

Article

Embracing Industry 4.0: Empirical Insights from Malaysia

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Abstract: Industry 4.0 revolution, with its cutting-edge technologies, is an enabler for businesses, particularly in reducing the cost and improving the productivity. However, a large number of organizations are still too in their infancy to leverage the true potential of Industry 4.0 and its technologies. This paper takes a quantitative approach to reveal key insights from the companies that have implemented Industry 4.0 technologies. For this purpose, 238 technology companies in Malaysia were studied through a survey questionnaire. As technology companies are usually the first in line to adopt new technologies, they can be studied better as leaders in adopting the latest technologies. The findings of this descriptive study surfaced an array of insights in terms of Industry 4.0 readiness, Industry 4.0 technologies, leadership, strategy, and innovation. This research paper contributes by providing 10 key empirical insights on Industry 4.0 that can be utilized by managers to pace up their efforts towards digital transformation, and can help the policymakers in drafting the right policy to drive the digital revolution.

Keywords: Industry 4.0; Industry 4.0 readiness; Industry 4.0 technologies; fourth industrial revolution; leadership; strategy; innovation



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1. Introduction

Industry 4.0 is a phenomenon whereby the physical world and the virtual world have merged into one as Cyber-Physical Systems (CPS) [1]. The conception of Industry 4.0 started in Germany in an economic debate in 2011 [2]. In the same year, 2011, the United States (US) started the “Advanced Manufacturing Partnership (AMP)” which is the Industry 4.0 version of manufacturing. In 2012, the German government crafted “Industrie 4.0” for the manufacturing sector. In 2013, the French government started “La Nouvelle France Industrielle”. In the same year, 2013, the United Kingdom (UK) government presented the “Future of Manufacturing for 2050”. In 2014, the European Commission initiated “Factories of the Future (FOF)”. In 2014, the South Korea government publicized the “Innovation in Manufacturing 3.0” for Korean manufacturing [3]. In 2015, the Chinese government initiated the “Made in China 2025” to accelerate the informatization and industrialization in China. In the same year, 2015, the Japanese government revealed “Super Smart Society”. In 2016, the Singapore government revealed the “Smart Readiness Index” to capture Industry 4.0 opportunities. In 2018, the Malaysian government launched “Industry4WRD” to take advantage of Industry 4.0 initiatives [4]. A summary of notions used for Industry 4.0 in different countries is presented in Table 1.

Table 1. Country-wise notions used for Industry 4.0.

Country	Industry 4.0 Notion
Germany	Industrie 4.0
United States	Advanced Manufacturing Partnership (AMP)
France	La Nouvelle France Industrielle
United Kingdom	Future of Manufacturing for 2050
European Union	Factories of the Future (FOF)
South Korea	Innovation in Manufacturing 3.0
China	Made in China 2025
Japan	Super Smart Society
Singapore	Smart Readiness Index
Malaysia	Industry4WRD

Around the globe, manufacturing companies have taken the first step in adopting Industry 4.0 technologies [5]. By digitizing their businesses, manufacturers in all sectors are finding innovative and cost-effective ways to run their production and serve their customers (Industry Week Magazine, 2020). The benefits of Industry 4.0 are immense in terms of improved quality, reduced turnaround time, and overall optimization. Despite this, according to the World Economic Forum (WEF), only 29 percent of the companies globally are deploying Industry 4.0 technologies at scale, granting them opportunities to realize game-changing impacts. The challenges faced in the process include awareness of new technology roadmaps, customization of existing processes, and existing technology upgradation [6]. To overcome this, companies from both manufacturing and service sectors, companies of small, medium, and large size, have to challenge some of their assumptions that are holding them back. This includes a belief that a massive overhaul of existing equipment will be needed and immense additional employee training will be required [7]. In fact, there are many small steps that companies can take to adapt their existing systems and processes for Industry 4.0 suitability [8].

In the context of Malaysia, the government expects to undergo a paradigm shift in companies resulting from the adoption of Industry 4.0 technologies, particularly after seeing the lost opportunities and slow growth due to the ongoing COVID-19 pandemic (Star Newspaper, 2020). However, there is little information available on the profiling of companies that have successfully adopted Industry 4.0. Therefore, this paper explores such key empirical insights from technology companies in Malaysia that have implemented Industry 4.0. In terms of research objectives, this paper focuses on five research questions considering the context of Malaysia. Here, two factors have been considered: organization age (3–5 years, 6–10 years, and more than 10 years) and organization type (manufacturing large, manufacturing medium, manufacturing small, services large, services medium, and services small). These two factors are important as they are often cited in other studies in literature on Industry 4.0 [9–11]. Furthermore, in terms of industry prominence, organization age is important as it compares older with newer organizations, and organization type is important as it shows the contrast of manufacturing and service firms. Furthermore, this paper considered three critical non-technology factors that help organizations in preparing for Industry 4.0: leadership, strategy, and innovation.

