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An Investigation of Engineering Technology Students'awareness and Basic Understanding of Industrial Revolution 4.0 (IR4.0)

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ABSTRACT

The Industrial Revolution 4.0 (IR4.0) is a novel transformative concept that entails a lot of changes to the way the community function. It has brought about significant changes in various workplace and industries, This study aims to assess the level of awareness on IR4.0 and the understanding of the technology pillars among 1st year engineering technology students of a private university via survey method and interview session. The findings show that the students have a fair knowledge of IR4.0 concept acquired from a number of sources and they are in the midst of learning more on this, via integration of the information into the curriculum, campus environment and activities with lecturers and fellow students. The students are positively impacted by the presence of IR4.0 within their study context and environment. This study will provide valuable insights into the current knowledge and perception of IR4.0 among university students, by highlighting areas for improvement in educational curriculum and industry readiness. As future leaders and new members of society it is crucial for them to have a deep understanding and awareness of its impact in life.

Keywords: : *IR4.0, Engineering, Technology, Awareness*

ABSTRAK

Revolusi Industri 4.0 (IR4.0) adalah konsep transformatif baru yang membawa banyak perubahan pada cara masyarakat berfungsi. Penelitian ini bertujuan untuk menilai tingkat kesadaran tentang IR4.0 dan pemahaman pilar teknologi di kalangan mahasiswa tahun pertama di bidang teknologi rekayasa di sebuah universitas swasta melalui metode survei dan wawancara. Temuan menunjukkan bahwa para mahasiswa memiliki pengetahuan yang cukup tentang konsep IR4.0 yang diperoleh dari berbagai sumber dan mereka sedang mempelajari lebih lanjut tentang hal ini, melalui integrasi informasi ke dalam kurikulum, lingkungan kampus, dan kegiatan dengan dosen dan sesama mahasiswa. Para mahasiswa mendapat dampak positif dari kehadiran IR4.0 dalam konteks dan lingkungan belajar mereka. Studi ini akan memberikan wawasan berharga tentang pengetahuan dan persepsi IR4.0 saat ini di kalangan mahasiswa, dengan menyoroti bidang-bidang yang perlu ditingkatkan dalam kurikulum pendidikan dan kesiapan industri. Sebagai calon pemimpin masa depan dan anggota baru masyarakat, sangat penting bagi mereka untuk memiliki pemahaman yang mendalam dan kesadaran akan dampaknya dalam kehidupan.

Kata kunci: *: IR4.0, Teknik, Teknologi, Kesadaran*

INTRODUCTION

Awareness and understanding on Industrial Revolution 4.0 (Henceforth IR4.0) is important not only for the industrail fraternity and academicians but also the public in general. This phenomenon is pursued not only for the sake of advancement but, but also for our planet's ethical and sustainable growth. Engineering students, as future industry personnel, innovators, leaders and important members of society will play an important role in navigating this shift in the world. Due to this, it is pertinent for engineering and technology students to have strong awareenss and understanding of IR 4.0, not only for their academic grades in their field of study but also for their overall minset growth and development of the right attitude in how the world should be managed (Yusuf et al., 2020). In addition, to fully embrace IR4.0, it is important to look at how educational institutions, industry collaborations, and individual initiatives help to prepare a workforce capable of harnessing technology for sustainable and inclusive development (Raj, et.al, 2020). Fostering awareness and understanding of the IR4.0 among engineering students is critical for developing a workforce capable of addressing global challenges while responsibly exploiting technology breakthroughs. Curriculum upgrades, practical initiatives, and joint efforts between educational institutions and companies can all help to bring about this integration (Ahmad, et al, 2021). This study investigates the relationship between IR4.0 and sustainable development in the context of engineering education by delving into the perceptions of university students on the potential benefits and challenges posed by IR4.0. In addition, this study endeavors to contribute to the ongoing discourse on the role of technology in advancing sustainability within the engineering domain.

