REVIEW OF TVET POLYTECHNIC CURRICULUM OF ELECTRICAL & ELECTRONICS TECHNOLOGY FROM THE PERSPECTIVE OF 4IR.

Md. Billal Hossain (Team Leader)

Md. Raisul Islam (Member)

Md. Nazmul Haque (Member)

Supervisor

Professor Dr. Mohammad Tariq Ahsan
Institute of Education & Research (IER)
Dhaka University

Directorate of Technical Education (DTE)

F-4/B, AGARGOAN, SHER-E-BANGLA NAGOR, DHAKA

Declaration

We declare that this dissertation entitled *"Review of TVET polytechnic curriculum of electrical & electronics technology from the perspective of 4IR"* is the result of our own research except as cited in the reference. This work has not been represented elsewhere by the authors for any degree or diploma. We also declare that the sources for information and materials, used in this report, are cited properly. Moreover, we have acknowledged the support and assistance that we received during the research.

Md. Billal Hossain
(Team Leader)
Instructor (Tech/Electronics)
Mymensingh Polytechnic Institute

Md. Raisul Islam
(Member)
Jnr. Instructor (Non-Tech)
Mymensingh Polytechnic Institute

Md. Nazmul Haque Hoque
(Member)
Jnr. Instructor (Non-Tech)
Mymensingh Polytechnic Institute

Date: 05 May, 2023

Abstract

This research aimed to explore the present scenario of TVET polytechnic curriculum of electrical and electronics technology regarding the fourth industrial revolution and suggested a way forward to mitigate the challenges. The main objective of this research was to find out the compatibility of the current curriculum to face the challenges of 4IR. Moreover, what types of 4IR related technologies are currently available in the industries or institutes and identify the challenges that may be necessary for this, was the purpose of this research too. This research was formatted in two stages. In the first stage, a literature searched was followed to identify the elements of 4IR and curriculum contents were analyzed to demonstrate the minimum skills that are needed to implement the 4IR technologies. In the second stages, primary data were collected from the students, teachers and personnel of industries based on the knowledge, practice and engagement regarding 4IR elements. This study used both qualitative and quantitative approaches to justify the research objectives and to answer the research questions. The target population was the students (8^{th} semester) of electrical and electronics technology, teachers of same technology of various polytechnic and the personnel of renowned industries in Mymensingh Division. A massive data set was generated by conducting a feasibility study using both close ended & matrix questionnaire from 240 students and information were collected through face-to-face interview from twenty-two teachers as well as three industry personnel. The data collection instrument consists of self-designed questionnaire and a semi-structured interview guideline while the data analysis techniques included descriptive statistics and thematic analysis. In this research, it was found that most of the students did not have proper knowledge about 4IR elements like artificial intelligence, internet of things (IoT), robotics and automation, Smart-Grid etc. and they thought the current curriculum is not updated enough to mitigate the challenge of 4IR. The teachers also thought that the laboratory works for the students should be modernized with the most contemporary topics of 4IR and they need more training in particular topics like Embedded System, PLC, RPA, Circuit prototyping etc. Industry professionals found their new recruit from TVET not qualified enough to mitigate the challenges of 4IR. We recommend that both structured and object-oriented programming language, Smart-Grid & IoT based subject contents need to be included in the curriculum of electrical and electronics technology. Finally, this study will contribute to the body of knowledge on TVET polytechnic curriculum policy maker. The information that demonstrated in this research can serve as a reference for policymakers, educators and researchers in improving TVET polytechnic curriculum and promoting sustainable growth in the era of fourth industrial revolution.

Acknowledgment

We would like to express our deep appreciation to the honorable Director General (Additional Secretary) **Dr. Md. Omar Faruque**, Directorate of Technical Education for his valuable bits of advice, constructive idea continuous support and time to time guideline to complete the research work. Our heartfelt gratitude also goes to Director (Admin), **Engr. Md. Jaynal Abedin**, DTE for his valuable and constructive suggestions of this research work. We are also grateful to Director (Planning & Development) **Engr. Md. Akhtaruzzaman**, Directorate of Technical Education for his kind instruction and continuous support.

We would like to express immense appreciation and gratitude to professor **Dr. Mohammad Tariq Ahsan**, Institute of Education and Research (IER), University of Dhaka. His consistent and sympathetic guidance, support and critical feedback helped a lot to prepare the dissertation. He always gave us important and crucial suggestions to make the paper as flawless as possible. Really, we learnt more about the structure of the report and methodology that we need to follow for successful completion of the work.

We also would like to express our honor and gratitude to the principal of Mymensingh Polytechnic Institute, **Md. Shoket Hossain** for his kind cooperation and direction. Most important contributors of this study are the respondents' teachers, students of the different polytechnic. We also want to thank to the principal, vice principal of different polytechnic institute, teachers & students of electrical and electronics technology for helping us to collect data and share their experience for the research. Moreover, express our gratitude to the DGM of Akij Economic Zone, AGM of Minister Hi-Tech Park, DGM and Chief engineer of Mymensingh Power Station for their valuable support in interview.

We are also thankful to the officials of **Research and Knowledge Management Cell** of DTE for their continuous support by giving the important information and providing necessary documents.

We hope this piece of research work will make a significant contribution in reforming the curriculum policy to improve the quality of polytechnic ET & ENT students and that will be the best reward for us.

Authors
Md. Billal Hossain
Instructor (Tech/Electronics)
Md. Raisul Isalm
Jnr. Instructor (Not-Tech)
Md. Nazmul Haque
Jnr. Instructor (Non-Tech)

Date: 05 May, 2023

Table of Contents

List of Tables

List of Figures

List of Abbreviation

2IR	Second Industrial Revolution
3IR	Third Industrial Revolution
4IR	Fourth Industry Revolution
AGM	Assistant General Manager
AI	Artificial intelligence
AR	Augmented Reality
BD	Bangladesh
BNQF	Bangladesh National Qualifications Framework
BTEB	Bangladesh Technical Education Board
CAD	Computer Aided Design
CPS	Cyber Physical System
DGM	Deputy General Manager
DTE	Directorate of Technical Education
ENT	Electronics Technology
ET	Electrical Technology
GDP	Gross Domestic Product
ICs	Integrated Circuits
IER	Institute of Education and Research
IIoT	Industrial Internet of Things
IoT	Internet of Things
IR	Industrial Revolution
KII	Key Informant Interviews
KPE	Knowledge-Practice-Engagement
M2M	Machine-to-Machine
MATLAB	Matrix Laboratory
NFC	Near Field Communication
NSC	National Steering Committee
NTVQF	National Training and Vocational Qualifications Framework
PBL	Project Based Learning
PCB	Printed Circuit Board
PL	Programming Language
PLC	Programmable Logic Controller
RPA	Robotic Process Automation
SPICE	Simulation Program with Integrated Circuit Emphasis
SPSS	Statistical Package for Social Science
SQL	Structured Query Language
SSC	Secondary School Certificate
STRS	Smart traffic and road systems Smart traffic and road systems
TMED	Technical and Madrasah Education Division
TVET	Technical and Vocational Education Training
VR	Virtual reality
CKT	Circuit

Chapter- One: Introduction of the Study

1.1.Introduction

Development of a country is possible by converting people into manpower. The Fourth Industrial Revolution (4IR) is a buzzword and building skilled manpower is essential to meet its demands. New generation needs to acquire new skills in automation, digitalization and information technology to cope with the changing scenarios. TVET is one of the ways to create skilled manpower. The graduates of TVET Polytechnic's Electrical and Electronics Technology can come forward to mitigate the challenges of the Fourth Industrial Revolution. For this reason, curriculum must be enriched and up-to-date to meet the challenges of 4IR. This research will review the curriculum of electrical and electronics technology regarding fourth industrial revolution.

The word "revolution" means abrupt and radical changes that occurred throughout the history when new technologies or thought introduced to trigger the profound change in economic and social structure (Alan & Tromble, 1999). **Industrial revolution** is defined as the major changes and transition in manufacturing and industrial process with new innovative technology. **Fourth Industry Revolution (4IR)** or **industry 4.0** is a new phase in the industrial revolution that introduce intelligent net-working of machines and process for industry with the help of information and communication technology. The Fourth Industrial Revolution is a way of describing the blurring of boundaries between the physical, digital, and biological worlds. In short, it connects physical world with digital world. It's a fusion of advances in artificial intelligence (AI), robotics, the Internet of Things (IoT), 3D printing, genetic engineering, quantum computing, and other technologies. That's meant the CPS (Cyber physical system) & M2M (Machine to Machine) have been brought together that can operate itself (machines) without human intervention (Chunguang, Patrick, Guido, & Joseph, 2021).

TVET (**technical and vocational education and training**) refers to all forms and levels of education and training which provide knowledge and skills related to occupations in various sectors of economic and social life through formal, non-formal and informal learning methods with practical implementation of various technologies (UNESCO, 2011). One of the TVET institute is polytechnic that can produce skilled diploma graduate as BNQF/NTVQF-6 category. Technology in the polytechnic like electrical and electronics can produce skilled person for the prosperity of the country.

The word "curriculum" began as a Latin word which means "a race" or "the course of a race" (Wiles, 2008)·The race is to mitigate the challenges of new idea or thoughts. A curriculum for a particular education policy plays vital role to cope with industry revolution. The industry revolution is not a new thing, so does the job transformation. The human race has been in a constant pursuant in developing technologies to transform jobs so that jobs are being done at a lower cost in producing higher quality outputs. Now, question is that if it has been happening since the beginning of our civilization why should we be concerned about its today's industry revolution?

The seeds of the **first industrial revolution (4IR)** were sown in the 18th century, when the world uncovered the potential of steam power. This power of steam was harnessed to replace muscle power in manufacturing. The **second industrial revolution (2IR)** was based on electricity, assembly lines and the replacement of iron with steel, to name a few. This had a dramatic impact on manufacturing resulting in increased production and decreased cost. The **third industrial revolution (3IR) (**also known as the **Digital Revolution**) is the shift from mechanical and analogue electronic technology to digital electronics which began in the later fall of 20th century

with the adoption and proliferation of digital computer and digital record keeping that continues to the present day (Signé & Ndung', 2020). Each industrial revolution has propelled the human race forward, in terms of economic benefits and the quality of life. So, the past three waves of industry revolution where technological advancement and demographic changes have led to increase the prosperity, productivity and job creation. That means these three transitions were free from risk and inequality. The technological advancement in the past three waves is not free from human intervention. But the 4IR technological advancement is free from human intervention and that can dragonize itself for operation. The anticipating and preparing for the current transition are therefore critical. So, it's time to predict and prepare with the right capacity for leveraging continuously unfolding opportunities. Competency about 4IR technology is important because it pushes the economic growth of the country towards sustainable development by generating human capital that can economically, socially and politically develop the country without neglecting environmental aspects. But the scenario of diploma graduates of electrical and electronics are very worse as they face various problem when they enter in the job market. A survey shows that most of the industry claims they had to spend extra two years to trained the graduates of diploma engineer to acquainted them with their technologies. So, definitely there is gap between learning and industry practice. This study is an endeavor to find out the gap. This study will find out the ramification of 4IR technologies and the review of curriculum of Electrical Technology (ET) and Electronics Technology (ENT) to mitigate the challenges.

1.2. Purpose of the research:

Unquestionably, Technical and vocation education & training might be a crucial component for long-term sustainable growth of a country. The present research will be able to know about the general condition of TVET polytechnics graduates who are engaged with electrical and electronics technology. This research will highlight the components of 4IR regarding the curriculum of electrical and electronics technology. This research will identify the current facts and forms of TVET polytechnic. It also justifies the compatibility of electronics technology regarding 4IR. As a result of this, on the one hand, as it will facilitate the adoption and implementation of necessary policies and programs to deal with the various problems and challenges for implantation of 4IR technologies. On the other hand, this research will also play a positive role in building awareness among the general public. Recommendations can be presented to government TVET policy makers. This research can also play a fruitful role in comparing the results of various researches conducted in the country and abroad on curriculum review for 4IR. Additionally, this study can serve as a secondary source for subsequent researchers.

1.2.1. Objectives

There objectives of this research are-

1. To review the compatibility of TVET polytechnic curriculum of Electrical & Electronics technology for 4IR.
2. To find out the current technologies related to 4IR are available in TVET Polytechnic institute and industries.
3. To identify the challenges for addressing 4IR.

1.2.2. Research Question

Based on the objectives of this research, this study will go forward by following some question:

i. What are the main elements of 4IR and its interaction with industries or factories?

ii. Are the curriculum contents of electrical and electronics technology suitable for 4IR?

iii. What is the general understanding of the current contents of curriculum of electrical and electronics technology by the students and teachers?

iv. What are the environmental facts of learning and practicing for electrical and electronics technology?

v. What are the perceptions of students, teachers and industry personnel regarding curriculum and learning process electrical and electronics technology?

1.3. Limitations of the study

The study has been conducted on the basis of Electrical and Electronics Technology (ET & ENT) of diploma engineering. The research area was based on Mymensingh Division. Data was collected from three polytechnic institute (Two government and One Non-Government) and three factories (one autonomous and two private). It has not been able to paint a true picture of the whole polytechnics of the country. Moreover, there was shorter period of time for data analysis and participants perceptions about this study wasn't considerable whole way.

Chapter-Two: Literature Review

2.1. Introduction

The TVET and skills development system has been adapted over a period of time to meet the specific needs and systemic preconditions of Bangladesh. The TVET policy and the institutional structure have focussed on the demand-supply side of the labour market. The country has given high priority for TVET system and skill development at all levels. There has been requisite scientific, technological education, technical skills that can help develop country's economic growth and development (Chandrasekar 2015).

For a country like Bangladesh the emphasis on TVET and skill development system is yet to reach the aspirations of learners and employers. The training on self-employment at this level has yet to achieve its importance. The human resource requirement with relevant skills needed for the employment have varied with time, trends of development in the market requirements and demand in the employment sector. These changes pose challenge to the training service providers, training units and relevant key stakeholders. Bangladesh as a country needs to adopt a dynamic strategy for rapid economic growth and realizing the vision of Vision 2041 and beyond.

