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Exploring Factors Influencing Fourth Industrial Revolution Skills Acquisition in The Food Services Industry

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Abstract

This study explores skills acquisition factors in utilizing 4IR technologies within the Malaysian Food Services Industry, specifically in dine-in restaurants. Applying a Sequential Exploratory mixed methods approach, the qualitative phase explores reasons for using 4IR technologies, factors influencing service staff skill acquisition, and the required 4IR skills in a Food Services working environment. Based on these qualitative insights, a survey instrument for Food Service staff is developed, integrating constructs from the Diffusion of Innovation (DOI) Theory and the Technological-Organisational-Environmental (TOE) Framework. DOI is used to analyze factors influencing technology adoption and skills acquisition, while TOE maps these constructs to technological, organizational, and environmental factors similar to Technical and Vocational Education and Training (TVET) curriculum components. Key findings reveal that 4IR technologies address staff shortages, allowing service staff to perform tasks other than taking orders and sending food to customers. Key factors influencing skills acquisition are the technology's low complexity and compatibility within the working environment. Key skills include operational handling of 4IR technology, communication skills, risk assessment, escalation of technical issues to maintenance personnel and training of technology use to new staff.

Keywords: Fourth Industrial Revolution Skills Acquisition, Technical and Vocational Education and Training (TVET) curriculum, Diffusion of Innovation (DOI) Theory, Technological-Organisational-Environmental (TOE) Framework.

Introduction

It has become commonplace in the recent half-decade that emerging technologies or more specifically, Fourth Industrial Revolution (4IR) technologies are increasingly used in various industries such as manufacturing (e.g. automation, remote monitoring), construction (e.g. Building Information Modelling (BIM), 3D Printing), utilities maintenance (e.g. water and electricity remote monitoring) and various other engineering-oriented industries. However, it has also become apparent that 4IR technologies are becoming more popular and being used in service industries such as Banking, Education, Health Services and currently one of the

industries that makes these technologies more easily accessible to the public is the food service industry. 4IR technologies which are now increasingly used in the food service industry are such as robot waiters and the Internet of Things via the scanning of QR (Quick Response) codes that store information such as menus of a restaurant. 4IR technologies are operationally defined in this study as emerging technologies that are used in the current Fourth Industrial Revolution (since the term was coined by the German government in 2011 Hermann et al (2016) and establish a cyber-physical working environment. Widely referred definitions and discussions on 4IR are such as those by Klaus Schwab Schwab (2016) and in reports by the World Economic Forum (WEF) published in 2016 World Economic Forum (WEF) (2016) and subsequent reports regarding future skills. Subsequent research has delved into the effects of the Fourth Industrial Revolution on the labour landscape. Owing to the technological advancements introduced by the Fourth Industrial Revolution which is characterized by cyber-physical systems, the workforce must possess appropriate skills when utilizing these technologies (Spöttl and Windelband, 2021).

This study focuses on the food services industry, particularly in light of its resilience during the Covid-19 pandemic, where digitization and 4IR technologies played a crucial role such as robotics serving food, IoT-enabled contactless payment, big data analytics for customer preferences, and blockchain with cybersecurity in e-commerce, that showcase the adaptability and integration of these technologies in the Food Service setting. The Food Service sector focused in this study is family dine-in restaurants in Malaysia where food is served by service staff and does not include restaurants in hotels. This is because based on input from one of the interview participants, hotels in Malaysia are not using 4IR technologies to maintain certain elements of the 'human touch' when serving customers who dine at hotel restaurants.

The study aims to explore factors that influence the skills required for a worker in a restaurant that uses 4IR technologies and subsequently identify a skills framework that can be referred to when updating the Technical and Vocational Education and Training (TVET) curriculum. This study operationally defines these skills as Fourth Industrial Revolution (4IR) skills. It is anticipated that the skills required would either be according to the job area, 4IR technology, and occupational level based on the TVET curriculum format in Malaysia in the National Occupational Skills Standard (NOSS). NOSS' counterparts in other countries are such as the Training Packages in Australia, Red Seal Occupational Analyses in Canada, and Workforce Skills Qualifications in Singapore that are developed based on competency requirements (Asia-Pacific Economic Cooperation (APEC), 2014). Research by APEC (2014) on the different forms of TVET curriculum among several APEC economies highlighted that the main components that are common among these curriculum documents are that they are industry-specific, are according to occupational or job levels, and include the components of knowledge, skills, attitude, and tools used.

In the qualitative phase of this study, the factors influencing skills acquisition when using 4IR technologies in the Food Service Industry were explored while keeping in mind the main components of TVET curriculum so that the findings could later be mapped.