Problem Statement

Despite the apparent importance of IR4.0 and the need to embrace it, engineering students appear to have a significant gap in their comprehension and awareness of the concept. The rapid speed of technological breakthroughs in IR4.0 necessitates a workforce capable of responsibly using its potential. Simultaneously, there is also urgency to develop an engineering community capable of incorporating creative IR 4.0 solutions into their practices to address global concerns. (Mohamad Shuhaimi et al., 2022). The issue is that IR4.0 has not been fully integrated into the educational framework, leaving engineering students unprepared for the intricacies of the modern workforce. There is an urgent need for a comprehensive approach that not only provides the technical skills required for IR4.0, but also instills a thorough grasp of the ethical, social, and environmental components of engineering practices aligned with *Sustainable Development Goals (SDGs).* The new wave of technology, for example smart manufacturing will help the process to evolve and lead to increased productivity. But to be able to put smart manufacturing into practice, it is indispensable for high-quality human resources. Theoretical understanding of IR4.0 may not fully transfer into actual project applications and efforts.

Furthermore, the gap between academic curriculum, understanding and practical applications still creates challenges in many fields such as engineering. (Ahmad, et al, 2017). This divide limits students' ability to make substantial contributions to sustainable development and innovation (Mohamad Shuhaimi et al., 2022). The problem addressed in this study is that engineering and technology students are not fully aware of the influence of the IR4.0 education in the classroom, which may limit their ability to adapt to modern-day needs.

This study is driven by three general objectives aimed at unraveling the multidimensional impact of the IR4.0 technology revolution on university students' knowledge, understanding and attitudes towards education; 1) to know the level of awareness and basic understanding of IR4.0 among engineering technology undergraduates; 2) to know the way the undergraduates apply the IR4.0 concept in their studies; 3) to know the perception on their receptiveness IR4.0 concept. The objectives of this study are quite similar to studies carried out by Hanh et al., (2021) and Mohamad Shuhaimi et al (2022)

which are strategically designed to capture the various relationships between university students and IR4.0 in a comprehensive manner. This study aims to answer the following pertinent questions; 1) how well are the students' awareness and understanding of IR4.0?; 2) how do the students see the influence of the IR4.0 on education?; and 3) what are the students' level of receptiveness towards IR4.0 and its impact?

The fourth industrial revolution or IR4.0 is the combination of technologies that are driving change in society today. The rapid advancements in technology brought about new lifestyle and career options that completely changed society. IR4.0, which combines cloud-based manufacturing, smart manufacturing, industrial internet, and the Internet of Things (henceforth IoT) is still seen by some people as a futuristic but a feasible notion that is happening around them (Elayyan, 2021). Irina (2019) highlights that IR4.0 hold a lot of promises in assisting businesses in overcoming the difficulties they are now facing in the value creation process. Along the value chain, it is the intelligent linking of devices, people, things, information, and communication systems. IR4.0 has caused some implications where it has transformed the manufacturing industries and created economies of value creation during the past four years (Devi, et al. 2020). In order to effectively manage and control the value creation process and supply chain IR4.0 entails the application of certain complementary technologies known as *Cyber-Physical Systems (CPSs),* which are able to connect people, machines, and things into the businesses' business models (Aravindaraj & Chinna,2022). In addition, Schumacher et al., (2016) highlighted the value chain's network of cutting-edge technologies where businesses across a range of industries will be reshaped by services, automation, robots, artificial intelligence, IoT and additive manufacturing. In IR4.0, the new Cyber-Physical Production Systems (CPPS) or Cloud-based manufacturing, is a phenomenon that will arise from the latest wave of changes in production systems that will obfuscate the lines between the actual world and virtual reality. CPSS is seen as a new generation of systems with integrated computational and physical capabilities that can interact with humans through many new modalities. According to Khan et al. (2021), by increasing resource efficiency, IR4.0 has great promise for attaining sustainable industrial value creation across social, economic, and environmental dimensions. It has also been emphasized that IR4.0 also act as a contributor to the Sustainable Development Goals (SDGs) (United Nations, 2015).

However, there are also seemingly negative impacts of IR4.0 where agencies like National Economic Action Council (EAC) and a number of researchers have identified several reasons that make it challenging for fresh graduates to enter the employment market. These include the lack of skills and working experience, weak communicative skills, particularly in the English language (Ahmad et al., 2017), gap between the requirements of the production and graduates' field of study, negative attitudes of certain graduates heading for jobs, and unconsciousness about the presence of several job opportunities (Devi, et al., 2020). Such socio-economic impact could be worsened where there is likely to be an increase in unemployment rates in Malaysia due to a significant gap between the specialized skills required in the labour market and the level of training provided by higher learning institutions (Ahmad & Mohd Said, 2013). The mismatch is also caused by the presence of new automation and artificial intelligent (AI) related jobs with less manpower, supply-demand gaps across fields of study and an imbalance between technical and generic skills and theories gained by graduates. (Devi, et al., 2020).

