English Skills and Competencies Requirements for Engineers of Industry 4.0

S. Indra Devi[1], Farah Shahnaz Feroz[2], Noraini Husin[1], Kenneth Sundaraj[2]

[1)] Centre for Language Learning, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia

[2)] Faculty of Electronic and Computer Engineering, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia

[*]Corresponding e-mail: indradevi@utem.edu.my

Keywords: English skill; competency; Industry 4.0

ABSTRACT –Increased automation and digitisation of industries in today's IR 4.0 calls for a transformation in the university curriculum. This study investigates on the English language skills and competencies required by undergraduate engineers via a needs analysis questionnaire administered to 25 practising engineers. Besides, through virtual interviews, this study identifies the perspectives of five industry players on aspects that need to be prioritised in the English language curriculum. The findings highlight on the highly required skills such as oral expression, reading comprehension and written expression. The industry players provide insights into the implementation of courses such as Technical Reading, and that materials, topics, assessments as well as group projects are reflective of tasks performed in industries.

1. INTRODUCTION

The unfolding of the 4th Industrial Revolution, or better known as IR 4.0, has resulted in technological developments such as sensors, cyber-physical systems, Internet of Things (IoT), or smart networks which have far reaching impact on work organisations. Despite the numerous promising benefits of IR 4.0 in terms of productivity, growth and sustainable development of enterprises, it has resulted in several constraints in terms of the requirements of specific skills and competencies among the workforce [1]. The overall shift accentuates the need for learners to be techno-savvy and to be able to make connections across elements of competence, integrate them interactively and respond to the demands and changes in the contexts.

Engineers need specialised language skills and competencies and there is going to be a disconnect from the content-driven education model as the world of work is going to be competency based. Thus, it is timely that faculties foster synergistic efforts with industries so as to develop undergraduates with English skills and competencies, including digital English, the commonly preferred language of IoTs and Industry 4.0 applications [2]. This kind of preparation is critical to prepare them for the resurging communicative tasks in the industries. This study aims to investigate the English language skills and competencies that are required by engineers to meet the needs of Industry 4.0. Besides, the study also aims to identify the industry players' perspectives and suggestions on the aspects that need to be prioritised in the English language curriculum for engineers in a technical university.

1.1 Impact of IR 4.0 on Technical Higher Learning Institutions

The 4th Industrial revolution has brought about disruptive changes to the labour market in terms of the demand for new breed of workers who are not only skilled but also tech-savvy and innovative [3]. Hence, technical higher learning institutions play a censorious role in spearheading a transition to the production of skilled workforce for Industry 4.0 as well as to realign their business model [4]. Its main challenges are in meeting the changing skill needs of employees at the workplace [5]. This could be done by developing new curriculum and adhering to the new literacy capabilities of the IR 4.0.

New literacies of IR 4.0 include big data literacy which involves the ability to read, analyse and use information in the digital world followed by technology literacy that includes the ability to understand the working systems of machinery and technology applications and finally the human literacy which encompasses the ability to improve communication skills and master of design science [6]. At this point of time, it has become crucial for technical institutions to collaborate with industries and adopt the views of industrial experts in transforming their curriculum [7], [8] as in this study which sought for feedback from practising engineers and industry players. The present study also focusses on the new literacy capabilities in terms of English skills and competencies required by engineering professionals in the Industry 4.0 era.

1.2 English Competencies Required in IR 4.0

Competencies are sets of behaviours that are significant in contributing towards desired results or outcomes [9]. These competencies should be acquired by undergraduate engineers so that they would be able to handle a wide range of work demands at the workplace. In a study by [10], competencies in IR 4.0 have been clustered into four main categories that include technical, methodological, social and personal competencies. In the context of this study, language skills and communication skills which belong to the social competency cluster is being explored. A study conducted to derive the attributes of communication skills using the systematic review method based on studies from 2006-2019 by [11] highlights on the six attributes of communication skills that include the ability to speak effectively with an audience, ability to communicate with people from different background, ability to deliver presentations,

ability to express own idea, listen and give appropriate feedback as well as being able to convey a clear written communication. Various other studies have also stressed on the fact that communication is one of the key competencies required in engineering graduates of IR 4.0 besides competency in technical communication, inter-cultural competency and the ability to present [12].

1.3 Needs Analysis in ESP

In the world of ESP, many ESP practitioners face challenges in the developing of new courses. In the engineering fraternity, undergraduates have specific English needs. In lieu with this [13] provided an evidence-based approach to needs analysis using the Common European Framework (CEF) professional profile which is an inclusive model focused on engineering and which identifies and deals with the complex discourse in the modern workplace. The characteristics of an effective needs analysis in ESP should identify the communicative tasks and the discourses that the learners have to practice at their workplace [13]. It has also been stressed that in the development of a curriculum for an ESP course, the needs resulting from multiple perspectives such as employers, alumni, institutional administrators or HR developers should be prioritised to ensure a successful curriculum development. Accordingly, this study prioritises the needs of industry players and practising engineers in profiling the input.

