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Adoption Strategy for Electrical and Electronics (E&E) Small and Medium-Sized Enterprises (SMEs): Malaysia IR4.0 Perspective

Zakirah Othman[1], Bavaani a/p Balakrishnan[1,*], Mohamad Faizal Ahmad Zaidi[1], Wan Ahmad Jaafar Wan Yahaya[2]

[1] School of Technology Management and Logistics, College of Business, Universiti Utara Malaysia, Sintok, Malaysia
[2] Centre for Instructional Technology and Multimedia, Universiti Sains Malaysia, 11800 USM, Pulau Pinang, Malaysia

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ABSTRACT

Many developing countries are facing difficulty in embracing Industrial Revolution 4.0 (IR4.0) technologies as it creates a challenging business environment for its manufacturing sector. It is vital for Malaysia, a developing country, in ensuring their manufacturing sector particularly Electrical and Electronics (E&E) Small and Medium-sized Enterprises (SMEs) are not left behind in the IR4.0. It is the mission that every E&E SMEs fully adopt IR4.0 technologies and drive towards sustainable and competitive economic growth. In doing so, concerns regarding the human dimension on digitally driven transformation initiatives are much more needed to be studied. Leveraging the human capabilities to the IR4.0 technologies is not only upskilling themselves in the field that is related to IR4.0 technologies, but also will decentralizing operations and coordinate processes. The IR4.0 will enable operations and processes equipped with extremely automated and digitized machines and robots that will be the parts of production in future. As such, this paper provides an insight on the research gap, the development of the manufacturing sector focusing on the E&E SMEs in Malaysia, the importance of IR4.0 and finally the significance of this research that explains the IR4.0 adoption.

1. Introduction

The rapid changes due to Industrial Revolution 4.0 (IR4.0) is creating massive transformations and disruptions that are causing a big impact on the society and the workforce. The IR4.0 nearly impacted every industry in which most jobs are vulnerable to automation leaving workers unemployed. More precisely, smart devices and robots would be replacing dull and routine jobs leading to creating new job responsibilities. Depending largely on ones' reasoning and notion, within the near future, IR4.0 presents both benefits and drawbacks that will shape the smart manufacturing of the country. Without doubt, IR4.0 would eradicate nearly every industry's repetitive job, causing

* *Corresponding author.*
E-mail address: s901755@student.uum.edu.my

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previously available jobs to disappear and rise of new job titles that significantly impact on employment in the future.

We can expect that the first sector to be affected by IR4.0 is the Electrical and Electronics (E&E) Small and Medium-sized Enterprises (SMEs). The E&E SMEs are seen as very much the core sector regarding all digitization efforts. Ultimately, E&E SMEs will enable more autonomous systems which are more connected and smarter. As such, the IR4.0 development and E&E SMEs are interconnected as they are the producer of printed circuit boards that are responsible for automation. Having to say that, the E&E SMEs of Malaysia currently serve almost 25 percent of the country's employment, and timely deployment and ensuring the IR4.0 adoption is significantly required. If the E&E SMEs end up lagging behind compared to other countries who are already driven by IR4.0, the Malaysian E&E SMEs will become a digital colony of others.

2. Research Gap

In spite of the fact that IR4.0 technologies are revolutionizing all sectors around the world, Nikolic, *et. al.,* [28] highlighted that the manufacturing industry will face big challenges especially in how to integrate the IR4.0 technologies into the production processes to ensure the buoyancy of the manufacturing industry. Malaysia is significantly dependent on the manufacturing industry, especially E&E SMEs, therefore, global development like IR4.0 have an effect on the growth, performance, and success of these E&E SMEs. Having said that, IR4.0 is built on the idea of companies sharing data and information in order to create an entirely new digital ecosystem. The existing business models, however, are highly distinct and individualized to support the respective firms.

Additionally, Rajaretnam [32] highlighted that the aspect of cyber security risk and privacy worries many firms. Data governance and data security are crucial for businesses in the digital age as it has a massive impact on businesses, consumer confidence and trust. When everything is connected, the risk of hacking data and tampering with it or misusing it for malversation intent may have huge financial consequences. To have a safe digital environment, Malaysian businesses need to rethink their data governance practices and develop strategies to protect consumer data and themselves from the risk of cyber security breaches, cyber crimes and cyber terrorism to ensure some level of data security.

