Readiness of Technical and Vocational Education Institutions and their Industry Partners for Fourth Industrial Revolution: Towards Theory Development

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ABSTRACT

The Fourth Industrial Revolution (4IR) is transforming industries globally, and Technical and Vocational Education and Training (TVET) institutions play a crucial role in preparing the workforce for this dynamic landscape. This quantitative study employs a descriptive-comparative research design to assess the readiness of TVET institutions and their industry partners for 4IR in Dipolog, Dapitan, and the 25 municipalities of Zamboanga del Norte, Philippines. Data were analyzed using percentage, weighted mean, Mann-Whitney U, and Kruskal-Wallis tests. This study presents a comprehensive analysis of the demographic profiles of respondents from TVET institutions and industry partners, examining their perceptions of readiness across three dimensions: Process, Infrastructure, and Organization. The findings indicate a moderate level of readiness, highlighting strengths and areas needing improvement, particularly in aligning curricula with 4IR demands. Differences in perceptions based on demographics, specifically sex and position, were also explored, revealing varied perspectives among different groups. To effectively incorporate 4IR technologies, this study introduces M'Lee Theory, the Adaptive Technological Perception Theory (ATPT), grounded in Albert Bandura's concept of self-efficacy—defined as an individual's belief in their capability to succeed in specific situations or accomplished a task, which is crucial in the 21st century's rapidly evolving technological landscape. There is a pressing need for the integration of insights from both social learning theory (Bandura) and the specific technological environment. Integrating Bandura's self-efficacy into ATPT (M'Lee Theory) provides a comprehensive understanding of how individuals and organizations adapt to technological advancements. This approach underscores the importance of both social and technological factors in preparing for the future workforce and technological innovations of the 4IR era, ensuring a competent and resilient future workforce. Moreover, while the Social Learning Theory implies that individuals' perceptions of readiness for 4IR would be similar across genders due to shared social influences, the Adaptive Technological Perception Theory (ATPT), M'Lee theory acknowledges that individuals' perceptions and attitudes are shaped not only by social influences but also by their capacity to adapt to changing environments and technological advancement so with their direct experiences with technology and their roles within technological ecosystems. Therefore, gender differences in technological expertise or exposure may lead to variations in perceptions of readiness for 4IR, beyond the scope of social learning alone. Adaptive Technological Perception Theory (ATPT) suggests that individuals' adaptability and resilience play a significant role in how they perceive and respond to changes, particularly in the context of technological advancements like the Fourth Industrial Revolution (4IR).

Keywords: Industry 4.0, Readiness, Industry Partner

INTRODUCTION

Technical Education and Vocational Training has been globally recognized as the most effective tool for increasing employment and reducing poverty. The advent of Industrial Revolution 4.0 posed a challenge towards employability of skilled workers. Technical and Vocational Education & Training in the Fourth

Industrial Revolution (TVET 4.0) is a complex, dialectical, and exciting opportunity, which can potentially transform society for the better. The revolution brings new exciting opportunities and solutions to global challenges such as automation of industrialization. It will also produce new jobs that have yet to be invented.

In the Philippines, TVET institutions have been facing innovation issues head on since new technologies and inventions play an important role in Industrial Revolution. While they have an adamant commitment to providing quality technical vocational education and are resilient in molding this commitment in accordance with the needs of the labor market, the demanding requirements of the Fourth Industrial Revolution is a challenge, especially for TVET, because of its technology-based nature. Though the revolution seems looming, TESDA has already laid the groundwork in its recognition to develop the changing skills need.

To survive the global competition, ASEAN countries should prepare an adaptive digital economy ecosystem as the foundation to participate in industry 4.0. The increasing level of Internet penetration in ASEAN nations provides a strong basis for this participation. According to a Google-Temasek survey, in 2016, 260 million individuals in the ASEAN region had regular access to the Internet. This is projected to increase to 480 million by 2020. With the average annual GDP growth rate standing at 4.9 percent in 2016, ASEAN has one of the highest regional rates in the world. Of the region's population of more than 600 million people, more than 65 percent are of productive age, with a rapidly expanding middle class. These factors have driven a massive increase in demand for online media, travel, and e-commerce services. In 2015, the value of these services in the region stood at US$31 billion. This is expected to grow by a factor of 6.5 by 2025. These technologies are expected to alter the patterns of consumption, production, and employment which will require proactive adaptation by corporations, governments, and individuals.

The governments, educators, and policy makers alike must ask the questions about how they can prepare present and future TVET to thrive in this transforming world. The fourth industrial revolution, fueled by artificial intelligence, is reshaping the workplace, shifting its focus from task-based attributes to human-centered ones. This convergence of man and machine is narrowing the gap between humanities and social sciences, and science and technology. This will necessarily require much more interdisciplinary teaching, research, and innovation in TVET. Hence, TVET stakeholders in the region have to set new initiatives and make efforts to cultivate holistic, entrepreneurial, and balanced graduates to be globally competitive and meet the needs of Industry 4.0.

The study aims to explore the differences in perceptions of readiness and provide a comprehensive analysis of the current state of readiness in terms of processes, infrastructure, and organizational capabilities, identify strengths and areas for improvement, and develop M'Lee theory, the Adaptive Technological Perception Theory (ATPT) to enhance the alignment of TVET curricula with 4IR demands. This will ultimately foster adaptability and continuous learning among individuals and organizations, ensuring effective incorporation of 4IR technologies.

Theoretical Framework

The theoretical framework is based on the concept of Industry 4.0, which refers to the integration of advanced technologies and digitalization into manufacturing and other industrial processes (Schwab & Samans, 2016). This framework emphasizes the need for technical and vocational education and training (TVET) institutions and their industry partners to adapt to the changes brought about by the Fourth Industrial Revolution (4IR) and prepare students for the skills needed in this new era.

According to Figueiredo et al. (2019), TVET institutions should focus on three main areas to prepare for 4IR: developing digital competencies, promoting innovation, and fostering entrepreneurship. This is supported by the framework proposed by Pereira et al. (2019), which highlights the importance of a holistic approach to 4IR readiness that includes both technological and non-technological aspects, such as human capital development, business models, and public policy.

Human Capital Theory is an economic concept that views education and training as investments that increase an individual's productivity and earning potential over time (Becker, 1975). This theory posits that individuals who possess more education, training, and skills are more valuable in the labor market and, as a result, earn higher wages. The theory also suggests that investments in education and training lead to positive spillover effects, such as increased productivity and innovation that benefit society as a whole. In the context of the readiness of Technical and Vocational Education Training (TVET) institutions and industry partners for the Fourth Industrial Revolution, human capital theory is highly relevant. With the increasing adoption of advanced technologies and automation, workers must develop new skills to remain competitive in the labor market. Investing in training and education can help individuals acquire the necessary skills and knowledge to succeed in a rapidly changing economy.

METHOD

Research Design

This study is a quantitative research that utilized descriptive-comparative research design. It is descriptive in the sense that it provides a detailed picture of the respondents in terms of demographic profile such as age, gender, educational background, employment status, and years of experience in the TVET sector or industry. It is also comparative as it sought to examine if a significant difference existed in the respondents' evaluation of their institutions readiness for the Industry Revolution 4.0.

Research Environment

The research locales for this study encompassed not only the twin cities of Dipolog and Dapitan but also the 25 municipalities scattered across Zamboanga del Norte. This expansive coverage ensures a comprehensive understanding of the province's dynamic environment, capturing the nuances and complexities of its various regions. Zamboanga del Norte boasts an impressive infrastructure of 41 registered Technical Vocational Education and Training (TVET) institutions, complemented by a diverse array of 50 different industries. This robust network forms the backbone of the province's growth and development, providing essential avenues for education, skills training, and employment.

The role of TVET institutions in Zamboanga del Norte is paramount. These institutions play a crucial role in equipping the local population with the necessary competencies to thrive in various industries. By offering vocational education and skills training programs, they empower individuals to pursue meaningful careers and contribute to the socio-economic fabric of the province.