A study was done by Eleyyan (2021) to uncover the impact of IR4.0 pillars application such as the IoT, cloud computing, big data, cybersecurity, artificial intelligence, blockchain, and robotics on learning context, instructional activities, and social consequences. Lecturers who served as the respondents believed that the IR4.0 pillars namely blockchain, cloud computing, and cybersecurity will be employed in a variety of applications in the future to preserve student data and activities. On the other hand, they stated that the teaching-learning processes would take place without real values with a low level of student-teacher contact. They also anticipated that robots and technology will eventually

replace people in educational occupations. Based on these findings, Eleyyan, (2021) advised considerable adjustments in educational programmes, curriculum, learning environments, instructional abilities, and teacher-student roles to deal with IR4.0 technology.

METHODOLOGY

The methodology used in this research's aim is to evaluate the understanding and awareness of engineering students regarding IR4.0. The researchers employed a quantitative approach like (Yusuf et al., 2020), conducting a survey among a sample of engineering students. The researchers also included questions regarding the students' perceptions of the potential impacts and challenges of IR 4.0. The survey questions are considered the backbone of a survey as it is used to collect data from the respondents. There are 15 research questions and they were created based on the three research objectives using response intervals of a typical 5-point Likert scale from Strongly Disagree to Strongly Agree, to determine understanding and awareness about IR4.0. Online apps like Google Form and interview session via Microsoft TEAMs were used to collect data. The questions with link of the survey was disseminated using Whatsapp to all first year engineering technology students at UniKL Malaysia France Institute (UniKL MFI), a private university. In total, 99 responses were obtained from the total new first year student population of 130 students. Based on minimum sampling calculation ratio by Krejcie & Morgan (1970), the minimum data figure was met and data could be analysed. The data collected from the survey was analyzed comprehensively and were compared to other studies (Irina, 2019). The obtained results were then compared to the objectives of the study and the findings from past studies in the literature review. Based on the data analysis, the researchers were able to determine the level of understanding and awareness among engineering technology students regarding IR 4.0.

FINDINGS AND DISCUSSION

Interview Session with Expert

The researchers also used qualitative approach by conducting a session interview with one of the IR4.0 experts who is a professor at a private university named UniKL Malaysia France Institute (UniKL MFI) to gain a deeper understanding of the challenges and opportunities faced by engineering technology students in relation to this avant garde concept. Microsoft Teams was used to carry out and record an online interview with Prof. D.r Wan Mansor bin Wan Muhamad as the Head for Mechanical Engineering Department. He has vast experience in working in mechanical and manufacturing industry which are related to IR 4.0 and he has served at three universities prior to his present work. The interview session provided valuable insights into academicians' perspectives on how prepared the students are to embrace IR4.0. The interview questions include his observations of students' engagement with IR4.0 and his thoughts on how the curriculum can be adapted to better prepare engineering technology students to meet the demands of IR4.0. The Professor highlighted the need for integrating more hands-on practical experiences and interdisciplinary approaches in engineering technology education to foster the skills and competencies required in IR4.0. He also emphasized the importance of continuous learning and adaptability, as technology is constantly evolving in the era of IR4.0. Prof Dr Wan Mansor Wan Muhamad highlighted below examples of his observations of the students;

> *"I have encountered a few of my students who designed a temperature control and remote control for 3D printing for their Final Year Project so, this means that the students at UniKL MFI already have some knowledge and awareness about the function and the importance of IR 4.0 technology*.

The students can already apply some of the 9 pillars of IR4.0 into their study and projects. For example, the student mentioned above applied the IoT technology in the remote control for the 3D printing device**.**

Findings from Survey Results

The results of the study indicated that engineering students generally had a fair level of understanding and awareness about. A total of 99 new bachelor students from 6 study programs at UniKL MFI responded to the survey. They comprise 88.3% male and 11.7 % female students and the respondents are from courses like HVACR, Mechanical, Machining, Electrical, Welding & Materials and Automotive.

