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COMPARISON OF ROBOTIC ENGINEERING SKILLS BETWEEN PAST STUDIES AND MALAYSIAN STANDARD CLASSIFICATION OF OCCUPATION (MASCO): SYSTEMATIC LITERATURE REVIEW

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Abstract:

Diverse kinds of economic advancements have been made to keep up with the times and to make sure the nation does not fall behind in the 4.0 industrial revolution. Among the changes that can be seen today are the use of robots and digitalisation in the industrial sector. The increase in the use of robots in the industrial sector has an impact on the socio-economic of the country especially in the field of employment. Therefore, in order to guarantee that workers can effectively operate these robotic systems, job requirements in the robotics industry demand a competent and highly skilled skill set. Thus, the objective of this study is to identify elements of robotic skills around the world and compare the findings with MASCO robotics engineering skills. Three databases—Scopus, WoS, and Google Scholar—were utilised in the study as search engines for previously published papers and journal studies. The research's findings revealed that there is a gap of robotic skill elements between past research finding and MASCO's robotics skills. Previous research has identified seven robotic skills: communication, teamwork, creative,

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documentation, problem solving, patience and persistence, and analytical thinking and innovation skill. Nevertheless, only one components of the skills which is problem solving was highlighted by MASCO's engineering capabilities.

Keywords:

Robotic Engineering Skills, MASCO, Industrial Revolution, Employability, Competency, Systematic Literature Review

Introduction

As a developing nation, Malaysia has been working together and strategizing to leverage the benefits of technology in this industrial revolution4.0 (RI4.0) so that Malaysia can improve the country's economy in joining forces with other developed countries due to the growing technological developments. There are nine elements in RI4.0 listed by the Ministry of Human Resource Development's Skills Department (2021) where three of the elements are autonomous robot, internet of thing (IoT) and cloud computing. These three elements were also the areas that RI4.0 will focus on(Sharif, Ahmad, & Sarwar, 2019).

In this era of the industrial revolution, it is expected that many robotic-based technologies will move away from the technological applications of the industrial sector and be expanded to other sectors such as agricultural, medicine and automotive. The World Economic Forum report entitled "Future of Jobs Report 2020", expects that 73% of businesses or companies in Malaysia will use robot technology within the next five years (Monash University, 2022; Yee, 2022). According to the WEF report again it states that machine technology and algorithmic programming will account for 42% of total hours worked when compared to 2018 only 29% (Crowe, 2018). This proves that the use of technology has a huge impact on business models that allow for high-quality output in a short time and at a lower cost (Akyazi et al., 2020; Borowski, 2021).

RI4.0 encompasses the digital transformation that takes place to input, output and production systems in the industrial sector which makes smart factories part of the industry development element(MITI, 2020; Osterrieder, Budde, & Friedli, 2020). Smart factories are manufacturing systems that mostly operate using digital technology to generate, transfer, receive or process data to produce output without the need for manpower(Osterrieder et al., 2020). In Malaysia, a "New Industrial Master Plan 2030" plan has been developed to ensure that the manufacturing industry can adopt and digitize more technology and automation thus creating 3,000 smart factories by 2030. Among the technologies used in smart factories are robot automation, cloud computing, additive manufacturing and artificial intelligence(AI) (MITI, 2023).

The increase in the use of robotic technology has a positive and negative impact on the job market. Some low-skilled jobs are easier to replace with robotics and automation technologies. Meanwhile, the need for workers who are skilled in handling robotic technology and automation is more needed in the future. It is also supported by Di Battista et al. (2023), in the "Future of Jobs 2033" report where a job as a robotics engineer is one of the jobs that will grow rapidly. This is because, the profession as a robotics engineer is needed to operate robotic technology that has been applied with IoT and AI in an industry more efficiently.

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According to the Department of Skills Development of the Ministry of Human Resources Malaysia (2019), the classification of occupations can be divided into three sections, namely high-level, semi-skilled and low-skilled jobs. This classification is also based on the Malaysia Standard Classification of Occupations (MASCO) and takes into account the definition outlined by the Malaysia Occupational Skills Qualification Framework (MOSQF). The classification of these occupations is divided according to the level where level four and above are highly skilled jobs, levels 2 and 3 are semi-skilled jobs and level one is a low-skilled job.