Different nations are going forward to include 4IR related subject like IoT, Robotics Automation, Smart-Grid etc. in their technology. India, the native country of Bangladesh has taken initiatives to include IoT (Internet of Things) in the diploma curriculum of electronics technology. Maharashtra State Board of Technical Education, Mumbai has already included IoT in electrical/electronic engineering curricula (Maharashtra State Board of Technical Education, 2019). Moreover, the diploma engineering process of Singapore and Malaysia are far fast. They have already introduced this in their respective curriculum. (EduSpiral Consultant Services, 2020).

In Bangladesh, Universities are taking steps to introduce IoT subject in their curriculum. Bangabandhu Sheikh Mujibur Rahman Digital University (BDU) have owned their department based on the components of 4IR and IoT. But, it a matter of sorrow that no initialization has taken for diploma engineering curriculum modification. It's impossible to make smart Bangladesh without keeping most of diploma engineer behind the dark. Sometimes, it has been called that diploma engineer especially the graduate of electronics technology is the torch bearer of country.

Thus, we need to prepare our students to fit into that newly emerging market. Many of our public and private universities have had a fair share of success as well as lacking in terms of developing their curriculum looking at the needs of the country as well as the needs of the global hyper-technology-based markets.

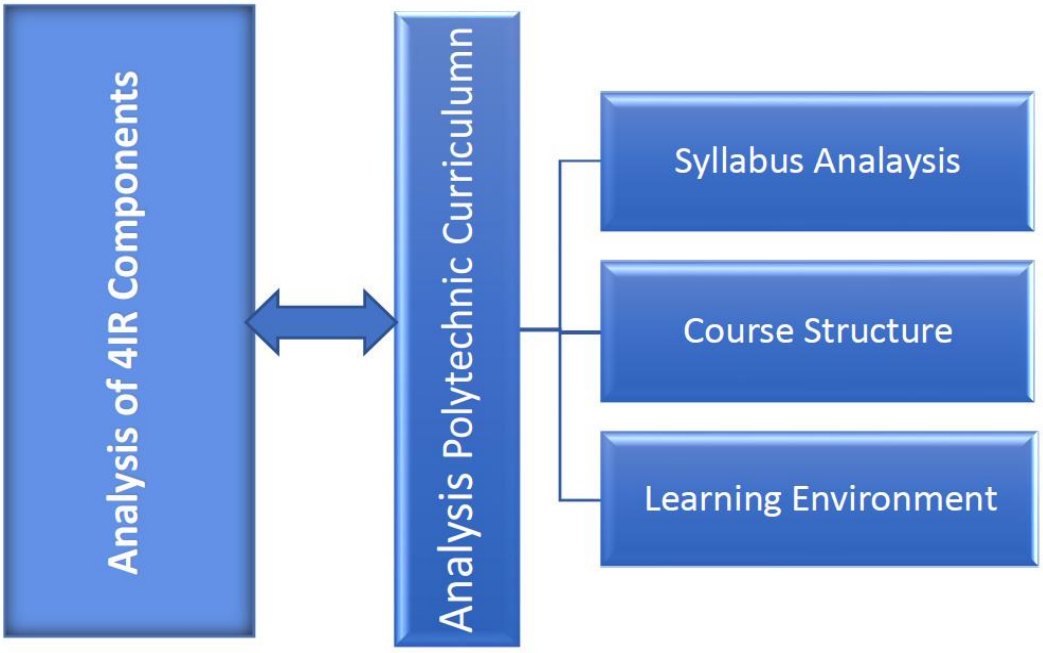
Countries such as Germany, France, Japan and Sweden have very effective and extensive technical and vocational education and training program, while TAFE (technical and further education) institutions in Australia have been running a wide range of mostly vocational courses. The result of TVET in Australia is a rigid system that is narrowly centered on work-related competencies to the elimination of broader education that makes the students response to quick changes in the economy, technology and social development. Australia has been a pioneer as well as a follower of the innovation perspective of TVET (Newaz, Jefferies, & Davis, September-2016).

We need to explore what new skills will be required in the coming years of the 4th industrial, digital and space revolution to compete with other countries. We need to spend more money for technical education not only for providing higher degrees but also for different certified diplomas

and short trade courses under various specialized technology departments. Bangladesh's budgetary allocation for higher education is less than 0.5 per cent of the GDP; this is way lower than some of the other least developed countries. A slow and fragmented approach to implementing the national education policy 2010 needs urgent action. According to policy recommendation BTEB is tuning and aligning the traditional TVET courses to the National Technical and Vocational Qualifications Framework (NTVQF). In these circumstances, in this research we tried to evaluate the compatibility of current curriculum of electrical and electronics technology of TVET system for fourth Industrial revolution. This study examined the readiness of the graduates of electrical and electronics technology from Mymensingh Division.

2.2. Study Design:

To find the answer of the research questions one and two, a literature study was designed in the following format-



For the study design-

- A literature search was conducted to identify the main components of 4IR technologies.
- A curriculum content was analyzed for electrical and electronics technology.
- A brief analysis of KPE (Knowledge, Practice and Engagement) was investigated for the graduates electrical and electronics technology considering the learning environment.

2.2.1. Curriculum Contents of ET & ENT that can work as Parameter for 4IR:

According to the probidha-16 and probidhan-22, the following subjects can be considered as the stack holders of 4IR elements (BTEB, 2023) .

Name of the Subject	Electronics Technology (ENT)	Electrical Technology (ET)
PCB Design & Prototyping	✓	✓
Control System and Robotics	✓	✓
Microcontroller/Microprocessor & Embedded system	✓	✓
Automation & PLC	✓	✓
Basic Electronics/Electricity	✓	✓
Digital Electronics	✓	✓
Industrial/Power Electronics	✓	✓
Programming Language	✓	✓
Generation of Power	✓	✓
Transmission & Distribution of Power	✓	✓

Table 1: Major contents of curriculum of electrical electronics engineering regarding 4IR.

2.2.2. Main components of 4IR:

Klaus Martin Schwab the founder chairman of World Economic Forum, this era to be marked by breakthroughs in emerging technologies in fields such as artificial intelligence, machine learning, robotics and automation, virtual & augment reality, internet/industrial internet of things, cloud computing & Big data, 3D printings, Biotechnology etc. (Schwab, 2016)

The following table shows main components of 4IR Technologies and minimum technical skills need to cope with these technologies.

Components	Description	Minimum technical skills need
AI (Artificial Intelligence) and Machine learning	Artificial Intelligence (AI) is a computer system's ability to mimic human behavior. Machines demonstrate this sort of intelligence, which can be compared to a natural intelligence that humans and animals demonstrate (Ciregan, Meier, & Schmidhuber, 2012).	• Programming languages, such as Python, Java, and C++ to build and implement models. • Spark and Big Data Technologies ((Vasquez, 2018)
Robotics and automation *	Robotics refers to the design, manufacture, and use of robots for personal and commercial use. They are used in fields as wide-ranging as manufacturing, health and safety, and human assistance (Rosheim & E., 1994) . Automation, on the other hand, refers to the technology by which a process or procedure is performed without human intervention. Automation can be achieved through the use of control systems, such as programmable logic controllers (PLCs).	• Knowledge about Embedded System (Coding, Electronics, Assembling, Integration with microcontroller) • PCB designing • PLC design (Northeastern University, 2020) ✓ **(ET & ENT)**
Virtual reality (VR) and augmented reality (AR)	VR offers immersive digital experiences (using a VR headset) that simulate the real world, while augmented reality (AR) merges the digital and physical worlds.	• Programming Knowledge- C#, C++ etc. • Content Creation /Integration-Graphics design

Internet of things (IoT) * & industrial internet of things (IIoT)	The **Internet of things** (**IoT**) describes physical objects (or groups of such objects) with sensors, processing ability, software and other technologies that connect and exchange data with other devices and systems over the Internet or other communications networks. Whereas IIoT refers to interconnected sensors, instruments, and other devices networked together with computers' industrial applications, including manufacturing and energy management.	Knowledge about- • Electronics & Circuits • Industrial Electronics • Programming /Machine Learning • Network & Security (Howell, 2020) ✓ **(ET & ENT)**
Cloud Computing	Cloud Computing is the on-demand availability of computer system resources, especially data storage (cloud storage) and computing power, without direct active management by the user. Cloud computing is the delivery of different services like data storage, servers, databases, networking, and software through the Internet.	Knowledge about- • Programming and Database - SQL, My-SQL, Java, Python, Ruby, Golang, PHP and .NET etc. • Networking and virtualization.
3D printing	3D printing (prototyping in engineering) allows manufacturing businesses to print their own parts, with less tooling, at a lower cost, and faster than via traditional processes. Plus, designs can be customized to ensure a perfect fit.	Knowledge about- • Graphics design like CAD/CAM/CAE system.
Quantum computing	Quantum computing is an area of computer science focused on the development of technologies based on the principles of quantum theory. These computers will have the potential to supercharge AI, create highly	-------

	complex data models in seconds, and speed up the discovery of new materials.	
Biotechnology	Biotechnology harnesses cellular and biomolecular processes to develop new technologies and products for a range of uses, including developing new pharmaceuticals and materials, more efficient industrial manufacturing processes, and cleaner, more efficient energy sources.	----------
Cybersecurity*	Cybersecurity technology is anything that protects your digital systems from internal and external attack vectors. Modern cybersecurity involves tech such as blockchain or artificial intelligence and can guard new technologies such as industrial IoT devices	Knowledge about- • Hardware, software and firewall intrusion, • cryptography • Programming knowledge- Python and C++ (BasuMallick, 2022) ✓ **(ET & ENT)**
Moreover, Some other component of 4IR technologies		
Smart grid	Smart grid is an electricity network based on digital technology that is used to supply electricity to consumers via two-way digital communication. This system allows for monitoring, analysis, control and communication within the supply chain to help improve efficiency, reduce energy consumption and cost, and maximize the transparency and reliability of the energy supply chain.	Knowledge about- • Circuits, digital systems, and power system • Programming knowledge- C/ C++, MATLB • Renewable energy (AET LABS, 2021) ✓ **(ET & ENT)**
Smart traffic and road systems*	Smart traffic and road systems (STRS) include smart roads, driver assistant, traffic congestion monitoring, smart traffic and streetlights, smart parking, smart transportation etc.	Knowledge about- • Electronics & Circuits • Bigdata analysis • Programming /Machine Learning • Network & Security ✓ **(ET & ENT)**

5G wireless system *	5G wireless technology is meant to deliver higher multi-Gbps peak data speeds, ultra-low latency, more reliability, massive network capacity, increased availability, and a more uniform user experience to more users. Higher performance and improved efficiency empower new user experiences and connects new industries.	Knowledge about- • Communication Engineering • Networking • IT (Tagami, 2019) ✓ **(ET & ENT)**

Table 2

(4IR main technolgies with respect to curriculum contents ofET &ENT)

Note: This table demonstrate the components of 4IR technologies and the minimum technical skill that need to acquire.

✓ (ET & ENT) - Cross analysis the component of 4IR with the polytechnic curriculum contents of Electrical and Electronics technology.

* After analyzing the curriculum contents this study had found that some 4IR components such as **Robotics and Automation**, **IoT & IIoT, Smart- grid, Cybersecurity, Smart traffic and road system** can match with syllabus content of Electronics and Electrical technology of polytechnic curriculum. This study used these key term * for the interview and questionnaire.

2.2.3. Learning Environment

A learning environment is more than just a classroom and its space in which students feel safe and supported in their pursuit of knowledge as well as inspired by their surroundings. Learning environment increases student's attention and focus promotes meaningful learning experiences, encourage higher levels of student's performance and motivates students to practice higher level critical thinking skills (Bonwell & Eison, 1991). Learning environments can be students or learner centered, knowledge centered, assessment centered and community centered. So, this study aimed to focus on on polytechnic pedagogic and didactic practices, workshop materials and equipment for practical training, teaching methods, work integrated learning and integration of theory and practice in technical subjects regarding 4IR technologies.

2.2.4. Industry-Academia Linkage (Student's Engagement)

Over the years, industry-academia collaboration has enhanced knowledge, innovation and played an integral part in the economic growth of developed countries. The objectives of such linkages can vary on the basis of its scope and agreement between university and industry. They may involve in high intensity linkage to low intensity linkage. (Gandhi, 2014)

Current practice in the academia of Bangladesh-

The students of ET & ENT have to search for industrial attachments by own self or the attachments may be arranged by the faculty teachers. We tried to figure out any partnership exist between polytechnic institute and industry. Moreover, in every there is a facilities of job placement cells but the effects of these in the industry academia practice is negligible.

