



Nurturing Engineers of Industry 4.0 Workforce with Entrepreneurial Quality Skills in Leadership, Innovation, Communication, and Teamwork

Fauziah Sh. Ahmad¹, Ong Sin Ru¹, Bhavani Kolan de Velu¹, Sya Azmeela Shariff^{2,*}, Aini Suzanna Ariffin²

¹ Azman Hashim International Business School, Universiti Teknologi Malaysia, Johor Bahru, Malaysia

² Razak Faculty of Technology and Informatics, Universiti Teknologi Malaysia, Johor Bahru, Malaysia

ABSTRACT

The Industrial revolution 4.0 (IR 4.0) has triggered the need for engineering education transformation in preparing the future professional workforce not just with strong technical skills but also with entrepreneurial and relevant soft skills. These additional skills are crucial to ensure the all-rounded development of the workforce as well as to increase employability. A study by Talent Corp reported in 2014 postulates that young professional talents must improve their skills in communication, critical thinking, leadership, as well as creativity for better marketability and job opportunities. Following years of efforts by Malaysia's tertiary education providers to equip graduates with necessary soft skills particularly through embedment on academic program's learning outcomes, it would be appropriate to gather empirical evidence on the progress of graduate skills of leadership, innovation, communication, and teamwork (LICT) amongst the engineers. This paper examines the skills amongst working engineers and assesses whether they have major impact on job performance. Two consecutive studies have been carried out where the first study was conducted in East Malaysia in 2019 followed by the second study carried out in West Malaysia in 2021. The findings for both studies confirmed the crucial role of LICT skills amidst the higher expectations towards job performance in new normal context with competitiveness and relevancy of IR 4.0. This finding supports the necessity of continuous LICT embedment in the engineering syllabus via more efficient integration, engagement, and appreciation towards human-centred education and entrepreneurial qualities enhancement.

Keywords:

Entrepreneurial skills; Engineers; Leadership; Innovation; Communication; Teamwork

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1. Introduction

Due to increased globalization and the necessity for multi-talented people, industry skills preferences for professional graduates such as engineers have altered over time. Technical abilities used to be the most important criterion for engineering employment. Soft skills, on the other hand, are now seen as a crucial prerequisite when it comes to employing engineers. The skills gap is clear, and it has gotten worse as Malaysia's unemployment rate has risen. To put it another way, of

* Corresponding author.

E-mail address: azmeela.kl@utm.my

leadership, innovation, communication, and teamwork (LICT) abilities are valued in a broader job performance context as well as in enhancing graduates' entrepreneurial qualities. The challenge of teaching entrepreneurship is that the soft skills are considered more relevant for talent development and entrepreneurship educators should not concentrate exclusively on technical content [3]. There is a critical need to incorporate soft skills in enhancing entrepreneurial quality especially the promotion of creative and innovative behavior.

Obviously, education in the twenty-first century should differ from that of the twentieth century. After all, between these two periods, the Industrial Revolution (IR) leapt from 2.0 to 4.0. However, most educators including those of unified disciplines in tertiary institutions, such as entrepreneurship education for engineers, were taught in the twentieth century with a technical approach emphasising on the feasibility and viability of bureaucratic environments. Skill relating to communication, creativity, problem-solving, and being independent were identified as among the skill shortfalls in fresh graduates affecting their marketability [19]. The Fourth Industrial Revolution has given a fresh impetus to educational transformation, with significantly stronger demands for graduates with strong entrepreneurial orientations, as well as higher LICT attributes. This has demanded significant changes in Education 4.0 policy, content, and delivery which are influenced by innovations, and will need to prepare students to create innovations as well as to be more analytical, flexible, and future-ready [1,6,18].