Research Respondents

In Zamboanga del Norte, particularly in Dipolog and Dapitan, stakeholders across various sectors actively participated in this research on vocational education and training (TVET) and industry collaboration. The 25 municipalities in the province provided a suitable setting for this exploration.

The research included 15 administrators, supervisors, and principals, providing insights into the challenges and opportunities within the TVET sector. Additionally, 35 trainers and experts contributed their knowledge and experience, guiding the development of effective training programs.

The involvement of 50 trainees and graduates from TVET institutions offered firsthand experiences that inform about the efficacy of vocational training programs and their readiness for the workforce. Their feedback helped identify strengths and areas for improvement within the TVET sector.

The participation of 25 CEOs, managers, and staff members from various industries highlighted their commitment to collaborating with TVET institutions. Their input assisted in designing training programs aligned with market demands.

Furthermore, the involvement of 50 student immersion or on-the-job training (OJT) participants provided insights into the practical application of theoretical knowledge acquired through TVET programs.

The study employed complete enumeration to capture a diverse range of perspectives from the TVET and industry landscape in Zamboanga del Norte.

Research Instruments

A set of adopted questionnaire was employed as data-gathering tool. The questionnaire is composed of two parts. The first section of the questionnaire was dedicated to capturing the demographic profile of the respondents. Through a series of meticulously crafted items, stakeholders were invited to share insights into their roles, experiences, and affiliations within the TVET sector and industry landscape of Zamboanga del Norte. This section provided essential context for interpreting responses and understanding the diverse perspectives of the participants.The second section of the questionnaire delved into the core elements of 4IR technologies implementation within the realm of TVET. Divided into categories encompassing infrastructure, organization, curriculum content, and pedagogy, this section sought to gauge the readiness of TVET institutions and industries to embrace and integrate cutting-edge technologies into their practices. A carefully calibrated scale ranging from 1.00 to 5.0 was employed, ranging from 1.00-1.79: Not At All/Very Low(NAA/VL); 1.80-2.59: A Little/Low (AL/L); 2.60-3.39: Somewhat/Average (S/A); 3.40-4.19: Moderately So/High(MS/H); 4.20-5.00: Very Much So/Very High (VMS/VH). This scale offered a spectrum of response options, allowing participants to express the extent to which they perceived the implementation of 4IR technologies across various dimensions.

Research Procedure

The researcher requested personally permissions and endorsements were also requested and secured from the different TVET Institutions Administrators and Industries CEO/Managers across the province of Zamboanga del Norte for the administration of the questionnaire. These permissions were crucial in gaining access to the target respondents and conducting the research in a collaborative and ethical manner.

Upon obtaining necessary permissions, the researcher personally administered the questionnaire to the identified respondents in the cities and municipalities of Zamboanga del Norte. The questionnaire was carefully crafted to capture relevant insights into the readiness of TVET institutions and industries in embracing Fourth Industrial Revolution (4IR) technologies. During the administration process, the researcher ensured that respondents fully understood the instructions and were given adequate time to provide thoughtful responses. Following the administration phase, the researcher personally retrieved the completed questionnaires from the respondents. This step was crucial in ensuring the timely collection of data and minimizing potential data loss or inaccuracies. Additionally, the researcher maintained open communication with respondents to address any queries or concerns they may have had regarding the questionnaire or the research process.

Finally, the data was meticulously recorded and encoded into an excel spreadsheet for subsequent statistical analysis. This phase involved organizing and categorizing the responses to facilitate meaningful interpretation and insights generation. The encoded data served as the foundation for the subsequent stages of data analysis and interpretation.

Data Analysis

The percentage, weighted mean, standard deviation, Mann -Whitney U and Kruskal Wallis test were utilized in analyzing data. The percentage was used in presenting the distribution of the respondents in terms of their profile, designation as well as the administrator, extent of capability in terms of the Technical-Vocational

Schools (process, infrastructure, organization), extent of capability of the training institutions (skills and competencies, curriculum, national assessment and pedagogy) as well as the extent of capability of the industry partners (strategy leadership, customer experience, products, operations and innovations).

Weighted mean, on the other hand, was utilized in summarizing the respondents' assessment on the capability of the aforementioned institutions. Together with the weighted mean was the standard deviation, which specified whether or not homogeneity existed among the respondents with regards to their assessments on the institutions' extent of capability. Finally, Mann -Whitney U and Kruskal-Wallis's test were utilized to determine whether or not a significant difference existed in the perceptions between and among the groups of respondents.

Ethical Consideration

The researcher and all involved parties adhered to ethical guidelines and standards in the handling and processing of any pertinent information collected during the study. During the analysis of data, the names of participants were excluded to maintain confidentiality. Adequate measures were taken to ensure that the identity, dignity, and integrity of participating individuals and institutions were protected. Once the important data were collected, collated, and treated, the research instruments were disposed of by tearing them into tiny pieces to prevent any potential breaches of privacy. Finally, the data gathered were being utilized only for research purposes and will not be used for any other intent.

RESULTS AND DISCUSSION

Demographic Profile of the Respondents

Table 1 shows that among the respondents from training institutions, the males outnumbered their female counterpart. Though the disparity is not so wide, however, still they take preponderance, comprising fifty six percent while the females constituted only forty three percent. In terms of position, their percentage distribution is as follows: administrators, 6%; principals, 4%; students, 50%; supervisors, 5%; and teachers, 35%. The distribution of the respondents across categories is to balance the sources of information from the stakeholders such as the students, teachers, principals, supervisors, and administrators. In other words, this is to ensure having a diverse perspective, capturing insights from each group.

On the other hand, in the case of the industry partner respondents, sixty percent were males, thirty one percent were females, while the remaining nine percent did not indicate their sex. As regards position, 15% were CEO/managers; 25% were employees; 51% were students in their immersion or on the job training, while the remaining 9% failed to indicate their answers on the aforementioned item in the questionnaire. Moreover, the majority of industry partner respondents are involved in student immersion or on the job training, suggesting a significant engagement with the educational processes at training institutions. Meanwhile, CEOs/Managers and employees also form a substantial portion of the industry partner sample, providing insights from both leadership and workforce perspectives.

Furthermore, the diverse representation in terms of sex and position ensures a well-rounded understanding of the readiness for 4IR, considering viewpoints from students, teachers, CEOs and employees. In the context of educational engagement, the high percentage of industry partners involved in student immersion or OJT indicates a strong connection between the education sector and the industry which is crucial for aligning educational programs with industry needs. Towards leadership and workforce insights, the presence of CEOs/Managers and employees among industry partners provides insights in both strategic decision-making and practical and operational aspects related to 4IR readiness. Finally, the demographic profile suggests a comprehensive representation of stakeholders, laying a solid foundation for exploring the readiness of Technical and Vocational education and their Industry Partners for the Fourth Industrial Revolution.

Table 1 Demographic Profile of Respondents

Training Institutions		
Sex	**f**	**%**
Male	56	56.00
Female	43	43.00
Did not answer	1	1.00
Total	**100**	**100.00**
Position	**f**	**%**
Administrator	6	6.00
Principal	4	4.00
Student	50	50.00
Supervisor	5	5.00
Teacher	35	35.00
Total	**100**	**100.00**
Industry Partners		
Sex	**f**	**%**
Male	60	60.00
Female	31	31.00
Did not answer	9	9.00
Total	**100**	**100.00**
Position	**f**	**%**
CEO/Manager	15	15.00
Employee	25	25.00
Student Immersion/OJT	51	51.00
Did not answer	9	9.00
Total	**100**	**100.00**

Assessment on the Readiness of TVET Institution for 4IR

Table 2 presents the respondents' assessment of the readiness of their Technical and Vocational Education and Training (TVET) institutions for the Fourth Industrial Revolution (IR 4.0) that is conducted in three dimensions: Process, Infrastructure, and Organization.

Process

This refers to the various educational and operational mechanisms that TVET institutions employ to adapt and align with the evolving demands of the Fourth Industrial Revolution (4IR). Specifically, this encompasses curriculum content, stakeholder engagement, and pedagogical approaches.