A job as a robotics engineer has also been listed as a required critical job in Malaysia in 2015-2019(Critical Skills Monitoring Committee (CSC), Malaysia, & Analysis, 2021). According to Berger, von Briel, Davidsson, and Kuckertz (2021), this is supported by MITI (2018), that in Malaysia there are still issues related to the lack of talent, skills and knowledge needed in RI4.0 in a field involving robotics, IoT and AI. However, according to Malaysian Industrial Development Finance (MIDF) Research economist Zafri Zulkeffeli said according to the Department of Statistic Malaysia (DoSM), skills-related marketability is even more worrying, given that one over three people who had higher education are working in semi-skilled and low-skilled jobs (Khuen, 2022). Currently, in a survey by the Ministry of Human Resource Development (2020), local companies face challenges involving the skills gap between graduates and the industry.

It was also agreed by a previous study in which Tantawi et al. (2019), found that there are concerns in the aspect of the lack of trained manpower to manage robotic technology in the future. Experts in the automotive industry studies Halik Bassah and Mohd Asri Mohd (2023), also found that vocational education and training (TVET) students are introverted and do not want to stand out. This is evident when the study of A. A. Ismail and Hassan (2019), found that the soft skills of TVET graduates in Malaysia are still at a moderate level (Ismail & Hassan, 2019). Negative employee behavior towards robotic technology also contributes to the impact factor of using the technology (Çiğdem, Meidute-Kavaliauskiene, & Yıldız, 2023). This according to Blayon et al (2021) and Ruppert (2018) has proven that only highly skilled and qualified people can control the technology in RI4.0(Alhloul & Kiss, 2022).

In conclusion, the gap of competent and highly skilled skill sets in the field of robotics is very worrying and may contribute to the critical jobs required by the industry in Malaysia especially in terms of soft skills if there is no action or suggestions for improvement on this issue. This is because, many industrial sectors are making changes where they use robotic technology and automation to run their businesses. The set of skills or competencies required as a robotics engineer may be different from today as a result of technological improvement when the revolution took place. This makes it impossible for some skills that employees or graduates have to no longer be needed by the industry. Therefore, the improvement of competencies, skills and knowledge is one of the ways to build a multi-skilled workforce to overcome the problems of technological change in this industrial revolution and needs to be constantly upgraded. This is because a positive relationship can occur between high-competentcy skills education to the demands of the labour market which can reduce the insufficiency of the skilled workforce. Therefore, this study aims to identify elements of robotic skills around the world through findings from past studies as well as compare the findings with MASCO robotics engineering skills list that had been used as reference of robotic engineer skill set in Malaysia.

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Literature Review

In the review of this study, there are two things that will be detailed which are related to the industrial revolution and robotic engineering in this study.

Industrial Revolution

Revolution is a transition that takes place and in turn affects the change of the world. The industrial revolution began with RI1.0 and until now RI4.0. RI1.0 introduces steam engine, water power and mechanization (Low, Gao, & Ng, 2021). RI2.0 indicates a shift in the use of machinery in the assembly line(Low et al., 2021). Meanwhile, RI3.0 is a development in digital technology where the reliance on ICT and digital computing (Ghobakhloo, 2018). Currently RI4.0 shows manufacturers and large businesses using technology diversity in their business operations. There are nine main components available in the RI4.0 which are big data and analytics, robotic automation, simulation and virtual reality, vertical and horizontal system integration, IOT, cloud computing, augmented reality (AR), additive Manufacturing, and cyber security(Department of Skills Ministry of Human Resource Development, 2021).