Literature Review

Fourth Industrial Revolution Technologies Usage In The Services Industry

The advent of Fourth Industrial Revolution (4IR) technologies has transformed the landscape of work environments, incorporating advancements like the Internet of Things, Artificial Intelligence, robotics, virtual reality, and cybersecurity. These technologies, both novel and

integrated, play a pivotal role in creating a 4IR-enabled working environment. The Academy of Sciences Malaysia categorizes these technologies as Science & Technology Drivers, encompassing 5G/6G, sensor technology, 4D/5D printing, Advanced Materials, Advanced intelligent systems, Cyber-security and encryption, Augmented analytics and data discovery, Blockchain, Neurotechnology, and Bioscience technology. In the Malaysian context, the Economic Planning Unit identifies foundational 4IR technologies, including Blockchain, Internet of Things, Cloud Computing and Data Analytics, Artificial Intelligence, and Advanced Materials and Technologies. In prior literature, these technologies have been referred to as technology enablers Schwab (2016), technology pillars Ministry of International Trade and Industry (MITI) (2016), and science and technology drivers (Academy of Sciences Malaysia (ASM), 2020).

Theories Relevant To Technology Adoption

Qualitative data collection in this study serves as a precursor to developing a survey instrument in the subsequent quantitative phase. The interview questions are designed to extract responses guiding the survey's construction based on theoretical constructs, representing the independent variables. A Systematic Literature Review conducted by the researchers regarding this study identified the Diffusion of Innovation (DOI) theory (Rogers, 1983) and the Technological-Organisational-Environment (TOE) Framework by Tornatzky and Fleischer (1990) as relevant. DOI highlights innovation characteristics influencing adoption, while TOE extends these to include technological, organizational, and environmental aspects. This study integrates DOI and TOE elements to comprehensively examine factors influencing skills acquisition resulting from technology adoption as applied in previous studies (Haneem et al., 2019; Hiran and Henten, 2020; Zheng and Khalid, 2022). The applied integrated DOI-TOE conceptual framework considers DOI's Innovative Characteristics (Trialability, Observability, Low Complexity) within TOE's Technological Context. DOI's Compatibility and Relative Advantage align with TOE's Organisational Context, analysing technology advantage within the organizational structure. DOI's Social System parallels TOE's Environmental context, examining influences from relevant parties. The resulting theoretical framework is depicted in Figure 1.