This paper aims to address the following five important research questions:

Research Question 1: *What are the differences of Industry 4.0 readiness among companies according to the age and type of the organization?*

Research Question 2: *What are the differences of Industry 4.0 technologies employed among companies according to the age and type of the organization?*

Research Question 3: *What are the differences of leadership in embracing Industry 4.0 according to the age and type of the organization?*

Research Question 4: *What are the differences of strategy in embracing Industry 4.0 according to the age and type of the organization?*

Research Question 5: *What are the differences of innovation in embracing Industry 4.0 according to the age and type of the organization?*

The remaining paper follows this sequence: Section 2 states the theoretical background. Section 3 presents the research methods, and Section 4 states the results and discussion. Lastly, Section 5 summarizes this paper with the conclusions and study contributions.

2. Theoretical Background

2.1. Industry 4.0

Industry 4.0 is largely about digitalization [12]. In that respect, Industry 4.0 is defined as “the digitalization transformation driven by connected technologies to build a cyber-physical entity” [13]. There are various connotations to Industry 4.0, which lead to a variety of definitions. Combining all these technologies and concepts, the consulting firm called Boston Consulting Group (BCG) identified nine pillars of Industry 4.0. The nine pillars of Industry 4.0 are industrial internet, advanced manufacturing, additive manufacturing, simulation, horizontal/vertical integration, cloud, cyber-security, augmented reality, and big data analytics [14]. The popularity of these nine pillars of Industry 4.0 has increased in recent times, but several firms are still struggling to make use of them [15]. Sharma and Gandhi observed risks in adopting these technology pillars in the areas of data security and job loss [16]. Digital technology is the driving force for Industry 4.0. Nearly all the innovations of Industry 4.0 come through digital power [17]. Four aspects usually covered are Internet of Things (IOT), artificial intelligence, cloud computing, and big data. Moreover, IOT can serve as a technology enabler for Industry 4.0 vision [18].

The most recent extension of Industry 4.0 technologies is the concept of Industrial Internet of Things (IIOT). IIOT is primarily about converting traditional factory to Factory of the Future [19]. There is no universally accepted definition of IIOT as well. According to Bauer, IIOT is horizontal and vertical connection of people and machines [20]. It is also known as IOT plus Cyber-Physical Systems (CPS). IIOT’s reference with Industry 4.0 is relatively new as compared to IOT. Hence, Industry 4.0 readiness is defined as “the degree to which organizations are able to exploit and derive benefits from Industry 4.0 technologies” [21]. Hence, it is about getting companies ready for Industry 4.0. Though Industry 4.0 technologies have convergence which helps in integration within the organization, it brings its own set of challenges [22].

Similar to change readiness, Industry 4.0 can be implemented in companies on three prime levels [23]. At “operations” level, reconfiguration of Industry 4.0 technologies is needed. Next, at “organization” level, organizational processes require realignment to match with technicalities of Industry 4.0. Finally, at “customers” level, customer demands with respect to Industry 4.0 are to be anticipated, planned, and served. Overall, Industry 4.0 technologies are potent enough to cause disruption inside the organizations and across the markets [24,25].

2.2. Technology Acceptance Model (TAM)

Amongst the most popular models of technology is the Technology Acceptance Model (TAM) conceived by Davis in 1989 [26]. It is also the most cited and replicated empirically. The TAM is ranked high in the domain of information systems, where its conception of theory originated. The theory received prominence on findings and insights that clarified the patterns on acceptance of technology. The model is based on two primary factors that promote the use of new technology: perceived ease of use and perceived usefulness. Perceived usefulness (PU) implies that technology would enhance job performance, and perceived ease of use (PEOU) implies that technology would be hassle-free and less complicated [27].

