Industry revolution 4.0: the readiness of graduates of higher education institutions for fulfilling job demands

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Abstract: Industrial Revolution 4.0 (IR 4.0) is the mass implementation of cyber physical systems in the industry, which leads to an intelligent, connected and decentralised production that influences the value chain related to the regulation of organisation. Therefore, local graduates should have the ability to advance themselves and need to be flexible in order to adapt the shifting IR 4.0 trend in job competency, new knowledge and expertise so as to meet the new requirement pertaining to job demands in IR 4.0. Therefore, this paper aims to identify the issues related to the work readiness of local graduates before they work in a IR 4.0 environment. In this regard, several previous studies related to the issue of the graduate work readiness issue were analysed and reviewed. The reason for focusing on this issue is to make sure that IR 4.0 is human-led and human-centred. Based on the findings, Malaysian graduates were found to lack knowledge about working in a IR 4.0 environment. Other emerging issues are the inability of the graduates to apply the skills acquired during their studies especially the soft skills, their low proficiency in English, low self-confidence and attitude problem. Another issue discussed by many researchers was the graduates' skill gap and skill mismatch to the IR 4.0 job demands. Due to aforementioned issues, the previous studies attempted to solve the problem through the development of Learning Factory (LF) framework. The Pre-Professional Identity (PPI) theory was also set forth as one of the attributes pertaining to the graduate work readiness for IR 4.0.

Keywords: Industry 4.0, IR.40, work readiness, graduate employability, job demands.

1. Introduction

Industry Revolution 4.0 (IR 4.0) was introduced in Germany by the German government in 2011 as one of the country's high-tech strategic economic developments. This strategic plan is aimed at increasing the efficiency, productivity, transparency and safety of their industry (Boyes, Hallaq, Cunningham, & Watson, 2018; Hecklau, Galeitzke, Flachs, & Kohl, 2016). IR 4.0 was defined as the revolution of the industry embedded with advanced technology in internet to serve as a backbone in the integration of human, physical objects, intelligent machines, production lines and production processes across organisational boundaries to form a new intelligent, networked and agile value chain (Schumacher, Erol, & Sihn, 2016). Other researchers defined IR 4.0 as a new paradigm that embraces the future technologies such as Internet of Things, Internet of Services, robotics, big data, cloud manufacturing and augmented reality (Pereira & Romero, 2017). Technology development in IR 4.0 has a profound impact on the economy (Kazancoglu & Ozkan-Ozen, 2018).

A detailed list of the changes that occurred in technology since the first industrial revolution is shown in Table 1.

Table 1. Industrial Revolution summary

Industrial revolution	Duration	Technology
Industry 1.0	Late 18th century	Mechanical production using water and steam power
Industry 2.0	Beginning of 20th century	Electrical production line
Industry 3.0	Beginning of 1970s	Digital automation
Industry 4.0	Present	Cyber-physical system

(Sources from Maria, Shahbodin, and Pee., 2018)

The advancement of technology in the current industry has affected certain professions due to the trend of IR 4.0 employs intelligence systems in order to replace manual job performed by humans with smart machine, which resulted in significant changes in the workplace landscape. The IR 4.0 will change all the sectors' method in handling manual works and employment classes as well as the current skills of local graduates (Chui, Manyika & Miremadi, 2016). The recent issue of unemployment that was discussed is mostly related to the lack of IR 4.0 skills among graduates of HEIs that lead to the unemployment. Thus, more efforts should be made to develop a graduate work competency readiness model consist of skill needed parallel with IR 4.0 challenges in order to ensure that the graduates are competent with IR 4.0 job demand. The education revolution is taking place with a view to improving the curriculum structure in HEIs due to IR 4.0 which is summarised in Table 2.