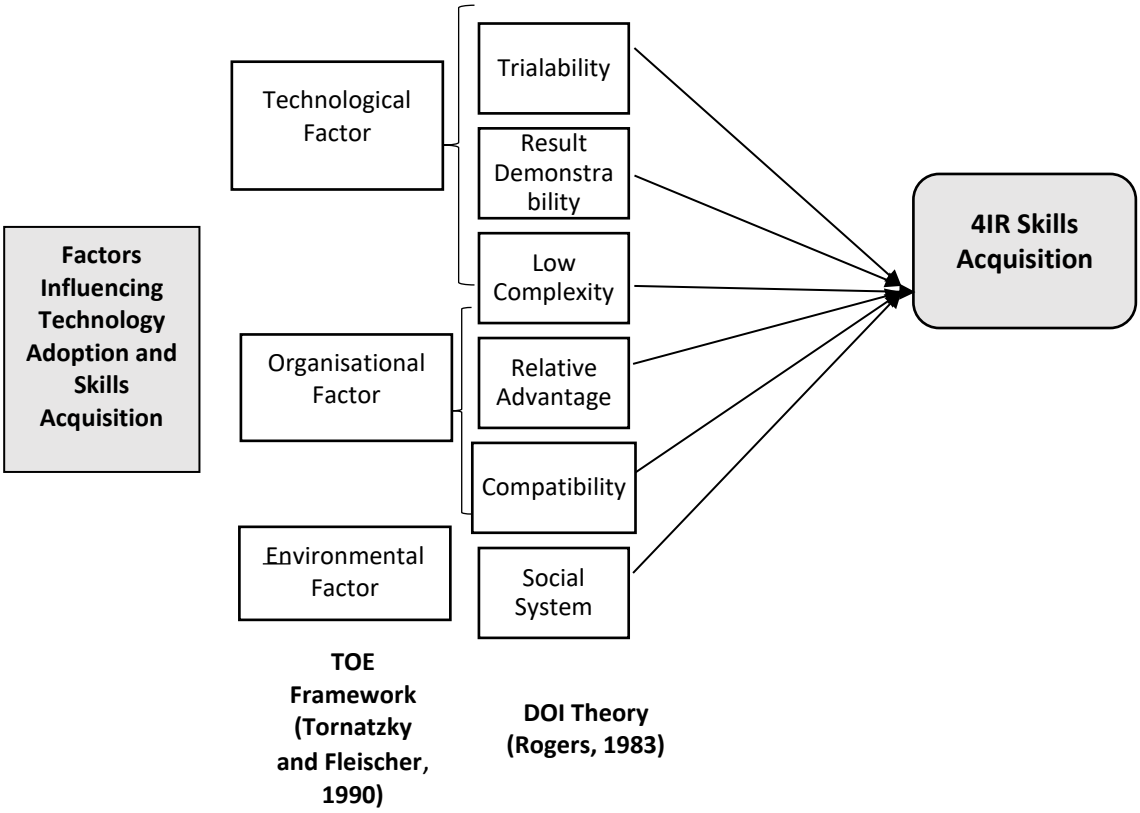

Figure 1: Theoretical Framework showing TOE and DOI factors

Figure 1 shows the factors that influence 4IR Technology Adoption leading to 4IR skills acquisition.

Methodology

Sampling and Data Sources

The overall research applies the sequential exploratory mixed methods approach (Creswell, 2014) which applies a combination of qualitative and quantitative approaches to collect and analyse data according to each sequential phase. The integration of the data occurs in the development of the survey instrument based on the findings from the qualitative phase. This article focuses on the qualitative phase's data collection and results. Data collection was carried out via interview sessions with purposive samples of interview participants representing personnel at the Food & Beverage (F&B) outlets who are either at the managerial level or are in charge of managing the use of 4IR technology at the restaurant. Purposive sampling was applied in the selection of the sample participants with the following criteria: (1) Has experience using 4IR technologies in restaurant work settings; (2) Is a Restaurant Senior Staff (Service Area) or Restaurant Managerial staff or restaurant (franchise) HR personnel or 4IR technology maintenance personnel who work closely with restaurants using 4IR technologies.

Research Instrument

A semi-structured interview protocol was developed and applied as the instrument in the qualitative phase of this study. It was developed based on the research questions of the study and the interview questions were crafted to elicit answers from interview participants on the

use of 4IR technologies in food services and skills acquired. The process of validating the interview protocol was done by obtaining confirmation from two experts, one was an expert in the food services industry and another expert was an expert in 4IR technologies e.g. robotics. The semi-structured interview protocol comprised the main questions and probing questions that enabled the researcher to explore deeper on newly surfaced topics during the interview. Table 1 shows the list of Research Questions and sections of the interview protocol that corresponded to the Research Questions.

Table 1
Semi-structured Interview Questions Vs. Research Questions and Relevant DOI and TOE Factors

Interview Questions (Key Questions and probing prompts)	**Research Questions**		
	Why is Fourth Industrial Revolution (4IR) technology used in restaurants?	**Which skills are required by workers in the Food Services sector?**	**What influences restaurant workers to acquire skills to use the 4IR technology?**
Question 1 **Which 4IR technologies are used in your restaurant?**	(TOE - Technological, DOI – Low Complexity)		
Question 2 **How long have you been using 4IR technologies?**	(TOE - Environmental, DOI – Social System)		
Question 3 **Which workers work directly with these 4IR technologies?**			(TOE - Organizational, DOI –Compatibility)
Question 4 **Why did the restaurant decide to use the 4IR technologies?**	(TOE - Organizational, DOI – Relative Advantage, Compatibility)		
Question 5 **How did the technology company train the workers to use the technology?**	(TOE - Technological DOI – Trialability)		
Question 6 **What are the skills required by the workers to use the technology?**		X	
Question 7		X	

Interview Questions (Key Questions and probing prompts)	Research Questions		
	Why is Fourth Industrial Revolution (4IR) technology used in restaurants?	**Which skills are required by workers in the Food Services sector?**	**What influences restaurant workers to acquire skills to use the 4IR technology?**
Should the workers be able to carry out basic maintenance especially when the service contract by maintenance personnel has expired?			
Question 8 **What have been the advantages of using the technology?**	(TOE - Organizational, Technological DOI – Relative Advantage, Result Demonstrability)		(TOE - Organizational, Technological DOI – Relative Advantage, Result Demonstrability)
Question 9 **How are the customer's perspective of the technology?**	(TOE – Organisational, Environmental DOI – Relative Advantage, Social System)		
Question 10 **What are the workers perspective of using the technology?**			(TOE - Organizational, Technological DOI – Compatibility, Relative Advantage, Result Demonstrability)
Question 11 **Will there be any new technologies that the restaurant will be using in future?**	(TOE - Technological DOI – Low Complexity, Trialability)		