In industry 4.0, entrepreneurship education for engineers should not just focus on either technical skill of engineering or feasibility aspects of running projects or businesses but instead must be more human-centred education that engages, empower, appreciate, and connects talents. Improvements in entrepreneurship education for engineers should be primarily based on their actual expertise with entrepreneurial soft skills such as LICT attributes, as well as how these abilities effect on their job performance. Consequently, this article will look into the soft skill proficiency equipped by engineer in terms of LICT capabilities and how it affects their performance. The findings are expected to support the need for engineering or technical graduates to develop entrepreneurial soft skills. The main hypothesis for this study is that LICT skills significantly influence the job performance of engineers and graduate professionals. Interestingly two separate studies have been carried out to validate this proposition on how LICT influence the job performance of engineers of professional workforce.

2. Literature Review

2.1 Job Market and Job Performance

The current job market is no longer predictable and becoming highly competitive. To some extent, graduates are expected to be capable to create jobs, rather than only seeking jobs. education 4.0 establishment is timely to meet the challenges of Industry 4.0 which requires new sets of graduate skills requirements. Entrepreneurship education was introduced in the Malaysian education system to instil entrepreneurial mindset and produce holistic graduates with entrepreneurial qualities and skills in tandem with the Malaysia Higher Education Blueprint 2015-2025 government aspirations [11]. Entrepreneurship is described as the capability of a person to transform an idea into an activity or a product. These include the ability to manage initiative in order to meet wealth creation goal, as well as creativity, innovation, competitiveness, leadership, and communication. Entrepreneurship skills encompass a wide range of technical, management, and interpersonal abilities.

Numerous soft skills have been identified for engineering graduates in Malaysia to stand out and perform better than their peers and these skills include LICT skills set together with adaptability skills where engineers must be able to keep up with global technological and information developments

while also being adaptable to shifting economic conditions [12]. These skills are integral for their job performance. Job performance normally depends on both the perceptions of performance by employers and employees. There are tendencies to two-measure job performance in a conventional way by looking at past performance, satisfaction, and immediate supervisor feedback [2,5]. However, in a “new normal” context and relevancy to the industry 4.0 revolution, there is a new way of measuring job performance based on confidence in developing new ideas, embracing a culture of development and meeting expectations from the multidisciplinary teams instead of just the immediate supervisor. Table 1 below summarizes the comparison between conventional and new ways of measuring job performance. This understanding was based on the comparison between past literature and the recent expectation such as those listed by Cousera Global Skill index published in 2020 [18].

Table 1
 Conventional measure vs new measure of job performance

Conventional measure	New Measure
<i>Past Performance Basis</i> I have been achieving good performance consistently for the past few years.	<i>Current Performance Basis</i> I have the ability to generate fresh ideas and see issues and possibilities in new ways.
<i>Satisfaction Orientation</i> I am very satisfied with my current job performance.	<i>Ready to Change Orientation</i> I embrace the culture of development and growth of ideas in entrepreneurship.
<i>Immediate Superior Concern</i> My superior acknowledged my efforts in delivering work results.	<i>Multidisciplinary Team Concern</i> I am capable of working in multidisciplinary teams

Source: Developed by this research

2.2 Soft Skill – LICT

Technical skills are not soft skills, often known as generic skills. It has nothing to do with the content of a person's individual knowledge in a particular field or profession. Soft skills, often known as interpersonal skills, are employed in engaging with and collaborating with others [21]. It included personality traits, sociability, language fluency and personal routines [15]. Soft skills are intimately linked to an individual's interpersonal and behavioural abilities. Soft skills are also crucial in a wide range of employment and are transferrable across industries. According to many surveys, the following soft talents are in high demand by industrial employers:

2.2.1 Communication skill (verbal & written)

Communication is essential in a company for connecting individuals, minimizing confusion, and increasing staff efficiency and output [13]. Communication skills refer to a person's ability to engage with others and transmit messages in the appropriate tone within an organisation. It is only considered efficient when the receiver can understand and interpret the message effectively [8]. Employees must be able to communicate clearly and respectfully with others. When speaking at different levels and settings, nonverbal communication such as body language, gestures, and tone should be used appropriately. It is also necessary for good communication for the individual to be able to transmit ideas clearly and in an easy-to-understand manner. Where plans are basically worthless without the human processes that translate plans into consistently productive actions, effective communication is critical [7].