In understanding the global trends, the study shows that overall, the respondents are in agreement on the moderate readiness of TVET institution in preparing for the industry revolution 4.0 in terms of process. This is exemplified in the aggregate weighted mean of 3.68 with a verbal description, *moderately so*. It is also delineated that there is confluence among them in coming up with such assessment as reflected in the standard deviation values which are all within the category: small. As signified by Cohen and Berry as cited by Reston and Refugio (2004), a standard deviation equal to or lesser than 3.0 is considered small, indicating the existence of homogeneity among the respondents.

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With the specific items, it is evident that majority of the items had been rated *moderately so*. However, it is also worth emphasizing that the item, “My institution understands that education is constantly changing to meet global trends” warranted the respondents’ assessment, *very much so*. This indicates that they are fully convinced that their institution is committed to staying current with the demands of the times. This is a positive indicator of their institutions’ willingness to be in step with technological development. Nonetheless, the study's findings on the readiness of TVET institutions and their industry partners for the Fourth Industrial Revolution (4IR) reveal a notable gap and areas of low performance, particularly in integrating advanced technologies into the curriculum. Despite a moderate overall readiness in terms of processes, as indicated by an aggregate weighted mean of 3.68, certain critical aspects require significant enhancement. The specific item "My institution has embedded the followings in the curriculum: big data, Augmented Reality, Simulation, Internet of things and cloud computing" received a notably low score with a weighted mean of 2.39, highlighting a considerable deficiency in embedding these essential 4IR technologies into the educational framework.

This gap can be attributed to several factors. Firstly, the rapid pace of technological advancement may outstrip the ability of institutions to update their curricula swiftly and effectively. This lag can result from the tendency of administrative processes and organizations to remain unchanged, resistant to innovation, and slow to adapt to new circumstances or technologies due to rigid structures, procedures, and a resistance to change, limited financial resources, or a lack of expertise in cutting-edge technologies. The moderate readiness rating, despite a clear understanding of the need for change, suggests a disconnection between recognition and implementation.

The Adaptive Technological Perception Theory (ATPT), grounded in Albert Bandura's concept of self-efficacy from social learning theory, offers a potential framework for addressing these gaps. Self-efficacy, or the belief in one's ability to succeed in specific tasks, plays a crucial role in how educators and institutions adapt to technological changes. High self-efficacy can drive proactive learning, experimentation, and the adoption of new technologies, whereas low self-efficacy can lead to resistance and stagnation.

In the descriptive rating, the score moderately reflects a 4.39 on the scale (Table 2-Process), indicating a strong awareness of how education dynamically responds to global trends. The ability to rapidly transform reflects a score of 3.91 on the scale, indicating a moderate level. This suggests that respondents moderately believe their institution can adapt quickly to changing global trends. However, for embedding trends in curriculum, the result indicates a lower level with a score of 2.39 on the scale, suggesting a need for improvement in this area. The low score on embedding advanced technologies suggests a need for robust strategies to enhance self-efficacy among educators and administrators. By leveraging ATPT, TVET institutions can create an environment where continuous learning and adaptation are integral to their culture. Encouraging educators to participate in professional networks, attend conferences, and collaborate with industry leaders can provide the observational learning experiences necessary to boost self-efficacy.

For working closely with Industry, the result shows a rating of 3.70 (MS - Moderately So). The respondents moderately believe that their institution works closely with the industry, suggesting a positive collaboration between the institution and industry in response to 4IR needs. For graduates' preparedness, the rating of 3.74 (MS - Moderately So) was given. The respondents moderately believe that graduates from their institution are prepared for the challenges of 4IR, indicating a positive perception. For data inputs and continuous improvement, the result shows a rating of 3.83 (MS - Moderately So). The respondents moderately believe that data inputs from stakeholders are used continuously to improve services indicating a tendency to utilize stakeholder feedback for continuous improvement. For personalized/customized learning, a rating of 3.86 (MS - Moderately So) was given. The respondents moderately believe that their institutions can offer personalized learning experiences. For other initiatives related to training and process, the result shows a

rating of 3.57 (MS - Moderately So). The respondents' moderate belief in other educational initiatives related to IR 4.0 suggests ongoing efforts beyond the specified areas.

Overall, the aggregate score of 3.68 (MS) suggests a moderately adopted approach in terms of processes. Institutions show strength in understanding global trends but display a need for improvement in embedding relevant elements in the curriculum. To contextualize the finding of a moderately adopted approach in terms of processes and the need for improvement in embedding relevant elements in the curriculum, Rogers' (2003) Educational Change Theory of Diffusion of Innovation provides insight into how innovations spread through societies and organizations. In the context of the study, it can be applied to understand the adoption of new educational practices and technologies. Institutions may show varying levels of readiness in adopting innovations based on factors such as relative advantage, compatibility, complexity, trialability, and observability. Bruner (1960) suggested that learning should be structured in a spiral manner, revisiting key concepts at increasing levels of complexity over time. Institutions adopting this approach may be more adept at integrating emerging trends like big data, augmented reality, and cloud computing into their curriculum through iterative and scaffolded learning experiences. It is also evident in the literature for 21st Century Learning. This framework identifies essential skills for success in the modern workforce, including critical thinking, creativity, communication, collaboration, and digital literacy. Institutions aiming to embed relevant elements in their curriculum should focus on developing these skills among students to prepare them for the challenges of the Fourth Industrial Revolution.

By drawing on these theories and literature, institutions can develop strategies to enhance their readiness for the Fourth Industrial Revolution by improving processes related to curriculum development and implementation. This may involve fostering a culture of innovation, providing professional development opportunities for faculty, and aligning curriculum with 21st-century skills and global trends in education and industry. Additionally, understanding the factors that influence educational change and curriculum development can help institutions overcome barriers and challenges to implementation, ultimately leading to more effective preparation of students for the future workforce.

Table 2 Respondents' Assessment of Their TVET institutions' readiness for the Industry revolution 4.0 in Terms of Process

Process	**WX**	**s**	**VD**
My institution understands that education is constantly changing to meet global trends.	4.39	0.67	VMS
My institution is able to transform rapidly as per the changing global trends.	3.91	0.70	MS
My institution is able to offer personalized/customized learning for the students.	3.86	0.65	MS
Data inputs from our stakeholders are used continuously to improve our service.	3.83	0.67	MS
Graduates from my institution: are work-ready, have the right technical skills, posses adaptive skills, and possess IT literacy skills.	3.74	0.89	MS
My institution work closely with industry in terms of: curriculum design, industrial attachments,training, and assessment.	3.70	0.94	MS
Any other initiatives taken related to education and training process in school related to IR 4.0 readiness.	3.57	0.86	MS
My institution has embedded the followings in the curriculum: big data, Augmented Reality, Simulation, Internet of things, and cloud computing.	2.39	1.08	AL
Aggregate	**3.68**	**0.51**	**MS**

1.00-1.79: Not At All/Very Low(NAA/VL); 1.80-2.59: A Little/Low (AL/L); 2.60-3.39: Somewhat/Average (S/A); 3.40-4.19: Moderately So/High(MS/H); 4.20-5.00: Very Much So/Very High (VMS/VH)

Infrastructure

This refers to the foundational physical and technological facilities, budget allocation, connectivity and technological services that support the effective adoption and integration of digital innovations within Technical and Vocational Education and Training (TVET) institutions.

The classroom/workshop/laboratory in the institution received a rating of 3.65 (MS - Moderately So). The respondents moderately believe that facilities are fully equipped for adopting digital innovation, indicating a positive stance toward the readiness of physical infrastructure for digital innovation. For budget prioritization on technological development, a rating of 3.58 (MS - Moderately So) was given. The respondents moderately agree that the institution prioritizes its budget on technological development, suggesting a positive prioritization. Meanwhile, in providing necessary infrastructure, the results show a rating of 3.42 (MS - Moderately So). The respondents moderately believe that the institution provides necessary infrastructure, indicating a moderate level of provision in specified areas. Furthermore, in giving any initiatives related to infrastructure, the respondents moderately believe that there are ongoing initiatives beyond the specified areas. Finally, the aggregate score of 3.50 (MS) indicates a moderately adopted approach in terms of infrastructure readiness. The institutions prioritize budget on technological development, but there is room for improvement in fully equipping classrooms for digital innovation.