Table 1 aligns interview responses with Research Questions, Interview Questions, and factors influencing technology adoption, contributing to skills acquisition according to DOI and TOE. Research Question 1 explores the technologies used by companies and the reasons behind their usage, aiming to grasp the use of the technologies based on the restaurant's objectives. Drawing from Amiron's (2020) findings, companies often apply 4IR technologies to optimize processes and reduce human errors. Research Question 2 delves into the skills essential for workers in the F&B services sector to use such technology. Research Question 3 investigates the factors influencing F&B workers in acquiring skills for 4IR technology use, tied to TOE

Organizational and Technological factors. Questions 6 and 7 are not mapped to DOI and TOE, as the questions focus on understanding skills required for using 4IR technologies, which is this study's Dependent Variable.

Data Collection

Data collection involved gathering insights from interview participants, where the number of interview participants followed a method to determine the point of information saturation outlined by (Guest et al., 2020). The number of interviews required was determined by considering the base size (minimum number of interviews to review), run length, and new information threshold. The new information threshold represents the proportion of new insights at a given point in data collection, typically set at 5%, but Guest et al (2020) proposed that researchers could choose between two levels of new information thresholds at either 5% new information or 0% which is no new information. Guest et al (2020)'s study suggested that with a base size of 4 interviews and a run length of 2 interviews, saturation could be achieved after 6-7 interviews. Previous studies (Hagaman & Wutich, 2017; Guest et al., 2017) highlight that new information is generated earlier and declines in terms of new information after a small number of interviews.

For this study, calculations indicated an 11.9% new information percentage after the base size of 4 interviews and the first run of 2 interviews, surpassing the 5% threshold. It must added that in the original calculation by Guest et al (2020) there was an overlap of new information between 2 sets of runs, as per their explanation, successive runs overlap, and each set of interviews shifts to the right or "forward" in time by one event. For this study, two additional interviews were conducted, and the new information percentage for this additional run was 2.4%, below the 5% threshold. Consequently, the information from the 8 interviews was considered saturated. The calculations are explained in the following steps.

Step 1

Number of themes for base size of 4 interviews = 42
Number of themes for run length of 2 subsequent interviews 5 and 6 = 5
Therefore, the new Information percentage for the base size and first run length of 2 interviews = 5/42 = 11.9%
The new information percentage of 11.9% for the base size and first run length of 2 interviews is more than the new information threshold of 5%, therefore an additional 2 interviews were conducted.

Step 2

New unique themes identified in the additional run of interviews 6 and 7 = 2 (1 theme from interview 6 and 1 theme from interview 7)
New Information percentage for an additional run against base size = 2/42= 4.7%
This result quotient of 4.7 % is less than the threshold of 5%, therefore the information from the 7 interviews can be considered to be saturated.
However, as a precaution by the researcher of this study to ensure that there was no missing important information by stopping the interviews upon the 7th interview, another interview was conducted which was interview 8. However, no new themes were identified.

New unique themes identified in the additional interview 8, and previous interview 7 = 1 (1 theme from interview 7 and 0 theme from interview 8)

New Information percentage for the additional interview = 1/42= 2.4 %
The result quotient of the additional interview was 2.4 % which is less than the threshold of 5%, therefore it shows that the additional interview is still under the threshold of 5% showing that the information was saturated and also proving that new information does decrease over time (Guest et al., 2020).

Table 2 illustrates a total of 9 interviews conducted, including an initial interview with a 4IR technology specialist responsible for installing and maintaining robots in multiple restaurants. This specialist's insights served as a benchmark for comparing findings with restaurant workers. Saturation analysis began with Interview Participant 2 (IP2), forming the base size for interviews from IP2 to IP5. Additional data saturation was achieved in subsequent interviews with IP6 to IP9. These eight interview participants were restaurant personnel using 4IR technologies such as robot servers and the Internet of Things (IoT) for QR Code-based online menus. The list of interview participants and their backgrounds is presented briefly in Table 2.

Table 2
Profile of Interview Participants

Interview Participant	Franchise Restaurant Manager/HR/ Staff	Restaurant Owner	4IR Technology Specialist
IP1			1
IP2	1		
IP 3	1		
IP 4		1	
IP 5	1		
IP 6	1		
IP 7	1		
IP 8	1		
IP 9		1	

Table 2 shows that the interview participants comprised; Franchise Restaurant Manager/Staff, Restaurant Owners, a Human Resource Manager of a Restaurant Franchise and a 4IR Technology Specialist. The sampling technique applied was purposive sampling where the initial interview with IP1 served as a source for snowball sampling. However, after obtaining information from the first interview participant, the planning of selecting sample interview participants became more apparent. The subsequent interview participants were selected based on the restaurant's use of 4IR technologies and also type of restaurant.
The saturation of interview responses indicates that their experiences using 4IR technology in restaurants were mostly similar. This may be due to the common working environments and common type of technology used in the restaurants which were robots and QR codes. The interviews were mostly conducted in situ which is that the interviews were conducted at the restaurants while the interview participants were working so the interviewer could also briefly observe how the technologies were used by the workers in the restaurant.