IR 4.0 increases the demand of highly qualified candidates in various industries. As a provider of skill and knowledge to a workforce, the educational sector will have to adjust the way students are trained in order to prepare them so that they can be qualified for the future employment trends (Maria et al., 2018). Lasakova, Bajzikova, and Dedze (2017) also stated that in order to comply with innovation in IR 4.0, HEIs should consider revising the curriculum model by focusing on developing the appropriate skills and knowledge to the students according to the needs of IR 4.0. For example, the provision of complementary training to the graduates can help reduce the gap between academic education and industry requirements (Büth, Bhakar, Sihag, Posselt & Bohme, 2017). Therefore, this study was conducted to identify the pertaining issues related to graduate work readiness before they work in IR 4.0 environment. This paper is organized as follows. Section 2 presents a review on the issue of graduate work readiness in Malaysia. Section 3 discuss the related theories pertaining to the issues of graduate competencies. The last section presents the conclusions of this study.

Table 2. Education Revolution

Education revolution	Methods	Technology
Education 1.0	Dictation Instructive Direct transfer of information	Not allowed during educational process
Education 2.0	Progressivism Begins to open to internet access	Limited access
Education 3.0	Knowledge-producing Co-constructivism	Graduates and educator gains full access for knowledge, construction and transmission
Education 4.0	Innovation-producing Replacing classrooms with virtual reality	Self-learners as major source technology Evolution
Education 5.0	Flexible learning	Digitalisation

(Sources from Maria, Shahbodin, and Pee.,2018)

2. Graduate work-readiness issues in Malaysia

Work readiness is defined as a skill comprising related to a set of achievement, one's understanding and personal attitude or a quality that enables graduates to potentially obtain the desired job (Yusof & Jamaluddin, 2015). Prikshat et al. (2018) explained that graduate work readiness comprises skills, knowledge, attitudes and commercial awareness that enable graduates to make a positive contribution once they are employed. Based on these definitions, it can be inferred that the graduate work readiness depends on the ability of graduates to utilise the skills acquired at the university in order to tackle their desired job.

One of the issues pertaining to graduate work readiness in Malaysia is the lack of soft skills (Teng et al., 2019). Soft skills comprise the skills, abilities and traits that reflect an individual's personality, attitude and behaviour. The majority of Malaysian graduates have poor soft skills, namely low self-confidence, poor time management, communication issue, problem solving,

critical thinking, a low creativity, proactive, low interaction behaviour and leadership skills (Nazron, Lim, & Nga, 2017). Moreover, the feedbacks from employers also added that the lack of positive work ethic, team-work, decision-making skills, communication skills and leadership skills were other issues that would affect graduate employability in Malaysia (Nazron et al., 2017). Lack of communication skills in English language among graduates is also discussed in recent literature (Prikshat et al., 2018). The inability to communicate in English becomes one of the barriers for the graduates to employment and becomes a major hindrance for employers to hiring local graduates (Zainuddin, Pillai, Dumanig, & Phillip, 2019).

Another issue concerning the graduate's unemployment in Malaysia is the lack of work experience (Azmi, Hashim, & Yusoff, 2018). According to (Belwal et al., 2017), employers recruiting graduates for a job expect them to have a basic experience in the work field. Work experience is one of the key aspects that many companies will consider before they decide to recruit local graduates. This will become a barrier for fresh graduates since most of them are novice future employees. Therefore, it is essential to embed industrial training programmes in academic curricula. The graduates will gain work experience during the training period when they can develop the skills and knowledge needed for IR 4.0 job demands.

Although industrial training is important, Prikshat et al., (2018) claimed that Malaysian industrial training is inadequate which results in the recruitment of inexperienced graduates for fulfilling job demand in IR 4.0. Due to nature of the workplace in IR 4.0 that has changed dramatically and is different from that of the traditional workplace, graduates are expected to have up-to-date skills in order to match with the current industry needs. Moreover, previous researcher also found that due to the inadequacy of the exposure to industrial training, Malaysian graduates are faced with skills gap issue for IR 4.0 employment market (Pitan, 2017). Employers prefer to hire skilled candidates with a view to reducing the cost of training as re-training new graduates will result in another operational cost.