2. METHODOLOGY

In this study, a mixed method research design that included both quantitative and qualitative data collection techniques were employed. This research design was chosen to obtain more comprehensive results with regards to determining the practising engineers and industry players' opinions on the English language skills and competencies required in the manufacturing industries.

At the initial phase, a needs analysis questionnaire adapted from the Common European Framework (CEF) professional profile was constructed to investigate on the English language skills and competencies that are required by engineers to meet the needs of industry 4.0. All items of the questionnaire were checked and validated by a content expert who has vast experience in teaching English and who is actively involved in research.

A pilot study was also conducted to ensure the reliability of the instrument. It was delegated to five practising engineers in manufacturing industries in Malaysia. Necessary amendments were made before it was administered for actual data gathering. This questionnaire aims to identify the language skills and competencies that the manufacturing industries demand so as to meet the demands of Industry 4.0. The questionnaire retrieves information on the occupational profile as well as the typical communicative tasks, frequent routine situations as well as skills and competencies required to perform the tasks. The quantitative data in terms of averages and percentages retrieved from the questionnaire to answer research objective 1.

Virtual open-ended interviews via Webex and via mobile phone were conducted with five industry players to gather their perspectives and suggestions on the aspects that need to be prioritised in the English language curriculum for engineering graduates. The interviews were conducted in English and were audio-taped. The main questions asked during the interview were as follows:

1. To what extent is Industry 4.0 implemented in your organisation?
2. Is it necessary for engineers to have mastery of digital English?
3. Out of the four basic skills (listening, speaking, reading and writing), which one is the most important for engineers in your organisation?
4. Which syllabus will be more appropriate, skill-based or communication-based?
5. What are other additional components that are needed in the industry and that you would like to suggest to be added into the English language syllabus?
6. Is technical communication, technical vocabulary and technical oral language proficiency important?
7. What about interpersonal skill, is it significant?
8. Do you have any suggestions to improve the graduate engineers' English language competencies?

The interviews totalling 162 minutes were transcribed verbatim by replaying the recording as many times as needed to retrieve the exact information. Thematic analysis was utilised as a method to identify the patterns of meaning in the interview transcripts. Patterns were identified through data familiarisation and data coding until themes were developed.

3. RESULTS AND DISCUSSION

In the first part of the results, the focus is on investigating the English language skills and competencies required by graduate engineers. The 25 practising engineers from all over Malaysia who answered the questionnaires hail from manufacturing industries that are related to electronics and electrical (20%), polymer (12%), chemical/oil and gas (16%), information technology (4%), telecommunication (8%), food manufacturing (4%) and high-tech industry (8%), automotive (4%) and others from ceramic sanitary ware (4%), semi-conductor (16%), XRF Spectrometer (4%). Their specific job titles include technologist (32%), production engineer (24%), process engineer (32%), software engineer (8%) and electrical engineer (4%). Table 1 indicates the top five typical tasks that are performed by the practising engineers in their related positions (in percentages).

Table 1 Top five typical tasks performed

Typical tasks	Percentage
Writing reports and documentation	80
Implementing/ Improving systems	72
Investigating and reporting on production problems	72
Developing standard operating procedures	68
Monitoring/ controlling processes systems and machinery	64

Out of the given 23 options on typical tasks performed, the five typical tasks that are highly

performed in their position include writing reports and documentation, implementing/ improving systems, investigating and reporting on production problems, developing standard operating procedures as well as monitoring/ controlling processes, systems and machinery respectively. Table 2 indicates the extent to which English language is needed in their job.

Table 2 Extent to which English language is needed in the job (Top three)

English language use in job	Percentage
Write emails, memos, letters, reports	96
Conduct meetings	88
Phone conversations/ teleconferencing	88

Out of the given eight job-related activities in which English language is used, the top three in which English language is used the most include writing emails, memos, letters and reports, followed by conducting meetings and phone conversations/ teleconferencing. Table 3 depicts the top five typical communicative language competences that are required in the participants' job positions.