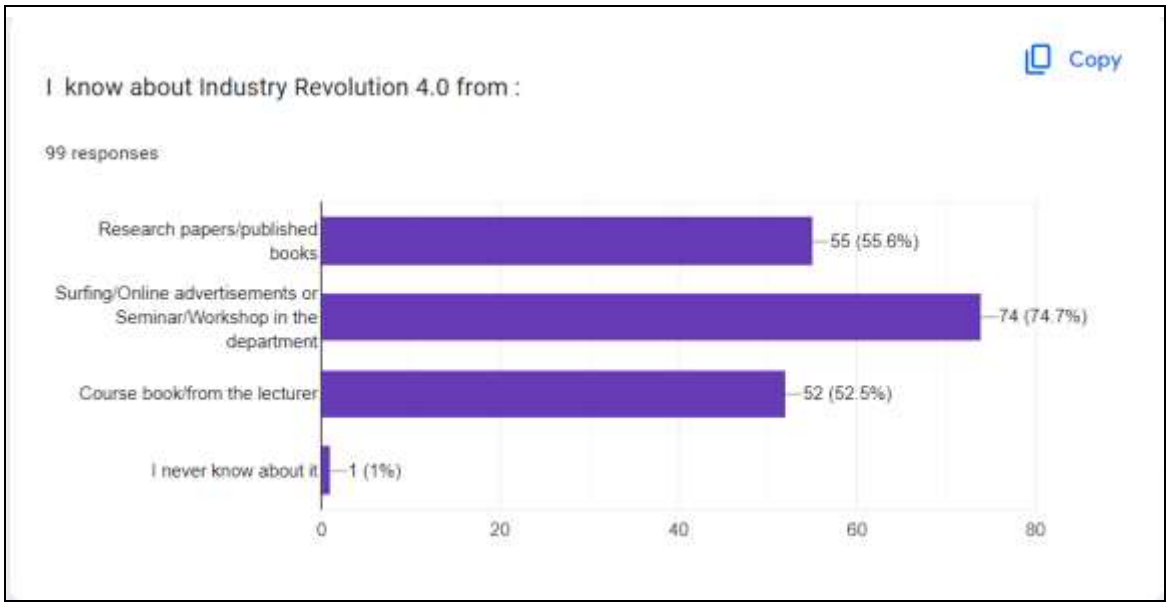

Figure 1. Source of Basic Knowledge about IR4.0

The first question from the survey was on the source of the students' knowledge about IR4.0. This question is crucial for this study because it can show the information source and the medium that contributes to the students' knowledge of IR4.0. The results are shown in figure 1 above. Most respondents, namely 74.7%, knew about IR4.0 through surfing the social media, reading online advertisement and listening to or attending talk, seminar or workshop organized by their respective academic departments. The findings from the data analysis revealed that 99% of respondents have knowledge and awareness about IR4.0 while only 1% claimed not knowing about it.

Next is the survey on the students' level of understanding on the aspects of IR4.0. Figure 2 below shows that almost all the respondents knew about the 9 pillars of IR4.0 which are AI, additive manufacturing, cloud computing, IoT, cyber security, big data, 3D printing, autonomous robot and radio frequency identifier device (RFID). From the data shown in the figure, the one that most respondents know about is AI, followed by IoT and 3D printing while additive manufacturing and cloud computing are the least known among the respondents. It is understandable for the students' limited knowledge on the work related additive manufacturing, but it is surprising that cloud computing is not well-known to them since it is a widely used technology in various industries and should have been introduced to them at high school or pre-university study platform prior to joining the degree level. Moreover, nowadays cloud computing is used a lot in students' daily lives, especially for storage and access to digital files. Therefore, it is important to further educate and raise awareness among engineering and technology students regarding this pillar of IR4.0.

