the national Gross Domestic Product (GDP) and provides employment for society. The manufacturing sector involves the use of various technologies in order to produce output. However, technological advancement has affected the manufacturing sector mainly in terms of skills demanded. Furthermore, studies focusing on skills demanded in the future from the manufacturing industry perspective regarding Industry 4.0 remain scarce. Therefore, this study aims to identify the present and future skills and determine the differences in the skills demanded. This paper intends to determine mismatch encountered concerning skills demanded by the industry due to the rise of Industry 4.0. The method used in this study was the review of literature on the skills demanded in the manufacturing industry obtained from journal articles, magazines, books and online news that were closely related to the keywords and research area. This paper emphasised the impact of the skills demanded by the manufacturing industry and the skills needed in the future for manufacturing in Malaysia. Most research has discussed the skills set based on the employers and universities' perspectives. The findings of the study found that there is a differences and mismatch between the present and future skills demanded by manufacturing industry. Therefore, the future studies required to conduct the study related to the future workforce skills in order to provide clear sight of the future workforce skills in the specific industries.

1. Introduction

Technological change and innovation have affected the industry in the last decades [1]. Dramatic changes in Industrial Revolution 4.0 or Industry 4.0 requires quality human resources that are responsive to the rapid changes and has a high qualification [2]. Technological advancement will take over the human workforce through automation and robotics [3]. Industry 4.0 requires the workforce to learn new skills as new jobs may appear across various industries [4]. In other words, new skills

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and competencies will be needed in the new working world [5]. Industry 4.0 drives transformation in the economy, education, lifestyle, employment and skill development [3]. Sohimi *et al.,* [6] agreed that skills development is one of the vital keys that spearhead the success and implementation of Industry 4.0 as the world undergoes a profound digital revolution [5].

Malaysia is no exception in facing the wave of Industry 4.0. This wave has affected all industries, particularly the manufacturing industry in Malaysia. The manufacturing industry has less awareness of the implication of Industry 4.0 [7]. The manufacturing industry and the government will benefit if the primary effect of the Industry 4.0 is understood [7]. According to Saleh [8], the skills demanded by the manufacturing industry must be in line with the nature of the business need. The skills are the pass for the future workforce to be promoted in their careers. Future workforce with multi-skills is the most demanded by employers [9]. Therefore, as one of the stakeholders that supply the future workforce demanded by the industries, universities are responsible for producing a quality workforce with the necessary skills.

Undeniably, education is one of the decisive factors contributing directly to the nation's advancement [10] as the primary tool to groom graduates for the world of work that is rapidly changing and increasingly demanding in order to enhance their employability [11]. Besides the manufacturing industry, Industry 4.0 also impacts the education system as the syllabus applied in the university pedagogy covers the skills demanded in the world of work [1]. Only employees that are competent and highly knowledgeable will be able to handle the use of high technologies. The industry will employ new and high technologies and savvy media that require qualification and workforce skills higher than present [1]. The learning and teaching methods will significantly change in future university pedagogy and the structure of the industries [12]. Besides, Malaysia is also facing challenges in education parallel to other developing countries [10]. Thus, universities must take actions to encounter the issue by identifying ways to meet the future skills demand by improving the skills and simultaneously produce good quality graduates [13].

The level of the skills determines the effect of Industry 4.0 on jobs. Skills that no longer meet industry requirements may lead to unemployment among graduates. The scenario worsens when the existing skill is no longer relevant to the technological advancement of Industry 4.0. In order to secure every individual's job in the Industry4.0 environment, the skill set that satisfies the market of future work must be developed asserted that skills development must be relevant for technological advancement to reduce graduates' unemployment rate [3]. However, existing skills are unlikely to be entirely replaced by automation [4]. Therefore, universities and industries must collaborate and show positive implications to the new skills development in Malaysia in respect of Industry 4.0 by providing training for employees [6].