The TAM is based on Theory of Reasoned Action (TRA) [28]. The study by the author Lin in 2007 combined technology readiness (TR) with TAM, and developed an integrated Technology Readiness and Acceptance Model (TRAM), which is an extension of TAM [29]. Subsequently, another interesting study by the author Chimay mentions the perspectives on e-readiness [9]. The author mentions that e-readiness is the ability to adopt information and communication technologies (ICTs). In the last few years, a good number of readiness assessment tools have been developed [30]. Harvard University’s

tool “Networked Readiness Index” is a similar measure but measures a country’s capacity to make use of its ICT resources [31]. Despite this, the TAM remains the prime model for technology-related revolution such as Industry 4.0. It is also important to note that in addition to perceived usefulness and perceived ease of use influencing technology adoption, there are external variables involved as well, such as training [32] and social influence processes [33]. It is also well-known that people in organizations are often uneasy and unwilling to implement the latest technologies such as Industry 4.0, hence a push of management support and leadership intervention is needed [34].

3. Methods

3.1. Scope and Respondents

This paper focused on technology companies as Industry 4.0 technologies are more relevant and needed by technology companies. Thereon, the key insights can be better understood first by studying technology companies. A technology company is one that uses technology as an advantage in its internal and external operations [35]. Precisely, 238 technology companies in the scope of this study included: (i) manufacturing technology companies; (ii) services technology companies; (iii) local technology companies; and (iv) foreign technology companies operating in Malaysia. Respondents were selected on the basis of two criteria: (i) he or she should be at least a manager working in that company; and (ii) he or she should have worked with that company for at least one year. These two conditions are important as this will filter professionals that are senior and have greater decision-making abilities [36,37]. Likewise, two filter questions were used for screening of companies: (i) the company should be a technology company; and (ii) the company should have implemented at least one of the Industry 4.0 technologies.

3.2. Questionnaire

In terms of questionnaire, data was collected through a cross-sectional survey using the 5-point Likert scale, 1 (Do not use) to 5 (Use to a very high degree). A 5-point Likert scale is better as it is adequate, and includes a middle option which does not force the respondent to take a leading side [38–40]. The data analysis was performed through analysis of variance (ANOVA) in Statistical Package for the Social Sciences (SPSS). It is important to note that authors in this study while performing the data analysis through ANOVA did not investigate the convergence of the results obtained, and the results were hence concluded on the basis of 238 surveyed companies. The questionnaire had 5 sections and 40 overall items/questions: Industry 4.0 Readiness (7 items), Industry 4.0 Technologies (12 items), Leadership (6 items), Strategy (7 items), and Innovation (8 items). As the questionnaire used in this study is under copyright with Malaysian Technology Development Corporation (MTDC), only selected items from the questionnaire are presented in this article, in Table 2.

Table 2. Selected items from the questionnaire.

Item No.	Items/Questions
Industry 4.0 Readiness	
A5	competencies to work on Industry 4.0
A6	motivation to work on Industry 4.0
Industry 4.0 Technologies	
B1	uses Big Data and Analytics
B2	uses Autonomous Robots
Leadership	
C3	leadership supports Industry 4.0
C4	leadership is comfortable with Industry 4.0 technologies
Strategy	
D2	strategic planning for Industry 4.0
D5	investments in Industry 4.0 technologies
Innovation	
E2	promotes innovation
E3	grasp of new business ideas for Industry 4.0

4. Results and Discussion

This study was based on 238 technology companies in Malaysia. In terms of organizational profiling, 62 percent of the organizations were services companies and the remaining 38 percent were manufacturing companies. In terms of respondent profiling, 37 percent of participating respondents were part of senior management, 53 percent represented middle management, and the remaining 10 percent were first-line management. This section presents the findings on embracing Industry 4.0 in terms of five areas: Industry 4.0 readiness, Industry 4.0 technologies, leadership, strategy, and innovation. These five areas are further supplemented with discussion based on the research questions that were established in the introduction of the paper.

4.1. Industry 4.0 Readiness

Industry 4.0 readiness is the degree to which organizations are able to exploit and derive benefits from Industry 4.0 technologies [41]. This section highlights the importance of Industry 4.0 readiness in embracing Industry 4.0 in terms of organization age and organization type.

First, considering Industry 4.0 readiness as the dependent variable, ANOVA analysis was conducted with age of the organization. The output of the ANOVA analysis in Table 3 shows that there is a statistically significant difference between the group means. As the significance value is $p = 0.000$ (which is below 0.05), there is a statistically significant difference among the groups reported with $F(2,235) = 8.623$. Furthermore, the mean and standard deviation of the five groups shows the highest mean ($M = 3.56$) for more than 10 years and highest standard deviation ($SD = 1.081$) for six to ten years. This implies that older organizations (over 10 years) have a better approach to embracing Industry 4.0.