RI4.0 Challenge

The phenomenon of job change is hard to deny. Employment skills in this RI4.0 era should be different from the previous RI(Ishak & Yaminb, 2019). Cicek, Akyuz, and Celik (2019), also agreed that there will be changes in skills that will be demanded resulting in new skills and new jobs will emerge thus impacting the industry(Rahmat, Adnan, & Mohtar, 2020). The study, conducted by analytics and advisory company Gallup Inc., found that 85% of employers in Malaysia report that it is challenging for them to find the talent needed especially in digital skills (Birruntha, 2023). While the study of Alhosani, Ahamat, and Ismail (2021), divided the RI4.0 challenge into four sections, namely the social aspect involving the need for new competencies and skills. On the other hand the economic aspect, involves increasing the productivity, competency and competitiveness of the industry. The technological aspect involves the need to integrate technology and finally the political aspect is the need to create new policies and regulations that support the development of RI4.0.

RI4.0 Skills

A survey by Crowe (2018) found the top five skill sets required in RI4.0 which are technology or computer skills, digital skills, programming skills for robots or automation, working with tools and technology, and critical thinking skills. But according to Sallati, de Andrade Bertazzi, and Schützer (2019), social capacity is also needed to communicate and lead the organization. Furthermore this revolution requires highly qualified workers to create software systems, AI, designing and programming (Kamarudin, 2018; Noah, 2021). In this RI4.0 also technical skills are required in the development and operation of the system so that they know to operate technical systems using digital machines and technologies (Ismail & Hassan, 2019; Grace et al., 2020; Sallati et al., 2019; Venkatraman, de Souza-Daw, & Kaspi, 2018). The study by Chaka (2020), found that 90% of RI4.0 skills involve generic skills and the rest of the technical skills based on its literature reviews of 64 articles. The Simic and Nedelko (2019), found that the competencies required in the manufacturing industry in this RI4.0 also involve behavioral competencies.

RI4.0 Engineering Skills

Mohd Kamaruzaman et al. (2022) study involving generic skills in IR4.0 has listed nine generic skill themes, namely communication skills, problem solving, leadership, emotional

International Journal of Modern Education IJMOE
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intelligence, creativity, critical thinking, adaptability, digital and management. In addition, Kamaruzaman, Hamid, Mutalib, and Rasul (2021), found that there are five attributes needed for leadership skill which are technical skills, thinking out-of-the-box, social skills, creative and lastly confident and decision-making. Next, the Mohd Kamaruzaman, Hamid, A. Mutalib, and Rasul (2020) study involving communication skills found six attributes required by engineering graduates, namely the ability to interact with the audience, the ability to convey clear information in the form of writing, the ability to communicate with people of different backgrounds, the ability to present, the ability to express their own ideas and the ability to listen and respond.

Robotics Engineering

Robotics engineering is a multidisciplinary field that requires a diversity of competencies (Rawboon, Yamazaki, Klomklieng, & Thanomsub, 2021). Robotics engineer is an occupational profession that involves the planning, testing and construction of robots (Ministry of Human Resources; Rawboon et al., 2021; Shmatko & Volkova, 2020).

Robotic Technology

Today's robot technology is more sophisticated because they also have artificial muscles and elastic cables for more flexibility (Heimgartner, 2020). Table 1 has shown a brief difference in human and robotic capabilities.

Table 1: Differences in Human and Robotic Capabilities

Human		Robot	
Advantage	Disadvantage	Advantage	Disadvantage
Ketangkasan	weak	Strength	No process knowledge
Flexibility	tiredness	Resistance	Lack of experience
Creativity	Inaccuracies	Accuracy	Lack of creativity
Decision to make	Low productivity	High productivity	No decision-making power

Source: Sherwani, Asad, and Ibrahim (2020)

MASCO Robotics Engineering Skills

According to the Ministry of Human Resources, MASCO is the national benchmark used for classification purposes in Malaysia's workforce. According to the Ministry of Human Resources' website regarding the MASCO code of robotics engineers 2141-02, the skills of robotics engineering are divided into two parts, namely basic skills and specific skills as shown in Table 2. The profession as a robotics engineer is also a highly skilled worker with the fifth level of competency in the National Occupational Skills Standard (NOSS).