2.2.2 Teamwork

Teamwork relates to a sense of belonging to a group and working efficiently within it, with an ideal team role assignment [18]. Many studies indicate that teamwork can boost organisational productivity. Tolerating, contributing, and maintaining the momentum and collaborative spirit for shared success, on the other hand, requires significant effort. To achieve common goals, the collaborative spirit must be fostered along with a respectful attitude toward one another. It is critical to understand the teammates' various skills, strengths, and motivations, as well as to be open-minded about different ways of thinking, feeling, and behaving [18].

2.2.3 Leadership abilities

Leadership skills define an individual's ability to lead a team, make decisions, take responsibility, work for the benefit of both team and company [16]. Individuals with leadership skills can inspire or influence those around them by offering and accepting criticism, delegating duties, modelling good behaviour, and being able to resolve any conflicts or problems. It also has a significant impact on the behaviour of followers towards discipline, commitment and belonging to the organization in which they work to achieve its desired goals [17]. Effective leaders will carefully consider the cultural knowledge, teamwork, motivation, and team management as an essential element of leadership [22].

2.2.4 Innovativeness

It is understood that "the study and practice of entrepreneurship integrate the knowledge acquired from various disciplines and, in emerging countries, the emphasis in teaching must be on the promotion of the triple helix of creativity, innovation and entrepreneurial behaviour and practice" [3,10]. Creativity and innovation refer to the ability to overcome routine and non-routine challenges that develop in an organisation in order to achieve business objectives. Creativity is the ability or response to come up with a fresh and acceptable solution [12], whereas the transformation of ideas or alternative solutions into useful applications is referred to as innovation [4].

3. Methodology

The goal of this research is to examine the engineers' soft skills in terms of LICT capabilities, as well as how that affects their performance. The following are the results of two distinct quantitative surveys conducted for this study:

(A) In 2019, the first survey was conducted on engineers working in an East Malaysian regional oil and gas corporation. - We will refer to this survey as East Malaysia Survey.

The study gathered 224 responses from graduate engineers working in the oil and gas industry in East Malaysia. An online survey questionnaire with a Likert scale was used for statements that related to the research constructs. However, because 20 respondents did not complete the survey, only 204 are included in the analysis. In measuring job performance, we used the conventional way as was suggested by the management of the corporation.

(B) In 2021, the second survey was conducted amongst the professional workforce in West Malaysia where the majority of the respondents are engineers – We shall refer to this survey as West Malaysia Survey.

A total number of 197 responses from the professional workforce in West Malaysia are received using an online survey questionnaire. 58% of the respondents are graduate engineers while the rest are of science, technology, and mathematic degree background. After checking each of the responses, 4 responses are removed due to incomplete information given for the survey. Therefore, only 193 responses are considered qualified for the data analysis. This time, in measuring job performance, we used the new approach as it is more appropriate considering the diverse employers setting and following the report from Cousera Global Skill index 2020 as discussed in Table 1 earlier.

The data is analysed using IBM SPSS software. To achieve the study's goal, descriptive techniques are used to examine the mean, mode, and median of each survey result, and correlation coefficients are used to assess links between the antecedents of LICT skills and job performance. One of the most common tests used in statistical investigations is the correlation test. It is also known as bivariate analysis and is used to determine the relationship between two variables. The figure of relationship strength and correlation coefficient is shown below in Figure 1. The Pearson correlation test is used to determine the correlation factor and the strength of the relationship between the soft skill qualities of respondents and job performance. The variables could not be investigated further for regression research if there is no correlation.