Data Analysis

The data analysis was conducted applying both deductive and inductive approaches. An inductive approach was applied to identify patterns and themes in the interview responses then the deductive approach was applied when mapping the themes and sub-themes to the study's DOI and TOE theories' constructs. Thematic analysis was applied when analysing the interview transcriptions. Saldana (2013) defines themes as phrases or sentences that describe a unit of data and what it means. Theme recognition was applied which is based on the premise that a repetition of codes indicates that it is most likely to be considered as a theme (Guest et al., 2012). However, Saldana (2013) stresses that themes do not depend on the frequency of themes, but also their meaning. Two coding cycles were conducted. The first, open coding, identified recurring themes in the initial 4 interviews and in each subsequent run of 2 interviews, revealing new themes or additional information. The second cycle refined codes into 12 main themes and 48 sub-themes, ensuring comprehensive coverage without omitting important text. The first round was inductive, aligning themes roughly with TOE and DOI theories' constructs. The second round identified new themes and compared them against TOE and DOI constructs for grouping. NVIVO facilitated coding, classifying interview transcriptions as Cases for effective querying, interpretation, and sense-making. The themes, sub-themes and related DOI and TOE constructs which were mapped after the analysis of themes are listed in Table 3. Themes 11 and 12 were not mapped to DOI and TOE as they were mostly about the required 4IR skills.

Table 3
Overall View of Codes and mapping to DOI/TOE Constructs

Themes	Sub-themes	Related DOI/TOE Constructs
1. Customer perception of QR code	1. Positive perception	Relative advantage/Organisational, Social System/ Environmental
	2. Negative perception	Relative advantage/Organisational, Social System/ Environmental
2. Customer perception of robots	3. Positive perception	Relative advantage/Organisational, Social System/ Environmental
	4. Negative perception	Relative advantage/Organisational, Social System/ Environmental
3. Ease of use of 4IR technologies	5. Customers can get their food from robot easily	Low Complexity/Technological
	6. All levels of workers can use the robot	Low Complexity/Technological
	7. Easy to learn how to use the robots	Low Complexity/Technological
4.Management Of Robots	8. Test robots before using	Trialability/Technological
	9. Remote monitoring of robot use by company headquarters	Relative Advantage, Compatibility/ Organizational

Themes	Sub-themes	Related DOI/TOE Constructs
	10. Mapping of restaurant or change of mapping location	Relative Advantage, Compatibility/ Organizational
	11. Train staff to use robots and QR code	Relative Advantage, Compatibility/ Organizational
5. Reason to use robot	12. As an alternative to shortage of workers	Relative Advantage, Compatibility/ Organizational
	13. As an attraction at areas with a lot of F&B outlets	Relative Advantage, Compatibility/ Organizational
	14. As an attraction at areas with high-end crowds	Relative Advantage, Compatibility/ Organizational
	15. As something different in F&B	Relative Advantage, Compatibility/ Organizational
	16. Provide customers access to robots	Relative Advantage, Compatibility/ Organizational
	17. So staff can do other tasks other than serving	Relative Advantage, Compatibility/ Organizational
6. Reason to use QR code	18. Monitoring of customer's food ordering preference	Relative Advantage, Compatibility/ Organizational
	19. Updating of menu in QR code online menu	Relative Advantage, Compatibility/ Organizational
	20. Obtain customers details such as phone number	Relative Advantage, Compatibility/ Organizational
	21. QR code is generated for each table	Relative Advantage, Compatibility/ Organizational
	22. Payment can be done online	Relative Advantage, Compatibility/ Organizational
7. Workers that can use 4IR technology	23. All levels of staff	Compatibility/Organisational
	24. Service area staff	Compatibility/Organisational
8. Worker perception of 4IR Technology	25. Helps in serving so staff can do other tasks	Low Complexity/ Technolog Compatibility/Organizational
	26. The human interaction is still required with customers	Low Complexity/ Technolog Compatibility/Organizational
	27. Less need for robot when there are enough staff	Low Complexity/ Technologica Compatibility/Organizational
	28. Easy to use and operate	Low Complexity/ Technologica Compatibility/Organizational
9. Most used 4IR technology	29. Robot waiters	Low Complexity/ Technological
	30. QR Code	Low Complexity/ Technological
10. Years using 4IR technology	31. Less than 3 years	Social System/ Environmental
	32. Less than 2 years	Social System/ Environmental
11. Required skills of service staff when using 4IR technology	33. Charging of robot	
	34. Check that the customer took the correct food	
	35. Check that speed settings, braking and programs such	