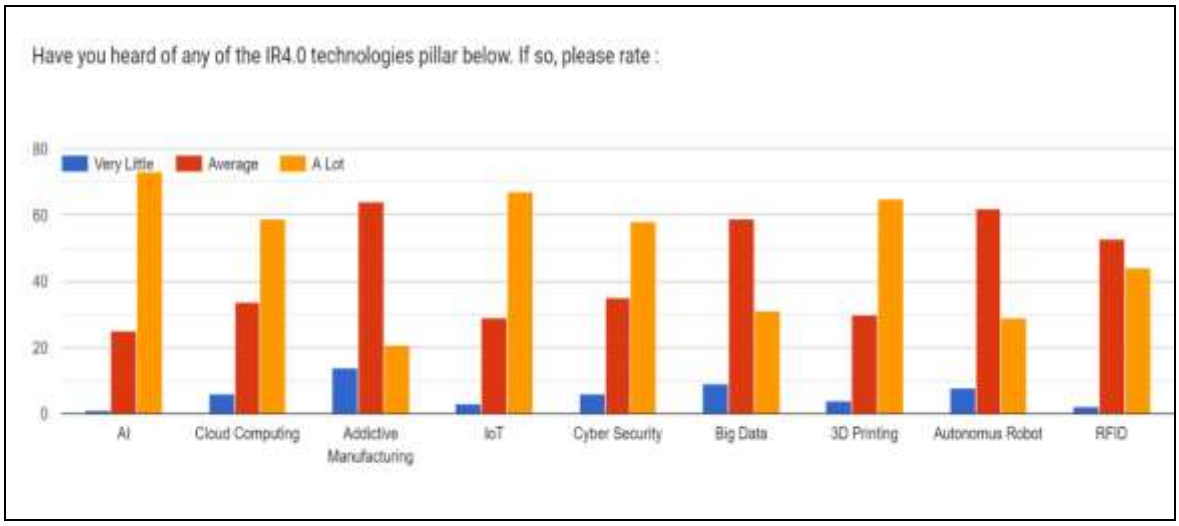

Figure 2. Students' Perception of Their Level of Knowledge on the 9 IR4.0 Pillars