Relationship Strength	Correlation Coefficient
Perfect	1
Strong	$0.7 < r < 1$ or $-0.7 < r < -1$
Moderate	$0.3 < r < 0.7$ or $-0.3 < r < -0.7$
Weak	$0 < r < 0.3$ or $0 < r < -0.3$

Fig. 1. Relationship Strength and Correlation Coefficient

4. Data Analysis and Findings

The research carried out the following (4.1) descriptive analysis, (4.2) correlation analysis, and (4.3) regression analysis based on the variables of study.

4.1 Descriptive Analysis

(A) East Malaysia Survey

According to the descriptive analysis of respondents, individuals between the ages of 23 and 30 make up the plurality of respondents (44.6%), followed by those between the ages of 41 and 50 (24%). In terms of education, 75% of respondents have a first or “bachelor” degree in engineering, 24% have a master's degree, and a small fraction have a doctorate degree. All of the responders, regardless of age or degree, are currently employed as engineers in the oil and gas industry. Table 2 shows the results of descriptive statistics on soft skills traits using three indicators: mean, mode, median and standard deviation.

Based on the mean and the ranking of the data received from the five Likert scale responses that connected to each construct, the engineers have good mastery of leadership, innovativeness, communication, and teamwork skills. The attribute that the Likert scale measure in this survey is the level of agreement by the respondents towards their LICT skills performance.

Table 2
 Soft skill attributes descriptive statistic

Descriptive Indicator	Soft Skills			
	Leadership	Innovativeness	Communication	Teamwork
“Mean”	3.82	3.95	3.97	4.02
“Mode”	4.00	4.00	4.00	4.00
“Median”	3.67	4.00	4.00	4.00
“Standard Deviation”	0.59	0.49	0.56	0.57

(B) West Malaysia Survey

According to the descriptive analysis of the second poll, the majority of respondents are between the ages of 35 and 55. (54.1 percent). In terms of education, the majority of respondents (79.7 percent) have bachelor's degrees, while 21.1 percent have a master's degree, and only 2.6 percent have completed their studies up to the PhD level. Engineers make about 58 percent of the responders, or the vast majority. Table 3 shows the results of descriptive statistics on soft skills qualities, together with indicators of mean, mode, median and standard deviation. Overall, the respondents had good mastery over leadership, innovations, communication, and teamwork skills based on the ranking of the data received from the 5 Likert scale responses connected to each construct. The purpose of the five Likert scales in this survey is to determine the level of agreement among respondents on their LICT performance.

Table 3
 Descriptive statistic on graduate professional’s soft skills

Descriptive Indicator	Compounded Variable			
	Leadership	Innovativeness	Communication	Teamwork
Mean	4.10	4.03	4.06	4.29
Mode	4.00	4.00	4.00	4.00
Median	4.00	4.00	4.00	4.00
Standard Deviation	0.754	0.760	0.714	0.684

In summary, the result of the first survey indicated mean for leadership (3.82); teamwork (4.02); communication (3.97); and innovativeness (3.95). While the mean indicator for the second survey is leadership (4.10); innovativeness (4.03); communication (4.06); and teamwork (4.29). Overall, based on the two pools, the mean score of graduate professionals’ soft skills in West Malaysia is higher than the graduate engineers of East Malaysia. The survey result of the mode scores for each indicator of both surveys are similar.

4.2 Pearson Correlation to Test Relationships between LICT and Job Performance

Based on the four LICT hypotheses listed in the following Figure 2, the goal of this study is to determine the relationship between soft skill qualities and the performance of engineers and graduate professionals. The summaries explanation of Figure 2 is as follows.

(A) East Malaysia Survey

Pearson Correlation value for the 204 participants in the association between communication skill and job performance is 0.429, indicating a somewhat good relationship between communication soft skills and job performance. R is a statistical symbol that is similar to r and can be used to represent a regular coefficient correlation value. It shows how strong the relationship between the independent

variables and dependent variables. The R Square value in the same table is 0.184, indicating that communication skills may account for 18.4 percent of the variance in the data. The link between communication abilities and performance is significant at the 0.01 level (2 tailed) test. The same reason was applied to the other three factors of leadership, innovativeness, and teamwork all of which had varied linked values.