Another attribute pertaining to graduate unemployment in Malaysia is the graduates' mismatch issue (Chavan & Carter, 2018). Mismatch issues vary from expectation mismatch to skill mismatch. These mismatch issues are inevitable as (Green and Henseke,2016) explained that there is always some degree of mismatch between educational achievement and job requirements especially with regard to IR 4.0 job requirements. Expectation mismatch occurs when there is a difference between competencies desired by employers and actual competencies demonstrated by university graduates (Norman, Razman, Latiff, & Said, 2018). For example, a study carried out by Azmi, Kamin and Noordin (2018) found that graduates feel that their critical thinking and problem solving skills are high for employability, however, employers in engineering industry rated graduates' skills to be of intermediate level. This mismatch of perception with regard to job seekers and employers lead to graduate unemployment (Belwal et al., 2017). In an interview conducted by Hsu (2015) with Rohit Sharma, CEO of INTI it was found that there is a significant mismatch of perception between graduates and employers and if left unchecked, it may lead to a serious problem of graduate unemployment.

Other issues regarding Malaysian graduate unemployment were the low level of self-confidence and attitude problems among graduates (Azmi et al., 2018; Prikhsat et al., 2018). Graduates with a low level of self-confidence have lower chances of being employed (Zainuddin et al., 2019). Interviewers would prefer to employ graduates who display a high level of self-confidence and are able to express themselves during job interviews. Graduates with a low level of self-confidence are too shy to speak up during interviews and their chances of being employed are lower compared to those of graduates with high self-confidence. Based on the Jobstreet.com (2015) Malaysian graduates' poor attitude and poor time management are the factors that contribute to graduate unemployment. Table 3 summarises the overview of previous studies related to the issue of graduate work readiness.

Table 3. Graduate Work Readiness Issues

Author (s)	Issues	Method	Findings
(Kapareliotis, Voutsina, & Patsiotis, 2019)	Study on internship and employability prospects help in accessing student work readiness through internship program	Online survey	The result of this study showed that students who attend internship programs are able to apply basic academic skills when they perform internship task, high-order skills, professional skills and fulfil the expectation of employers which are categorized based on work readiness construct.
(Zainuddin et al., 2019)	English proficiency and graduate employability	Interview	The results on this study showed that English proficiency plays a major part in employability as employers prefer to use English language when interacting with employees and customers. Another finding in this study is that the use of colloquial form of English by graduates at the workplace is no well-regarded by employers as they expect graduates to use standard form of English.
(Teng, Ma, Pahlevansharif, Turner, et al., 2019)	Students' perspectives on their university experience in terms of the soft employability skills	Online survey	The result on this study showed that soft skills are very important with regard to student preparedness for employment and Malaysian's university curricula are preparing students with the necessary soft skills based on the Goldsmiths soft skills inventory.
(Selvaratnam, 2019)	Malaysian graduates' English proficiency and their employability	Concept Paper	The results show that public and private sector universities are preparing graduates with insufficient English language skills and mental building blocks to think constructively.
(Azmi et al., 2018)	Non-technical skills demanded by employers in industry 4.0	Secondary data analysis and interview	The findings of this study revealed that non-technical skills are one of the requirements pertaining to graduate work readiness competencies for Industry Revolution 4.0.
(Chavan & Carter, 2018)	Study on students attending the management course and their perception of work readiness	Interview	The outcomes of this study revealed that students who get an early exposure to the work environment through part-time jobs while studying feature a better understanding of subject-related in their management course
(Azmi, Hashim, & Yusoff, 2018)	Study on employability skills of students in Malaysian HEIs with a view to measuring their	Quantitative	The result of this study led to the finding of 12 important employability skills of