Themes	Sub-themes	Related DOI/TOE Constructs
	as mapping are running smoothly	
	36. Cleaning of robot	
	37. Monitoring of customers taking food from tray	
	38. Observe route and robot delivery	
	39. Communication skills	
	40. Putting robot at starting point	
	41. Avoiding risks such as spilling of hot food or liquids	
	42. Set robot settings for special events	
	43. Set table number for robot to send order	
	44. Storage of robot	
	45. Escalate technical issues to maintenance staff	
12. Future skills for using 4IR technology	46. Perform simple troubleshooting such as lock key of robot	
	47. Perform simple programming	
	48. Perform simple troubleshooting	

The definitions of the codes elaborated above are included in the codebook to guide consistent coding of transcriptions based on standard definitions operationally defined in the study. To analyse the relationship and frequency of coding in the transcriptions, the cross-tab matrix query in NVIVO was applied. The findings from these queries are presented and discussed in the following section, Findings and Discussion.

Findings and Discussion

The findings in this section are presented according to the research questions of the study, where the related findings during the interviews are elaborated below.

Research Question 1 (RQ 1): Why is Fourth Industrial Revolution (4IR) technology used in restaurants?

Research by Amiron (2020) highlighted in its findings that one of the main enablers for the use of 4IR technology in an organisation was based on the organisation's goal of using 4IR technology such as to overcome the shortage of workers or to increase work productivity. Therefore in this study, RQ 1 asks this question to understand the motivation behind the use of 4IR technology in F&B. Based on the findings from thematic analysis conducted on the interview transcriptions with the restaurant personnel, the two most frequent answers were

that the use of 4IR technology was an alternative to the shortage of workers that was high during the Covid-19 lockdown period, as a new attraction for new customers and to enable service staff to carry out tasks other than serving customers. Extracts from the interview transcriptions are shared below.

"..it was because we did not have enough workers, but then it assisted marketing." – IP 4
"At first headquarters used the robot due to lack of workers. " - IP 3
"they (the staff) do not have to deliver food as much and they can do other work." - IP 2

Other reasons for using the technology were, as an attraction in areas with a lot of F&B outlets, where the use of robots would be unique in areas with high-end crowds. The latter were mostly reasons provided by privately owned restaurants that implemented the use of 4IR technologies such as robots and QR codes earlier than other restaurants at the time. These restaurant' owners were forward thinking of how they could stand out by using robots as an attraction and according to the DOI theory, they can be considered as early implementors of 4IR technology in the Food Services industry. Extracts are included below.

" Mainly from customer's experience, the robots attract more customers. This is because the robot helps in marketing, we worry that customers will get the food late but customers like it better when robots send the food. " – IP 4
" Yes, it was to be different from the other F&B restaurants because at that time there were no others using robots. and as an attraction as the first restaurant in Johor. " – IP 5

The usage of online menus accessed via QR Codes is a form of Internet of Things (IoT) and is one of the 4IR technologies. Based on the interview participant's views, it is used by restaurants due to its advantages which are monitoring customers' food ordering preferences, updating of menu online such as when an item is not available, obtaining customers' details such as phone numbers. A QR code is generated for each table and is useful for online payment and ordering of food, or ordering for delivery.

Research Question 2 (RQ 2) : Which skills are required by workers of the Food Services sector?

The results from the analysis of skills required by the Food Services sector are presented in Table 4 below according to Interview Participants (to observe the frequency of skills mentioned) and skills mentioned in the interviews.