International Journal of Modern Education
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Table 2: MASCO Robotics Engineering Skills

Basic Skills	Special Skills
Critical thinking	Computer design software
Active listening	Quick prototype
Problem solver	Automation skills
Decision maker	Technical engineering
Monitor	Mechanical
	Workplace safety and health

source: Kementerian Sumber Manusia

Methodology

This study was conducted using a systematic literature review that allows researchers to detect, evaluate and synthesize past studies on research issues and problems well (Cherry, Boland, & Dickson, 2017). According to Hensel and Nilson (2019), One of the important steps to take first of all in the research process is the study of literature as it can create knowledge by combining and interpreting the available knowledge (Alhosani, Ahamat, & Ismail, 2021). To see a gap or trend in the past study meta-analysis should be carried out after the review of the literature (Azmi, Kamin, & Noordin, 2018). Therefore, the resercher believe that a systematic review of literature is the best approach to looking at the well-being of past studies in a systematic way. There are five steps that researchers need to carry out in this systematic literature review as in Figure 1 below:

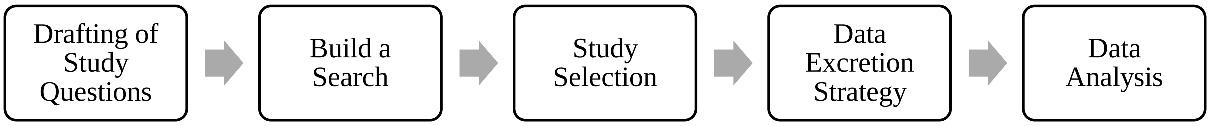

Figure 1: Procedure Conducting a Systematic Literature Review

Source: Hussain, Mohammed, Dahr, and Alrikabi (2015)

Step 1: Drafting of Study Questions

The purpose of this study is to answer the following questions:

1. What are the skills of robotic engineering in past studies?
2. Is there a comparison between MASCO robotics engineering skills and past studies?

Step 2: Build a Search

This study will only use completed past study articles and from peer-reviewed sources. Researchers will search by using databases from Web Of Science (WoS), Scopus and Google Scholar, as well as keyword and boolen operators to help researchers get the article more accurately. In addition, Scopus was chosen because it has extensive coverage with multidisciplinary, comprehensive and high-quality aritcles(Gusenbauer & Haddaway, 2020; Martín-Martín, Orduna-Malea, Thelwall, & López-Cózar, 2018). Meanwhile, *WoS* is also a database that indexes the world's leading scientific literature in various studies (Narandžić, Spasojević, Lolić, Stefanović, & Ristić, 2021). Furthermore, databases such as Scopus and WoS can be accessed for free under Universiti Teknologi Malaysia. Google Scholar was chosen as a support database because this database is able to find the diversity of academic literature from websites that are also identified as scientific(Haddaway, Collins, Coughlin, &

Volume 6 Issue 20 (March 2024) PP. 229-244
DOI: 10.35631/IJMOE.620018

Kirk, 2015; Narandžić et al., 2021). Table 3 shows the keywords and boolen operators used in each database
.

Table 3: Keywords and Boolen Operators Used

Database	Keywords
Scopus, Web Of Science, Google Scholar	("employability skill" OR "practical skill" OR "skill gap") AND ("robotics engineers" OR "robotics profesionals" OR robotics)

Source: Author

Step 3: Study Selection

To get relevant and best articles, criteria such as the following are used to find, select and review articles:

1. Repeated articles or journals, only one study report will be selected.
2. Grey literature such as article reviews, chapters in books, reports, and working papers will be excluded from this systematic literature review.
3. Articles or journals should be in English or Malay.
4. Only past studies published from 2019 to 2023 will be selected.
5. Researchers will look at keywords on the title as well as the abstract.
6. The study should have results or findings involving robotic engineering skills.

Step 4: Data Excretion Strategy

The purpose of this step is to plan data extraction activities. It involves the development of a complete table describing the studies that have been selected in detail for analysis(Ab Rashid, 2005). Typically, the number of articles or journals of past studies selected for analysis is less than the amount generated by the database(Mohd Kamaruzaman, Hamid, A. Mutalib, & Rasul, 2019).

Step 5: Data Analysis

For the purpose of reporting the data, this study classifies the findings of the data into several aspects, that is the author's name, year of publication, country, title, method and any further study recommendation.