Davis' (1989) Technology Acceptance Model (TAM) posits that perceived usefulness and perceived ease of use are key determinants of individuals' intention to use technology. In the context of infrastructure readiness, institutions should ensure that the technological tools and resources provided are perceived as useful and easy to use by faculty and students. This could involve training programs, technical support, and user-friendly interfaces. It is also equally important to include Community Capacity Building, an approach that focuses on empowering local communities to identify and address their own needs. Educational institutions can apply this concept by involving stakeholders in the planning and implementation of infrastructure projects, ensuring that initiatives are tailored to the specific needs and priorities of the community.

Before investing in infrastructure projects, institutions should conduct cost-benefit analyses to evaluate the potential return on investment. This involves assessing the costs and benefits associated with different options for infrastructure development, taking into account factors such as increased student engagement, improved learning outcomes, and enhanced institutional reputation. By then Technical Vocational Educational institutions can develop strategies to improve infrastructure readiness and fully equip classrooms for digital innovation. This may involve fostering a culture of technology adoption, engaging stakeholders in infrastructure development initiatives, and prioritizing budget allocations based on cost-benefit considerations. Additionally, leveraging external resources and partnerships can help institutions overcome financial constraints and accelerate the implementation of infrastructure projects to support teaching and learning in the digital age.

Table 3 Respondents' Assessment of Their TVET Institutions' Readiness for the Industry Revolution 4.0 in Terms of Infrastructure

Infrastructure	**WX**	**s**	**VD**
The classroom/ workshop/ laboratory in our institution are fully equipped to adopt digital innovation.	3.65	0.91	MS
My institution prioritizes its budget on technological development.	3.58	0.93	MS
My institution provides the following: good internet connectivity,user friendly LMS,remote access to the system,digital channels for easy collaborations,analyze students learning based on real time data and risk and cyber security management.	3.42	1.07	MS
Any other initiatives taken related to education and training infrastructure in school related to IR 4.0 readiness.	3.36	1.10	MS
Aggregate	**3.50**	**0.93**	**MS**

1.00-1.79: Not At All/Very Low(NAA/VL); 1.80-2.59: A Little/Low (AL/L); 2.60-3.39: Somewhat/Average (S/A); 3.40-4.19: Moderately So/High(MS/H); 4.20-5.00: Very Much So/Very High (VMS/VH)

Organization

This refers to the structural and managerial aspects of TVET institutions, including the readiness of their talent, in relation to the Fourth Industrial Revolution (4IR). This dimension examines how well these institutions are equipped in terms of their internal structures, management practices, strategic planning, and workforce capabilities to adapt to and integrate 4IR technologies.

There are mandates to encourage institution to adapt, embrace, and transform to 4IR-related technologies. The result of the study shows that the moderate agreement of respondents (3.75) suggests a positive perception of institutional encouragement to adapt/embrace/transform 4IR-related technologies. Further, the institution has embedded 4IR in the organization's vision and mission indicating a positive integration since the respondents moderately believe so (3.76) (Table 2-Organization). Given the strategies and plans in place for implementing Fourth Industrial Revolution (4IR) technology within the institution, respondents rated their belief at 3.82 (MS - Moderately So), indicating a moderate level of confidence in the existence of these strategies and plans for 4IR-related technology implementation. Meanwhile, the institution has not started implementing 4IR adoption and transformation plan. The respondents moderately agree (3.77), indicating that some respondents acknowledge a delay in the implementation of 4IR adoption and transformation. The current workforce then is capable of adopting 4IR-related technology as the respondents moderately agree (3.60), suggesting a positive perception of the current workforce's capabilities in adopting IR4.0 related technology. There are training plans in place to develop workplace capabilities, skills and competencies. The respondents moderately believe (3.60) that there are existing training plans in place for workplace development. Additionally, the respondents moderately agree (3.58) that their institutions have set up a task force to drive 4IR integration. For any other initiatives taken related to education and training organization, the respondents moderately believe (3.66) that ongoing initiatives beyond the specified areas are being implemented. The overall organizational readiness is considered moderate, with the score 3.69, which falls in the "Moderately So (MS)" category. In order to understand the findings regarding training plans, task force establishment, and other initiatives related to organizational readiness for Fourth Industrial Revolution integration, it is valuable to explore the TPACK Framework and Learning Organization Theory. The Technological Pedagogical Content Knowledge (TPACK) framework emphasizes the intersection of technological knowledge, pedagogical knowledge, and content knowledge in effective teaching and learning. Institutions can apply this framework to ensure that training plans and other initiatives related to Fourth Industrial Revolution integration are grounded in sound pedagogical principles and aligned with the needs of learners and educators.

Meanwhile, the Learning Organization Theory, popularized by Senge (1990), emphasizes the importance of fostering a culture of continuous learning and innovation within organizations. Institutions can cultivate learning organizations by promoting collaboration, knowledge sharing, and experimentation, thereby enhancing their readiness for technological advancements associated with Fourth Industrial Revolution. With all these theories and frameworks, technical educational institutions can develop comprehensive strategies to enhance organizational readiness for Fourth Industrial Revolution integration. This may involve establishing clear goals and objectives, engaging stakeholders in the change process, providing professional development opportunities, and fostering a culture of innovation and continuous improvement. Additionally, leveraging technology integration frameworks can help ensure that initiatives related to Fourth Industrial Revolution integration are grounded in best practices and aligned with the needs of learners and educators.

Table 4 Respondents' Assessment of Their TVET Institutions' Readiness for the Industry Revolution 4.0 in Terms of Organization

Organization	**WX**	**s**	**VD**
There are mandates to encourage my institution to adapt/embrace/transform IR4.0 related technologies.	3.75	0.82	MS
My institution has embedded IR4.0 in the organization's vision and mission.	3.76	0.82	MS

There are strategies/plan to implement IR4.0-related technology in my institution.	3.82	0.77	MS
My institution has not started implementing IR4.0 adoption/transformation plan.	3.77	0.94	MS
Our current workforce is capable to adopt IR4.0- related technology.	3.60	1.02	MS
There are training plans in place to develop our workplaces' capabilities, skill & competencies.	3.60	1.02	MS
My institution has set up a task force to drive IR4.0 integration.	3.58	1.00	MS
Any other initiatives taken related to education and training organization in your school related to IR 4.0 readiness, please specify	3.66	1.03	MS
Aggregate	**3.69**	**0.80**	**MS**

1.00-1.79: Not At All/Very Low(NAA/VL); 1.80-2.59: A Little/Low (AL/L); 2.60-3.39: Somewhat/Average (S/A); 3.40-4.19: Moderately So/High(MS/H); 4.20-5.00: Very Much So/Very High (VMS/VH)

Findings in the assessment showed that the institution demonstrates a moderate perception of readiness across processes, infrastructure, and organization. There is a consistent belief in moderate readiness, with the aggregate scores (3.69) falling within the "Moderately So (MS)" range and suggesting a moderately adopted approach in terms of organizational readiness. The moderately adopted approach across all dimensions indicates a baseline level of readiness, but there are areas that require attention for a more comprehensive and effective implementation of 4IR. The institutions have mandates and strategies for 4IR, but there is room for improvement in workforce capabilities and training plans.

There is an acknowledgement of the need for curriculum enhancement (Table 2 - Process). Areas for improvement may include embedding global trends in the curriculum, enhancing infrastructure initiatives (Table 2-Infrastructure), and ensuring a more robust implementation plan for 4IR adoption (Table 2-Organization). It is important to consider these insights for targeted improvements and strategic planning to enhance overall readiness for the Fourth Industrial Revolution. Continuous assessment and adaptation will be crucial to staying abreast of global trends and industry requirements. Finally, the presented data suggest the need for theory development in the context of Technical and Vocational Education and Training (TVET) institutions' readiness for the Fourth Industrial Revolution. The moderate readiness across the dimensions of Process, Infrastructure, and Organization indicates areas for improvement and strategic development.