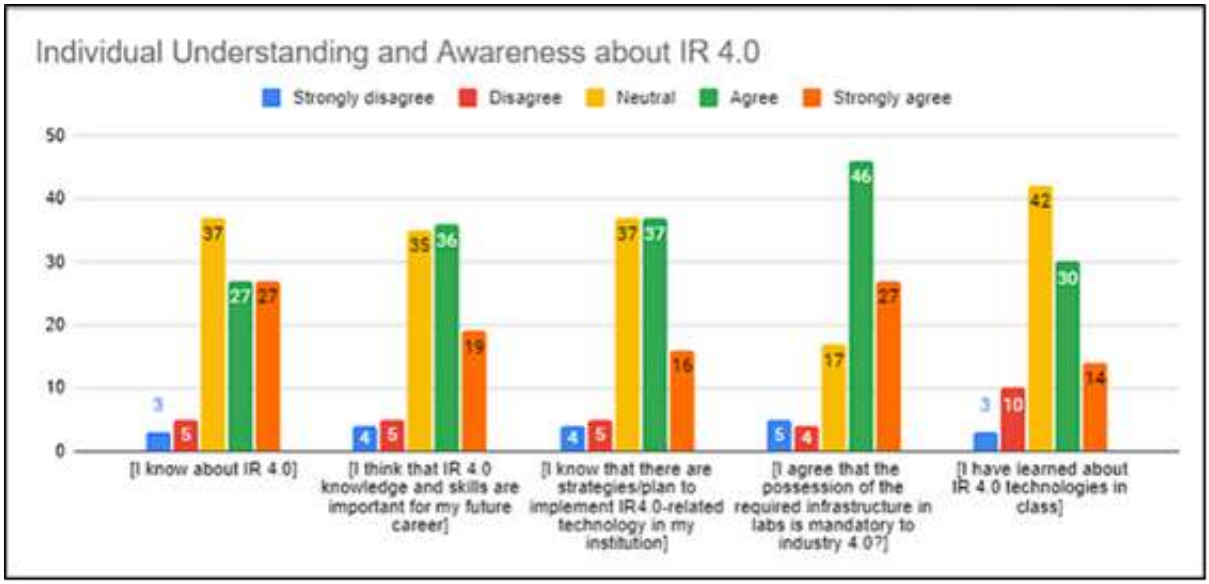

Figure 3: Students' Perception on Impact of IR4.0 To Their Study Environment

Figure 3 above shows that the students responded positively with the survey rating skewed to the right on the presence of IR4.0 information and required infrastructure in their study environment and its implication on their future career. This indicates that they are receptive to the availability of IR4.0 related information, platform, infrastructure and their significance in supporting their tertiary studies. The IoT is perceived as a tool that makes studying easier for students, indicating that it is valued for its potential to enhance learning experiences and content accessibility. Many respondents confirm that IR4.0 topics have been incorporated into their university syllabuses, reflecting a proactive approach to embed these subjects into the academic curricula. Most of the figures above illustrate that majority of the respondents gave mostly "neutral" response and the "agree" response option received the second highest count. Meanwhile, the "strongly disagree" option had lesser than 5 votes in each poll. The bar charts in figure 4 above present data on institutional involvement in disseminating knowledge about IR4.0 to students. The chart reveals a positive inclination of the students towards the adoption and impact of IR4.0 within educational institutions, based on responses to a series of statements.

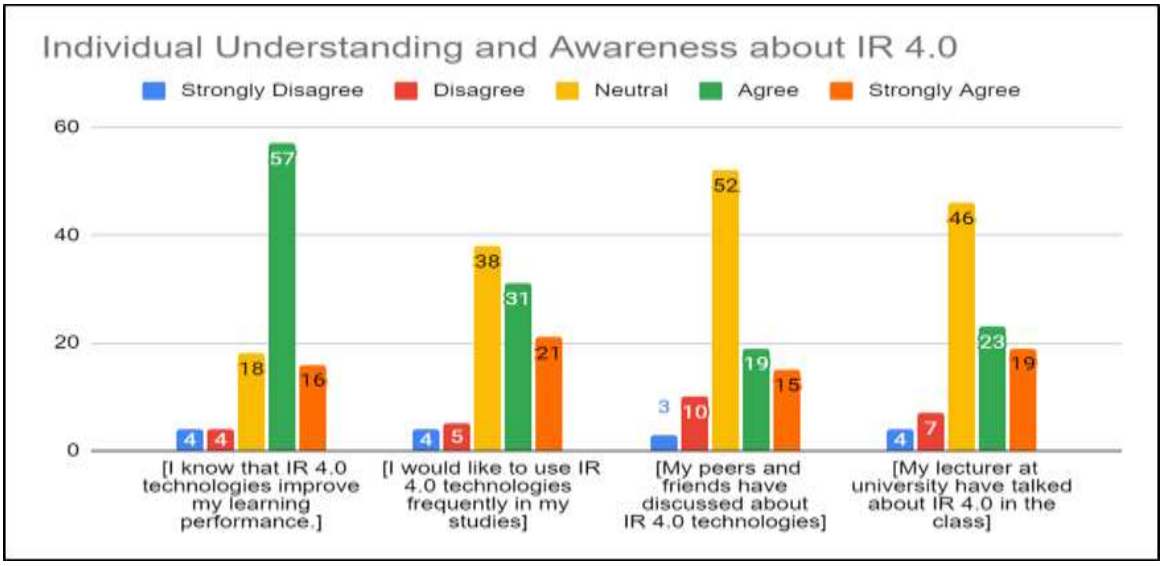

Figure 4: Students' IR4.0 Experience at University and Their Acceptance of It

The potential impact of IR4.0 technologies on education is widely acknowledged, with a large majority of the students agreeing on its importance. This indicates acceptance and recognition of the roles that these IR4.0 technologies can play in their education.