Today, many employers struggle to recruit qualified employees and continuously face the challenge [14]. Malaysia is no exception in this situation, whereby the Malaysian government needs to cope with the increasing unemployment and inequality in income [15,16]. The government must understand the necessity to provide skills training to the workforce to reduce the gap between universities and industries [13]. According to the recent report by Chang *et al.,* [17], the writer assumed that 137 million people's jobs in Southeast Asia would be replaced by automation in the next 20 years. Therefore, the future workforce must be nurtured to master a blended set of future skills.

The mismatch between existing skills and required skills will lead to increasing unemployment. The deficiency in required skills will cause a significant decline in performance and diminish the competitiveness of the organizations [18]. Many negative comments are given to local graduate trainees who lack the essential skills required by the industry [10]. However, loopholes exist between the required skills and developed skills in Industry 4.0 [19]. Nevertheless, two different schools of

thought are present between both stakeholders (universities and industries, respectively) [14]. Undertaking a study on skills requirements in Industry 4.0 is crucial to assist job seekers and skills development institutions about what has to be done and what should be expected [18]. Therefore, this study aims to identify the impact of the skills demanded by the manufacturing industry and the skills required in the future from the manufacturing industry in Malaysia. Thus, the following section will explain the literature review related to the field of this study comprehensively.

2. Literature Review

2.1 History of Industry 4.0

Industry 4.0 firstly began in Germany and subsequently followed by the United States (US), Japan, China and other countries [15]. The industrial revolution was caused by mechanization in the first industrial revolution. Subsequently, electrical energy usage (mass production and electricity) followed in the second industrial revolution, whereas the third industrial revolution used electronics and automation. Digitalization and robotics will follow suit in the fourth industrial revolution [1,18]. Some jobs will be lost, while others will be created in different industrial revolution phases as some skills become redundant [18]. However, the skills are valuable for others [18]. The industrial revolution affects the skills demanded by the future workforce in various industries [1]. In other words, a significant change is evident in the skills requirements between Industry 4.0 and the previous industrial revolutions [18]. New technologies usher new workplace practices and turn past practices out of date [4].

2.2 Theory of Skills

According to Lysaght and Altschuld [20], skill can be defined as an ability to perform something with the desired results. However, according to Yaakob *et al.,* [21], skills can also be described as the special knowledge, ability or competency required to achieve something successfully. Two forms of skills exist, namely soft skills and hard skills [22,23]. The soft skills and hard skills can be nurtured with collaboration among graduates, university, industry players and policymakers [24]. Soft and hard skills are crucial in the science and technology areas, especially in the world of work [25]. However, according to previous studies, there are many definitions for soft and hard skills (Refer to Table 1).

Table 1
Definition of soft skills and hard skills

References	Soft Skills	References	Hard Skills
Ritter *et al.,* [22]	Related to the emotional intelligence of an individual	Sopa *et al.,* [2]	Producing something tangible and direct; Evaluated through the practical or technical test; Easy to be measured
Abd Rahmad Ahmad *et al.,* [26]	Capabilities for all jobs that are considered important in preparation for works	Sopa *et al.,* [2]	Recognised from the Intelligent Quotient (IQ) thinking including counting, critical thinking, comprehensive, knowledge, designing and modelling
Qizi [27]	Skills possessed by an individual that does not belong to a professional society	Yaakob *et al.,* [21]	Involve methods, processes, procedures and techniques that require understanding and efficiency in a specific activity
Chen *et al.,* [29]	Too personal and include knowledge in the human mind		Defined as an art that involves the use of body where the technique and ability can be possessed through training and experience
Hartley [30]	Core actions and experiences that include idealism, values and emotions	Yaakob *et al.,* [21]	Involve knowledge and experience that can be learned in classrooms
		Abd Rahman Ahmad *et al.,* [26]	Competencies to use specific instruments, processes and methods
		Qizi [27]	Represent several skills and ability of an individual possible to perform a particular task and activities
		Lombardi [28]	Can be created, written and transferred between companies
		Azmi *et al.,* [31]	Related to professional knowledge, tools and techniques that include more specific teachable skills