Table 3. Industry 4.0 readiness and organization age.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	15.849	2	7.925	8.623	0.000
Within Groups	215.970	235	0.919		
Total	231.819	237			
	N	Mean	Std. Deviation		
Three to Five Years	20	3.15	0.875		
Six to Ten Years	40	2.90	1.081		
More than 10 Years	178	3.56	0.938		
Total	238	3.42	0.989		

Second, considering Industry 4.0 readiness as the dependent variable, ANOVA analysis was conducted with organization type. The output of the ANOVA analysis in Table 4 shows that there is a statistically significant difference between the group means. As the significance value is $p = 0.032$ (which is below 0.05), there is a statistically significant difference among the groups reported with $F(5,232) = 2.487$. Furthermore, the mean and standard deviation of the six groups show the highest mean ($M = 4.02$) for services large and highest standard deviation ($SD = 0.705$) for services small. Thereby, large size service organizations are more advanced in embracing Industry 4.0.

Table 4. Industry 4.0 readiness and organization Type.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4.717	5	0.943	2.487	0.032
Within Groups	88.013	232	0.379		
Total	92.729	237			

	N	Mean	Std. Deviation
Manufacturing Large	45	3.80	0.693
Manufacturing Medium	22	3.73	0.546
Manufacturing Small	22	3.61	0.670
Services and Others Large	73	4.02	0.564
Services and Others Medium	49	3.91	0.567
Services and Others Small	27	3.68	0.705
Total	238	3.85	0.626

Research Question 1: *What are the differences of Industry 4.0 readiness among companies according to the age and type of the organization?*

The findings presented in this section reflect that Industry 4.0 readiness is important for embracing Industry 4.0 in two ways: organization age and organization type. In terms of organization age, older organizations (over 10 years) have better approach to embracing Industry 4.0. This yields that established organizations can gear up better and faster with new revolutions such as Industry 4.0. This can be due to multiple factors, including the strong processes and reputation [30]. Additionally, the older the organization, the more resilient the organization is, which is much needed in gearing up for Industry 4.0. Secondly, with respect to Industry 4.0 readiness and in terms of organization type, large size service organizations are more advanced in embracing Industry 4.0. This can possibly be resulting from the intangibility of service offerings which gives an advantage over manufacturing companies [42]. It is relatively expensive for manufacturing organizations to develop Industry 4.0 readiness, as machinery and equipment is involved.

4.2. Industry 4.0 Technologies

Industry 4.0 technologies are technologies that build a cyber-physical organization [43]. As per the Boston Consulting Group (BCG), they mostly include these nine technologies: (1) Big Data, (2) Simulation, (3) Horizontal and Vertical Integration, (4) Industrial Internet of Things, (5) Autonomous Robots, (6) The Cloud, (7) Cyber Security, (8) Augmented Reality, and (9) Additive Manufacturing. This section highlights the prominence of Industry 4.0 technologies in embracing Industry 4.0 in terms of organization age and type.

First, considering Industry 4.0 technologies as the dependent variable, ANOVA analysis was conducted with organization age. The output of the ANOVA analysis in Table 5 shows that there is a statistically significant difference between the group means. As the significance value is $p = 0.071$ (which is below 0.10), there is a statistically significant difference among the groups reported at 90 percent significance. In social sciences, 90 percent significance level is also considered important particularly in new domain or subjects, such as Industry 4.0 [44,45]. Here, the mean ($M = 3.32$) also indicates that older organizations (more than 10 years) have better technologies. This implies that there are significant differences in Industry 4.0 technologies in terms of organization age in embracing Industry 4.0.

Table 5. Industry 4.0 technologies and organization age.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.322	2	1.661	2.678	0.071
Within Groups	145.755	235	0.620		
Total	149.077	237			
	N	Mean	Std. Deviation		
Three to Five Years	20	3.17	0.929		
Six to Ten Years	40	3.01	0.779		
More than 10 Years	178	3.32	0.773		
Total	238	3.26	0.793		

Second, considering Industry 4.0 technologies as the dependent variable, ANOVA analysis was conducted with organization type. The output of the ANOVA analysis in Table 6 shows that there is a statistically significant difference between the group means. As the significance value is $p = 0.001$ (which is below 0.05), there is a statistically significant difference among the groups reported with $F(5232) = 4.169$. Furthermore, the mean and standard deviation of the six groups show the highest mean ($M = 3.45$) for manufacturing large and highest standard deviation ($SD = 0.958$) for manufacturing small. Thereby, large size manufacturing organizations, in contrast to the large size service organizations, are more advanced in embracing Industry 4.0.