(B) West Malaysia Survey

The Pearson Correlation between communication skills and graduate performance is 0.569 for the second survey, indicating a moderately positive association between communication skills and job performance. The same figure shows the value of R Square is 0.324 and this indicating an independent variable of communication might account for 32.4 percent of the variance in the data. The relationship between Communication skills and Performance is significant at the 0.01 level (2 tailed) test. The same reason was applied to the other three factors of leadership, innovativeness, and teamwork all of which had varied linked values.

No.	Hypotheses	First Survey		Second Survey	
		Pearson Correlation Sig (2 tailed) at <.001 N= 204	Model Summary	Pearson Correlation Sig (2 tailed) at <.001 N= 193	Model Summary
1.	“Leadership influence job performance”	0.475**	R = .475a R Square = .225 Adjusted R Square = .222 Std. Error of Est. = .506	0.539**	R = 0.539 R Square = 0.290 Adjusted R Square = 0.287 Std. Error of Est. = 0.532
2.	“Innovativeness influences job performance”	0.528**	R = .528a R Square = .279 Adjusted R Square = .275 Std. Error of Est. = .488	0.509**	R = 0.509 R Square = 0.259 Adjusted R Square = 0.256 Std. Error of Est. = 0.544
3.	“Communication skill influence job performance”	0.429**	R = .429a R Square = 0.184 Adjusted R Square = 0.180 Std. Error of Est. = .519	0.569**	R = 0.569 R Square = 0.324 Adjusted R Square = 0.320 Std. Error of Est. = 0.519
4.	“Teamwork influence job performance”	0.418**	R = .418a R Square = .175 Adjusted R Square = .171 Std. Error of Est = .522	0.479**	R = 0.479 R Square = 0.229 Adjusted R Square = 0.225 Std. Error of Est = 0.555

** . Correlation is significant at the 0.01 level (2-tailed)

Fig. 2. Correlation results and model summary

4.3 Regression Analysis

The result of regression analysis of the two surveys is illustrates at the model summary at tables 4 and 5. The independent variables were leadership, innovativeness, communication, and teamwork and these variables are group together to assessing their impacts on the dependent variables of job performance. The result is shown in Table 4.

Table 4

Model summary of East Malaysia survey

Model summary				
Model	R	R square	Adjusted R square	Std. error of estimate
1	0.582	0.338	0.325	0.471
Predictors (Constant): Leadership, Innovativeness, Communication, Teamwork, Dependent Variable: Job Performance				

First survey's R value is 0.582, indicating a moderate relationship between the grouped soft skills and job performance. According to the R-square, soft skills have contributed approximately 33.8 percent of the variance in performance results. The unstandardized and standardised beta coefficients shown a positive relationship between grouped LICT soft skills and engineer job performance.

Table 5

Model summary of West Malaysia survey

Model summary				
Model	R	R square	Adjusted R square	Std. error of estimate
1	0.669	0.448	0.436	0.473
Predictors (Constant): Leadership, Innovativeness, Communication, Teamwork Dependent Variable: Job Performance				

The second survey's R value is 0.669 which indicating a stronger relationship between the grouped LICT soft skill and job performance. Soft skills have contributed approximately 44.8 percent of the variance in performance results based on the R-square. The unstandardized and standardized beta coefficients show that there is a positive relationship between grouped LICT soft skill and job performance.

From the coefficient findings, the most significant variables in the first survey that affecting job performance are innovativeness (0.528) followed by leadership qualities (0.475). For the second survey, the most significant dependent variables affecting performance are communication skills (0.569) followed by leadership (0.539). Both surveys indicated teamwork skills has the lowest loading score yet with moderate strength of 0.418 in first survey and 0.479 in the second survey compared to other skills variables.