Table 3 Top five typical communicative language competences

Typical communicative language competences	Percentage
Reading emails, office documents, project documents, professional texts	88
Writing emails, periodic reports, memos, presentation slides, business letters, project proposals, research reports	80
Delivering oral presentations	72
Discussing work-related matters formally in meetings/ informally	68
Listening to spoken instructions/ advice	68

The participants were provided 28 options on typical communicative language competences that are required in their job. Out of the top five selected, reading emails, office and project documents and professional texts seems to be the top most with a score of 88% followed by writing with a score of 80%and speaking which entails delivering oral presentations (72%) and discussing work-related matters (68%). Listening to spoken instructions, being the last in the top five list carries a score of 68%. Table 4 depicts the top five significant texts and discourse types used at the participants' workplace.

Table 4 Top five texts and discourse types

Texts and discourse types	Percentage
Phone calls	88
Email correspondences	88
Minutes of meetings	84
Teleconference	76
Reports	76

Based on the given 15 texts and discourse types, findings indicate that the five most deployed are phone calls (88%), followed by email correspondences (88%), minutes of meetings (84%), teleconferencing (76%) and reports (76%) respectively. The last section of the questionnaire consists of 5 questions using a five Likert scale, namely, 'Very important', 'Important', 'Moderately important', 'Less important', and 'Not important'. These questions were on the basic skills used at the workplace and the participants were required to number them according to the order of importance. The criteria used to determine the most important basic skill is by adding up the percentages of the 'Very important', 'Important' and 'Moderately important categories. The idea for using this criterion was retrieved from [14] study which used this procedure to report on the University of Craiova, Romania's fourth year Computer Science undergraduates' familiarity level in the use of multimodal tools. Following is Table 5 on the order of importance of basic skills at the workplace.

Table 5 Importance of basic skills

Basic skills	Percentage
Oral expression	80
Reading comprehension	76
Written expression	68
Active listening	64
Digital English	60

The findings are indicative of the fact that oral expression is the most significant basic skill followed by reading comprehension, written expression and active listening. Last on the list is the digital English skill.

Generally, the findings of this study converge with the literature on Industry 4.0 as in [10], [11] that stress on the importance of communication skills and competencies such as oral expression, reading comprehension, written expression and listening skills. The categorisation of oral expression, reading comprehension and written expression as important qualifications and skills to be mastered in Industry 4.0 [15] concurs with the present study. It has also been stated by [15] that the ability to work with data, example the ability to process and analyse data and information obtained from machines is an important skill required in Industry 4.0. The findings from the questionnaire are consistent to [15] as reading has been highlighted as the topmost typical communicative language competence required at the participants' workplace. 88% of the participants opted for reading emails, office documents, project documents and professional texts as the most required communicative language competence.

In the second part of the results, the focus is on the five industry players holding managerial posts in various departments in manufacturing industries. Further details on their background are not included to preserve the anonymity of the participants and their companies.

The themes that were identified based on the analysis of the interview scripts are as follows:

3.1. IR 4.0

Based on the interview data, it is evident that all the companies implemented IR 4.0 with the exception of one employer who mentioned that it has not been embraced. Generally, they require graduates to be upskilled and

prepared for IR 4.0.

3.2. Digital English

It is necessary to expose undergraduates to digital English. It must be added as a compulsory content in the English language curriculum for engineers. Companies are using new machines and robots which are operated using high technology and hence, software and hardware are being constantly updated. Therefore, it is necessary for employees to be well-versed with digital English.

3.3. Basic English Skills

All the five employers believe that the basic skills such as oral expression, reading comprehension, written expression and active listening are important. From the input gathered, it was evident that writing skill is necessary as sometimes employees are required to write reports. One of the employers mentioned that listening and reading are the highly prioritised skills as the employees are required to read and understand messages from vendors or product makers and in the next stage, they will be involved in verbal discussions or meetings with the vendors. In face-to-face meetings, they are required to listen and convey messages.

3.4. Skill-based and communication-based syllabus

Both are important. Communication is important because employees are required to analyse, improve and present ideas. Presentation is important to convince the management. Management prefers to see presentation in PowerPoint in point form and not lengthy explanations in written form as bosses do not have time to read. Graduates must have good knowledge and skill in preparing effective slides. Presentation skill is also very important to convince the management. Employees will also be required to do short reports when they investigate issues or problems. They should be able to inform what the problem is, how to solve the problem and how to prevent the problem from happening again.

3.5. Important Components

Other important components include competency in writing emails, formal letters, letter of enquiry, letter of complaint as well as persuasive writing.

3.6. Technical Communication, Technical Vocabulary

It is necessary to expose undergraduates to technical content and they must be well-versed in using specialised/ technical content and technical vocabulary. Oral proficiency in technical language is an added benefit.

3.7. Interpersonal Skills

Interpersonal skills are very important to be able to communicate with internal and external customers and to be able to deliver ideas effectively.