Difference in Respondents' Assessment based on Demographic Profile

This section presents the findings on the exploration of differences in respondents' assessments of their TVET institutions' readiness for Industry Revolution 4.0 (4IR) when they are grouped according to demographic profiles, specifically sex and position. The mean ranks for males and females are close (50.10 and 49.90, respectively) suggesting a similar perception of readiness for the 4IR. The U value is 1200.50, and the p-value is 0.98, indicating that there is no significant difference in the assessment between males and females. In terms of position, the mean ranks for administrators/principals/supervisors, students, and teachers are 57.60, 50.00, and 48.20, respectively. The H value is 1.13, and the p-value is 0.57, indicating that there is no significant difference in the assessment of readiness based on the position.

The study's findings reveal no significant differences in the respondents' assessments of TVET institutions' readiness for the Fourth Industrial Revolution (4IR) based on demographic profiles, specifically sex and position. The close mean ranks for males (50.10) and females (49.90), coupled with a U value of 1200.50 and a p-value of 0.98, suggest that both male and female respondents have similar perceptions regarding their institutions' readiness for 4IR. Similarly, when examining the data by position, the mean ranks for administrators/principals/supervisors (57.60), students (50.00), and teachers (48.20), along with an H value of 1.13 and a p-value of 0.57, indicate that there are no significant differences in assessments based on position.

Several possibilities might explain the lack of significant differences in these assessments. One reasonable explanation is that the overall awareness and understanding of 4IR and its requirements are uniformly disseminated across all groups within the TVET institutions. This uniformity could be due to standardized training programs, institutional policies, and shared resources that ensure all members, regardless of their demographic profile, receive similar information and guidance on 4IR readiness.

The findings can also be interpreted through the lens of the Adaptive Technological Perception Theory (ATPT), grounded in Albert Bandura's concept of self-efficacy and social learning theory. Self-efficacy, or the belief in one's capability to succeed in specific tasks, is influenced by observational learning, social influences, and direct experiences with technology. In a well-integrated educational environment, such as a TVET institution preparing for 4IR, the collective experiences and social interactions among administrators, teachers, and students can lead to a shared perception of readiness. These shared experiences and observations might foster a common level of confidence and perceived capability across different demographic groups.

Moreover, the social learning aspect of Bandura's theory emphasizes that individuals learn and adopt behaviors by observing and modeling others, particularly within their social environment. If TVET institutions actively promote a culture of technological competence and readiness through mentorship, peer learning, and collaborative projects, it is likely that all members, regardless of their position, develop a similar understanding and perception of the institution's readiness for 4IR. This cohesive environment ensures that differences in sex or position do not significantly impact the overall perception of readiness, as everyone is collectively working towards the same goals and standards.

In conclusion, the absence of significant differences in the assessments based on sex and position underscores the potential effectiveness of TVET institutions' strategies in fostering a unified approach to 4IR readiness. The integration of ATPT and the principles of social learning and self-efficacy further supports the idea that a shared technological environment and collaborative culture can lead to consistent perceptions of readiness among diverse groups within the institution. This finding highlights the importance of inclusive and comprehensive training programs and institutional policies that cater to all demographic groups, ensuring that everyone is equally prepared to meet the challenges and opportunities presented by the Fourth Industrial Revolution.

Table 5 Difference in the Respondents' Assessment of Their TVET Institutions' Readiness for Industry Revolution 4.0 in Terms of Process when Grouped according to Demographic Profile

Sex				
Mean ranks for			**U**	**P**
Male		**Female**		
50.10		49.90	1200.50	0.98
Position				
Mean ranks for			**H**	**P**
Administrator/Principal/Supervisor	**Student**	**Teacher**		
57.60	50.00	48.20	1.13	0.57

Moreover, under infrastructure, the mean ranks for males and females are equal (50.00), suggesting a similar perception of readiness for the 4IR between sex. The U value is 1206.00, and the p-value is 0.99, indicating that there is no significant difference in the assessment between males and females. On the other hand under position, the mean ranks for administrators/principals/supervisors, students, and teachers are 45.20, 55.30, and 46.00, respectively. The H value is 2.69, and the p-value is 0.26, indicating that there is no significant difference in the assessment of readiness based on the position. These findings show that there is no significant difference in the mean ranks based on sex or position in the infrastructure domain. Both male and female respondents, regardless of their positions, have similar perceptions of the institution's readiness

regarding infrastructure for 4IR. This uniformity in perception could be understood through the lens of the Adaptive Technological Perception Theory (ATPT) grounded in social learning and self-efficacy. Bandura's concept of self-efficacy, which refers to an individual's belief in their ability to succeed in specific situations, plays a critical role in shaping how individuals perceive and engage with technological advancements. In environments where self-efficacy is cultivated through consistent support, training, and positive reinforcement, individuals are likely to develop a similar level of confidence in their capabilities, regardless of their demographic background or institutional role.

The lack of significant differences in perception could be attributed to a well-established culture of continuous learning and adaptation within these institutions, where both male and female participants, as well as individuals in various positions, are equally exposed to the necessary resources, training, and experiences that enhance their self-efficacy. This equal exposure leads to a convergence in their perceptions of readiness.

Table 6 Difference in the Respondents' Assessment of Their TVET Institutions' Readiness for Industry Revolution 4.0 in Terms of Infrastructure when Grouped according to Demographic Profile

Sex				
Mean ranks for			**U**	**P**
Male		**Female**		
50.00		50.00	1206.00	0.99
Position				
Mean ranks for			**H**	**P**
Administrator/Principal/Supervisor	**Student**	**Teacher**		
45.20	55.30	46.00	2.69	0.26

In terms of organization, the mean ranks for males and females are 52.20 and 47.10, respectively.The U value is 1079.00, and the p-value is 0.38, indicating that there is no significant difference in the assessment between males and females.

Meanwhile, in terms of position, the mean ranks for administrators/principals/supervisors, students, and teachers are 41.10, 60.80, and 39.80, respectively. The H value is 12.72, and the p-value is 0.00, indicating that there is significant difference in the assessment of readiness based on the position. This suggests that respondents with different positions have varied assessment of their institutions' readiness in this particular dimension. The significant difference in the assessment of readiness for the Fourth Industrial Revolution (4IR) based on position within TVET institutions suggests nuanced perspectives among administrators/principals/supervisors, students, and teachers regarding their institutions' preparedness. This discrepancy aligns with the Adaptive Technological Perception Theory (ATPT), grounded in social learning and self-efficacy. Administrators/principals/supervisors, occupying leadership roles, may exhibit higher self-efficacy due to their responsibilities in guiding institutional strategies and policies, potentially leading to a more optimistic assessment of readiness. Conversely, students, positioned at the receiving end of education, may perceive readiness differently, influenced by their immediate experiences and expectations. Understanding the relevance of the number of years individuals have spent in their positions within TVET institutions is crucial for integrating the results of this study on readiness for the Fourth Industrial Revolution (4IR). The length of time someone has been in their role can significantly influence their perceptions and self-efficacy, which are central to the Adaptive Technological Perception Theory (ATPT) grounded in social learning. Administrators, principals, and supervisors with many years in their positions are likely to have accumulated extensive experience and developed a higher self-efficacy, leading to a potentially more favorable assessment of their institution's readiness for 4IR. Their long-term involvement in strategic planning and policy implementation might give them a broader perspective on the institution's capabilities and areas of strength.

On the other hand, students, who are typically in their roles for a shorter duration, may not have the same level of institutional knowledge or experience. Their perceptions are more immediate, focusing on their day-to-day educational experiences and the direct relevance of their curriculum to the demands of 4IR. This could explain their potentially critical viewpoint, as they are more acutely aware of any gaps between the education they receive and the skills required in the evolving job market.

Teachers, whose tenure in their positions can vary widely, serve as a bridge between students and administrators. Those with more years in their roles might have developed a higher self-efficacy, feeling confident in their ability to adapt and integrate new technologies into their teaching. In contrast, newer teachers might still be developing their self-efficacy and could view institutional readiness differently. Their assessments tend to be shaped by both the directives they receive from administration and the realities they face in the classroom.