Results

In this study, Researchers have found a total of 1380 articles related to keywords used in all three databases. After analysis researcher found only four articles that discussed robotic engineering skills as a research finding. So in the study, there are two aspects that will be analyzed, namely robotic engineering skills in past studies as well as the comparison of MASCO robotics engineering skills and past studies. These two aspects are the main important findings in this study. Therefore, Table 4 shows the findings of robotic engineering skills from the past four studies. Meanwhile, Table 5 shows the comparative gaps in MASCO robotics engineering skills as well as past studies.

International Journal of Modern Education IJMOE
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Volume 6 Issue 20 (March 2024) PP. 229-244
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Table 4: Robotic Engineering Skills Findings From Past Studies

<table>
<tr><th>Writer/ Year</th><th>Title</th><th>Study methods</th><th>Findings</th><th>Further studies</th></tr>
<tr><td>Berry, Reck, and Gennert (2020) -United States-</td><td>Practical skil for students in mechatronics and robotics education</td><td>-Focus group discussion with experts
-Questionnaire</td><td>The most important practical skills
<table>
<tr><th>Category</th><th>Skills</th></tr>
<tr><td>Self-Learning</td><td>Can debug and troubleshoot system</td></tr>
<tr><td>System Design</td><td>System design to meet specifications</td></tr>
<tr><td>Self-Learning</td><td>Read and interpret datasheets</td></tr>
<tr><td>Software Development</td><td>Can debug and troubleshoot code</td></tr>
<tr><td>Simulation and Numerical Analysis</td><td>Interpreting data from the system</td></tr>
<tr><td>System Design</td><td>Have a multidisciplinary perspective</td></tr>
<tr><td>Electronic Skills</td><td>Select a sensor for the system</td></tr>
<tr><td>System Design</td><td>Breaking the system into subsystems</td></tr>
<tr><td>Electronic Skills</td><td>Interface with sensors</td></tr>
<tr><td>Professional Skills</td><td>Properly documenting a technical project</td></tr>
<tr><td>Electronic Skills</td><td>Interface with actuators</td></tr>
</table></td><td>The findings of this study will then be used to develop the content framework of minor and major courses of study for mechatronics and robotics.</td></tr>
<tr><td>Shmatko and Volkova (2020) -United States and Russia-</td><td>Bridging the skill gap in robotics: Global and national environment</td><td>-Text-mining (collecting and analyzing online job postings for robotics engineers from Indeed.com and hh.ru)
-Expert interview.</td><td>The 10 most necessary technical skills by engineers and researchers specializing in robotics in the United States and in Russia.
<table>
<tr><th>United States</th><th>Russia</th></tr>
<tr><td>Programming (robots and individual components)</td><td>Programming (robots and individual components)</td></tr>
<tr><td>Welding and soldering skills</td><td>A reminder of the principles, and skills in, of the CAD system</td></tr>
<tr><td>Testing and quality control skills</td><td>System architecture management</td></tr>
<tr><td>Reasons on the principles of pneumatic and hydraulic mechanisms</td><td>Ability to read and prepare technical and design documentation, standardizers</td></tr>
</table></td><td>1. Further studies are to take into account other countries (for example, recognized world leaders in robotics such as Germany, China, or Japan)
2. Comparing different</td></tr>
</table>

International Journal of Modern Education
EISSN: 2637-0905
IJMOE
Volume 6 Issue 20 (March 2024) PP. 229-244
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<table>
<tr><td>Understanding computer vision and image processing principles</td><td>PCB design and detection</td></tr>
<tr><td>Computer modeling skills</td><td>Soldering skills (ability to solder and ensure proper operation of the device)</td></tr>
<tr><td>Years of human–machine interfaces</td><td>Experience installing and launching new production equipment, providing design support for production systems</td></tr>
<tr><td>Ability to create prototypes and experimental models</td><td>Experience using instrumentation equipment and devices</td></tr>
<tr><td>CNC machine tool operation skills</td><td>Development of testing systems, testing newly developed algorithms</td></tr>
<tr><td>In the field of artificial intelligence</td><td>Years about the machine vision system</td></tr>
</table>
CAD = computer-aided design; PCB = printed circuit board; CNC = computer numerical control