Table 6. Industry 4.0 technologies and organization type.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	12.289	5	2.458	4.169	0.001
Within Groups	136.789	232	0.590		
Total	149.077	237			
	N	Mean	Std. Deviation		
Manufacturing Large	45	3.45	0.679		
Manufacturing Medium	22	3.41	0.559		
Manufacturing Small	22	2.69	0.958		
Services and Others Large	73	3.37	0.767		
Services and Others Medium	49	3.27	0.860		
Services and Others Small	27	2.98	0.702		
Total	238	3.26	0.793		

Research Question 2: *What are the differences of Industry 4.0 technologies employed among companies according to the age and type of the organization?*

The results presented showcase that the adoption of various Industry 4.0 technologies is imperative for embracing Industry 4.0 in two ways: organization age and type. In terms of Industry 4.0 technologies, the more the merrier, as it gives lessons on failure and success, and overall gives confidence to the managers in organizations to implement the right fit of Industry 4.0 technologies [46]. The results here show that there is significant difference in Industry 4.0 technologies in terms of organization age in embracing Industry 4.0, inferring that more than 10 years organizations adopt Industry 4.0 technologies more effectively. With respect to Industry 4.0 technologies, and in terms of organization type, large size manufacturing organizations, in contrast to the large size service organizations, are more advanced in embracing Industry 4.0. It is a double advantage for adoption of Industry 4.0 technologies if the company is large sized and the company is a manufacturing concern as well [47]. As most of the Industry 4.0 technologies were designed originally for manufacturing concerns, it is more relevant and pragmatic to gain control and efficiency on Industry 4.0 technologies to embrace Industry 4.0.

4.3. Leadership

Leadership is defined as the role of the organization’s management team in communicating and reinforcing the organization’s vision [48]. This section focuses on the importance of leadership in embracing Industry 4.0 in terms of organization age and organization type.

First, considering leadership as the dependent variable, ANOVA analysis was conducted with organization age. The output of the ANOVA analysis in Table 7 shows that there is a statistically significant difference between the group means. As the significance value is $p = 0.017$ (which is below 0.05), there is a statistically significant difference among the groups reported with $F(2,235) = 4.141$. Furthermore, the mean and standard deviation of the three groups show the highest mean ($M = 4.09$) for more than 10 years and highest standard deviation ($SD = 0.722$) for six to ten years. This implies that older organizations (over 10 years) have a better approach in terms of leadership to embracing Industry 4.0.

Table 7. Leadership and organization age.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.810	2	1.905	4.141	0.017
Within Groups	108.095	235	0.460		
Total	111.905	237			
	N	Mean	Std. Deviation		
Three to Five Years	20	3.63	0.596		
Six to Ten Years	40	4.05	0.722		
More than 10 Years	178	4.09	0.676		
Total	238	4.05	0.687		

Second, considering leadership as the dependent variable, ANOVA analysis was conducted with type of the organization. The output of the ANOVA analysis in Table 8 shows that difference between the group means is not significant. As the significance value is $p = 0.182$ (which is not below 0.05), there is a statistically insignificant difference among the groups reported. This implies that there are no significant differences of leadership in terms of organization type in embracing Industry 4.0.

Table 8. Leadership and organization type.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.569	5	0.714	1.529	0.182
Within Groups	108.336	232	0.467		
Total	111.905	237			
	N	Mean	Std. Deviation		
Manufacturing Large	45	4.03	0.733		
Manufacturing Medium	22	4.02	0.638		
Manufacturing Small	22	3.80	0.689		
Services and Others Large	73	4.12	0.651		
Services and Others Medium	49	4.18	0.716		
Services and Others Small	27	3.86	0.652		
Total	238	4.05	0.687		

Research Question 3: What are the differences of leadership in embracing Industry 4.0 according to the age and type of the organization?