The skills possessed by graduates are assets for graduate employability and a decisive factor in securing a job. The skills enable graduates to attract employers to hire them to work in an industry [13]. Graduates are required to possess some skills to be employed [23]. Nevertheless, Subramonian [32] considered that skills and competencies have the same definition although defined differently by other authors. Previous studies used different terminologies for soft and hard skills (Refer to Table 2). However, Table 3 displays the repetition of the terms used in previous studies as the current study utilized the terms with the highest frequency.

Table 2
The frequency of terminologies used for soft skills and hard skills

Terminologies	Authors	Frequency
Soft skills	Sopa *et al.,* [2], Ra *et al.,* [4], Kergroach [5], Azmi *et al.,* [9], Tan *et al.,* [14], Maisiri *et al.,* [18], Qizi [27], Yaakob *et al.,* [21], Ritter *et al.,* [22], Azmi *et al.,* [23], Azmi *et al.,* [33], Abdullah [34], Rumsey *et al.,* [35], Osmin [36], Ghazali and Bennett [37], Jaaffar *et al.,* [38], Asonitou [39]	18
Non-technical skills	Maisiri *et al.,* [18], Abd Rahman Ahmad *et al.,* [26]	2
Applied skills	Qizi [27]	1
Employability skills	Azmi *et al.,* [23], Abd Rahman Ahmad *et al.,* [26], Asonitou [39], Lisá *et al.,* [40], Triyono *et al.,* [41], Messer [42], Kamaliah *et al.,* [43], Chan *et al.,* [44], Jaafar *et al.,* [45], Rahmat *et al.,* [46]	10
Generic Skills	Yaakob *et al.,* [21], Ghazali and Bennett [37], Chhinzer and Russo [62]	3
Hard skills	Sopa *et al.,* [2], Azmi *et al.,* [9], Tan *et al.,* [14], Yaakob *et al.,* [21], Ritter *et al.,* [22], Azmi *et al.,* [23], Qizi [27], Azmi *et al.,* [33], Osmin [36], Ghazali and Bennett [37], Jaaffar *et al.,* [38], Asonitou [39]	12
Technical skills	Maisiri *et al.,* [18], Yaakob *et al.,* [21], Abd Rahman Ahmad *et al.,* [26], Rumsey *et al.,* [35]	4

Table 3
Repetition of terminologies used for soft skills and hard skills

Terminologies	Repetition
Soft skills	18
Non-technical skills	2
Applied skills	1
Employability skills	10
Generic skills	3
Hard skills	12
Technical skills	4

3. Methodology

A systematic review methodology was used to identify skills demanded in the manufacturing industry. The systematic review was applied by providing evidence and informative answers. Additionally, the related information in this paper was obtained from different sources, such as journal reports, books and electronic references. However, the study field has been undertaken by previous researchers in different areas (Refer to Table 4). According to Abdullah [34], the skills required could be differentiated as the skills depends on the organizations' nature of business.

Table 4
The frequency of skill studies in different sectors

Sector	Frequency	Author
Manufacturing	7	Kamaruzaman *et al.,* [3], Tan *et al.,* [14], Abd Rahman Ahmad *et al.,* [26], Lisá *et al.,* [40], Chan *et al.,* [44], Rahmat *et al.,* [46], Jaaffar *et al.,* [38]
Others	20	Benešová and Tupa [1], Sopa *et al.,* [2], Sohimi *et al.,* [6], Othman *et al.,* [10], Adebakin *et al.,* [11], Yusof *et al.,* [13], Ghani and Muhammad [15], Jajuri *et al.,* [16], Maisiri *et al.,* [18], Yaakob *et al.,* [21], Azmi *et al.,* [23], Qizi [27], Abdullah [34], Ghazali and Bennett [37], Jaaffar *et al.,* [38], Asonitou [39], Lisá *et al.,* [40], Triyono *et al.,* [41], Cicek *et al.,* [47]
Total	27	

Table 5 shows the frequency of the type of studies used by previous researchers. The type of study can be classified into two types, namely empirical study and non-empirical study. The empirical studies used in this research include surveys, questionnaires, interviews, experiments, observations and case studies. An empirical study is in contrast with a non-empirical study which excludes quantitative and qualitative methods. Conversely, non-empirical studies include critical studies, systematic reviews and also meta-analysis methods.