	work readiness		employment. Another finding of this study is a significant relationship between the graduates' skills and their gender. It was also found that educational institutions play an important part in the development of graduates' skill especially as the decision-making skills are concerned.
(Prikshat et al., 2018)	Graduates' qualification, skills and personal capabilities as related to their work readiness	Qualitative triangulation method	The result of this study revealed that Asian countries are experiencing difficulties in attracting graduates with high qualification of education, skills and personal capabilities which constrains economic growth and future productivity. In this study, Human Resource department contributes to bridging the skills gap through skills required from various industry.
(Belwal et al., 2017)	Graduate attributes and employability skills	Survey	This research found that graduates' employability skills are computing skills, English proficiency, teamwork, job-related training and their personality. Lack of interaction between stakeholders (university, alumni and industry players) becomes a barrier to the development of graduate work readiness competencies.
(Büth et al., 2017)	Graduate work readiness is based on professional, social, personal and methodological competencies	Interview	The study found that the Learning Factory approach is able to prepare engineering graduates for employment experience at the level of their academic studies.
(Lasakova, Bajzikova & Dedze., 2017)	This paper studies the aspects that can directly influence Higher Education Institutions' (HEIs) innovation in a negative way	Case study / interview	These are the graduates' negative attitude towards innovation, their lack of interest in learning and their lack of participation and involvement and insufficient ICT- related skills.
(Nazron et al., 2017)	Examining the relationship between graduate soft skill attributes and employment status among graduates from Universiti Malaysia Sabah	Survey	The result of this study indicated that knowledge, ICT skills, technical skills, problem solving skills, communication skills, teamwork, leadership skills, professionalism and ethics bear no significant relationship to employment status of graduates.
(Pitan, 2017)	Investigates graduate employ-yability skills with regard to the extent to which university	Purposive sampling technique	The result of this study shows that generic skills are important competencies for graduates

	education in Nigeria is responding to the increased skill requirements of employers		however graduates are not adequately prepared for their job requirements due to the lack of training to perform well in their job.
(Cheong, Hill, Fernandez-Chung, & Leong, 2016)	Examining issue of employability attributes when Malaysian graduates enter labour market	Survey and interview	The findings of this study show that in Malaysia, employability aspects that graduates should excel in their soft skills, positive personality traits and attitude in order to secure their early employment after graduation.
(Ang, 2015)	Malaysian graduate employability awareness based on gender perspective	Survey	The findings of this study revealed that knowledge about business, computer literacy, conflict resolution, information retrieval skills, self-management and planning are the skills that graduates considered to be no critical skill however, they were highly valued by the industry.
(Yusof & Jamaluddin, 2015)	Examining the nature of Malaysian undergraduate proactive actions with regard to employment preparedness	Questionnaire survey	The result of this study revealed that interventions of industry players at university level enhance the students' employability and expose them to the experience of actual work environment.
(Hsu, 2015)	Mismatch of Expectations Between Employers and Students Poses a Big Challenge in Tight Market Conditions	Interview	The findings in this interview report that current graduates' lack of pre-requisite soft skills for workplace success

3. Graduate work readiness approach

3.1. Developing Pre-Professional Identify in the context of graduate work readiness through Learning Factory approach

The linkage between academia and industry must be strengthened in order to improve graduates' understanding of the concept of IR 4.0 and its needs. Tomlinson (2017) stated that graduates build their employability competencies based on the actual work context that they have experienced. This emphasised the importance of HEIs curricula in providing a learning environment that exposed graduates to actual work situation and meeting the industry y needs. Based on this requirement, Learning Factory (LF) concept is applied. LF concept was developed in 1994 and it was employed as a work placement concept in order to expose graduates to actual work situation (Abele, Metternich, Tisch, Chryssolouris, Sihn, ElMaraghy, Hummel & Ranz., 2015). Since then, LF concept has evolved to enhance the learning experience that covers all aspects from the use of technology and process that are based from real working site.