Leadership in embracing Industry 4.0 is associated with age of the company. Older companies (10 years and above) have better leadership than younger companies (3 to 5 years) in embracing Industry 4.0. Leadership skills are developed and tested faster and better in old and large organizations, as the business complexity and stakes are higher [49,50]. Another factor of contribution is that old and large organizations have more staff and naturally more leaders. This creates more chance of preparing a leadership

pipelines in terms of Industry 4.0 skillset and expertise [51]. Hence, older organizations (over 10 years) have a better approach in terms of leadership to embracing Industry 4.0. However, the findings reflect that there is no significant difference of leadership in terms of organization type in embracing Industry 4.0. This implies that there is no major difference between manufacturing and services companies in terms of leadership.

4.4. Strategy

Strategy is the creation of a unique and valuable position, involving a set of activities [52]. This section highlights the importance of strategy in embracing Industry 4.0 in terms of organization age and organization type.

First, considering strategy as the dependent variable, ANOVA analysis was conducted with age of the organization. The output of the ANOVA analysis in Table 9 shows that there is a statistically significant difference between the group means. As the significance value is $p = 0.074$ (which is below 0.10), there is a statistically significant difference among the groups reported at 90 percent significance. In social sciences, 90 percent significance level is also considered important particularly in new domain or subjects such as Industry 4.0 [44,45]. Here, the mean ($M = 3.76$) also indicates that older organizations (more than 10 years) have better strategy. This implies that there are significant differences of strategy in terms of organization age in embracing Industry 4.0.

Table 9. Strategy and organization age.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2.906	2	1.453	2.633	0.074
Within Groups	129.726	235	0.552		
Total	132.633	237			
	N	Mean	Std. Deviation		
Three to Five Years	20	3.37	0.610		
Six to Ten Years	40	3.66	0.628		
More than 10 Years	178	3.76	0.779		
Total	238	3.71	0.748		

Second, taking strategy as the dependent variable, ANOVA analysis was conducted with organization type. The output of the ANOVA analysis in Table 10 shows that there is a statistically significant difference between the group means. As the significance value is $p = 0.048$ (which is below 0.05), there is a statistically significant difference among the groups reported with $F(5232) = 2.276$. Furthermore, the mean and standard deviation of the five groups show the highest mean ($M = 3.92$) for services large and highest standard deviation ($SD = 0.833$) for manufacturing large. Thereby, large size service organizations are more advanced in terms of strategy in embracing Industry 4.0.

Table 10. Strategy and organization type.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	6.202	5	1.240	2.276	0.048
Within Groups	126.431	232	0.545		
Total	132.633	237			
	N	Mean	Std. Deviation		
Manufacturing Large	45	3.73	0.833		
Manufacturing Medium	22	3.63	0.543		
Manufacturing Small	22	3.56	0.772		
Services and Others Large	73	3.92	0.677		
Services and Others Medium	49	3.66	0.817		
Services and Others Small	27	3.42	0.682		
Total	238	3.71	0.748		

Research Question 4: *What are the differences of strategy in embracing Industry 4.0 according to the age and type of the organization?*

Strategy in embracing Industry 4.0 was studied with the age and type of the company. The findings reflect that organization age is material to establish better strategy-making in organizations. So, there is significant difference of strategy in terms of organization age in embracing Industry 4.0. Likewise, organization type differences are material in terms of strategic management. Large services companies have better strategy than medium and small companies in embracing Industry 4.0. Strategy is an extensive exercise which requires conducting scenario-planning and building roadmaps [53,54]. In terms of Industry 4.0, the minority of the companies have been successful in preparing and executing Industry 4.0 roadmaps, as the technologies involved are mostly disruptive and have high pace of upgradation and obsolesce. Furthermore, small and medium size organizations often work on the most pressing and immediate business investments, hence the exercise of strategic planning seems a burden for them. Therefore, large size service organizations are more advanced in terms of strategy in embracing Industry 4.0.

4.5. Innovation

Innovation is about openness to new ideas as an aspect of an organization [55]. Finally, this section focuses on the importance of innovation in embracing Industry 4.0 in terms of organization age and organization type.

First, considering innovation as the dependent variable, ANOVA analysis was conducted with organization age. The output of the ANOVA analysis in Table 11 shows that there is a statistically significant difference between the group means. As the significance value is $p = 0.097$ (which is below 0.10), there is a statistically significant difference among the groups reported at 90 percent significance. As mentioned earlier as well, in social sciences, 90 percent significance level is also considered important particularly in new domain or subjects such as Industry 4.0 [44,45]. Here, the mean ($M = 3.91$) also indicates that older organizations (more than 10 years) have better innovation. This implies that there are significant differences of innovation in terms of organization age in embracing Industry 4.0.