Since the impact of IR4.0 is worrisome because the development of IR4.0 is huge and it is moving at an incredible speed, adoption of IR4.0 is indeed needed. Several recent researches undertaken in Malaysia, had been discussed in the view of IR4.0 such as IR4.0 adoption in agriculture sector [21], IR4.0 impact on language and culture [18], lean manufacturing with IR4.0 in Automotive industry [4], IR4.0 impact on technical and vocational education [15,38], and artificial intelligence implementation for fault detection in industrial manufacturing [2]. Even though these studies were related to the IR4.0, nonetheless, there is relatively not much research has been conducted on IR4.0 adoption particularly in the Malaysian E&E SMEs setting.

3. Literature Review

3.1 Manufacturing Sector in Malaysia

Malaysia's manufacturing sector primarily comprises twelve industries. These twelve industries are divided into two groups, namely non-resource based and resource based. Under non-resource-based category machinery and equipment, electrical and electronics, metals industry, textiles and apparel, medical devices and transport equipment, while resource-based category listed rubber and rubber products, food processing, pharmaceuticals, wood-based products, oil palm-based industry

and petrochemicals [13]. This sector contributes to national growth by focusing exports on rising regional and global markets, hence increasing the country's GDP. Malaysian Investment Development Authority (MIDA) has identified a number of significant manufacturing industries namely Electrical and Electronics industry (E&E), automobile industry, the textile industry, wood-based industry, the steel industry and petrochemical industry. These industries are extremely important and have been a significant contributor to the growth of the nation.

Apart from that, Malaysia was discovered to be ideally placed in the heart of Southeast Asia, providing a dynamic commercial climate in which Malaysian manufacturing may chart its course ahead. At the same time, Malaysia is blessed with criteria such as being politically stable, having a strong legal system, offering attractive incentives for investors and having well-developed infrastructure such as telecommunication network built with digital and fibre optic technology, financial and banking sector, fully developed industrial parks including free industrial zones, technology parks and the Multimedia Super Corridor (MSC) that inspire investors and business owners to invest in Malaysia.

Beginning January 1st, 2014, companies in Malaysia will be classified as SME based on sales turnover and number of employees. The sales turnover in the manufacturing sector should not exceed RM50 million, and the number of full-time workers should not exceed 200. The definitions are described in Table 1 below by category, namely micro, small, and medium.

Table 1
Detailed Definition by Category Micro, Small, and Medium

Size	Micro		Small		Medium	
	Sales Turnover	Employees	Sales Turnover	Employees	Sales Turnover	Employees
Manufacturing	< RM 300,000	< 5	RM300,000 to < RM15 million	5 to < 75	RM15 million to ≤ RM50 million	75 to ≤ 200

Source: SME Annual Report 2018/19

At the same time, based on the most recent profile, 98.5 percent of Malaysian business enterprises are Small and Medium sized Enterprises (SMEs). A total of 907,065 businesses were registered, with 693,670 being micro-enterprises (76.5 percent), 192,783 being small (21.2 percent), and 20,612 being medium size (2.3 percent), which contribute around 40 percent to economic output, and employ two-thirds of all workers in Malaysia. Hence, SMEs may be classified according by their sizes, as shown in Table 2 below.

In terms of geographical location, the West Coast of Malaysia has the majority of SMEs. The majority of SMEs are located in the West Coast because of Malaysia's commitment to industrialize this area and provide easy accessibility of ports facilities. Selangor contributed the most, at 19.8 percent, followed by W.P. Kuala Lumpur at 14.7 percent. Johor has 10.8 percent, whereas Perak has 8.3 percent.

In Malaysia, the manufacturing sector is critical and plays a key role in the economy, contributing 22 percent of GDP during the last five years. Even though their presence in the global arena is weak, they have potential to be global exporters. Gladly to say, the Malaysian manufacturing sector has continuously created jobs and business opportunities, as well as encouraging foreign direct investment (FDI) which could help in the development of better infrastructure for its people and nation. Malaysia, as a transit and destination for global multinational manufacturing businesses looking to invest, needs to be more competitive in order to compete in the manufacturing sector.

Table 3 shows Malaysia's major export products in the year 2020 and 2021 and Table 4 shows Malaysia's international export market in 2020 and 2021.