Top 10 Most Needed Soft Skills of Engineers and Researchers Specializing in Robotics in the United States and in Russia
<table>
<tr><th>United States</th><th>Russia</th></tr>
<tr><td>Organizational skills</td><td>English proficiency</td></tr>
<tr><td>Communication skills</td><td>Communication skills</td></tr>
<tr><td>Become a team player</td><td>Self-motivation</td></tr>
<tr><td>Problem solving skills</td><td>Creativity</td></tr>
<tr><td>Self-motivation</td><td>Project management skills</td></tr>
<tr><td>Time management</td><td>Writing skills</td></tr>
<tr><td>Analytical thinking</td><td>Analytical thinking</td></tr>
<tr><td>Multitasking</td><td>Become a team player</td></tr>
</table>
</td>
<td>industries. This is because, the use of robotics in many areas (among them automotive, pharmacy, medicine and agriculture) is a growing trend, so in the future it will be beneficial to analyze the specifics of the skills requirements in different domains.</td>
</tr>
</table>

International Journal of Modern Education
IJMOE
EISSN: 2637-0905
Volume 6 Issue 20 (March 2024) PP. 229-244
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<table>
<tr><td></td><td></td><td></td><td><table><tr><td>Work under pressure</td><td>Responsibility</td></tr><tr><td>Documentation skills</td><td>Work under pressure</td></tr></table></td><td></td></tr>
<tr><td>Rawboon et al. (2021)
-
Thailand-</td><td>Future competencies for three demanding careers of industry 4.0: Robotics engineers, data scientists, and food designers</td><td>-Literature study
-Focus group discussion
-Interview and questioning of expert</td><td>Future competency for robotics engineers as an important career in industry 4.0<table><tr><th>Category</th><th>Skills</th></tr><tr><td rowspan="5">Social copetension:
Skills and abilities and attitude to work together and communicate with others</td><td>Effective communication</td></tr><tr><td>Coordinate with others</td></tr><tr><td>Customer orientation</td></tr><tr><td>Consultation</td></tr><tr><td>Team building</td></tr><tr><td rowspan="6">Personal copetension:
Social values, motivation, and individual attitudes</td><td>Active learning</td></tr><tr><td>Ability to adapt to change</td></tr><tr><td>Leadership</td></tr><tr><td>Emotional intelligence</td></tr><tr><td>Patience and persistence</td></tr><tr><td>Observing and curious</td></tr><tr><td rowspan="9">Methodological copetension:
Skills and abilities to solve general problems and make decisions</td><td>Complex problem solving</td></tr><tr><td>Critical thinking</td></tr><tr><td>Project management</td></tr><tr><td>System thinking</td></tr><tr><td>Creativity, originality, and initiative</td></tr><tr><td>Analytical thinking and innovation</td></tr><tr><td>Design thinking</td></tr><tr><td>Creative integration</td></tr><tr><td>Time management</td></tr></table></td><td>Career context can be explored by future studies that can also focus in detail on the current aspects and challenges of the world.</td></tr>
<tr><td>Germany, Pejic</td><td>Transformation towards smart</td><td>-Semi-structured</td><td>Technical skills and soft skills as a robotics engineer coordinator<table><tr><th>Technical skills</th><th>Soft skills</th></tr></table></td><td>Future research should try to</td></tr>
</table>

International Journal of Modern Education
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Bach, and Aleksic (2020) - Slovenia-	factory system: Examining new job profiles and competencies	interview with a expert -Literature review	Ability to use HMI / Continuous learning Ability to repair a robot / Flexibility/adaptation to change Ability to perform supervisory and machine operator duties / Innovation and creativity Technical skills / technical literacy / Troubleshooting HMI=Human–machine interface	include additional data and opinions from various stakeholders in the production process and smart factories. In addition, it should include additional industries in addition to automotive, to provide a more general and broader view of the employment profile and future completions for Industry 4.0