Table 5
The frequency of the type of study

Type of Study	Frequency
Empirical Study	19
Non-empirical Study	8
Total	27

4. Results

Based on the previously undertaken literature reviews, this study found that previous studies researching skills required in Industry 4.0 are too general. Only a few studies listed the skills required in Industry 4.0. However, studies identifying the manufacturing industry's skills that align with Industry 4.0 requirements must be conducted. Table 6 displays the frequency of the previous studies that researched the skills generally and those who conducted studies focusing on the type of skills required in Industry 4.0.

Table 6
The frequency of the study of skills and Industry 4.0

Study on Skills	Frequency
Skills + Industry 4.0 (general)	9
Skills + Industry 4.0	18
Total	27

Table 7 shows the study on present skills by previous authors, whereas Figure 1 and Figure 2 shows the studies on future skills based on the reviewed report. As shown in Table 7, Figure 1 and Figure 2 above, it is found that gaps exist between present skills and future skills required in Industry 4.0 as the future skills demands are more related to the advanced technology used. Most studies concerning present skills were focused on soft skills rather than technical skills. This study only chose the nine highest skills for the present skills in Table 7. Nevertheless, future skills study (in Figure 1 and Figure 2) listed by the foresight magazines worldwide shows that the required future skills are related to soft and hard skills.

In Figure 1, the highest number of frequencies recorded by the ethics and moral professionalism skills. However, different from other countries reports that showed the highest frequencies recorded are by critical thinking, emotional intelligence, leadership, autonomy and people management. This due to some scholars debated that the soft skills are as essential as hard skills. The use of advanced technologies requires blended skills to handle the technologies. Subramonian [32] and Chan *et al.,* [44] agreed that soft skills are complementary to hard skills as the skills encompass capabilities and learning outcomes of the standard operational procedures (SOP) or practical tasks. However, due to the limited resources on future skills, future studies are suggested to research future skills as the previous studies discussed the skills essential in Industry 4.0 generally.

Table 7
The study on present skills

Present Skills	Authors
Personal Qualities Skills	Saleh [8], Tan *et al.,* [14], Chan *et al.,* [44], Rahmat *et al.,* [46], Karre *et al.,* [53]
Teamwork Skills	Adebakin *et al.,* [11], Chan *et al.,* [44], Rahmat *et al.,* [46], Guilland [49], Hanapi *et al.,* [50], Paschou *et al.,* [57], Ngoo *et al.,* [61], Anuar *et al.,* [63]
Communication Skills	Adebakin *et al.,* [11], Yusof *et al.,* [13], Tan *et al.,* [14], Abdullah [34], Jaaffar *et al.,* [38], Rahmat *et al.,* [46], Hanapi *et al.,* [50], Paschou *et al.,* [57], Ngoo *et al.,* [61]
Leadership Skills	Adebakin *et al.,* [11], Chan *et al.,* [44], Guilland [49], Hanapi *et al.,* [50], Paschou *et al.,* [57], Ngoo *et al.,* [61]
Creative and Innovating Skills	Tan *et al.,* [14], Jaaffar *et al.,* [38], Rahmat *et al.,* [46], Katarzyna [48], Hanapi *et al.,* [50], Ngoo *et al.,* [61], Anuar *et al.,* [63], Jaaffar *et al.,* [38]
Critical and Problem-Solving Skills	Adebakin *et al.,* [11], Tan *et al.,* [14], Jaaffar *et al.,* [38], Chan *et al.,* [44], Rahmat *et al.,* [46], Katarzyna [48], Hanapi *et al.,* [50], Ngoo *et al.,* [61], Anuar *et al.,* [63]
Interpersonal Skills	Saleh [8], Adebakin *et al.,* [11], Jaaffar *et al.,* [38], Guilland [49]
Social Skills	Saleh [8], Adebakin *et al.,* [11], Jaaffar *et al.,* [38], Chan *et al.,* [44]
Adaptive Skills	Saleh [8], Tan *et al.,* [14], Chan *et al.,* [44], Guilland [49]