2.3. TVET Skills Framework:

The Bangladesh Skills Development System has two components; the National Training and Vocational Qualifications Framework (NTVQF) and the National Skills Quality Assessment System. The Bangladesh National Qualifications Framework (BNQF)combines general education, technical-vocational education and higher education into one harmonized, quality-assured system. For four years, the ILO Bangladesh has been supporting the Technical and Madrasah Education Division (TMED) of the Ministry of Education to develop this framework and define clear pathways, level descriptors and a concrete structure for the BNQF. The government has demonstrated its commitment to the BNQF by setting up a National Steering Committee (NSC) chaired by the Minister of Education. It has also set up seven technical working groups, headed by senior education officials. (NTVQF, 2020)

Each qualification level is described in terms of level descriptors that are internationally accepted since they are appropriate for both competency-based and knowledge-based learning programs. Level descriptors are used by curriculum developers to design learning and assessment programs for each level. They can also be used by learners and employers to determine what knowledge, skills and attitudes a person can apply at that level. student to leave the TVET and Skills

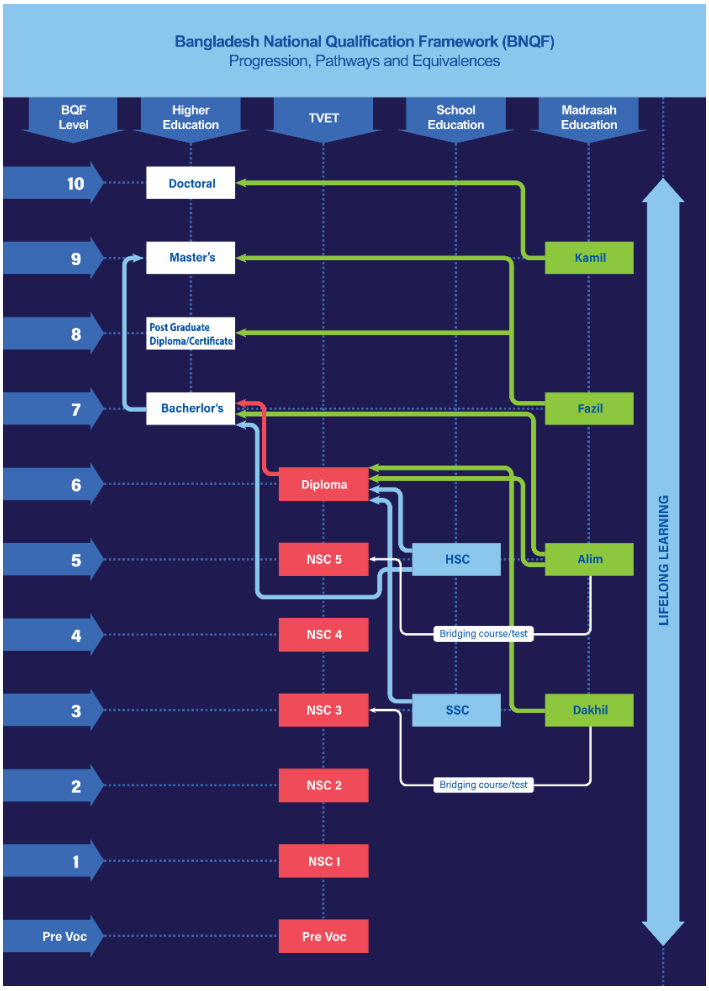
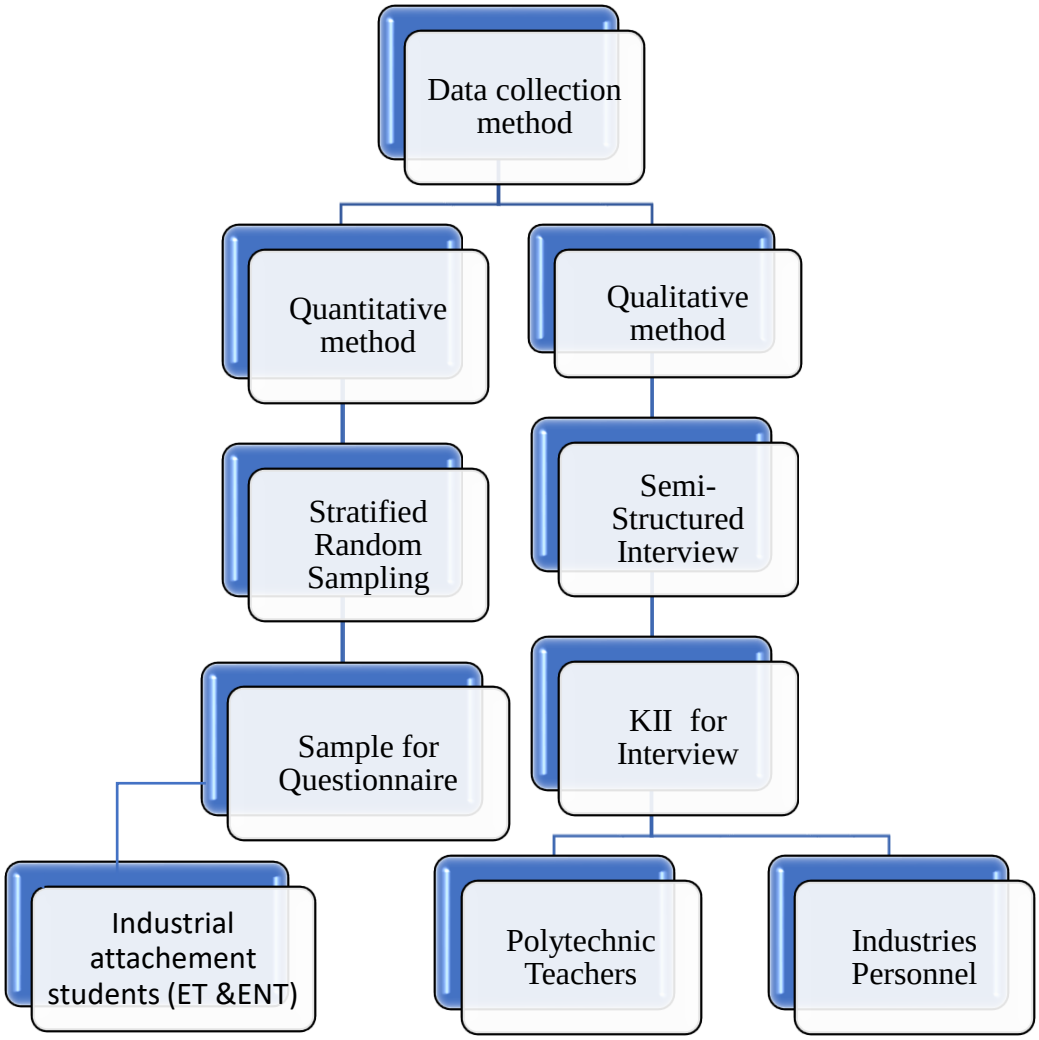


Figure 1 (BNQF Skill Framework of Bangladesh)

Chapter- Three: Methodology of The Study

3.1. Research Design:



This study had followed **mixed method both qualitative and quantitative**. This study collected primary data from the students & teachers of polytechnic and industries in Mymensingh division. It is a case of three (3) factories and Four (3) TVET polytechnic institute from Mymensingh division. For **Qualitative method,** this study has focused on polytechnic pedagogic and didactic practices, workshop materials and equipment for practical training, work integrated learning and integration of theory and practice in technical subjects regarding 4IR technologies. The methodology of collecting data for qualitative method was **semi-structure interview** and observation of various TVET institute and factories of Mymensingh Division. Data also had been gathered via **semi-structured interviews purposively** from number of TVET teachers and

employers of factories. Interview had been conducted from the polytechnic institution's instructor /chief instructor (male &female) and industries person at selected factories. Observation was done in the class of interviewed teachers and working environment of factories.

For **Quantitative method**, A descriptive research design had been used and data was collected over a period of 2 months (February 2023-March 2023) by a **stratified random sample** of ET & ENT students in three polytechnics. It allowed the researchers to amass a great deal of information from a large sample of participants, for example, by means of a survey.

3.2. Data Source

Data was collected from both primary and secondary sources. Primary data were collected form the students and teachers of different polytechnic institute and the personnel of industry by questionnaire and face-to-face interviews. And the secondary sources data were collected from different journals, research paper, website of BTEB etc.

3.3. Sample & Sampling:

Data Source	Sample Size	Sampling Technique	Tools
Raw data from the students of ET & ENT (8^{th} Semester)	240	Stratified random sampling	Questionnaire
Teachers of Polytechnic Institute	22	Semi-structured (purposively)	Interview
Personnel of Industry	3	Semi-structured (purposively)	Interview

Table 3

Note: The table-3 demonstrated primary data sources with sample size and sampling technique. It also illustrates the tools of data collection.

3.4. Data Collection Method:

We use two methods to collect primary data: a questionnaire and face-to-face interview. We also used secondary data to support our findings.

3.4.1. Questionnaire:

We designed thirty items close ended and matrix questionnaire based on the three criteria-

- General understanding of the curriculum contents regarding 4IR.
- Learning environment and practicing in industries/factories
- Perception about the diploma degree

We also pilot -tested the questionnaire on 20 students who were not part of this study. We revised the questionnaire based on their feedback and suggestions. We have used stratified random sampling to select 240 students from two government polytechnic (Mymensingh Polytechnic & Sherpur polytechnic) and one private polytechnic (RUMDO Institute of Modern Technology).

These were the students of eighth semester both shifts who have recently experienced for industrial attachments. Two member was appointed to collect raw data. The questionnaire was distributed physically among the students and a discussion class was conducted before they filled out the questionnaire. We collected data confidentially with the basic information of the participants.

3.4.2. Face-to-Face Interview:

We designed semi-structured interview question based on the research objectives and questions of the research. The interview questions aimed to demonstrate the current condition in the institute and industries. We interviewed twenty-two teachers (instructor/Jnr. Instructor/ Chief Instructor) of same polytechnic institute and three personnel of industries (AKIJ Economic Zone, Minister Hi-Tech Park and Mymensingh Power Station). We conducted the interviews at their convenient time and place. We recorded and transcribed the interviews with their permission.

3.5. Data Analysis Method:

We used different methods to analyze our primary and secondary data.

3.5.1. Questionnaire data:

A massive data set was generated by conducting a feasibility study using closed ended and matrix questionnaire from 240 students of various polytechnic students of ET & ENT technologies. SPSS has also been used in this study to analyze quantitative data. The data was cleaned by using SPSS, so that we can ensure the missing data. There was no any missed data and we analyzed data successfully. Additionally, in order to emphasize on the outcome, we analyzed the data by using suitable codebook. We performed descriptive statistics to summarize the demographic characteristics of the participants and their responses to each item. We interpreted and reported the findings using tables, graphs, charts and narrative. SPSS is an IBA statistical software suite for data management, advanced analytics, data filtering, business intelligence and many more investigation. SPSS is popularly used for social science research. So, our findings of quantitative data analysis can provide strong validation.

3.5.2. Interview data:

We applied thematic analysis for information & opinion that had been collected from the teachers and personnel of industries. We interpreted, compared and reported the findings using quotes, charts, tables and narratives.

3.6. Overall Research Approach

In order to find the answer of research questions, this research had been splinted into two stages.

In the first stage, data was analyzed based on secondary source and in the second stage, data was analyzed based on primary sources.

3.6.1. Stage-1:

- A literature search was conducted to identify the major elements of 4IR technologies and its interactions with industries or factories.
- The contents of curriculum of electrical and electronics technology were analyzed to find the components that can cope with the technologies of fourth industrial revolution.

- To support this study, environmental fact of learning and practicing of polytechnic institute were analyzed based on knowledge, practice and engagement for the students of electrical and electronics technology.

Literature investigation can provide the answer of research question-1. Based on the literature investigation, this study forwarded to collect primary data.

3.6.2. Stage-2:

In the second stage, primary data were collected and for this-

- Face to face interview were taken from the TVET polytechnic teachers and the personnel of industries or factories.
- Questionnaire for polytechnic students of 8^{th} semester (ET & ENT) who have experienced both institute lab practice and industrial attachments.

The primary data were analyzed by descriptive statistics and thematic analysis. Finally, a critical discussion and recommendation was given for the enhancement of curriculum contents.

Chapter-Four: Findings

Since Bangladesh is thriving to be a developed country by 2041, 4IR can play the most pivotal role in this journey. For successful adjustment with 4IR and mitigate the challenges of 4IR contemporary TVET is a must. For the development of TVET in this research tried to find out the current problem of TVET polytechnic (ET & ENT) and updated its curriculum to mitigate the challenges of 4IR.

4.1. Findings from the secondary sources:

The preliminary findings of research question one and two were demonstrated in the point 2.2 and 2.3 in the section of literature review. The key elements of 4IR that can accomplish the task of current curriculum are-

- Robotics and Automation
- IoT and IIoT
- SMART-GRID
- Smart traffic and road system and
- 5G Wireless system and Networking

Based on the discussions of main 4IR technologies and by the analysis of syllabus content. For the implementation of these 4IR technologies a graduate of electrical & electronics technology should have following minimum technical skills-

- Electronics & Circuit Design
- Embedded System, Integration of Circuit with Microcontroller and Microprocessor
- Circuit Simulation, PCB design
- PLC
- Programming Language & Machine Learning
- Networking & Security, Communication Protocol
- Power distribution system etc.

Then it was needed to find out actual scenario of polytechnic institute and industries.

For this purpose, this study was carried based on three criteria-

- General understanding of the curriculum contents regarding 4IR.
- Learning environment and practicing in industries/factories
- Perception about the diploma degree

4.2. Findings from the primary sources:

This research was collected data from the students electrical and electronics technology of various polytechnic institute and teachers of same polytechnic as well as personnel of industries. Findings were represented with various graph, chart, table etc.

4.3. Sample Demographic Characteristics

Firstly, we demonstrate the demographic characteristics of participants for validation of our findings.

4.3.1. Demographic Characteristics of Students:

Table-4 summarize the demographic and academic characteristics of 240 students who have almost completed their diploma degree and experienced for industrial attachments. The first set of information shows that among two hundred and forty participants only 6% were female and rest of participants were male. The second set of information demonstrates the institute types of students. It shows that 83.3% were from government polytechnic where rest of were from private institute. Third set shows equal number of students from both technologies. The fourth set of information shows that most of data were collected from the students (140) of first shift where the number of second shift students were hundred.