By considering the number of years individuals have spent in their positions, institutions can better understand the diverse perspectives and self-efficacy levels across different roles. This understanding can guide tailored strategies that address specific needs and experiences, fostering a more cohesive approach to enhancing 4IR readiness. Encouraging professional development and continuous learning, especially for those newer to their roles, can help build self-efficacy and align perceptions more closely. Additionally, leveraging the experience of long-term administrators and teachers in collaborative decision-making processes can ensure that institutional strategies are well-informed and broadly supported, ultimately promoting a shared sense of efficacy and collective readiness for the challenges and opportunities of the 4IR.

Table 7 Difference in the Respondents' Assessment of Their TVET Institutions' Readiness for Industry Revolution 4.0 in Terms of Organization when Grouped according to Demographic Profile

Sex				
Mean ranks for			**U**	**P**
Male		**Female**		
52.20		47.10	1079.00	0.38
Position				
Mean ranks for			**H**	P
Administrator/Principal/Supervisor	**Student**	**Teacher**		
41.10	60.80	39.80	12.72	0.00*

Finally, in all three dimensions (Process, Infrastructure, and Organization), there is no significant difference in the assessment of readiness for the 4IR based on sex. In terms of position, there is no significant difference in the assessment of readiness for the 4IR in Process and Infrastructure dimensions. However, there is a significant difference in the Organization dimension, suggesting that administrators/principals/supervisors have a different perception compared to students and teachers. The specific aspects contributing to this difference may provide valuable insights for targeted improvements in organizational aspects based on sex and position. Tailored strategies may be needed to address the varying perspectives of different demographic groups, especially in organizational aspects.

In addressing the concern of whether or not a significant difference exists in the respondents' assessment of their TVET institutions' readiness of TVET for Industry Revolution 4.0 when grouped according to demographic profile, Mann-Whitney U and Kruskal-Wallis's tests were employed. The choice of these statistical tools was based on the level of measurement of the data as well as the number of sets of data to be subjected to the comparative analysis. The results of such analysis indicated that only one among the dimensions (process, infrastructure, and organization) has reached the significant level: organization. The basis for the declaration of whether or not a significant difference exists is the rule which states that for a significant difference to exist, the probability or p value must be equal to or lesser than the alpha which in this study is at 0.05.

As evident, in terms of process and infrastructure, sex and position do not matter. In other words, these are not factors to consider when it comes to their assessment on the extent of readiness of their institution in facing the challenges brought about by Industry Revolution 4.0. That being the case necessitates looking into their level of assessment on the matter. It must be noted, however, that their assessment is just within the verbal description, *moderately so.* Hence, it can be construed that there exists the need for further improvement.

In the context of organization, once again the data indicated the absence of a significant difference between the male and female respondents. In other words, there is concordance among them that indeed an improvement is to be aspired. However, in terms of position, a significant difference has been established. This phenomenon is exemplified by the Kruskal-Wallis's (H) value of 12.72 whose p value is lesser than the alpha. An examination of their respective mean ranks leads to the finding that among the groups of respondents, it is the students that have the highest rating, followed by those in the administration, and lastly by the teachers. This significant disparity in their perspectives needs to be looked into so as to determine the underlying causes, which will also subsequently lead to the identification of measures that will address such concern. Ideally, a confluence must prevail among the three groups of respondents.

Assessment of Industry Partners on the Readiness of Institutions to Adopt the Fourth Industrial Revolution (4IR)

This section details the assessment of industry partners on the readiness of the institutions to adopt the Fourth Industrial Revolution (4IR), specifically in terms of strategy and leadership, customer experience, operations, product and innovation, and people. The strategy and leadership dimension assesses key leadership qualities and strategic approaches critical for navigating 4IR. Elements such as negotiating, encouraging uniform procedures, maintaining honesty, and developing alliances are considered.

The findings show a score of 4.00 with a variation deviation (VD) of 0.56, which indicates a high level of adoption (HA) in Strategy and Leadership. Overall, the industry partners show high confidence in the institutions' adoption of various leadership and strategic attributes.

Customer experience evaluates aspects related to providing satisfactory service, addressing customer queries, demonstrating product knowledge, and maintaining a user-friendly platform. The result of the study shows a rating of 4.05 with a VD of 0.55, suggesting a highly adopted (HA) approach in Customer Experience. Thus, the industry partners show high confidence in the institutions' adoption of various customer experience attributes.

Operations focus on defining duties, establishing organizational charts, maintaining written procedures, and ensuring proper resource management. The findings show a score of 3.99 with a VD of 0.61, indicating a highly adopted (HA) level in Operations. Overall, the industry partners show high confidence in the institutions' adoption of various operational attributes.

Project management assesses the institution's commitment to proactive project management, flexibility in applying processes, and expert use of current techniques.The findings show a score of 4.08 with a VD of 0.60, signifying a highly adopted (HA) approach in Product and Innovation. Overall, the industry partners show high confidence in the institutions' adoption of various product and innovation attributes.

Furthermore, concerning employee welfare, the people dimension evaluates policies concerning personnel, employee welfare, safety, recognition, and opportunities for development. The results indicate a score of 3.99 with a VD of 0.54, suggesting a highly adopted (HA) approach within the People dimension. Overall, industry partners exhibit high confidence in the institutions' adoption rate of various people-related attributes.

The consistently high adoption scores imply a robust commitment across all dimensions. Based on assessments from industry partners, the institution appears well-prepared and has effectively implemented

strategies and practices associated with the Fourth Industrial Revolution. These high adoption scores reflect a proactive approach across various dimensions essential for addressing the challenges and capitalizing on the opportunities presented by the 4IR.

Table 8 Industry Partners' Assessment of the readiness of Institutions to Adopt the Industry Revolution 4.0

Strategy and Leadership	**WX**	**s**	**VD**
Negotiates willingly to get things done	3.89	0.88	HA
Encourages people to use uniform procedures	3.94	0.78	HA
Maintains honesty in dealing with people	4.04	0.78	HA
Associates individuals who have influence	3.82	0.76	HA
Holds people accountable for results	3.92	0.77	HA
Encourages staff members to do "what is right"	4.16	0.76	HA
Preserves the relationship by finding compromising solutions	4.09	0.73	HA
Decides on how things are done	4.02	0.78	HA
Develops alliances with people from inside the organization	4.13	0.75	HA
Shows respect and consideration on staff members' options	4.18	0.74	HA
Respects the privacy of people	4.02	0.78	HA
Develops alliances with people from outside the organization	4.14	0.68	HA
Encourage people to become leaders	3.86	0.87	HA
Enforces rules and policies	4.03	0.88	HA
Promotes commitment of people to the industry's long-term goals	4.04	0.78	HA
Creates win-win solutions when dealing with people	4.11	0.74	HA
Stands firm on decisions based on principle	4.00	0.75	HA
Establishes work rules	4.11	0.74	HA
Recognizes people for good work	4.00	0.75	HA
Works hard to develop a shared direction for the organization	4.00	0.82	HA
Puts the interest of the organization before their own	4.06	0.71	HA
Assists people to anticipate opportunities	3.78	0.92	HA
Holds people responsible for their commitments	3.76	0.90	HA
Monitors the work of staff	3.79	0.83	HA
Tries to meet the people needs	4.17	0.69	HA
Aggregate	4.00	0.56	HA
Costumer Experience			
Provides satisfactory service by the customer care	4.11	0.81	HA
Helps or attends to customer queries	3.98	0.82	HA
Manifests knowledge of the products and services offered by the institution	4.06	0.75	HA
Exhibits politeness to customers	4.01	0.81	HA
Opens to suggestions to improve the quality of services and products	4.17	0.77	HA
Maintains a user-friendly website or platform	4.00	0.75	HA
Aggregate	4.05	0.55	HA
Operations			
Clearly defined the duties of key employees of the company	4.17	0.77	HA
Establishes organizational chart with clearly defined line of responsibility	4.11	0.74	HA
Evidence of written procedures maintenance covering the recording of transactions	3.89	0.74	HA
Provides for requisition of materials	3.98	0.83	HA