The findings of this systematic literature review found four studies that discussed the skills of robotics engineering in four countries, namely the United States, Russia, Thailand and Slovenia. All four studies also included experts in study methods. Some of these studies used methods focus group discussion and also semi-expert interviews. The Berry, Reck, and Gennert study (2020), brought about a twist by using an online job search base to gather information on robotic engineering skills. There are two studies that divide robotic engineering skills into two parts, namely soft skills and technical skills.(Germany et al., 2020; Shmatko & Volkova, 2020). Past studies have also suggested that further studies can be conducted in any other country as well as in various fields to see the difference in the domain of skills required(Shmatko & Volkova, 2020). In conclusion, the skills that many of the four countries emphasize are communication, teamwork, creative, documentation, problem solving, patience and persistence, and analytical thinking and innovation skill.

International Journal of Modern Education
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Table 5: MASCO Robotics Engineering Skills Gap and Past Studies

MASCO skills element gap -Malaysia-	Shmatko and Volkova (2020)		Jerman et al. (2020) - Slovenia-	Berry et al. (2020) - Amerika Syarikat-	Rawboon et al. (2021) -Thailand-
	- Amerika Syarikat-	- Russia-			
Communication	/	/			/
Teamwork	/	/			/
Creative		/	/		/
Documentation	/	/		/	
Patience and persistence	/	/	/		
Analytical thinking and innovation		/	/	/	/

There is also a gap in skills as a robotics engineer from MASCO with a list of skills of robotics engineers from past studies. This skill gap is seen from the three times repetition of the engineering skills listed in the past study. After the analysis, there was a gap in the six skills elements based on the past three studies, namely communication, teamwork, creative, documentation, patience and persistence, and analytical thinking and innovation skill.

Discussions

Skills development and mastery are the most important elements in ensuring that graduates can be competitive in pursuit of their success(Mohd Kamaruzaman et al., 2019). In this study, two aspects were discussed on robotic engineering skills from the last four studies. Based on the mapping that has been created, the skills that many of the four countries emphasize are communication, teaming, problem solving, critical thinking, creativity, and design thinking. In this regard, the second aspect discusses the gap between MASCO engineering skills and past studies where there are three skills that have been repeatedly listed in the last three studies but not listed in MASCO which are communication, team and creative skills.

In this RI4.0 era graduates must be given early exposure to the demand in skills required by the industry(Mohd Kamaruzaman et al., 2019). It is very important that every graduate produced by higher education institution to always at the forefront and they are also aware of the current needs of the industry(Baser, Hasan, Suradin, Abidin, & Buntat, 2012). At the same time it can improve the employability of graduates and narrow the skills gap between graduates and industry. This is because, it can be seen that there is concern over the need for the profession of robotics engineering jobs in handling robotic technology and automation in the future(Berger et al., 2021; Tantawi et al., 2019).

Conclusion

This study identifies the skills that are emphasized by four countries and compares them with the MASCO engineering skills. It also highlights the need for early exposure to the industry demands and the challenges of handling robotic technology and automation in the future. There is some possible ways that higher education institutions can improve graduates' employability such as by better engagement with industry, embedding in-demand skills in curricula and focusing on developing human skills.

Volume 6 Issue 20 (March 2024) PP. 229-244
DOI: 10.35631/IJMOE.620018

In this study, there are limitations from the systematic literature review process where researcher found only four studies that discussed the related skills of robotics engineering as a result of the study in the past study. This is because, many past studies have discussed robotic engineering skills in the literature section rather than as their findings. Therefore, it is difficult for researchers to identify the source of skills specified in the literature section of past studies based on expert or non-expert sources.

Finally, this study will be used in further studies to develop robotic engineering skills in the automotive manufacturing industry in Malaysia by engaging experts as recommended by past studies (Germany et al., 2020; Shmatko & Volkova, 2020). Thus, the robotic engineering employability framework to be developed can serve as a guide to Higher Education Institution of Malaysia for the process of drafting or improving their curriculum. This is to ensure that robotics engineering graduates in Malaysia can be competitive and have no issue getting a job in the future.

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