Sample characteristic	*Frequency (%)*	
	n	*%*
Gender of responds		
Female	*16*	*6.7*
Male	*224*	*93.3*
Type of institute		
Government	*200*	*83.3*
Non-government	*40*	*16.7*
Technology of responds		
Electrical	*120*	*50*
Electronics	*120*	*50*
Shift of the responds		
1st Shift	*140*	*58.3*
2nd Shift	*100*	*41.7*

Table 4: Demographic and academic characteristics of the students

4.3.2. Demographic Characteristics of Teaches:

Table-2 summarized the professional and demographics characteristics of teachers who were selected for face-to-face interview. The first set of information displays the distribution of teachers based on gender. Among twenty-two teachers five female were selected for interview and rest of them were male teachers. Second set demonstrate the designation of the participants. This study has collected and recorded information from 4-chief instructor, 4 -instructor and 11-jnr Instructor. It was confirmed that there was no selection of part time teachers for the interview. The department of the teachers show in the third set of the table. It demonstrated that 54.5 % were from electrical technology and 45.5 percentage were from electronics technology. The shift percentage were equal comparing to the percentage of technology of the selected teachers.

Sample Characteristics	*Frequency (%)*	
	n	*%*
Gender of Teachers		
Female	*5*	*22.7*
Male	*17*	*77.3*
Designation		
Chief Instructor	*4*	*18.2*
Instructor	*7*	*31.8*
Jnr. Instructor	*11*	*50.0*
Others[a]	*0*	*0*
Departments of Teachers		
Electrical	*12*	*54.5*
Electronics	*10*	*45.5*
Shift		
First	*12*	*54.5*
Second	*10*	*45.5*
Employed	*30*	*60*

[a] *Reflects the number and percentage of participants who were designated as part time teachers.*

Table 5: Professional and demographics Characteristics of Participants

4.4. Findings from General understanding of the curriculum contents

Curriculum is the essence of any education system. Education is the transfer of knowledge, attitudes and skills from one generation to the next generation but the curriculum "reflects (the) forms of knowledge, habits of thinking, and cultural practices that a society considers important enough to pass on to succeeding generations". (Adams & Adams, 2003) For better practice in the field, better understanding is need for the curriculum. So, we asked some question to the students of electrical and electronics technology based on curriculum contents that are needed to mitigate the challenges of 4IR.

4.4.1. Idea about 4IR

The research questionnaire was based on three criteria. The first part was based on understanding level of current curriculum content. Based on finding the current technologies of 4IR, this study started questionaries "What is 4RI?" Among 240 samples (students), surprisingly almost 84% of the students do not know the term 4IR and its impact on their technology. Only 16% students have said 'yes', they know what it is but they can't explain details without elaboration the term. We also wanted to know by a supplementary question that any seminar or workshop arranged in their institution or not. Most of them answered 'no'.

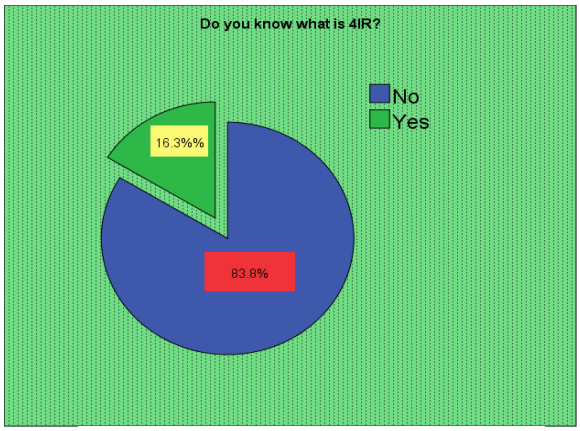


Figure 2 (Percentage of students)

The same query was for the KII of polytechnic teachers, 32% said they have no idea about 4IR and 68% were tried to show logic for the answered 'yes' but couldn't explain the impacts on their technology. Moreover, few of them said their institution arranged workshop or seminar for 4IR or industry 4.0. Most of them didn't experience for this (as shown figure-5).

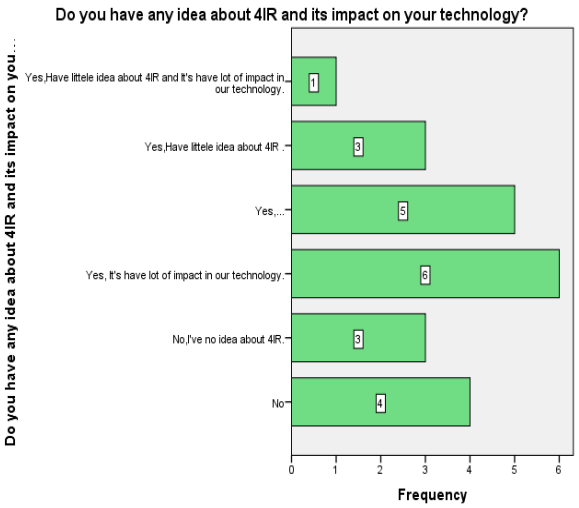


Figure 3 (Percentage of teachers of ploytechnic)

- The same query was ended by the KII of industry personnel, they explained it clearly and they are coping with challenges gradually. They are also being used some basic pillars of industry 4.0 or 4IR. When we asked about the automation in their zone, most of them

interviewed that they are being automated in the following field-*Water Tank Level Control System, Car Washing and Parking System, Flashing Light Controlling System, Automatic Door Opening/Closing System, Remote Monitoring Application like Air Fan, ON/OFF Switching Application like Light, Motor Smart Elevator Control System, Fire Detection and Alarm System, Automatic Machine Handling System, Automatic Vehicle Washer System Automation System f Well Drainage System, Sequence or Numerical Counting and Packing System, Mining Equipment Line Detection and Remote-Control System etc.*

4.4.2. Use of simulation software for circuit design

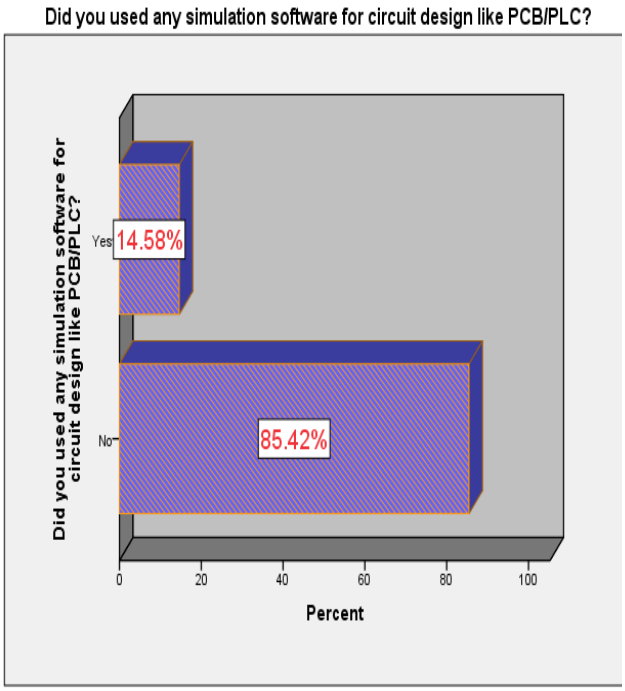


Figure 4 (Percentage of Students used Simulation software)

Circuit design is a basic knowledge for the students of electrical and electronics technology. To cope with the automation, designing circuit with simulation software can be considered as key skills of diploma graduate. It's also part of practicing in their academic learning. The second query was that if they had used simulation software for circuit design. But it's matter of sorrow that 85% among 240 students said they do not know how to use software for circuit design.

Approximately 15% says they have little idea about the circuit simulation though they learnt it from open source and used personally (shown figure-3).

The same query was for the KII of polytechnic teachers, twelve of among 22 teachers expressed their opinion that they never used any simulation software to teach students for circuit design. Rest of them said, they sometimes used simulation software either personal purpose or in lab class. The percentage is ignorable as they were not capable to show valid explanation (as shown in table-3).

Table 6 (Number of teachers used Simulation software)

What kind of simulation software do you use for circuit design like PCB/PLC?

	Frequency	Percent
No	12	54.5
I personally use simulation software like Proteous,MATLAB	1	4.5
Sometimes I use eagle software.	3	13.6
Sometimes Multicim-8 Software used	1	4.5
Sometimes Proteous Software are being used in our Lab class.	5	22.7
Total	22	100.0

- We asked to KII of industry personnel about the use of software in their working procedure. They are using software for a decade. We did not stop by hearing their voice. We also visited most of the working area where everything is monetarized by using software.

4.4.3. Efficiency in programming language

To be competent for 4IR, having good command about programming language is must. As 4IR technologies depends on communication between machine to machine. We wanted to know how much they learned programming language like python/c from their academic's context. We found disaster result of their learning. Among the 240 participants only 7% marked they have the ability to write program whereas 93% unable to learn programing language from their course (as shown figure-7).

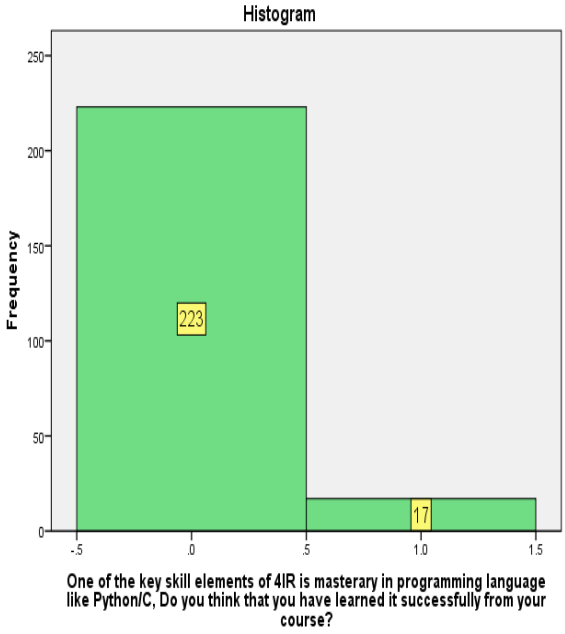


Figure 5 (No of students Efficency in PL)

On the other hand, teachers are the main creator who led their students for learning and the contents of the curriculum. So, this research depicted the scenery of teachers also.

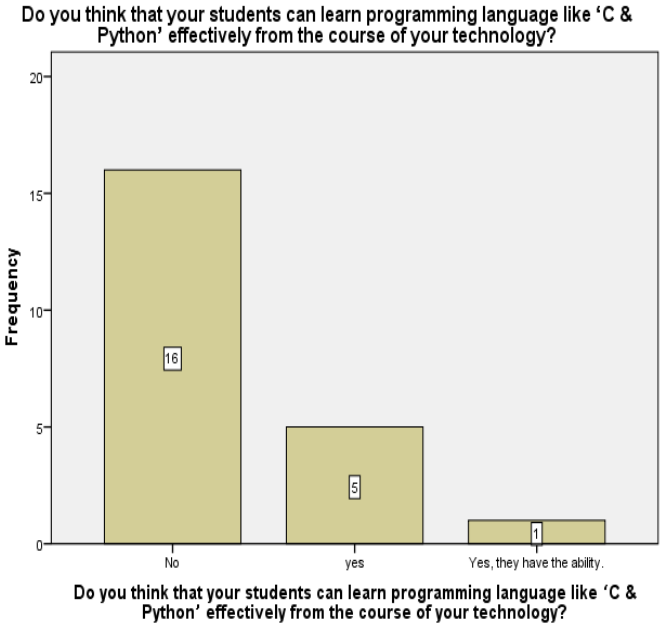


Figure 6 (No. of teachers perception about PL)

Among the 22 teachers of various polytechnic institute, only 28% think that they have minimum knowledge to write program and rest of them expressed their opinion as negative. (Figure-8)

- The researcher of this research wanted to know the perception of industry personnel about the graduate of electrical & electronics engineer. The research asked what they thought about the competency level of programming language for the graduate of ET & ENT. Most of them informed that graduates of polytechnic especially ET & ENT have less knowledge in algorithm and machine learning. Even they do not know what is basic structured of programming. Moreover, most of the graduates ET & ENT do not know how design circuit by u sing software as we were told by the personnel of industries.

4.4.4. Competency in PLC, Embedded System, RPA

An embedded system is processor-based computer hardware that has software that is designed to perform dedicated functions, either as a part of a larger system or as an independent control system. The processor that had been used can be a microcontroller or a microprocessor. Robotic process automation (RPA) is a form of business process automation technology based on metaphorical software robots(bots) or on artificial intelligence (AI)/digital workers. A PLC is a large standalone control unit that is pre-packaged and typically rack-mounted in a control cabinet near the equipment or the process being controlled. So, embedded system and PLC system directly related to robotics process automation. So, this research tried to identified the learning and practicing process of students of ET & ENT about PLC, Embedded system and RPA. This study found that 80% students did not complete any project (practically) based on PLC/Embedded system. Only twenty percent of 240 students marked that they have complete some small projects like water water level control, traffic light system, motion control etc. Almost 96 percent students never completed any project regarding RPA where four percent replied they did it by their own interest (as shown Figure-9).

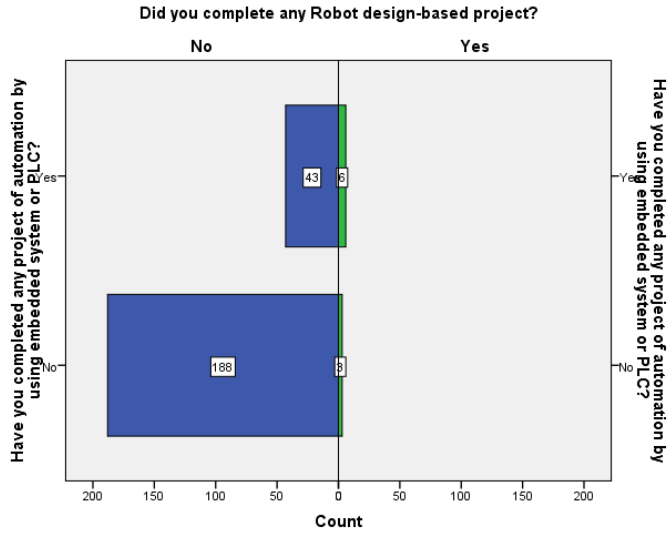


Figure 7 (No of students who completed/not completed the project)

We interviewed the same question to the to the mentors of ET & ENT technology. 73% replied they never supervised any project based on PLC or embedded system. The result was second question was very disaster 96 percent of twenty teachers replied they never supervised any RPA (Robot process automation) based project for the students. Only one teacher replied he supervised a project of RPA (As shown Table- 7).