Table 11. Innovation and organization age.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.975	2	0.987	2.355	0.097
Within Groups	98.530	235	0.419		
Total	100.505	237			
	N	Mean	Std. Deviation		
Three to Five Years	20	3.58	0.684		
Six to Ten Years	40	3.83	0.610		
More than 10 Years	178	3.91	0.652		
Total	238	3.87	0.651		

Second, considering innovation as the dependent variable, ANOVA analysis was conducted with organization type. The output of the ANOVA analysis in Table 12 shows that there is also a statistically insignificant difference between the group means. As the significance value is $p = 0.291$ (which is not below 0.05), there is a statistically insignificant difference among the groups reported. This indicates that there are no significant differences of innovation in terms of organization type in embracing Industry 4.0.

Table 12. Innovation and organization type.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2.615	5	0.523	1.240	0.291
Within Groups	97.889	232	0.422		
Total	100.505	237			

	N	Mean	Std. Deviation
Manufacturing Large	45	3.87	0.655
Manufacturing Medium	22	3.89	0.559
Manufacturing Small	22	3.81	0.708
Services and Others Large	73	3.95	0.604
Services and Others Medium	49	3.91	0.696
Services and Others Small	27	3.60	0.689
Total	238	3.87	0.651

Research Question 5: *What are the differences of innovation in embracing Industry 4.0 according to the age and type of the organization?*

It is interesting to note that innovation in organization in embracing Industry 4.0 is associated with organization age but not organization type. First, this finding reflects that older companies (10 years and above) have better innovation than younger companies (3 to 5 years) in embracing Industry 4.0. This implies that innovation in terms of Industry 4.0 cannot be largely expected from small or startup companies. Second, this finding suggests that manufacturing and service type organizations both can be innovative in terms of Industry 4.0. It is assumed that manufacturing type companies have more opportunities and muscles to execute innovative interventions and projects as compared to service-based organizations [56,57]. However, this research paper confirms that there is no significant difference of innovation in terms of organization type in embracing Industry 4.0.

5. Conclusions

In the landscape of today's technological developments and organizational sustainability, embracing Industry 4.0 is a need, more than a want [54–58]. This research paper draws empirical insights from 238 technology companies in Malaysia to understand and support the prevalent approaches of organizations to Industry 4.0. In summary, this paper unfolds 10 key empirical insights that can help organizations improve their curve on the adoption of Industry 4.0.

These 10 theoretical contributions are: (i) older organizations (over 10 years) in terms of Industry 4.0 readiness have a better approach in embracing Industry 4.0; (ii) large size service organizations in terms of Industry 4.0 readiness are more advanced in embracing Industry 4.0; (iii) older organizations (over 10 years) in terms of Industry 4.0 technologies have a better approach to embracing Industry 4.0; (iv) large size manufacturing organizations in contrast to the large size service organizations are more advanced in terms of Industry 4.0 technologies in embracing Industry 4.0; (v) older organizations (over 10 years) have a better approach in terms of leadership to embracing Industry 4.0; (vi) there is no significant difference of leadership in terms of organization type in embracing Industry 4.0; (vii) older organizations (over 10 years) have a better approach in terms of strategy to embracing Industry 4.0; (viii) large size service organizations are more advanced in terms of strategy in embracing Industry 4.0; (ix) older organizations (over 10 years) have a better approach in terms of innovation to embracing Industry 4.0; and (x) there is no significant difference of innovation in terms of organization type in embracing Industry 4.0.

Thereon, these key insights clubbed together answer the five research objectives of this paper: the differences of Industry 4.0 readiness, Industry 4.0 technologies, leadership, strategy, and innovation in embracing Industry 4.0. In terms of practical contributions, this study can be used by the government for policymaking, industry players for benchmarking, and managers for decision-making and project management of Industry 4.0. This study was focused on technology companies alone, but future studies can survey non-technology

companies from different industry sectors. That study will be also insightful as it will gauge the ability of non-technology companies as opposed to technology companies towards embracing Industry 4.0, and prove if there are any similar patterns or observations. Future studies can also focus on the factor of organizational age and organizational type, from other countries and cultures, to further validate the existing findings. In addition to organizational age and organizational type, personnel qualifications can also be considered in future studies to draw new insights on Industry 4.0.

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