Table 2
Number of Establishment by Sector and Size (2016)

Sectors	No of SME Establishment				Share of SMEs (%)	No. of Large Firms	Overall Establishment
	Micro	Small	Medium	Total SMEs			
Services	649,186	148,078	11,862	809,126	89.2	9,185	818,311
Manufacturing	22,083	23,096	2,519	47,698	5.3	1,403	49,101
Construction	17,321	17,008	4,829	39,158	4.3	1,400	40,558
Agriculture	4,863	4,143	1,212	10,218	1.1	1,410	11,628
Mining & Quarrying	217	458	190	865	0.1	161	1,026
Total	**693,670**	**192,783**	**20,612**	**907,065**	**100**	**13,559**	**920,624**

Source: Economic Census 2016: Profile of Small and Medium Enterprises (reference year 2015), Department of Statistics, Malaysia

Table 3
Malaysia's Major Export Products in the Year 2020 and 2021

Products	2021[p] (RM Million)	2020[f] (RM Million)	Change (%)
Total Exports	**1,239,800.6**	**983,826.8**	**26.0**
E&E Products	455,729.3	386,291.9	18.0
Petroleum Products	95,657.9	61,888.8	54.6
Palm Oil & Palm Oil Based Agriculture Products	75,811.6	52,326.4	44.9
Chemicals & Chemical Products	70,677.9	50,735.9	39.3
Rubber Products	64,607.0	44,301.8	45.8
Manufacturers of Metal	61,560.3	36,830.0	67.1
Machinery, Equipment & Parts	49,590.4	39,445.7	25.7
Optical & Scientific Equipment	46,925.9	42,220.1	11.1
LNG	36,589.4	29,868.1	22.5
Palm Oil - Based Manufactured Products	32,704.1	21,005.9	55.7

Notes: p – provisional data, f – final data, Source: Department of Statistics, Malaysia, Tabulated by: MATRADE

Table 4
Malaysia's International Export Market in the 2020 and 2021

Markets	2021[p] (RM Million)	2020[f] (RM Million)	Change (%)
Total Exports	**1,239,800.6**	**983,826.8**	**26.0**
China	192,049.0	159,223.0	20.6
Singapore	173,386.5	142,145.6	22.0
USA	142,237.0	109,080.3	30.4
Hong Kong	76,626.3	68,166.8	12.4
Japan	75,270.1	62,561.4	20.3
Thailand	52,396.7	45,339.5	15.6
Vietnam	45,502.1	30,904.6	47.2
India	45,183.8	30,403.8	48.6
Taiwan	40,538.9	33,873.5	19.7
Indonesia	39,216.9	29,588.8	32.5

Notes: p – provisional data, f – final data, Source: Department of Statistics, Malaysia, Tabulated by: MATRADE

In December 2021, there were 2,259,619 people employed in the manufacturing industry, up 2.7 percent from 2,199,195 in December 2020. Table 5 depicts the number of employees of the manufacturing sector by sub-sector from 2019 to 2021.

Table 5
Number of Employees of Manufacturing Sector by Sub-Sector from 2019 to 2021

Sub-sector	2019	2020	2021
Food, beverages and tobacco	**294,505**	**290,799**	**297,901**
Manufacture of food products	275,355	273,958	280,751
Manufacture of beverages	17,552	15,681	15,951
Manufacture of tobacco products	1,598	1,160	1,199
Textiles, wearing apparel, leather and footwear	**93,969**	**80,451**	**82,500**
Manufacture of textiles	28,347	26,699	27,738
Manufacture of wearing apparel	53,463	41,919	42,474
Manufacture of leather and related products	12,158	11,833	12,288
Wood products, furniture, paper products and printing	**298,131**	**284,313**	**293,945**
Manufacture of wood and products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	98,930	91,127	93,465
Manufacture of paper and paper products	57,044	54,294	56,213
Printing and reproduction of recorded media	66,042	65,015	67,428
Manufacture of furniture	76,116	73,877	76,839
Petroleum, chemical, rubber and plastic	**414,144**	**417,319**	**420,316**
Manufacture of coke and refined petroleum products	17,918	16,623	17,093
Manufacture of chemicals and chemical products	108,158	101,429	101,692
Manufacture of basic pharmaceutical products and pharmaceutical preparations	21,320	23,344	25,092
Manufacture of rubber and plastics products	266,749	275,924	276,438
Non-metallic mineral products, basic metal and fabricated metal products	**367,904**	**368,721**	**373,358**
Manufacture of other non-metalic mineral products	107,017	103,386	105,600
Manufacture of basic metals	111,660	110,682	111,076
Manufacture of fabricated metal products, except machinery and equipment	149,227	154,653	156,682
Electrical and electronic products	**562,778**	**556,233**	**585,527**
Manufacture of computer, electronics and optical products	376,161	365,538	390,477
Manufacture of electrical equipment	95,456	98,712	102,080
Manufacture of machinery and equipment n.e.c.	91,161	91,983	92,969
Transport equipment and other manufactures	**212,357**	**201,360**	**206,071**
Manufacture of motor vehicles, trailers and semi-trailers	89,154	82,994	83,798