Identifies and procures material resources	3.94	0.85	HA
Proper accounting of the material resources	3.97	0.77	HA
Maintains periodic schedule for preventive and corrective maintenance of equipment and technical materials	3.97	0.84	HA
Maintains proper time scheduling for ordering of resources	3.93	0.85	HA
Aggregate	3.99	0.61	HA
Product and Innovation			
Welcomes proactive response project management as essential contributor to meeting business objectives	4.27	0.68	HA
Commits to proactive and systematic management of projects	4.16	0.70	HA
Shows evidences that formal processes are flexibly applied to match requirements	3.94	0.71	HA
Project management processes are regularly refreshed or updated	4.02	0.73	HA
Expert use of all current techniques	4.01	0.74	HA
Aggregate	4.08	0.60	HA
People			
Defines clearly the policies in regard to authority, responsibilities and duties of the personnel	4.00	0.75	HA
There is a provision for the personnel selection, placement, training, development and promotion	4.01	0.74	HA
Provides for human relation functions necessary for the development of employee morale and for the maintenance of discipline and union relations	4.11	0.73	HA
Provides for a reasonable and justifiable employee remuneration consisting of wages, salaries, bonus or other monetary incentive schemes	3.82	0.84	HA
Provides welfare activities and employee services both within and outside the organization	3.94	0.71	HA
Considers recommendations of the different committees in the formulation of policies	3.94	0.71	HA
Provides policies for job analysis, sources of recruits and selection procedures	3.98	0.75	HA
Provides policies which cover the employees health, safety, hygiene, industrial hazards, etc.	3.78	0.92	HA
Gives recognition and appreciation for quality and exemplary services	4.14	0.71	HA
Considers employee suggestions	3.98	0.75	HA
Gives opportunities for personnel development	4.09	0.74	HA
Provides facilities for participation and counseling	3.96	0.75	HA
Maintains effective communication and management decisions	4.14	0.70	HA
Aggregate	3.99	0.54	HA

**1.00-1.79: Not Adopted (NA); 1.80-2.59: Partly Adopted (PA); 2.60-3.39: Neutral (N); 3.40-4.19: Highly Adopted (HA); 4.20-5.00: Fully Adopted (FA)

CONCLUSION

In conclusion, the findings of this study shed light on the capability of Technical and Vocational Education and Training (TVET) institutions in Zamboanga del Norte and their industry partners for the Fourth Industrial Revolution (4IR). Through an analysis of demographic profiles, assessment of readiness dimensions, and industry partners' perspectives, several key insights have emerged.The demographic profile analysis sheds light on the composition of respondents from both training institutions and industry partners, showcasing a diverse representation in terms of gender and position. This diversity ensures a comprehensive understanding of readiness for 4IR, encompassing viewpoints from various stakeholders such as students, teachers, administrators, CEOs, and employees. The high involvement of industry partners in educational processes underscores the vital collaboration between the education sector and industry, essential for aligning educational programs with industry needs.

Furthermore, the assessment of TVET institutions' readiness for 4IR across three critical dimensions (Process, Infrastructure, and Organization) reveals both strengths and areas for improvement. While there is a moderate level of agreement among respondents regarding the institution's preparedness, highlighted by positive perceptions in understanding global trends and working closely with industry, there are noticeable gaps, particularly in embedding crucial elements like big data and cloud computing into the curriculum. With strategies drawn from theories, such as the Innovation of Diffusion Theory (Rogers 2003), institutions can develop strategies to enhance their readiness, focusing on fostering a culture of innovation, providing professional development opportunities, and aligning curriculum with 21st-century skills.

Moreover, the study reveals a significant disparity in perceptions of organizational readiness for the Fourth Industrial Revolution (4IR) among different position groups within TVET institutions and their industry partners. Specifically, while there is a general agreement among male and female respondents on the need for organizational improvement, significant differences emerge when analyzing responses based on position. The data indicate that students rate the organization's readiness highest, followed by administrators, with teachers rating it the lowest. This divergence, evidenced by a Kruskal-Wallis (H) value of 12.72 and a p-value less than the alpha level, suggests differing experiences and expectations among these groups.

The disparity in perceptions can be understood through the lens of the Adaptive Technological Perception Theory (ATPT), grounded in Bandura's concept of self-efficacy from social learning theory. Self-efficacy, the belief in one's ability to succeed in specific situations, significantly influences how different groups perceive and engage with technological advancements. Students, often digital natives, may exhibit higher self-efficacy regarding new technologies, leading them to view the institution's readiness more favorably. Their continuous exposure to technology in their personal and educational lives likely bolsters their confidence and optimism about the institution's capabilities.

Administrators, on the other hand, might have a more balanced view, acknowledging both the progress and the gaps in readiness due to their strategic role and oversight responsibilities. They are likely aware of the institutional efforts towards integrating 4IR technologies and the challenges in implementation, resulting in moderate ratings.

Teachers, however, who are on the frontline of implementing technological changes, may encounter practical challenges that students and administrators do not fully appreciate. These could include insufficient training, inadequate resources, and the pressures of adapting teaching methods to incorporate new technologies. Their lower ratings reflect these on-ground realities and a possibly lower self-efficacy in dealing with these rapid changes, highlighting a critical area for targeted interventions.

To address these disparities and achieve a cohesive readiness across all groups, it's essential to enhance the self-efficacy of teachers through comprehensive training programs and support systems. These should focus on practical, hands-on experiences with new technologies to build confidence and competence. Furthermore, fostering an environment of continuous feedback and collaboration among students, teachers, and administrators can bridge the perception gap, ensuring that all stakeholders feel equally prepared and supported in navigating the 4IR landscape. This alignment is crucial for fostering an organizational culture that embraces technological advancements and collectively drives towards improved readiness and innovation.

Lastly, the assessment of industry partners' readiness in adopting 4IR reveals a high level of adoption across various dimensions such as Strategy and Leadership, Customer Experience, Operational Efficiency, Product and Innovation, and People. These findings indicate a strong commitment and effective adoption of strategies and practices associated with 4IR, positioning the institutions well to navigate the challenges and opportunities presented by the Fourth Industrial Revolution. In summary, while there is no significant difference in the assessment of readiness for IR 4.0 in terms of organization based on sex, there is a significant discrepancy based on position. Administrators/principals/supervisors have a distinct perception of readiness compared to students and teachers in the organization dimension. This highlights the importance of

considering the perspectives of different positions when evaluating organizational readiness for IR 4.0 in TVET institutions.

RECOMMENDATION

Based on the comprehensive conclusion and findings of the study, it is evident that there are several key recommendations that can significantly enhance the readiness of Technical and Vocational Education and Training (TVET) institutions and their industry partners for the Fourth Industrial Revolution (4IR).

There is a pressing need for curriculum enhancement to address identified gaps, particularly by integrating essential elements such as big data, Augmented Reality, Simulation, Internet of Things, and cloud computing. This entails a thorough revision and updating of the curriculum to ensure alignment with the evolving demands of 4IR. Moreover, incorporating 21st-century skills and global trends into the curriculum is crucial to adequately equip students for the future workforce.

Foster a culture of innovation within TVET institutions is paramount. This can be achieved by providing faculty and staff with opportunities for professional development focused on innovative teaching methods, emerging technologies, and industry trends. Encouraging experimentation and creativity in teaching approaches will better prepare students for the rapidly changing technological landscape.

Strengthen collaboration between TVET institutions and industry partners is essential to ensure that educational programs meet industry needs and requirements. Facilitating ongoing communication and engagement between educators and industry professionals will enable the identification of emerging trends, skills gaps, and job market demands, allowing TVET institutions to tailor their programs accordingly. Establishing platforms for sharing successful initiatives, lessons learned, and innovative approaches can foster a supportive ecosystem conducive to collective growth and development. Identifying best practices and successful strategies employed by industry partners and integrating them into TVET institution practices and policies will further enhance readiness for 4IR.

Develop tailored strategies to address varying perspectives among stakeholders, especially in organizational aspects. Recognizing the diverse roles, responsibilities, and levels of authority within the institution is crucial. Implementing strategies that effectively engage and align the perspectives of administrators, teachers, and students towards common goals is essential for success.