Statistics

		Do you supervised any project of automation by using embedded system or PLC?	Did you supervise any robot-based project?
N	No	16	21
	Yes	6	1

Table 7 (No. of Teachers)

4.4.5. Lab Facilities

A lab cannot function effectively without precision and accuracy. Scientists and researchers always make it a point to measure reagents accurately in order to record the right readings and get precise results. Incorrect measurements make it difficult to get the desired outcome and the most common ways of making an error are either manual or an error in the lab instrument itself. When you use a lab instrument correctly, not only do you improve the degree of operational safety but also decrease the incidence of manual error. Further, an error in the lab equipment itself can be eliminated by properly calibrating it. To cope with the modern technology, practical knowledge is must for all. This study wanted to know from the students of electrical and electronics technology that how much compatible were their lab equipment when they practice in industrial attachment.

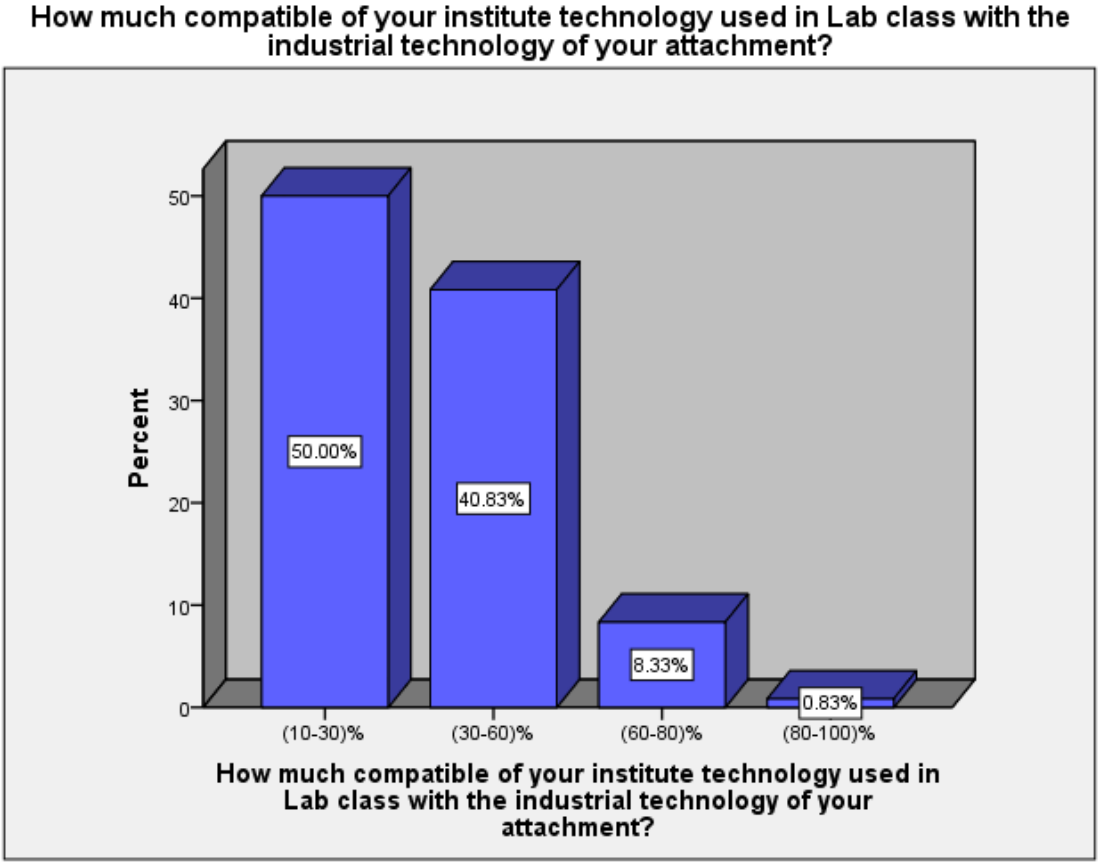


Figure 8 (Percentage of lab equipments matches with industry equipments)

Among 240 student's fifty percent said equipment of lab are not suitable for industry practice and rest of the students marked as below average. Even some students said in the answer option, they had bad experienced in lab class practice.

- When we asked the personnel of industries about the computability of Lab equipment's with their equipment. "We use updated machine; we cope the trends." We feared to rely on the graduates of diploma engineer. They have less experience with the modern device. We have to trained them for few months to cope with the new technologies.

4.4.6. Methods of Teaching:

Teaching methods are the ways to instruct students in a classroom, helping them to understand and remember what they've learned. Some of the best teaching strategies allow educators to convey information in a clear and concise way while also ensuring students retain it over the long term. So, we wanted to hear from the students if their teacher used microteaching or other teaching style in their class. Most of them said "no" only twenty of 220 answered "yes" but they did not provide explanation (as shown in figure-11). Blended learning could be great part of engineering students of ET & ENT. But our findings show a tremendous scenario. It was found that most of the students do not know about this method except 9% of total sample.

Same question was asked to the teachers in the interview, 90.91% expressed that they used tradition methods of teaching whereases only 9.09% told they used other method in teaching (as shown in figure-12).

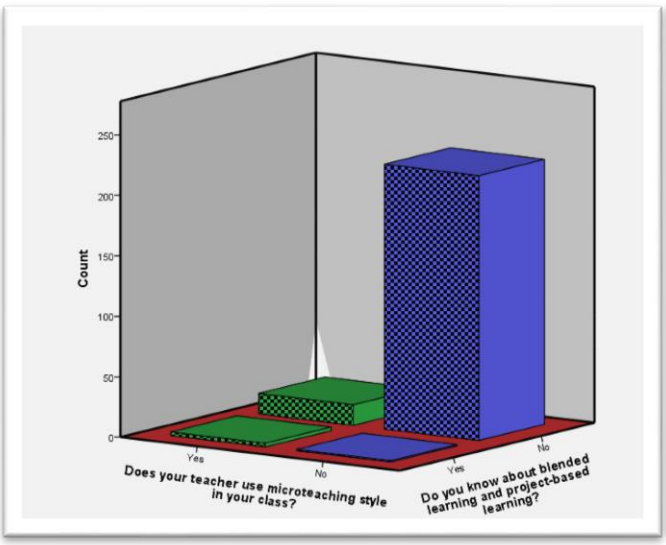


Figure 9: Students answered about teaching methods.

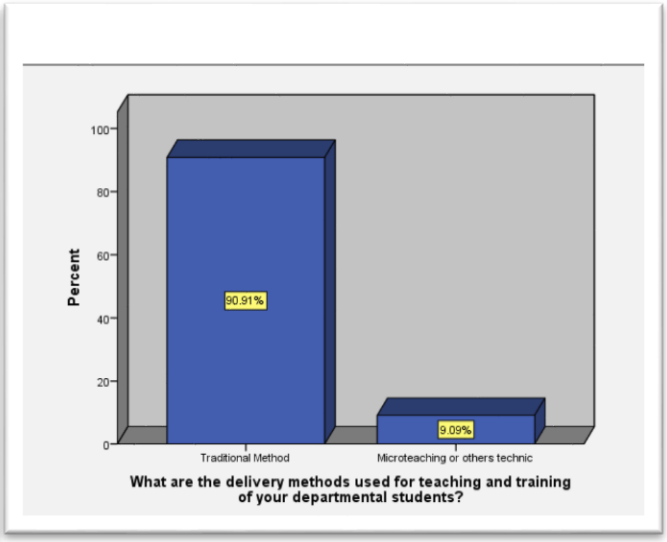


Figure 10: Teacher's opinion about teaching style

4.4.7. SMART GRID:

A smart grid is an electricity network based on digital technology that is used to supply electricity to consumers via two digital communications. This system allows for monitoring, analysis, control and communication withing the supply chain to help improving efficiency, reduce cost and energy consumption. As it can considered the part of subject contents (transmission and distribution of power) we wanted to know this buzzword from the three stack holders. Firstly, we wanted to get answered from the first stack holder of the research sample. We asked to know the knowledge about SMART GRID but the result was shocking. Among the two hundred and forty students only 11.6% heard the term Smart-Grid before although they were unable to provide proper explanation. On the other hand, rest of 88.33% marked this as a new term hearing for the first time (as shown in the figure-13).

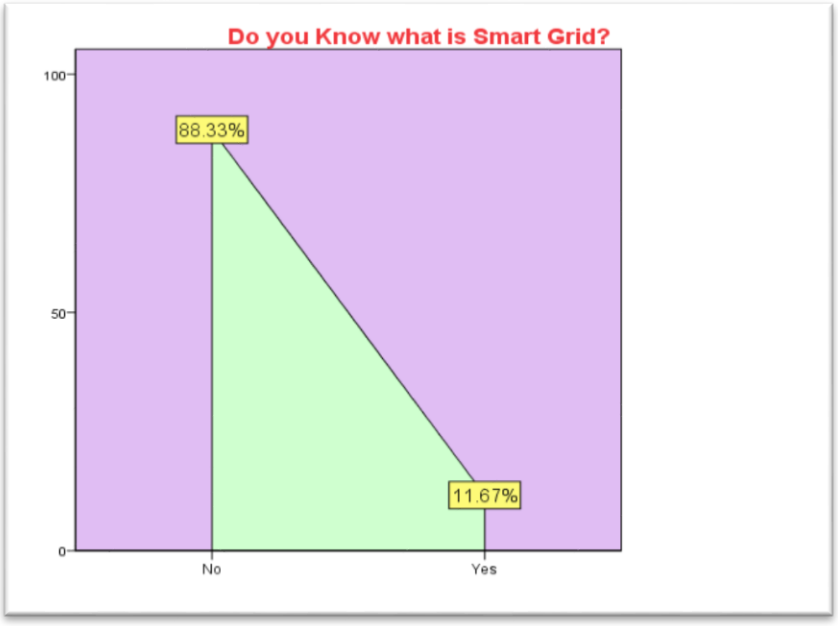


Figure 11: Percentage of Students about Smart Grid

- Same query was for the second stack holders of the sample, the teachers of polytechnic institute. We wanted to the term of Smart-Grid based on the lesson. Among twenty-two only one said that few lesson included in the content although it has no validation owing to give proper proof. Rest of twenty-one teachers expressed their opinion as no (as shown in table-5).

In the content of transmission and distribution, is there any lesson of SMART-GRID system?

Response of the teachers	Frequency	Percent	Valid Percent
No	21	95.5	95.5
Yes, few lesson included.	1	4.5	4.5
Total	22	100.0	100.0

Table 8: Percentage of teachers about the lesson of SMART-GRID.

- The third stack holder was the personnel of industries. We wanted to know if their area were in under SMART-GRID system. Among three of the industries, one industries zone is in under SMART-GRID system and rest of two are trying to cope with this system.

4.5. Learning Environment:

In the second part we tried to find out if the environment of the TVET system is suitable for learning. 64% of the participants agreed with the hypothesis that teaching mentors have a good knowledge of their relative field. 46% thought that the method of teaching is not satisfactory in their classroom 58% of them did not learn python/C program by the guidelines of appointed teachers and they cannot design the module of IoT with practical experience. 60% thought that the communication in students' staff and faculty within their department is clear and frequent and their lab are not highly equipped with modern technologies. Moreover, they strongly disagree with the hypothesis that the library resource is insufficient to further study.

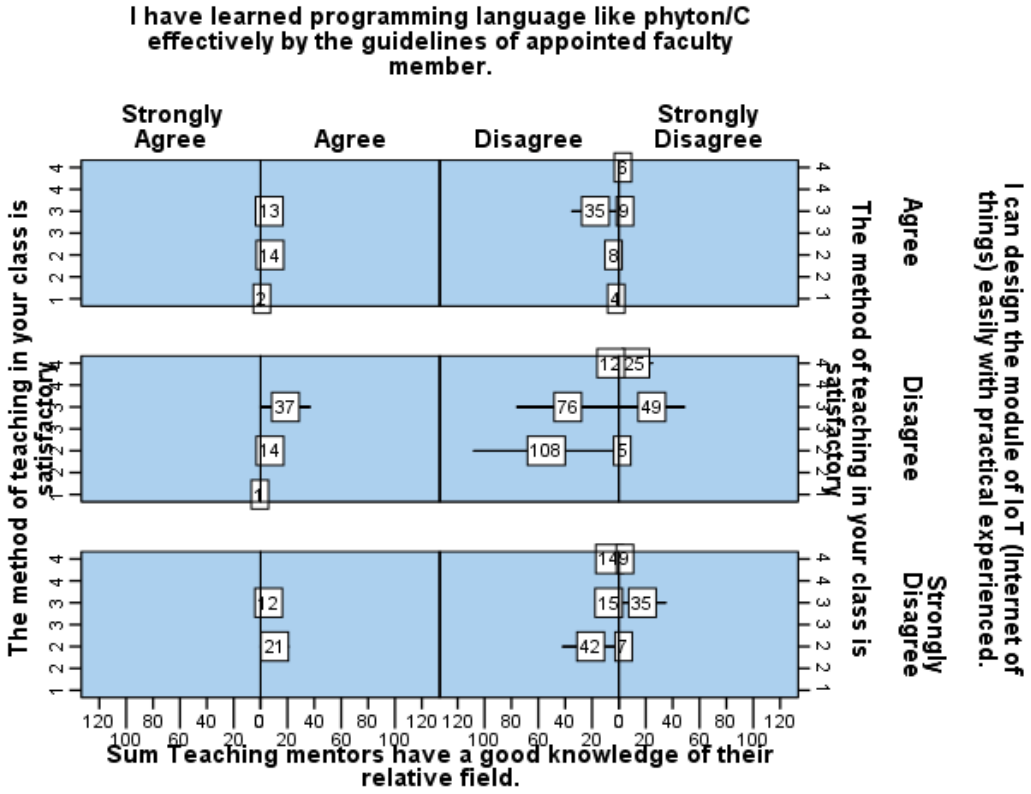


Figure 12 (Practicing facts of students about learning environment)

We have interviewed the teachers of polytechnic and wanted to know the method of teaching they usually taught their students. Almost all 91% teachers said they used traditional methods for the teaching. 9% teacher said they also experienced others method also like microteaching /blended learning but when they asked to explain they were unable to give proper explanation.