Sub-sector	2019	2020	2021
Manufacture of other transport equipment	45,413	41,252	41,596
Other manufacturing	36,734	37,138	39,222
Repair and installation of machinery and equipment	41,056	39,976	41,456
Total Employees	**2,243,788**	**2,199,195**	**2,259,619**

Table 5 clearly indicated that the E&E sub-sector has the largest number of employees followed by petroleum-based industries. The same category can be seen in major export products. These facts demonstrate the importance of the manufacturing sector to economic growth and without a doubt, these manufacturing sub-sectors serve as the engine that drives other areas such as finance, services sectors, transportation and so on.

3.2 Electrical and Electronics (E&E) Small and Medium Enterprise (SMEs)

In specific, the Electrical and Electronics (E&E) Small and Medium Enterprises (SMEs) are considered the backbone of Malaysia's manufacturing industry as its' major role in enabling the nation to move to the next level. E&E SMEs fall under the non-resource-based category which has become the source of value creation and enhancement of the innovation capacity by its effort in adopting smart manufacturing processes and technologies so-called IR4.0 [1].

E&E SMEs in Malaysia is consisting of several product categories such as semiconductors and radio frequency identification (largest component of exports), industrial electronics (telecommunications, computers and computer related devices, and scientific equipment), consumer electronics (television sets and digital audio-visual products, thin-film train transistor - liquid crystal displays (TFT-LCD), and within electrical products. Most of the semiconductors are situated in areas that are declared as Free Zones such as in Penang Island, Selangor, and Melaka.

Products from E&E SMEs are exported to the United States of America (USA), Japan, Singapore, the European Union (EU), China, India, Australia, and ASEAN countries. Table 6 depicted the main trading partners of electrical and electronics from January to June 2021. According to Table 6, ASEAN countries include Singapore, Thailand, Indonesia, Vietnam, the Philippines, Brunei, Myanmar, Cambodia, and the Lao People's Democratic Republic. The EU is made up of Germany, the Netherlands, Italy, France, and Ireland; APEC is made up of the People's Republic of China, Singapore, the United States, Japan, and Chinese Taipei; EFTA is made up of Switzerland, Norway, Iceland, and Liechtenstein; and the CPTPP is made up of Singapore, Japan, Vietnam, Australia, and Mexico. Simultaneously, Table 7 depicted principal statistics of electrical and electronics products by states in 2020.

Table 6
Main Trading Partners of Electrical and Electronics Products in 2021 (Jan-June)

Country	Export		Import	
	(RM mil.)	(US$ mil.)	(RM mil.)	(US$ mil.)
ASEAN	60,676.1	14,812.2	24,689.5	6,027.2
EU	20,049.9	4,894.5	11,797.2	2,879.9
APEC	184,210.9	44,969.3	129,411.5	31,591.7
EFTA	199.8	48.8	288.6	70.5
CPTPP	68,249.0	16,660.8	29,653.0	7,238.9

Note: Value in US$ computed by MITI
Sources: Department of Statistics Malaysia and MATRADE

Table 7
Principal Statistics of Electrical and Electronics Products by States, 2020