Regular assessment and evaluation of initiatives and interventions, coupled with feedback mechanisms, will allow for the refinement and adjustment of strategies as needed. Fostering a culture of continuous learning and adaptation will ensure that TVET institutions remain responsive to evolving technological and educational trends.

Moreover, the development of the Adaptive Technological Perception Theory (ATPT) suggests several additional recommendations to guide TVET educational and organizational initiatives towards fostering a culture of technological readiness and adaptation. There is a need for the integration of insights from both social learning theory (Bandura) and the specific technological environment ATPT (M'Lee theory). Educational and organizational efforts should strive to create environments where social interactions are enriched by exposure to relevant technological contexts and experiences. Moving forward, there is a need for further research and evaluation to deepen our understanding of individuals' perceptions and attitudes toward technological advancements, particularly concerning gender differences. This research can inform the development of targeted interventions and strategies to address specific challenges and opportunities identified within different demographic groups.

Moreover, the development of the Adaptive Technological Perception Theory (ATPT) suggests several additional recommendations to guide TVET educational and organizational initiatives towards fostering a culture of technological readiness and adaptation. There is a pressing need for the integration of insights

from both social learning theory (Bandura) and the specific technological environment. Educational and organizational efforts should strive to create environments where social interactions are enriched by exposure to relevant technological contexts and experiences. Furthermore, by implementing these recommendations, organizations can effectively leverage the insights of the Adaptive Technological Perception Theory (ATPT) to navigate the challenges and opportunities presented by the Fourth Industrial Revolution (4IR) in an inclusive and informed manner.

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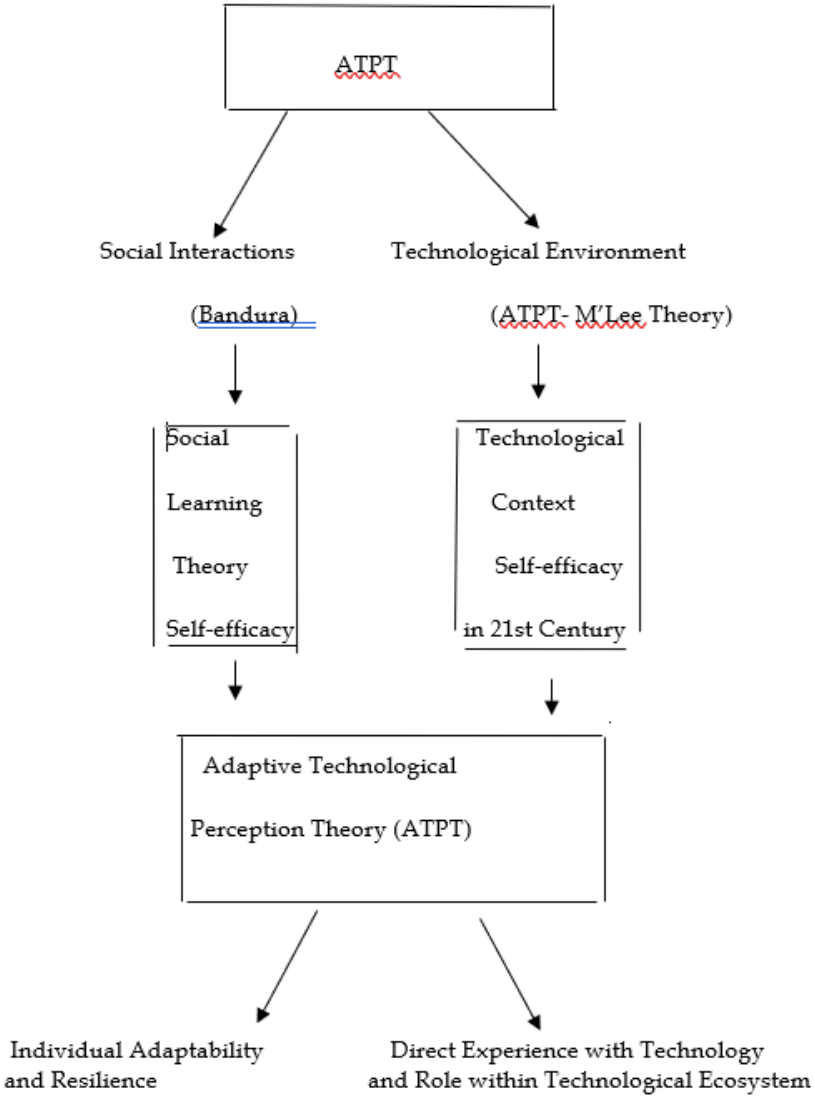
APPENDIX

Adaptive Technological Perception Theory (ATPT)



Albert Bandura's concept of self-efficacy, defined as an individual's belief in their capability to succeed in specific situations or accomplished a task, is integral to the development of the Adaptive Technological Perception Theory (ATPT) within the context of the Fourth Industrial Revolution (4IR). This concept is highly relevant in the 21st century, where rapid technological advancements, globalization, and changing socio-economic landscapes demand continuous learning, adaptability, and resilience.

In the rapidly evolving technological landscape of the 4IR, self-efficacy significantly influences how individuals perceive and engage with new technologies. Those with high self-efficacy are more likely to explore, adopt, and master new technologies, enhancing their readiness for 4IR challenges and opportunities. This readiness is not merely a function of technological familiarity but also of adaptive capacity—the ability to cope with and thrive amidst technological changes, which is bolstered by a strong sense of self-efficacy.

Self-efficacy is a key determinant of how well individuals adapt to new technological environments. Individuals with high self-efficacy exhibit greater confidence in their ability to learn and apply new technological skills, making them more resilient and adaptable in the face of 4IR-related changes. This adaptability is driven by a continuous learning mindset; individuals who believe in their ability to learn new technologies are more inclined to pursue lifelong learning, ensuring they remain relevant in an ever-changing job market.

Social influences also play a vital role in shaping self-efficacy within ATPT. Bandura's social learning theory emphasizes observational learning, where individuals with high self-efficacy model successful behaviors observed in peers, mentors, and industry leaders, further enhancing their technological readiness. Social interactions and peer support reinforce self-efficacy, encouraging individuals to embrace new technologies and innovate within their organizations.

Direct experiences with technology, particularly those that result in mastery, build self-efficacy. Successful interactions with new technologies boost confidence, reinforcing the belief in one's ability to handle future technological challenges. Positive feedback and reinforcement from these experiences further motivate individuals to continue exploring and adopting advanced technologies.

In the context of technological ecosystems, self-efficacy empowers individuals to take on roles that require frequent interaction with advanced technologies. These empowered roles enable them to lead technological initiatives and drive innovation within their organizations. High self-efficacy individuals often assume leadership and mentorship positions, guiding others through technological transitions and fostering a culture of technological competence and readiness.

At the organizational level, cultivating self-efficacy in the 21st century (M'Lee) among members is crucial for 4IR readiness. Organizations that encourage a belief in the collective ability to succeed with new technologies can drive transformation and innovation. Targeted training and development programs that build self-efficacy through practical, hands-on experiences with new technologies can enhance overall organizational readiness for 4IR, ensuring that both individuals and organizations can navigate the complexities and opportunities of the digital era with confidence and resilience.

Integrating Bandura's self-efficacy more deeply into ATPT (M'Lee Theory) offers a thorough perspective on how individuals perceive and adapt to technological advancements in organizational settings. These experiences are closely linked to individuals' roles within technological ecosystems, which vary across different positions within an organization, such as students, teachers, and administrators in TVET institutions—especially in the context of the 21st century.

Collectively, these factors—technological environment, adaptation capacity, social influences, direct experiences, and roles within ecosystems—impact an organization's readiness for technological advancements, such as the Fourth Industrial Revolution (4IR). The diagram emphasizes that while social learning provides a foundation for understanding how behaviors and attitudes are formed to encourage

creativity and productivity, ATPT extends this by considering the direct and specific impacts of the technological context. This comprehensive approach underscores the importance of both social and technological factors in preparing individuals and organizations for the future workforce and technological innovations.