LF concept aims to develop technological and organisational innovation, effective competency and graduates' ability to master a complex and unfamiliar situation once they enter a workplace (Baena, Guarin, Mora, Sauza, & Retat, 2017). Another study carried out by Faller and Feldmüller (2015) shows that LF concept covers every aspect of learning environment from management level to production level. This theory proved to be effective for developing practical and theoretical knowledge in a real work environment (Baena et al., 2017). As suggested by Prikhat et al., (2018), Malaysian employers emphasised the need for open dialogue, government funding

and support to boost the universities' research and development. This approach can be established through the development of LF where all of the concerned parties such as educators, employers and policy makers will participate in the graduates' learning process such as hand-on project from industry to a student. Furthermore, they will explain the needs of IR 4.0 such as IT skills, critical thinking skills, technological skills, data analysis skills, IT and data security skills, and soft skills (Sony & Naik, 2019). The summary of literature overview on LF approach is presented in Table 4.

Table 4. Learning Factory Approach(s)

Year	Citation	Learning Factory Approach	Study	Result
2020	Angrisani, Arpaia, Bonavolontá, Moccaldi, & Schiano Lo Moriello, (2020)	Learning Factory practice at University of Naples Federico II, Italy	This study focused on the process of innovation for IR 4.0 with the use of Internet of Things (IoT) and Addictive Manufacturing technology. The findings of this study can be used for developing instruments and measurements or smart industry.	Students who were involved into this project, have shown an improvement and have gained a lot experience of real work environment
2018	Elbestawi, Centea, Singh, & Wanyama, (2018)	Learning Factory at School of Engineering Practice and Technology at McMaster university, Canada	LF was employed in order to educate undergraduate students, in order to carry out research activities by means of graduate students, to train employees from relevant industry, to develop and test innovative ideas in cooperation with industrial and community partners.	It complements the students' qualifications and abilities by providing new technical skills that emphasize the inherent multidisciplinary nature of digital technologies and advanced manufacturing
2018	Sangwan, K. S., Herrmann, C., Soni, M. S., Jakhar, S., Posselt, G., Sihag, N., & Bhakar, V. (2018)	Learning Factory at Technische Universitat (TU), Braunschweig, Germany	This university attempted to address the possibility of using solar energy and of using it in their own learning factory. Based on the related analysis, the students replaced conventional electricity that is used in their university with a solar product by their own.	Learning Factory can be employed in order to develop important skills in the context of current workforce and develop the graduates' necessary skills before their entering real work environment
2017	Büth, L., Bhakar, V., Sihag, N., Posselt, G., & Böhme, S. (2017)	Learning Factory plays a part in bridging the qualification gap between academia and industry in India	This study employed Learning Factory approach to prepare the Indian engineering graduates ready for their future job at the level of their academic studies and provide a proper training based on industry recommendations. Additionally, this study also provides a roadmap for using Learning Factory for technical academic system.	Learning Factory can contribute to a continuous exchange in term of the skills and knowledge needed for industrial revolution 4.0, to a more sustainable education and to the internationalization of education across the country.
2016	Wank, A., Adolph,	Learning Factory approach at Institute	This study uses the Learning Factory approach	Learning Factory became a

S., Anokhin, O., Arndt, A., Anderl, R., & Metternich, J. (2016).	of Production Management, Technology and Machine Tools, Darmstadt, Germany	to embed the existing SME production system into digitalization in the framework of Industry 4.0 concept. The uniqueness of this study lies in using the existing measurement system in Learning Factory to evaluate the success of its implementation	demonstrator to raise the awareness of benefits using digitalization, analysing the potential method to use, training in the learning factory enable individual to implement their own company and lastly evaluate the effort of digitalization.