4.6. Perception of the students, Teacher and industry personnel:

The process of measuring and judging the extent to which the planned courses, programmers, learning activities and opportunities as expressed in the formal curriculum actually produce the expected results. So, we tried to get opinion of students, teacher and personnel of industry.

4.6.1. Perception of Students:

According to the BNQF/NTVQF skill level criteria, A diploma engineer successfully fulfills the demand of BNQF/NTVQF-6 skills level requirements. But 98% of among 240 participants think that are not skilled as BNQF/NTVQF requirements. Only, two percent thought they are cable as requirements (as shown figure-7). Whereases only nine percent think that they can produce as skilled person as BNQF/NTVQF-6 requirements where 91% failed to produced skilled graduates (as shown table-6).

A diploma engineer successfully fulfills the demand of NTVQF/BNQF-6 skill level requirements, do you think that students are skilled as BNQF-6 requirements?

	Frequency	Percent	Valid Percent
No	20	90.9	90.9
They are qualified as BNQF-6 standard.	1	4.5	4.5
Yes	1	4.5	4.5
Total	22	100.0	100.0

Table 9 (Percentage of teacher's perception for students about BNQF-6 requirements)

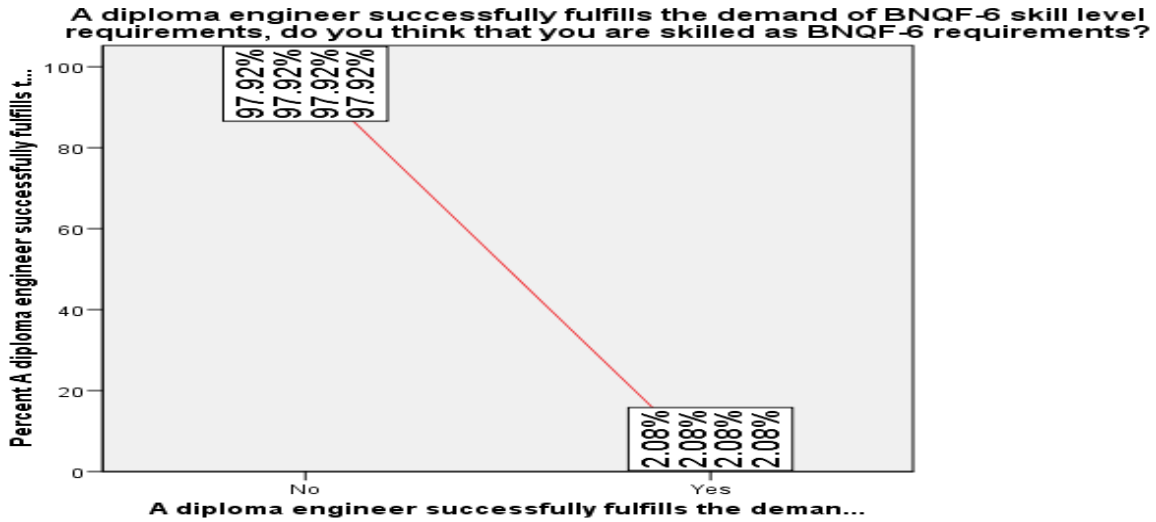


Figure 13 (Percentage of students perception about BNQF-6 requirements)

Again, in the final part students provided opinion about the diploma engineering system and learning process. More than 45% graduate of electrical and electronics technology thought that their skill level is poor to mitigate the challenges of 4IR. Moreover, 39% of total students provide opinion that their lab class quality was very poor and only twenty percent thought that lab class was in moderate level. They thought that their curriculum of diploma engineering is in moderate level and need to update to cope with 4IR technologies.

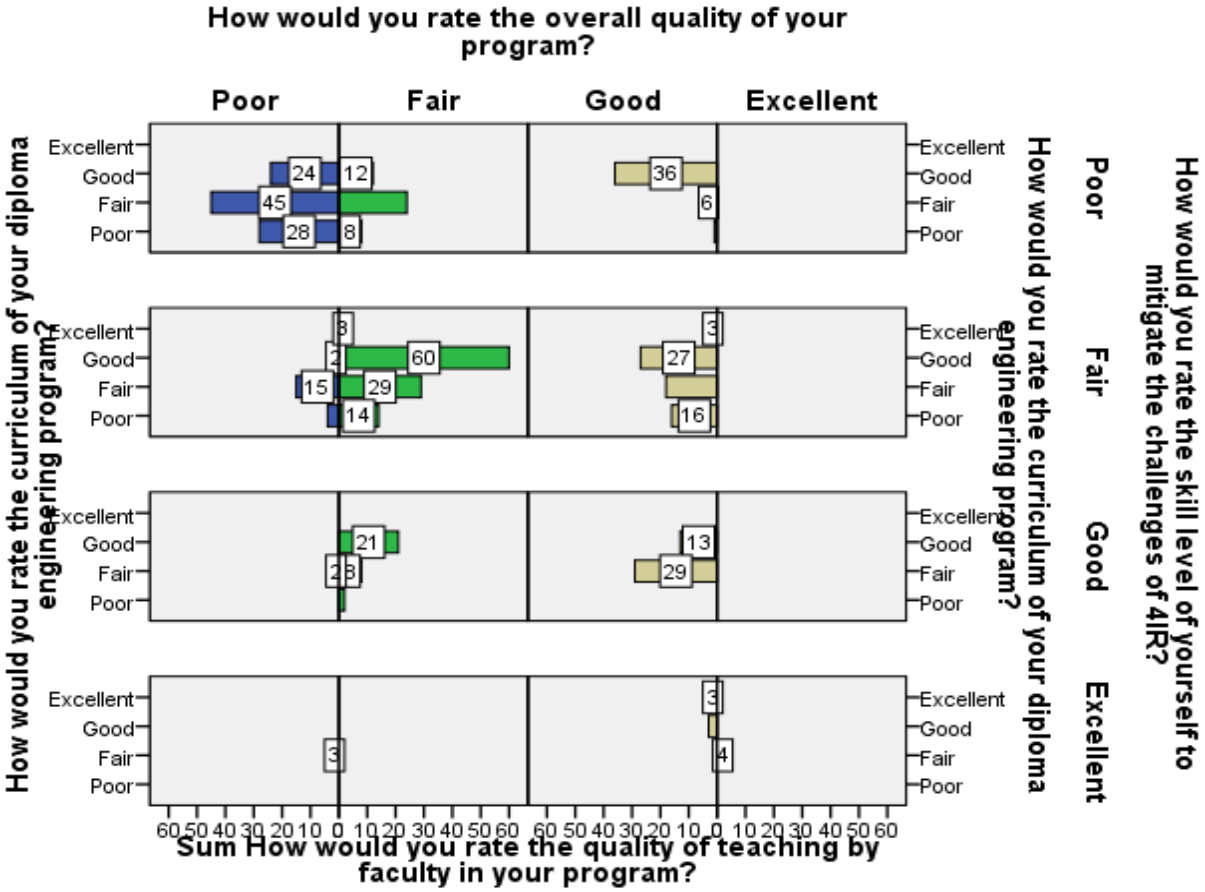


Figure 14 (Perception of students regarding their curriculum)

4.6.2. Perception of Teachers:

Most of the policy makers of developed and developing countries declare Technical Education, a master key for the swift economic growth of a nation. Regrettably, the evidences show that Technical Education could not play the expected role in the industrial and economic growth of Bangladesh. The study aimed to diagnose the causes of not achieving set targets of technical education in Bangladesh and to suggest the solutions to these problems. As the graduate of ET and ENT considered as torch bearer of future industry transformation. So, we wanted to know the facts from the mentors of diploma graduates. Various opinion was found. But more than 50 percent gave same opinion. They provided various opinion regarding their practice and experience.

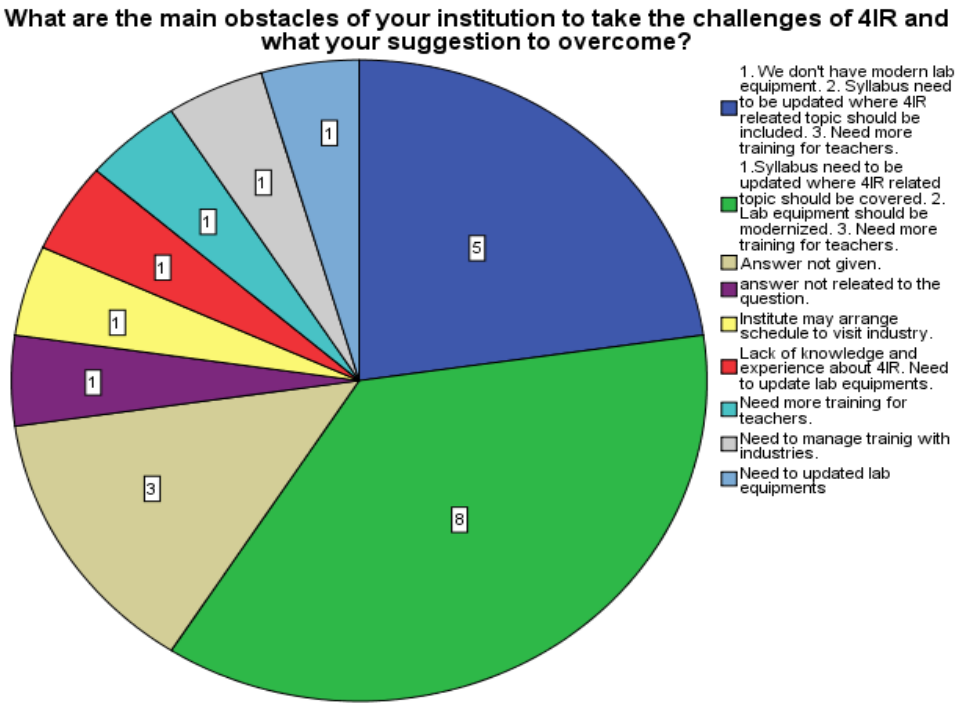


Figure 15 (Represents opinions of teachers of ET & ENT)

This study found some point when summarized their opinion-

- They think that their lab equipment's are not well enough to cope with modern technologies.
- The contents of curriculum need to be updated. 4IR related contents need to add gradually.
- Need more training for teachers to cope with 4IR challenges.

4.6.3. Perceptions of industry personnel:

The researchers asked them "what are the main obstacles of TVET polytechnic institute to take the challenges of fourth industrial revolution and how to overcome?" This research summarized their opinion as pointed below-

- Obstacles
    - Contents of syllabus
    - Learning Environment o
    - Skills gaps or mismatch
    - Acquisition of Teachers and students about industry 4.0
    - Gap in industry-academia linkage
- Overcome
    - Curriculum contents need to update. 4IR and industry practice related content need to add in their syllabus. If authority want, they can hire our experts in curriculum making committee.
    - Students should be taught practically and with circuit simulation.
    - Teacher needs to be trained. Moreover, teacher can stay in our industry to acquainted with our modern technology.

One of them quoted as, "If polytechnic produce skilled graduate, we may save two years".

Chapter-Five: Discussion and Recommendation

5.1. Discussion

The research aimed to identify the challenge of 4IR in the context of TVET system. For precision we only work on the ER & ENT technology. We analyze the content of syllabus and curriculum of this technologies that are taught for the diploma Engineering degree for 4-year duration. This curriculum has been modified time to time and being upgraded to meet the challenge of modern world. We have to new challenge in our hand that is 4IR. To prepare our graduates of ET & ENT the syllabus should be upgraded with 4IR technologies. At first, we approached to identify the current of problems faced by the stakeholders of TVET systems. They seemed have some serious issues with the curriculum and learning environment. Majority of the students find the current situation not suitable for their preparation to meet the challenges they faced in their professional life. Most of the students do not have a fair knowledge of 4IR and its impact in future world. The students do not have practical knowledge of modern technology like smart grid, PLC, programming language on their laboratory is not well equipped and well supervised by the teacher. Many of them find at the learning process uncomfortable as most of the teachers used traditional method of technology. Micro-teaching or project-based learning should be practical all over the country as the students find it very useful. The third stakeholder are the industry personnel who will hire this student, thought that the curriculum must be upgraded as it does not fulfil their fresh circuits are not acquainted with modern 4IR technologies. They recommended that the students should have done practical experiment of PLC, PCB, python, c++ etc. in their curriculum.

Environmental facts of learning and practicing which may declare various terms. The classroom lecture is a special form of communication in which voice, gesture, movement, facial expression, and eye contact can either complement or detract from the content. (Davis, 1993) McCarthy, P. (1992) in article “Common Teaching Methods” stated strengths of lecture method that it presents factual material in direct, logical manner, contains experience which inspires, stimulates thinking to open discussion, and useful for large groups. **Microteaching,** a teacher training technique currently practiced worldwide, provides teachers an opportunity to perk up their teaching skills by improving the various simple tasks called teaching skills. (Sagban, AlMumar, & Hashim, 2021) With the proven success among the novice and seniors, microteaching helps to promote real-time teaching experiences. The core skills of microteaching such as presentation and reinforcement skills help the novice teachers to learn the art of teaching at ease and to the maximum extent. (Rachel, 2016) The impact of this technique has been widely seen in various forms of education such as health sciences, life sciences, and Engineering. This Stanford technique involved the steps of “*plan, teach, observe, re-plan, re-teach and re-observe*” and has evolved as the core component in 91% of on-campus clinical teaching development programs, with the significant reduction in the teaching complexities with respect to number of students in a class, scope of content, and timeframe, etc. (KR, 2019) From the analysis of data in the section of learning environment (4.2) it has been found that most of the students said they do not know other teaching method and 80% of among 22 teachers said they used traditional method and rest of them follow other criteria for teaching.