Table 4
Skills Required by Food service staff

Interview Participant (IP)/Skill	IP1	IP2	IP3	IP4	IP5	IP6	IP7	IP8	IP9
Robot operation (e.g. Charging, cleaning, keying in table to send food)	/	/	/	/	/	/	/	/	/
QR Code operation (e.g. updating of online menu items, updating unavailable items on menu)			/	/	/		/		
Robot Risk Assessment (e.g. spills from hot food, robot speed)	/	/		/	/	/	/		/
Communication Skills (e.g. explain about the use of QR Code and use of Robots, addressing customer grievances (issues))	/	/	/	/	/	/	/	/	/
Technical issues escalation of robot/ online menu (IoT via QR Codes) to maintenance personnel	/	/	/	/	/	/	/	/	
Train new staff to use technology	/	/	/	/	/	/	/		

Table 4 shows that findings from the analysis of interviews highlight that key skills for restaurant staff include operational tasks that are carried out when handling the 4IR technology such as cleaning and charging of robots and updating of online menu items. Skills that enhance the skill set of these workers are risk assessment and effective communication. When it comes to technology use, especially with robots, staff must assess and manage risks like spills onto robots or customers. Adjusting the robot's speed based on the type of food or drink being carried is essential for successful delivery to designated tables. Monitoring is crucial for detecting malfunctions, and staff need to promptly communicate technical issues to maintenance personnel through direct messaging. This may lead to temporary pauses in robot use until the issues are resolved, typically taking a few days to a week.

In the context of online menus accessed via QR Codes, communication skills play a vital role. Staff must respond promptly and effectively to customer inquiries, ensuring a positive experience during online ordering. Troubleshooting includes addressing issues like internet connectivity and online menu access, tasks that can be handled by authorized staff. The analysis also revealed that interview participants with more technology experience emphasized the importance of these skills. In areas with stable internet connections and tech-savvy customers, the need for assistance with QR codes was reduced.

Training new staff in technology use, covering both robots and online menus, emerged as a critical aspect. The technology was generally considered user-friendly, and training typically occurred within the first week of employment. Existing staff, trained by suppliers or maintenance personnel, then passed on this knowledge to their colleagues. This training covered various aspects, including handling robots and setting parameters such as table assignments, music, and robot speed based on the type of food being carried. The same training approach was applied to the use of QR codes.

Research Question 3 (RQ 3): What influences restaurant workers to acquire skills to use the 4IR technology?

Table 5 below lists the factors that influence the acquisition of skills to use 4IR technology.

Table 5

Mapping of TOE and DOI Constructs to factors influencing 4IR skills acquisition

TOE Framework Constructs	DOI Constructs/ Interview Participants	IP1	IP2	IP3	IP4	IP5	IP6	IP 7	IP 8	IP9	Total
Technological	Low Complexity	/	/	/	/	/	/	/	/	/	9
	Trialability	/				/					2
Organisational	Relative Advantage	/	/	/	/	/	/	/	/	/	9
	Compatibility		/		/	/					3
Environmental	Result Demonstrability	/					/		/		3
	Social Systems		/		/		/	/		/	5

The thematic analysis of the interviews presented in Table 5 shows that the most significant factor is the low complexity of the technology and the relative advantage of the technology that influences the service staff to acquire the skills to use the robots and QR codes to access the online menu. Interview participants highlighted that robots and QR Codes (Online menu) are easy to use and the settings are easy to understand therefore making it easier for service staff to use, maintain, and teach others on how to use it. Workers have also ensured they can use the technologies so they can communicate the advantages of the robot/QR codes to customers. Another factor is that by understanding the Relative Advantages of the technology also enables a more driven will to learn how to use the technology. Other factors are the Compatibility of the technology to be used in the working environment and how it is monitored remotely by the management of franchised restaurants and monitored directly by business owners who are at the restaurant daily. This monitoring is to gauge the use of the robots per day and to monitor any technical issues of the robots.

Table 5 illustrates the mapping between TOE Framework Constructs and DOI factors, highlighting the importance of Organisational and Technological factors in influencing the acquisition of skills for using 4IR technologies in restaurants.

Conclusion

Based on the findings, the adoption of 4IR technologies initially aimed to address the challenges posed by worker shortages during Covid-19 social distancing requirements. Other advantages became apparent with robots handling repetitive tasks such as sending food to customers, and customers directed to online menus through QR codes, where restaurant staff were able to focus on other tasks. Consequently, the adoption of these technologies necessitated the development of skills among workers, extending beyond operational duties to include effective communication with customers, addressing technical issues, and training colleagues in robot and QR code usage. Notably, skills in handling robots and managing online menus, along with understanding network connectivity and electronic gadget use, became crucial for workers to address customer concerns.