In the employers' perspective, this method is effective since they can share their opinion towards graduate skill development according to the future needs of the labour market, compared to sending their own employees to training, which is claimed to be ineffective and a waste of resources. Meanwhile, from the graduates' perspective, this method can enable them to have an insight into the actual workplace and allow them to have an experience in term of problem based learning to develop IR 4.0 core competencies. This learning concept provides a valuable opportunity for developing graduate's pre-professional identity (PPI). According to Tomlinson (2017), graduate identity plays a significant part in graduate employability. PPI is a key component for graduates' early professional development and formation (Jackson, 2017) and it is related to graduates' understanding and connection with their own skills, qualities, behaviours, values and standards of their chosen profession. Through the concept of PPI, graduates are required to make a personal investment into their future career and employability by actively participating in IR 4.0 environment. This can be done by interacting with employers, engaging in extra-curricular activities and becoming involved in other forms of experimental learning. This will then drive them towards meeting the job demand of IR 4.0 and thus, will perhaps reduce all the discussed issues of graduate work readiness.

4. Conclusion

There are several emerging issues pertaining to the fulfilment of job demands in IR 4.0. The findings of this study revealed that most of the Malaysian graduates are ready to enter the IR 4.0 work environment however, they lack critical skills when entering the world of work. Based on the literature overview, the issues related to Malaysian graduate work readiness in fulfilling job demands in IR 4.0 are compiled. Firstly, research revealed that there is a problem related to the Malaysian's graduates' soft skills, especially English proficiency and communication skills. Due to this problem, most of them remain unemployed (Cheong, Hill, Fernandez-Chung, & Leong, 2016; Zainuddin et al., 2019). Soft skills and technical skills are considered very important for graduate to secure their early job. According to Pitan (2017), technical skills are crucial for university graduates because they relate to new knowledge. The combination of technical skills and soft skills comprises the competencies that employers are looking for in Malaysian graduates so that they succeed in fulfilling IR 4.0 job demands (Pitan, 2017). Technical skills should comprise all job-related knowledge and skills for example, information literacy, media skills and digital analytics skill (Grzybowska & Łupicka, 2017). This skill requires for the graduate to have practice and learn these skills in order to master them. For example, an individual who possesses a particular proficiency or skill set, such as excellent computer coding skills, is a qualifying candidate for a computer or technology company. Meanwhile, soft skills are combinations of various skills such as communication skills, problem solving skills, and leadership skills among others. Future local graduates are expected to have the ability to combine various skills and they are expected to apply their knowledge, innovate and able to face the challenge in future IR4.0 environment. Therefore, the higher education institutions should embed all the elements discussed above in their teaching curriculum which could enhance the technical and soft skill competencies of the local graduates.

Secondly, lack of work experience is also one of the issues that peculiar to a Malaysian

graduate who is not work ready. (Azmi, Kamin, & Noordin, 2018) and inadequate industrial training provided during the academic years in university has added to the problem (Prikshat et al., 2018). Local graduates should gain work experience before they start with working in a real environment in future. The work experience can be gained during industrial training period. Beside that another finding is that graduate's poor attitude would lower their employability chances (Prikshat et al., 2018; Zainuddin et al., 2019).

This issue becomes a concern when discussing graduate work readiness in present-today work environment. Negative attitude and demanding attitude are the reasons why the employer loses interest in hiring graduates (Prikshat et al., 2018). It is essential to pay attention to graduate work readiness as it serves as a predictor for graduates' potential with regard to their future job performance and career advancement once they enter the workplace. Therefore, developing a proper job competency in local graduates should be the focus in order to make them competent to meet IR 4.0 job demands.

Further research should focus on graduate's exposure to job demands in IR 4.0 in terms of necessary knowledge and skills. This study suggested that the theory of Learning Factory and graduate pre-professional identity should be integrated as they could develop graduates' insight into IR 4.0 competencies. Based on the findings of this study, the gap between students' acquired skills and employers' expectation skills are the issue in developing graduate work-readiness competencies models towards meeting the IR 4.0 job demands. Therefore, graduates' exposure to IR 4.0 is crucial for them to acquire the proper knowledge and skills necessary for entering the work environment. Last, future research may also explore other dimensions that might contribute to enhancing the graduate work readiness for entering the IR 4.0 job environment.

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