Circuit simulation is a technique for checking and verifying the design of electrical and electronic circuits and systems prior to manufacturing and deployment.

Simulating a circuit's behavior before actually building it can greatly improve design efficiency by making faulty designs known as such, and providing insight into the behavior of electronics circuit designs (Maksimovic, 1995).
Therefore, form the discussion it is clear that circuit simulation is important part for Electrical & Electronics technology. In the curriculum of ET & ENT, there is clear instruction to use software for circuit design. (BTEB, 2022)
Findings by analysis: In the curriculum of ET & ENT, there is clear instruction to use software for circuit design. But in our findings in Query-2, Approximately 86% student did not know how to use simulation software for circuit design in lab class practicing. On the other hand, 55% of among 22 teachers never used simulation software for circuit design.
Reason: Most of the department of electrical and electronic technology have no own lab facilities. Moreover, they are not well trained for the application of software.

A **programming language** helps in speeding up the input and output processes in a machine. To mitigate the challenges of 4IR having good command over programming language is essential. In the **technical board of Maharashtra India**, it has been found that they already introduce two programming language c & C++ in their respective curriculum of Electrical, Electronics and communication engineering. (Maharashtra State Board of Technical Education, 2019) .Why programming language needed for ET & ENT students? As electrical/electronic engineers, any programming language need to learn, it should have been C/C++. They are need to program the microcontrollers, configure the registers, and students have to be designing and writing test firmware to exercise various parts of the circuit. It allows students to dig into the nuts and bolts of the hardware, writing values into different registers, accessing memory buses, and controlling hardware peripherals. (Secules, Bhattacharyya, & Gupta, 2016) According to the Prabodhan-2016 of diploma engineering curriculum, there was only one subject of programming (python). According to the Prabodhan-2022, it was replaced by the programming-c. Moreover, a new subject computer office application is also included in the latest Prabodhan. (BTEB, 2022) The research analysis shown (Query-4) that 93% students of ET &ENT did not learn programming successfully from the course of academic. Their mentor thought students unable to learn it successfully. ***Embedded System & PLC*** An embedded system is processor-based computer hardware that has software that is designed to perform dedicated functions, either as a part of a larger system or as an independent control system. The processor used can be a microcontroller or a microprocessor. (Shirriff, 2016) A PLC is a large standalone control unit that is pre-packaged and typically rack-mounted in a control cabinet near the equipment or the process being controlled. (Tubbs, 2018)Each topic is included in the curriculum of electrical and electronics technology for learning & practicing. The findings of data analysis in query-4 shows that eighty percentage students of ET & ENT did not complete any project by using embedded system or PLC where 70% teachers have no good command over this and they did not supervise any project regarding PLC/Embedded System.

The **Internet of things** (**IoT**) describes physical objects (or groups of such objects) with sensors, processing ability, software and other technologies that connect and exchange data with other devices and systems over the Internet or other networks. this subject can be acquainted with the modern engineering (Shafiq & Gu, "The Rise of "Internet of Things, 2022). There are some new radio communications protocols to be aware of things, like Bluetooth LE, Near Field

Communication (NFC) and LoRa, so technology introduced projects using these as well (Igoe, 2017). Different nations are going forward to include this subject in their technology. Maharashtra State Board of Technical Education, Mumbai has already included IoT in electrical/electronic engineering curricula. (Maharashtra State Board of Technical Education, 2019) Moreover, the diploma engineering process of Singapore and Malaysia are far fast. They have already introduced this in their respective curriculum. (EduSpiral Consultant Services, 2020)

Smart Grid A smart grid is an electricity network based on digital technology that is used to supply electricity to consumers via two-way digital communication. **Findings by analysis** This research analyzed the curriculum of ET & ENT, there was no content about SMART GRID. Moreover, the research found that 89% of among 240 students do not know the term smart grid.

5.2. Recommendation:

1. Based on the discussion and our analysis of the current practice and teaching methodology in various polytechnic institute, this study recommended for microteaching method or for the betterment further study need to acquainted new style of teaching in polytechnic.
2. For **Circuit simulation,** Computer lab need to established for ET & ENT departments of polytechnic institute. So that they can be able to practicing software for designing circuit. Moreover, teachers need to be trained either in house or external for the circuit simulation.
3. Two type **programming language** need to be included in the curriculum of ET & ENT-
    - Structured Programming – C *[Due to characteristic of Imperative, Procedural]* (Valentine, 1974)
    - OOP (Object Oriented Programming)- C++ *[Due to characteristic of Imperative, Object oriented, Functional, Procedural, Generic]* (McLoone, 2012)

    Moreover, computer office application needs to be dropped out as it was included in the curriculum of class nine & ten (SSC level). (Secondary and Higher Education Division, n.d.)

4. For **Embedded System & PLC**, the content of second-generation language like assembly needs to be concise in the curriculum content as they are not suitable for modern equipment's like Arduino Uno, raspberry pi etc. Programming language like C, C++ need to include for practicing in ET & ENT technology. (Barr & Massa, 2006)For learning and practicing others programming language need to be specified. Moreover, Teachers of ET & ENT technology have to trained for PLC and Embedded system.
5. For **Robotics Process Automation**, Teacher needs training for robotics so that they can cope with project supervision. Lab equipment's need to modernized regarding robotics. Further research needs for content analysis of RPA regarding curriculum of ET & ENT.
6. IoT (Internet of Things) needs to include this as a subject in electrical and electronics curriculum. For this student should have minimum technical skills to acquire-
    - Good command about circuit design.
    - Embedded system
    - Programming Language and Machine Learning
    - Networking & security
    - Communication protocol

    Moreover, Further research need to find out the procedure to include this subject in the curriculum of electrical & electronics technology.

7. Lesson of **Smart Grid** need to be included in the subject of transmission and distribution of power and for this further research need to find the way forward.
8. For minimizing the **industry academia linkage gap**, need to build student motivation, need to build a balanced syllabus, consistent knowledge transfer, need to create agreement between government and industry. Moreover, further study needs to minimize the gap between industry academia linkage.

Conclusion

The fourth industrial revolution(4IR), primarily driven by automation, robotics and AI has been transforming the way we work and live. The 4IR is underpinned by the disparaging, creative as well as efficiency innovation capacities of eleven powerful technologies, starting from sensors to machine learning. This research discussed the earlier industrial revolution as well as the current industry revolution. The study began by outlining the history of industrial revolution, curriculum contents and the study policy formation of TVET polytechnic institute. The literature review identified the difficulties associated with the full deployment of technological drivers in the 4IR. The research aimed to identify the challenges of 4IR in the context of TVET systems. The conversation then switched to the topic of assistive technologies for intelligence industry process. Then the cross analysis was done for the elements of 4IR with curriculum contents of ET & ENT. This study found some context like IoT, Robotics & Automation, Smart-Grid, 5G wireless system etc. similar to the curricula. This study collected data from the graduates (8^{th} semester) of ET & ENT by questionnaire on the basis of minimum technical skill of 4IR challenges. Questionnaire data were collected by three dimension-1) General understanding of curricula 2) Learning Environment 3) Perception of the learning process. This study also collected supplementary information from the mentors of the graduate and the personnel of industry where graduates want to apply their skills.

The current curriculum of ET & ENT has been analyzed and found some lack of topics that are really needed to updated to cope with the challenges of 4IR. This research found that students of ET & ENT do not have enough knowledge about the elements of fourth industrial revolution and they do not know about the content of curriculum that are really needed for industry 4.0 or 4IR. Not only the students but also the mentor of perspective department have no sufficient idea for 4IR. Seminar or workshop should arrange to acquainted with fourth industrial revolution technologies. The laboratory's equipment's are not suitable enough for practicing with simulation software and teachers are not experienced for this. Moreover, two major pillars of 4IR such as IoT and SMART-GRID need to include in the curriculum of Electrical & Electronics technology. Further study needs to draw the whole countries polytechnic scenery of ET & ENT and need to find the way to include IoT & SMART GRID contents to the curriculum.

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7. Annexure

7.1. Appendix-A

ID:

(This study data will be used for research purpose only and we undertake the responsibility to keep personalized data in confidential.)

Please read the Questionnaires carefully and write the answer as well as put tick marks where necessary.

Questionnaires for Students

Informants: Polytechnic Students of Electrical and Electronics Technology

FIRST PART

Personal Information: *(Please provide your personal information correctly.)*

- *Name: ……*
- *Gender:*
  - *Male*
  - *Female*
- *Name of the Institute: ……*
- *Type of your Institute:*
  - *Government*
  - *Non-Government*
- *Name of your Technology: ……*
- *Class Roll: ……..*
- *Shift:*
  - *1st Shift*
  - *2nd Shift*

SECOND PART (General Understanding of Curricula)

(Based on the discussion of nine pillar of 4IR technologies and by the analysis of syllabus content. Please, choose the option carefully and fill up the circle with ball point pen.)

1. **Does your teacher use microteaching style in your class?** *(শিক্ষক কি তোমাদের ক্লাসে মাইক্রোটিচিং স্টাইলে ক্লাস নেয়?)*
   - *Yes*
   - *No*

2. **Do you know about blended learning and project-based learning?** *(তুমি কি ব্লেন্ডেড লার্নিং বা প্রজেক্ট বেসেড লার্নিং সম্পর্কে জানো?)*
    - *Yes*
    - *No*
- *If yes, please specify ……*

3. **Do you know what is 4IR or Industry 4.0?** *(4IR কি জানো?)*
    - *Yes*
    - *No*
- *If yes, please write ……*

4. **Do you have any 4IR related topics in your syllabus?** (*তোমাদের সিলেবাসে কি 4IR সম্পর্কিত কোনো বিষয় আছে?)*
    - *Yes*
    - *No*
- *If yes, please write the topics ……*

5. **Any 4IR related technologies like Virtual reality or Augmented Reality (VR/AR) are being used in your lab system?** (*ল্যাব সিস্টেমে ভার্চুয়াল রিয়েলিটি বা অগমেন্টেড রিয়েলিটি (VR/AR) এর মতো কোন 4IR সম্পর্কিত প্রযুক্তি ব্যবহার করা হচ্ছে কি?)*
    - *Yes*
    - *No*
6. **Did you used any simulation software for circuit design like PCB/PLC?** (*ক্লাসে কি PCB/PLC এর মত সার্কিট ডিজাইনের জন্য কোন সিমুলেশন সফটওয়্যার ব্যবহার করছো?)*
    - *Yes*
    - *No*
- *If yes, mention the name of software ……*

7. **Have you completed any project of automation by using embedded system or PLC?** *(তুমি কি এমবেডেড সিস্টেম বা পিএলসি ব্যবহার করে অটোমেশনের কোনো প্রজেক্ট সম্পন্ন করছো?)*
    - *Yes*
    - *No*
- *If yes, write the name of project title ……*

8. **One of the key skill elements of 4IR is masterary in programming language like Python/C, Do you think that you have learned it successfully from your course?** *(4IR-এর মূল দক্ষতা উপাদানগুলির মধ্যে একটি হল Python/C-এর মতো প্রোগ্রামিং ভাষায় দক্ষতা, তোমরা কি মনে করো যে কোর্স থেকে এটি সফলভাবে শিখতে পেরেছো?)*
    - *Yes*
    - *No*

9. **Do you Know what is Smart Grid?** *(স্মার্ট গ্রিড কি জানো?)*
    - *Yes*
    - *No*
- *If yes, please write ……*

10. **Did you complete any Robot design-based project?** *(তুমি কি কোন রোবট ডিজাইন ভিত্তিক প্রজেক্ট সম্পন্ন করেছো?)*
    - *Yes*
    - *No*

11. **Did you perform curriculum content related practicing during your industrial attachment?** *(তুমি কি ইন্ডাস্ট্রিয়াল অ্যাটাচমেন্টের সময় পাঠ্যক্রমের বিষয়বস্তু সম্পর্কিত অনুশীলন করেছো?)*
    - *Yes*
    - *No*

12. **Did you work with 4IR related technologies during your industrial attachments?** *(তুমি কি তোমার ইন্ডাস্ট্রিয়াল অ্যাটাচমেন্টের সময় 4IR সম্পর্কিত প্রযুক্তির সাথে কাজ করেছো ?)*
    - *Yes*
    - *No*
- *If yes, Name the Technologies (যদি হ্যাঁ, হয় তাহলে প্রযুক্তির নামগুলো লেখ)* ……
  ……

13. **How much compatible of your institute technology used in Lab class with the industrial technology of your attachment***? (তোমার ইন্ডাস্ট্রিয়াল অ্যাটাচমেন্টের সময় ব্যবহৃত শিল্প প্রযুক্তির সাথে ল্যাব ক্লাসে ব্যবহৃত তোমার ইনস্টিটিউটের প্রযুক্তি কতটা সামঞ্জস্যপূর্ণ?)*
    - *i. (10-30) %*
    - *ii. (30-60) %*
    - *iii. (60-80) %*
    - *iv. (80-100) %*

14. **Do you think That contents of Curriculum are well enough to mitigate the industry 4.0 challenges?** *(তুমি কি মনে করো যে পাঠ্যক্রমের বিষয়বস্তু 4র্থ শিল্পের চ্যালেঞ্জ মোকাবেলার জন্য যথেষ্ট ?)*
    - *Yes*
    - *No*

15. **Did your institution arranged any workshop or seminar related to 4IR?** *(তোমার প্রতিষ্ঠান কি4IR- সম্পর্কিত কোন কর্মশালা বা সেমিনারের ব্যবস্থা করছে?*
    - *Yes*
    - *No*

16. **A diploma engineer successfully fulfills the demand of BNQF-6 skill level requirements, do you think that you are skilled as BNQF-6 requirements**? *(একজন ডিপ্লোমা ইঞ্জিনিয়ার সফলভাবে BNQF-6 দক্ষতা স্তরের প্রয়োজনীয়তার চাহিদা পূরণ করেন, তুমি কি মনে করো যে তুমি BNQF-6 এর চাহিদা অনুযায়ী দক্ষ?)*

- *Yes*
- *No*

<u>THIRD-PART</u> (Learning Environment & Practicing)

(Environment facts of learning and practicing)

(Considering minimum technical skill to mitigate the challenges of 4IR technologies. Please give your opinion by Tick Mark.)