Building on these findings from the qualitative phase, the subsequent quantitative phase will involve the development of a survey instrument. This survey will target restaurant workers using 4IR technologies, aiming to delve deeper into the factors influencing skills acquisition and the specific skills required. This comprehensive analysis, considering both occupational levels and job areas, ensures a direct connection between the study's findings and the design of TVET curricula which in Malaysia is the NOSS. This approach avoids skills mismatches by tailoring curriculum elements to specific occupational areas and levels, ensuring that the skills taught align closely with industry demands. The study's findings enable the mapping of 4IR skills to elements of the NOSS in Malaysia. By identifying the main influences on skills acquisition, which are technological and organizational factors, it is apparent that embedding skills required when using 4IR technologies in the curriculum could be done in NOSS sections that correspond to the technological and organizational factors. In terms of Technological factors, the NOSS has a section that lists the skills according to the main work activities and usage of certain technologies which is named, "Related Abilities", therefore the skills required when using robot waiters or online menus accessed via QR codes can be stated in this section. In terms of Organisational factors, this can be incorporated according to occupational levels and job areas that deal with the use of 4IR technologies, where via this study it has been identified that restaurant service staff and restaurant managers. Identifying the implications of rapid technological advancements on the current workforce is crucial for adapting the curriculum and skills training to keep abreast with the evolving needs of the industry.

References

Academy of Sciences Malaysia (ASM). (2020). *10-10 Malaysian Science, Technology, Innovation and Economy (MySTIE) Framework*. ISBN 978-983-29 15-49-2.

Amiron, E. (2020) . *Industry 4.0 Skills And Enablers For Electronics Manufacturing Industries*. [Masters Thesis, Universiti Teknologi Malaysia].

Asia-Pacific Economic Cooperation (APEC). (2014). *ANSSR: Enhancing the quality and relevance of TVET for current and future industry needs – Phase 1.* Retrieved February 2, 2021, from https://www.apec.org/docs/default-source/Publications/2014/7/ANSSR-Enhancing-the-Quality-and-Relevance-of-Technical-and-Vocational-Education-and-Training-TVET-fo/ANSSR-S-EC-08-12A-Final-report_v2.pdf

Creswell, J. W. (2014). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. 4th ed.*, Sage Publications. ISBN 978-1-4522-2609-5. 2014.

Guest, G., Macqueen, K.M., & Namey, E., E. (2012) *Applied Thematic Analysis*. Sage Publications. ISBN 978-1-4129 7167 -6

Guest, G., Namey, E., Chen, M. (2020) A simple method to assess and report thematic saturation in qualitative research. *PLOS ONE* 15(5): e0232076. https://doi.org/10.1371/journal.pone.0232076

Hagaman, A. K., & Wutich, A. (2017). How Many Interviews Are Enough to Identify Metathemes in Multisited and Cross-cultural Research? Another Perspective on Guest, Bunce, and Johnson's (2006) Landmark Study. *Field Methods*.29(1), 23-41. https://doi.org/10.1177/1525822X16640447

Haneem, F., Kama, N., Taskin, N., Pauleen, D., & Abu Bakar, N. A. (2019). Determinants of master data management adoption by local government organizations: An empirical study. International Journal of Information Management, 45, 25-43. doi:https://doi.org/10.1016/j.ijinfomgt.2018.10.007

Hermann, M., Tobias, P., & Boris Otto. (2016). *Design Principles for Industrie 4.0 Scenarios*. 49th Hawaii International Conference on System Sciences (HICSS), Koloa, HI, USA, January 5–8, pp. 3928–37.

Hiran, K. K., & Henten, A. (2020). An integrated TOE–DoI framework for cloud computing adoption in the higher education sector: case study of Sub-Saharan Africa, Ethiopia. *International Journal of System Assurance Engineering and Management, 11*(2), 441-449. doi:10.1007/s13198-019-00872-z

Ministry of International Trade and Industry (MITI). (2018). *Industry4wrd: National Policy on Industry 4.0.* ISBN 978-967-5842-29-0

Rogers, E. M. (1983). *Diffusion of Innovations*, 3rd ed. Free Press, New York.

Saldana, J. (2013). The *coding manual for qualitative researchers*. Sage.ISBN 978-1-44624-737-5

Schwab, K. (2016). *The Fourth Industrial Revolution*. ISBN-13: 978-1-944835-01-9

Spöttl, G., & Windelband, L. (2021). The 4th Industrial Revolution – its impact on vocational skills. *Journal of Education and Work*, 34:1, 29-52, doi: https://doi.org.10.1080/13639080.2020.1858230

Tornatzky, L. G., & Fleischer, M. (1990). *The processes of technological innovation*. Lexington, MA: Lexington Books.

World Economic Forum (WEF). (2016). *The Future of Jobs Report*. Retrieved February 7, 2021, from http:/ww.weforum.org.

Zheng, J. H., & Khalid, H. (2022). The Adoption of Enterprise Resource Planning and Business Intelligence Systems in Small and Medium Enterprises: A Conceptual Framework. *Mathematical Problems In Engineering.* doi:10.1155/2022/1829347