State	Value of Gross Output (RM Million)	Value of Intermediate Input (RM Million)	Value Added (RM Million)	Number of Persons Engaged	Salaries & Wages Paid (RM Million)	Value of Fixed Assets (RM Million)
Johor	57,362	46,448	10,914	98,769	3,957	7,027
Kedah	51,886	43,079	8,806	38,046	1,914	10,756
Kelantan	1,295	1,086	209	2,246	84	439
Melaka	18,892	15,328	3,564	30,353	1,507	6,200
Negeri Sembilan	12,680	10,582	2,098	17,000	918	4,096
Pahang	704	550	153	3,293	119	187
Pulau Pinang	141,529	110,582	30,947	155,843	9,363	27,279
Perak & Perlis	13,047	10,717	2,330	29,214	1,194	2,410
Selangor	113,366	86,962	26,404	179,974	6,435	12,874
Terengganu	24	18	6	239	6	32
Sabah	48	35	13	728	11	18
Sarawak	5,133	3,740	1,394	10,078	479	1,529
W.P. Kuala Lumpur & W.P. Labuan	1,457	1,017	440	9,905	395	473
Total	**417,424**	**330,145**	**87,279**	**575,689**	**26,380**	**73,321**

Source: Department of Statistics Malaysia

In 2020, the E&E SMEs contributed a significant 6.8 percent of the country's GDP (2019: 6.3 percent) and generated 39 percent of export earnings (2019: 37 percent). Although the E&E SMEs has grown greatly since its establishment, it now confronts a number of obstacles that are limiting its development. A shortage of talent is regarded as one of the underlying obstacles impeding the sector's development. A large percentage of companies express difficulty in locating domestic people with the advanced technical, communication, and job-specific skills needed to move the E&E business ahead. It is not surprising, then, that electrical, electronic, and mechanical engineers, whose abilities and skills are in high demand in the E&E sector, have been featured on Malaysia's Critical Occupation list for the past five years, showing continued talent shortages in these critical occupations (CSC, 2020).

The workforce's competencies, skills, and capabilities will define and highlight talent development along the value chain. However, a lack of highly technical skills limits future work opportunities and may have a negative influence. Malaysia Digital Economy Corporation (MDEC) also investigated the present manpower deficit in order to execute an innovative business model, which required the attention of several stakeholders. The MDEC Digital Talent Report 2017 - Final Findings has released a list of technical skills that will be in high demand over the next three years. Table 8 depicts an evaluation of employment demand based on technical skills shortages.

Table 8
Job Demand Side Assessment: Technical Skills Shortage in Next Three Years

Profile of Workforce	Technical Skills Shortages in next Three Years
Software Development	• Java • JavaScript • .Net
Creative Multimedia	• Adobe Creative Suite • AutoDesk Suite • Apple Final Cut Studio
Networking and Network Security	• IP, SIP • CISCO • HP
OS and Server Technologies	• Windows • Linux • Android
Cyber Security	• Risk assessment and management • Incident handling and response • Penetration testing/assessment
Database	• MS SQL • My SQL • Oracle
Embedded System	• Embedded Java • C/C++ • Assembly Languages
Big Data and Analytics (BDA)	• Data Management • Data Science • Python
Emerging Technologies	• Artificial Intelligence • Automation and Robotics • Integrated Automation/IoT
e-Commerce related skills	• Web Development • e-Commerce platform • Search Engine Optimization

Source: MDEC Digital Talent Report 2017- Final Findings

According to the Eleventh Malaysia Plan, several reasons have been identified for the E&E SMEs to be a catalyst for IR4.0. E&E SMEs have a strong potential to contribute significantly to the country's exports and employment in the manufacturing sector. With input from policymakers, industry leaders, academia, scientific community, and non-governmental organizations (NGOs), the Emerging Science, Engineering and Technology (ESET) study concluded that the E&E SMEs should be prioritized because digital technologies will first impact this sector and there will be cross-cutting challenges associated with IR4.0 [33]. The Malaysian Productivity Blueprint also noted that there is a need to strengthen our innovative practices and partnerships between industries, as well as to begin by prioritizing sub-sectors such as E&E SMEs, since IR4.0 is expected to improve flexibility and efficiency [34].

Furthermore, Malaysia's strategic position and commitment to encouraging international high-quality and technology investment will provide a platform for investors to establish their operations. The current state of the global market offers an excellent opportunity for Malaysia's E&E SMEs.

In addition, the Covid-19 pandemic had a severe impact on the world in early 2020, putting people's health and well-being at risk and interrupting economic activity [19]. This pandemic also created uncertainty in world commerce, which negatively impacted Malaysia's economy as the country's E&E exports plummeted. Nonetheless, exports have mostly rebounded since May 2020 as a consequence of increased external demand and the global E&E value chain's general robustness. The worldwide pandemic and ongoing trade disputes between China and the United States were largely viewed as chances for Malaysia to increase its E&E exports in the medium to long term [17].