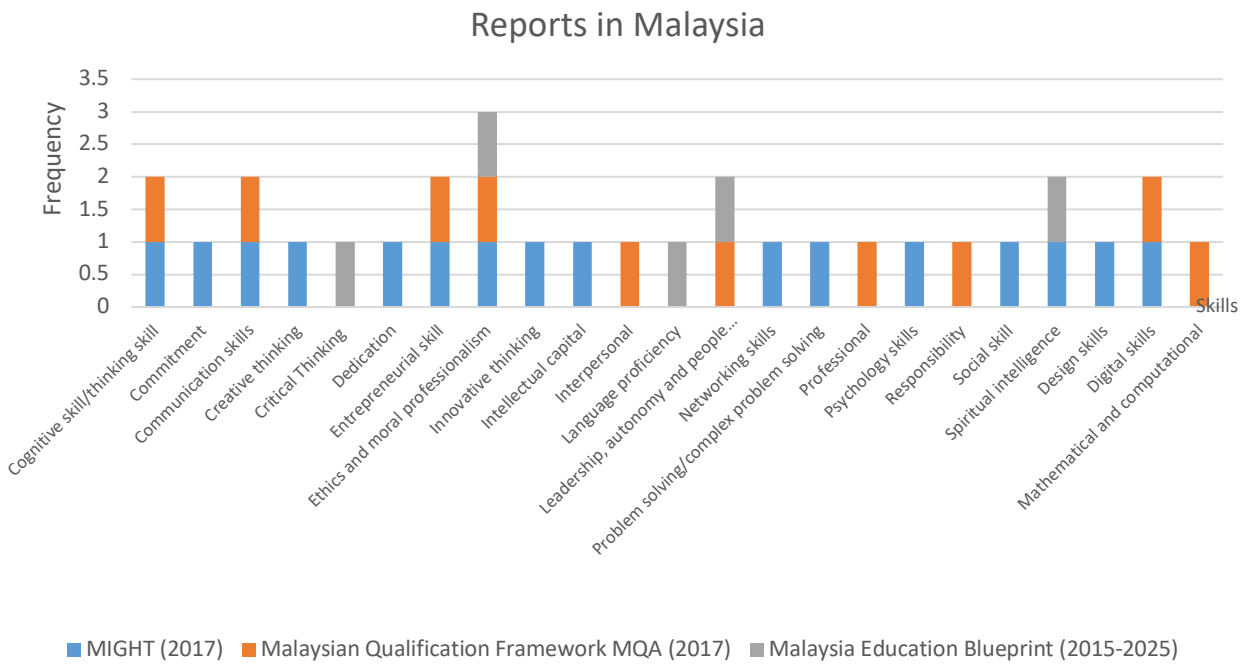

Fig. 1. Studies on future skills from the reports in Malaysia

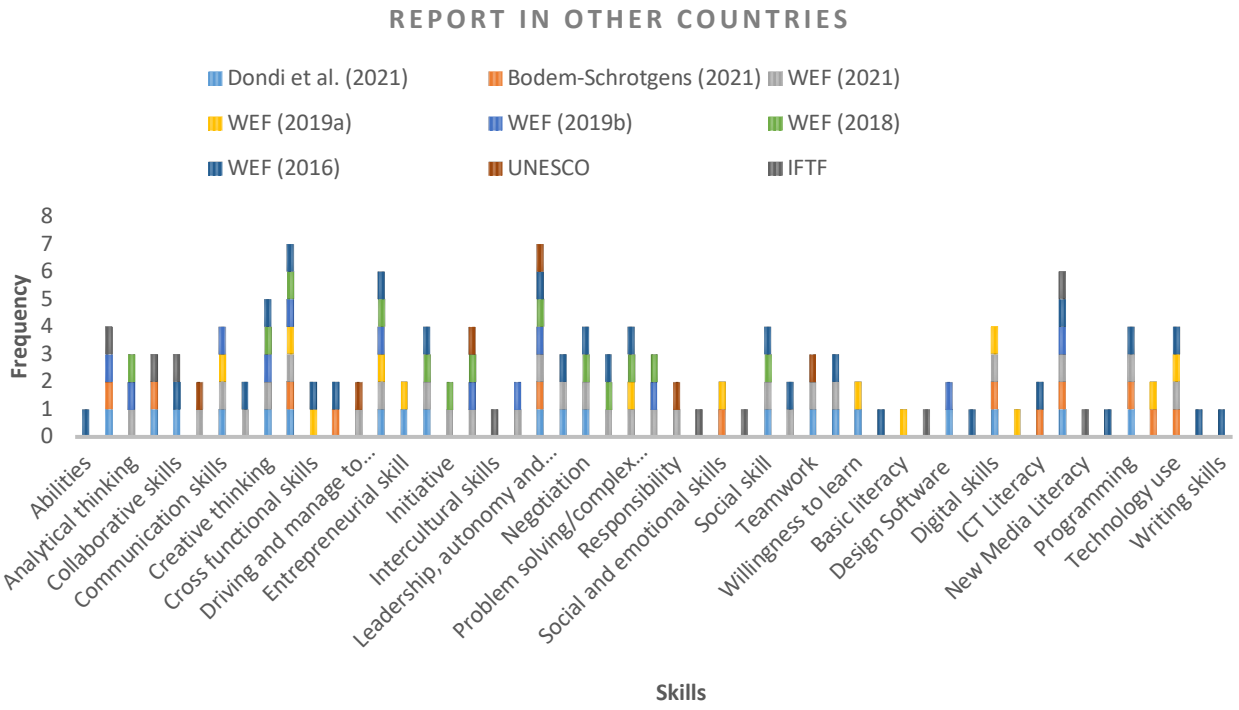

Fig. 2. The study on future skills from the reports in other countries

5. Conclusions and Recommendation

In today's complex work environment, every stakeholder faces challenges to equip and internalise young people with soft skills and hard skills. On the supply side, universities should revise teaching and learning methods to produce graduates for a future workforce that master both skills that tandem with the industry's demands. On the demand side, the industry can provide training that includes both skills that align with technological advancement. This study revealed that the skills required in Industry 4.0 are different compared to previous industrial revolutions. Therefore, future studies must identify the future skills required by various industries as all industries face the fourth industrial revolution's wave.

Future studies can use different methods in identifying the skills demanded, such as utilising the quantitative method, qualitative method or mixed-method. Factors influencing skills in Industry 4.0 and the perception between both stakeholders can be assessed in future studies to reduce the loopholes in the skills demanded in the future. The research on soft skills and hard skills requires an ongoing effort to reduce the gap related to the skills between the perception of higher education institutions and industry. Therefore, higher education institutions can reform employers' skills for job performance and produce quality graduates.

6. Suggestion for Future Study

Future studies can employ different methods to identify the skills demanded, such as utilising quantitative, qualitative or mixed methods. Factors influencing the skills in Industry 4.0 and the perception between both stakeholders can be undertaken in future research to reduce the loopholes for the skills demanded in the future. Both soft and hard skills must be continuously researched to narrow the gaps between higher educational institutions and the industry to drive skills

transformation by higher education institutions to produce high-quality graduates and a workforce with exceptional skills.

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