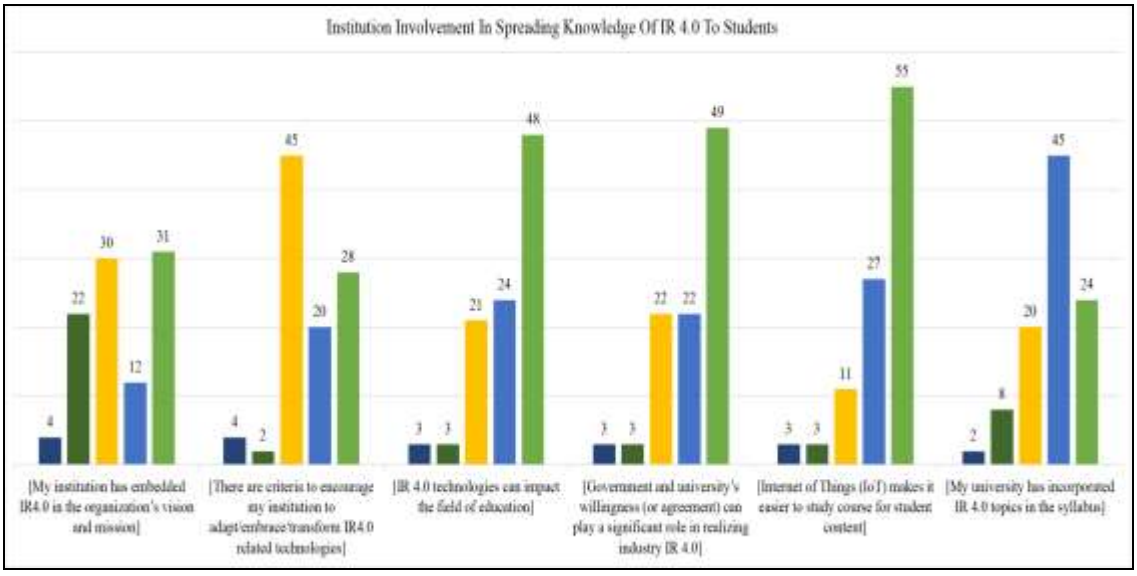

Figure 5: Perception on Campus Efforts to incorporate IR4.0 and Its Impacts to Students

The outcome of the survey is not surprising due to the nature of engineering students that is related in almost every aspect of IR4.0 itself. The majority of students felt that the implementation of IR4.0 had a positive impact on them. For example, as a whole, for many of the question items in the survey, the average responses are dominated by "agree" and "strongly agree" responses on the average. This is followed by the "neutral" response as the third highest chosen response option. As for negative responses of "disagree" and "strongly disagree", they are the less preferred response options.

Based on the survey data and the insights gained from the interview, it is evident that there is a need for universities and educational institutions to enhance their educational courses and curriculum in order to provide engineering technology students with a more comprehensive understanding of IR4.0. Hanh et al. (2021) suggest that further education and awareness initiatives should be implemented to enhance the knowledge and understanding of engineering technology students regarding IR4.0. The

findings of the study have significant implications for engineering education and curriculum development.

The investigation has illuminated a prevailing positive attitude towards and active implementation of IR4.0 within educational institutions. These establishments have not only seamlessly integrated IR4.0 into their overarching vision and mission but have also established specific criteria to foster the widespread adoption of cutting-edge technologies associated with IR4.0. Moreover, the widespread recognition of the potential impact of IR4.0 on education underscores the collective understanding of its transformative power (Shuhaimi, et al., 2022). The collaborative spirit between government bodies and universities stands out as a crucial factor for the successful implementation of these advancements. Particularly noteworthy is the students' perceptiveness, as they regard IoT as a valuable tool for enriching their learning experiences. In essence, the findings of this study indicate a robust awareness and understanding of IR4.0 among the respondents, paving the way for a promising and enthusiastic embrace of these technologies within the educational landscape. This positive trajectory signifies a progressive shift towards an integrated future where education and technology coalesce for a more advanced and impactful learning environment (Yusuf et al., 2020). In tackling this issue, there is a chance to rethink engineering education, stimulate interdisciplinary collaboration, and provide opportunities for students to actively engage with the problems and opportunities (Ahmad, et al 2017). By doing so the next generation of engineers can be not only technologically competent but also socially and environmentally conscientious, thereby promoting positive change in our global community.

CONCLUSION

It can be concluded that the engineering and technology undergraduates have positive awareness and understanding of IR4.0 which could be enhanced further in their tertiary studies. They are fairly receptive towards the incorporation of IR4.0 concept in their study programme at educational institutions and recognize its overall potential impact on their education. The undergraduates also see the pillars of IR4.0 like IoT as a valuable tool for enhancing their learning experiences. Overall, there is a clear understanding and awareness of IR4.0 among the undergraduates indicating a positive direction towards formation of an advanced IR4.0 community in the near future. The visible presence of tertiary institutions' effort to embrace and integrate these technologies into the educational landscape is welcomed and appreciated by the undergraduates.

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