The involvement of Malaysian E&E SMEs in IR4.0 is no exception. The IR4.0, in general, provides enormous difficulties and challenges to E&E SMEs; yet, it also brings fresh potential for development and improvement. The IR4.0 impact would boost competitiveness, costing, and time reduction, putting pressure on industrial participants to adopt IR4.0. E&E SMEs must continue to learn and make a difference in order to expand and get a competitive edge.

4. Importance of IR4.0

IR4.0 is hacking into the reality and changing reality as we know in which it presents a huge talent crisis that has never occurred in history before. Big data and analytics, autonomous robots, 3D simulation, horizontal and vertical system integration, Industrial Internet of Things (IoT), cyber security, cloud computing, additive manufacturing, and augmented reality are the nine (9) pillars of IR4.0 that are identified and capable of transforming the manufacturing landscape [31,37].

There are at least four important reasons to go for IR4.0. There are (1) **the product life cycle has become shortened.** Responding to the rapidly changing customers' needs really offered opportunities for industry digitization. Due to that, various innovative products that are renewed from time to time to solve customer product specification is expected to rise, (2) **significant reduction of cost** that improve the financial result and the supply chain. IR4.0 is expected to reduce logistics and material handling cost, inventory, shorter lead times, improving asset utilization (e.g. sensor, RFID) and fewer shortages during shipment [7], (3) **to venture new capabilities of the organization** such as continuous innovation, lifelong learning, trust and data sharing which required maximum transparency in order to integrate in the corporate value chain that enable next new manufacturing level [27], and (4) **the scarcity of global resources** for future usage, global warming and climate change have been causing tension. Furthermore, the growing human population has created the need for more resources. Tapping to renewable resources to generate energy is just a temporary solution. Knowing that, IR4.0 is another step to address the problems and find permanent solutions [14].

5. Significance of the Study

This present study has a significant effect on manufacturers, particularly E&E SMEs. Managers of E&E SMEs play the role of 'student' since they are the link between the manufacturer and IR4.0 technologies. Automation becomes the center of the development of highly sophisticated products, leaving manufacturers with little choice but to follow suit in terms of technological change. In an increasingly uncertain environment, it is absolutely vital for E&E SMEs to be able to build more durable products. Because the technological ecosystem provides difficulties to the E&E SMEs, E&E SMEs must be responsive in recognizing future obstacles, taking decisive action, and seizing opportunities that may arise in order to thrive in the future business landscape.

The transition to IR4.0 is unavoidable, and it has served as a crucial facilitator in keeping Malaysia competitive. Despite the findings of the "2016 GE Global Innovation Barometer," which reported that a significant number of the Malaysian organizations decided to embrace the Fourth Industrial

Revolution, this study found that around 81 percent of the respondents are still engaged in IR2.0 and IR2.5 related activities. This study provides insight to manufacturers about the importance of IR4.0 adoption.

Furthermore, this study is able to help policymakers in laying a framework for promoting the importance of IR4.0, which is critical in addressing the difficulties that manufacturers face. The formulation of the policy should help organizations become more resilient in the presence of technological change. Policy, as well as the stipulation of stimulus packages related to human resources, give opportunities for manufacturers to improve skill levels, with training scheme initiatives increasing skilled workers. Such a policy would encourage manufacturers, especially E&E SMEs, to increase automation, operational efficiency, and effectiveness without having to make huge investments.

Moreover, the pandemic has created more opportunities and more intense awareness to move up as in the doctrine of IR4.0. Business survival in post Covid-19 required IR4.0 in bringing more innovative solutions as well as moving up in the value chain aspect.

6. Conclusion

IR4.0 will integrate all equipment, machinery, materials and end products to compute, communicate and control (3C), hence promote transparency, flexibility, productivity, profitability, resource and energy efficiency by technical features from an autonomous architecture that is friendly to staff [35]. Generally, enormous challenges are offered to E&E SMEs by IR4.0; however, it also presents new opportunities for growth and advancement. IR4.0 effect would increase competition, costing, and time reduction which has been pressing industrial players to undertake a structured way to improve the process effectively. The E&E SMEs know that IR4.0 is essential for viability. Organizations which resist change, the organization will die. To grow and be a competitive advantage, E&E SMEs must continue to learn and make a difference in their industry.

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