4.4 Discussions

Higher education institutions (HEIs) play a significant role in incorporating soft skill traits/attributes with technical skill development in order to prepare graduates for employment. Incorporating soft skills into technical learning is not as simple as it may appear. This is due to the lack of a standard or absolute assessment to assess students' soft skill mastery or improvement. The employment rate of graduates is a widely accepted indicator of sufficient mastery of soft skills. LICT

skills are typically assessed through questions or activities during the interview process. The employability rate is currently being utilised in Malaysia as an indication of graduate competitiveness and quality.

Graduate attributes are a collection of abilities or qualities that a student must acquire and develop during their education journey. The quality of a country's human capital is determined by the quality of its graduates. The connection between human capital development and economic and globalization is critical for developing countries to advance and satisfy globalization's goals and challenges. As a result, inventive and skilled labour is a must for long-term competitive advantage and sustained economic growth. In order for Malaysia to achieve its goal of becoming a fully developed nation by 2050, HEIs must play a critical role in producing skilled graduates. It's also critical to emphasize that, in order to meet business needs, the educational system must be relevant, dynamic, and highly efficient.

Malaysian grads are well-educated, but they lack soft skills such as communication and inventive thinking, according to the industry. This become a challenge for businesses and the country to adapt in the long run a difficult environment and economy. Professor Dwight H. Perkins mentioned Malaysian institutions are failing to create the sort of graduates needed to fuel innovation and research and development (R&D), both of which are critical to the country's economic prosperity [20]. Stephen Isherwood, the chief executive officer of ISE, delivered a similar message, stating that because the workplace is changing constantly, graduates must guarantee that their skills and abilities are able to secure and prosper as their careers progress [14]. Employers' preferences beyond academic credentials, as well as the recession, prompted the government and educational institutions to rethink their comprehensive curriculum structure in order to generate future graduates with stronger employability skills. Many HEIs are still figuring out how to adapt their curriculum structure to match both hard and soft skill expectations on their students, thanks to the recent surge of soft skill preference. In summary, the two polls found that LICT has had a greater impact on engineers' job performance over time, as well as demonstrating talent's preparedness to accept the new paradigm of job performance in the IR 4.0 age.

The findings are also consistent with Jobstreet's framework for Malaysia engineering graduates to perform better from their peers [9]. The top-ranked skill is social skill, which refers to the capacity to connect with others through excellent communication abilities. The ability to lead has risen to second place. This ability is essential for leading, managing, and resolving any issue. Another talent that engineers should cultivate is creativity and innovativeness, which allows them to perceive an issue with innovative thinking and solutions. These characteristics were emphasised as essential qualities for a high-performing engineer. The ability to collaborate or operate in a team was the next talent on the list. Adaptability was highlighted as an extra skill. Engineers must be able to keep up with global technological transformation trends and respond to shifting economic conditions and societal growth.

5. Conclusion

Engineering education's job is to prepare the students for the development that Industry 4.0 will bring. This research has shed light on the entrepreneurial abilities that should be prioritised in engineering education 4.0 in terms of LICT soft skills. According to our most recent poll, communications and leadership are more critical to engineers' performance than the other three important graduate traits. The importance of the soft skill attribute of innovation and creativity cannot be overstated, as it is the key to problem-solving and differentiating strategy in a business. As a result, engineers who are creative and imaginative are expected to outperform their peers, as

innovation is important in Industry 4.0. Teamwork skills are equally important, and they provide comparative benefits in separating talent, when the hired engineers have equivalent technical competency. Engineers must always be on their toes. Engineers should work to improve their communication skills and be able to effectively communicate their ideas, while leadership skills are a valuable asset because they position engineers for career advancement by allowing them to take on supervisory roles and increase their decision-making authority.

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