3.8. Technical Reading

Today, there are lots of new products and innovations. Students must be exposed to technical reading so that they can identify new things in the market. Fast reading should be inculcated. Any project work/assignments should involve wide reading and related to tasks performed in the context of industries. Topics in the English language courses or assessments should be related to technical content specialisation.

The findings based on the interview with industry players are consistent with [2] who postulate that digital English is an important employee competency of Industry 4.0 thus emphasising on its impact. Besides, the interview findings have also stressed on the blending of English language courses with discipline-specific content, hence concurring with the findings by [8]. The industry players have also pontificated on the importance of exposing undergraduates to technical communication, technical vocabulary and technical-based oral language. This finding is consistent with [14] who have also stressed on the importance of technical communication competency.

4. CONCLUSION

The findings from the present study have provided more rooms for the empowerment of English language skills and competencies. This would be a starting point for further research regarding graduate engineers' English skills and competencies for Industry 4.0. This study would also be contributive as a reference tool for language faculties in technical universities in the production of graduate engineers who would be work ready and who would be advantageous to the manufacturing industries in the IR 4.0 era.

5. ACKNOWLEDGEMENT

This study was supported by the UTeM short-term grant project PJP/2019/PBPI(3D)/S01690. The authors would like to express their sincere gratitude to Universiti Teknikal Malaysia Melaka (UTeM) for the opportunity given to do this research.

REFERENCES

[1] Mian, S. H., Bashir, S. Wadea, A., Khaja, M., & Hisham, A. (2020). Adapting universities for sustainability education in Industry 4.0: Channel of challenges and opportunities. *Sustainability 12(15)*, 6100.

[2] Hariharasudan, A. & Sebastian, K. (2018). A scoping review on Digital English and Education 4.0 for Industry 4.0. *Social Sciences 7(11)*, 227.

[3] Manda, M.I. & Backhouse, J. (2017), Digital transformation for inclusive growth in South Africa. Challenges and opportunities in the 4th Industrial Revolution, *2017 2nd African Conference on Information Science and Technology, Cape Town, South Africa*.

[4] Peters, M. A. (2017). Technological unemployment: Educating for the Fourth Industrial Revolution. *Educational Philosophy and Theory 49(1)*, 1-6.

[5] Hrmo, R. Mistina, J., & Kristofiakova, L. (2016). Improving the quality of technical and vocational education in Slovakia for European labour market needs. *International Journal of Engineering Pedagogy (iJEP) 6(2)*, 14-22.

[6] Sudlow, B. (2018). Review of Joseph E. Aoun (2017). Robot Proof: Higher education in the age of artificial intelligence. Cambridge, Massachusetts.

[7] Weiss, M. L. (2014). *Routledge Handbook of Contemporary Malaysia*. Routledge.

[8] Maisiri, W., Darwish, H., & Van Dyk, L. (2019). An investigation of Industry 4.0 skills requirements. *South African Journal of Industrial Engineering 30*(3), 90-105.

[9] Bartram, D., Robertson, I.T. & Callinan, M. (2002). Introduction. A framework of examining organisational effectiveness. In: Robertson, I.T., Callinan, M. & Bartram, D. (eds.) Organisational effectiveness: The role of psychology, 1-10. John Wiley & Sons, UK.

[10] Panos, F., Paraskevi, T. & Vassilis, G. (2018). Dominant technologist in 'Industry 4.0'. *International Scientific Journal 'Industry 4.0'. 3(3)*, 130-133.

[11] Mohd Kamaruzaman, F., Hamid, R., Mutalib, A.A. & Rasul, M.S. (2020). Communication skills attributes for IR 4.0 for engineering graduates. *European Journal of Molecular & Clinical Medicine 7(8)*, 573-588.

[12] Prifti, L., Knigge, M.,Kienegger, H. & Krcmar, H. (2017). A competency model for Industry 4.0 employees. *Proceedings der 13 Internationalen Tagung Wirtschaftsinformatik* (WI) St. Gallen,S. 46-60.

[13] Huhta, M., Vogt, K., Johnson, E., Tulkki, H., Hall & David, R. (2013). Needs analysis for language course design: A holistic approach to ESP. Cambridge: Cambridge University Press.

[14] Popescu, E. (2010). Students' acceptance of Web 2.0 technologies in higher education: Findings from a survey in a Romanian university, *Proceedings of DEXA 2010 workshops*, 92-96.

[15] Wilfred, A., Arvind, C.J. & Rishi, B. (2016). Skill development for Industry 4.0, BRICS Skill Development Working Group.

[16] Viji, R., Dorothy, D. & Norlidah, A. (2021). The need for technical communication for 21st Century learning in TVET institutions: Perceptions of industry experts. *Journal of Technical Education and Training 13(1)*, 148-158.