17. Teaching mentors have a good knowledge of their relative field. *(শিক্ষকদের তাদের প্রাসঙ্গিক ক্ষেত্রের ভালো জ্ঞান ও দক্ষতা রয়েছে)*

☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree

18. The method of teaching in your class is satisfactory. *(ক্লাসে পাঠদান পদ্ধতি সন্তোষজনক)*

☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree

19. I have learned programming language like phyton/C effectively by the guidelines of appointed faculty member. *) আমি নিযুক্ত বিভাগীয় শিক্ষকের শিক্ষাদানের মাধ্যমে কার্যকরভাবে পাইথন (শিখিছো ভাষা প্রোগ্রামিং মতো এর সী*

☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree

20. I can design the module of IoT (Internet of things) easily with practical experienced. *(আমি ব্যবহারিক অভিজ্ঞতার সাথে সহজেই IoT (ইন্টারনেট অফ থিংস) এর মডিউল ডিজাইন করতে পারি)*

☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree

21. The communication between students, staff, and faculty within my department/program is clear and frequent.)আমার বিভাগের মধ্যে ছাত্র, কর্মচারী এবং শিক্ষকদের মধ্যে যোগাযোগ সহজ এবং সাহায্যকারী (

☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree

22 Institution frequently arranged workshop or seminar to acquainted us how to mitigate the challenge of 4IR .(4IR এর চ্যালঞ্জে কীভাবে মোকাবলো করা যায় তা আমাদরে জানাতে প্রতষ্ঠিানটি প্রায়ই ওয়ার্কশপ বা সমেনিাররে আয়োজন কর।ে)

☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree

23. The labs of our department is highly equipped with modern technology. *(আমাদরে বভিাগরে ল্যাবগুলি আধুনকি প্রযুক্তত িঅত্যন্ত সজ্জতি।)*

☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree

24. The syllabus content and practicing of Microcontroller and microprocessor are relevant to the industry practice. *(মাইক্রোকন্ট্রোলার এবং মাইক্রোপ্রসসেররে সলিবোসরে বষিয়বস্তু এবং অনুশীলন industry তে অনুশীলনরে সাথে সামঞ্জসপূর্ণ।)*

☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree

25. The library resource are sufficient to further study and acquainted with 4IR technologies. *(লাইব্ররেি রসিোর্স অধ্যয়ন 4IR. প্রযুক্তরি সাথে পরচিতি হওয়ার জন্য যথষ্টে।)*

☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree

FOURTH-PART (Perception)

(Considering the minimum technical skill to mitigate the challenges of 4IR technologies and your experience in both academic and industrial training. Please give your opinion by Tick Mark.)

26. How would you rate the skill level of yourself to mitigate the challenges of 4IR?

□Excellent □Good □Fair □ Poor

27. How would you rate the quality of teaching by faculty in your program?

□Excellent □Good □Fair □ Poor

28. How would you rate the quality of your lab class practical experience?

□Excellent □Good □Fair □ Poor

29. How would you rate the curriculum of your diploma engineering program?

□Excellent □Good □Fair □ Poor

30. How would you rate the overall quality of your program?

□Excellent □Good □Fair □ Poor

I declare that I provided all the information mentioned above intuitively with awareness.
(আমি ঘোষণা করছি যে আমি সচতেনতার সাথে স্বজ্ঞাতভাবে উপরে উল্লখিতি সমস্ত তথ্য প্রদান করছে।ি)

Sign:……

Name: ……

Date:……

7.2. Appendix-B

(This study data will be used for research purpose only and we undertake the responsibility to keep personalized data in confidential.)

INTERVIEW GUIDELINE

Informants: Polytechnic Teachers (Chief Instructor/ Instructor / Jnr. Instructor)

First Part

Personal Information: *(Please, provide your personal information correctly.)*

- ***Name**: ……*
- ***Designation:***
  - *Chief Instructor*
  - *Instructor*
  - *Jnr. Instructor*
- ***Education Qualification (Max. Degree):*** *……*
- ***Name of the Institution:*** *……*
- ***Type of your Institution:***
  - *Government*
  - *Non-Government*
- ***Select your Technology:***
  - *Electrical*
  - *Electronics*
- ***Shift:***
  - *1st Shift*
  - *2nd Shift*
- ***Select the highest level of NSC (Occupational) you have achieved.***

- *Level-1*
- *Level-2*
- *Level-3*
- *Level-4*
- *Level-5*
- *Level-6*

Second Part

1. **What are the delivery methods used for teaching and training of your departmental students?** *(আপনার বভিাগীয় ছাত্রদরে ক্লাসে শক্ষিাদান ও প্রশক্ষিণরে জন্য কে·ান ধরণরে ডলেভিারি পদ্ধতি ব্যবহার করা হয?)*

➢

2. **Do you have any idea about 4IR and its impact on your technology?** (*4IR কি এবং আপনার টকেনে·োলজতিে এর প্রভাব সম্পর্কে কে·ান ধারণা আছে?)*

3. **What kind of 4IR related materials/technologies and equipment are being used in your lab class?** (*আপনার ল্যাব ক্লাসে কি ধরনরে 4IR সম্পর্কতি উপকরণ এবং সরঞ্জাম ব্যবহার করা হচ্ছে?*

➢

4. **Do you think that your students can learn programming language like 'C & Python' effectively from the course of your technology?** (*আপনি কি মনে করনে যে আপনার শক্ষিার্থীরা আপনার প্রযুক্তরি কে·োর্স থকেে কার্যকরভাবে 'সি অ্যান্ড পাইথন'-এর মতে·া প্রে·াগ্রামিং ভাষা শখিতে পার?*)

➢

5. **What kind of simulation software do you use for circuit design like PCB/PLC?** (*আপনি PCB/PLC এর মত সার্কটি ডজিাইনরে জন্য কি ধরনরে সমিুলশেন সফটওয়্যার ব্যবহার করনে?)*

➢

6. **Do you supervised any project of automation by using embedded system or PLC?** *(আপনি কি এমবডেডে সস্টিমে বা পএিলসি ব্যবহার করে অটে·োমশেনরে কে·োনে·া প্রকল্পরে তত্ত্বাবধান করছেনে??)*

➢

7. **In the content of transmission and distribution, is there any lesson of SMAR-GRID system?** *(ট্রান্সমশিন এবং ডস্ট্রিবিউশনরে বষিয়বস্তুতে, SMAR-GRID সস্টিমেরে কে·ান পাঠ আছে কি?)*

➢

8. **Did you supervise any robot-based project**? *(আপনি কি কোনো রোবট ভিত্তিক প্রজেক্টের তদারকি করছেন?)*

➢

9. **How much compatible of your institute technology used in Lab class with the industrial technology of your student's attachment**? (*আপনার শিক্ষার্থীদের ইন্ডাস্ট্রিয়াল অ্যাটাচমেন্টের সময় ব্যবহৃত শিল্প প্রযুক্তির সাথে ল্যাব ক্লাসে ব্যবহৃত আপনার ইনস্টিটিউটের প্রযুক্তি কতটা সামঞ্জস্যপূর্ণ ?)*

➢

10. **What partnership exists between TVET polytechnic institute and industries?** *(TVET পলিটেকনিক ইনস্টিটিউট এবং ইন্ডাস্ট্রির মধ্যে কোন ধরণের অংশীদারিত্ব বিদ্যমান আছে কি?)*

➢

11. **What kinds of Challenges have you faced for establishing and maintaining relationship between your institution and industries**. (*আপনার প্রতিষ্ঠান এবং ইন্ডাস্ট্রির মধ্যে সম্পর্ক স্থাপন এবং বজায় রাখার জন্য আপনি কোন চ্যালেঞ্জের সম্মুখীন হয়েছেন?)*

➢

12. **Do you think that contents of Curriculum are well enough to mitigate the industry 4.0 challenges?** *(আপনি কি মনে করেন যে পাঠ্যক্রমের বিষয়বস্তু ৪র্থ শিল্পের চ্যালেঞ্জ মোকাবেলার জন্য যথেষ্ট ?)*

➢

13. **Did your institution/department arrange any workshop or seminar related to 4IR?** *(আপনার প্রতিষ্ঠান/বিভাগ কি 4IR- সম্পর্কিত কোন কর্মশালা বা সেমিনারের ব্যবস্থা করছে?)*

➢

14. **What are the main obstacles of your institution to take the challenges of 4IR and what your suggestion to overcome?** (*4IR-এর চ্যালেঞ্জেগুলি নিতে আপনার প্রতিষ্ঠানের প্রধান বাধাগুলি কী কী এবং তা অতিক্রম করার জন্য আপনার পরামর্শ কী?)*

➢

15. **A diploma engineer successfully fulfills the demand of NTVQF/BNQF-6 skill level requirements, do you think that students are skilled as BNQF-6 requirements**? *(একজন ডিপ্লোমা ইঞ্জিনিয়ার সফলভাবে BNQF-6 দক্ষতা স্তরের প্রয়োজনীয়তার চাহিদা পূরণ করেন , আপনি কি মনে করেন যে আপনার শিক্ষার্থীরা BNQF-6 এর চাহিদা অনুযায়ী দক্ষ?)*

➢

********** *Thank you for giving us your valuable time.* **********

Signature: ……

Date: ……..

//

7.3. Appendix-C

(This study data will be used for research purpose only and we undertake the responsibility to keep personalized data in confidential.)

INTERVIEW GUIDELINE

Informants: Personnel of Industry/Factory

First Part

Personal Information: *(Please, provide your personal information correctly.)*

- ***Name of the Informants****: ……..*
- ***Name of the Organization/Factory/Industry****: ……*
- ***Address****: ……*
- ***Designation:*** *……*
- ***Education Qualification (Max. Degree):*** *……*

- ***Certified Skill Level (if any):*** *……..*
- ***Experience in this sector (years):*** *…….*

Second Part

1. **Do you know what is 4IR or industry 4.0?**
➢
2. **What kinds of 4IR related materials/technologies are being used in your industry?**
➢
3. **What are the qualification that you are expecting from the graduates of polytechnic especially from Electrical & Electronics technology?**
➢
4. **Does your factory use simulation software/ software for circuit design like PCB/ PLC or Embedded systems?**
➢
5. **Do you know what is SMART-GRID and does your factory area are in under SMART-GRID system?**
➢
6. **Here are some useful domestic/office applications of automation that can be implemented by PLC or Embedded system. Please, put tick mark if they are used in your factory or domestic application.**
    - *Water Tank Level Control System*
    - *Car Washing and Parking System.*
    - *Flashing Light Controlling System.*
    - *Automatic Door Opening/Closing System.*
    - *Remote Monitoring Application like Air compressor (AC), Fan.*
    - *ON/OFF Switching Application like Light, Motor*
7. **Here are some useful industry applications of automation that can be implemented by PLC or Embedded system. Please, put tick mark if they are used in your factory or industry application.**

    - *Packing and Labeling System in Food & Beverage.*
    - *Automatic Bottle or Liquid Filling System.*
    - *Packaging and Labelling System in Pharma Industries.*
    - *Transportation System like Escalator and Elevator.*
    - *Industrial Crane Control System for Operation of Overhead Traveling Crane.*
    - *Paper Industries for the production of Pages, Books or Newspapers, etc.*

- *Cement Industries for manufacturing or mixing the right quality and quantities of raw materials, and accuracy of data regarding.*
- *Automatic Drainage Water Pump Monitoring and Controlling System.*
- *Time and Count-based Control System for an Industrial Machine.*
- *Temperature Controller or Humidity by using the Sensors Input to the PLC system.*
- *Fault Detection and Protection of Industrial Machines like an Induction Motor.*
- *Conveyor Belt System controls the Sequence of Conveyors and Interlocking procedure.*
- *Energy Management System like Boiler, Ball Milling, Coal Kiln, Shaft Kiln, etc.*

8. **Here are some useful commercial applications of automation that can be implemented by PLC or Embedded system. Please, put tick mark if they are used in your factory or office application.**

- *Smart Elevator Control System.*
- *Fire Detection and Alarm System.*
- *Automatic Machine Handling System.*
- *Automatic Vehicle Washer System*
- *Automated Guided Vehicle System.*
- *Automation System for Well Drainage System.*
- *Luggage Handling System. For example, at the Airport.*
- *Pressure Controller in Multi-Motor Pump Applications.*
- *Sequence or Numerical Counting and Packing System.*
- *Mining Equipment Line Detection and Remote-Control System.*

9. **Do you think that graduates of polytechnic (especially electrical and electronics technology) have good knowledge about machine learning like phyton/C and simulation software?**

➢

10. **Do you think that graduates of polytechnic (especially electrical and electronics technology) have good skill about PLC/Embedded system and automation?**

➢

11. **Does your industry take the tests the capabilities/skills of the graduates (fresher) before appointing for employment?**

➢

12. **What partnership exists between TVET polytechnic institute and industries?**

➢

13. **What kinds of challenges did face for establishing and maintaining relationship between your industry and polytechnic institute? And your suggestion to overcome the challenges.**

➢

14. **Do you think that contents of Polytechnic Electrical & Electronic technology Curriculum are well enough to mitigate the industry 4.0 challenges?**

➢

15. **What are the main obstacles of TVET polytechnic institution to take the challenges of 4IR and what your suggestion to overcome?**

➢

16. **A diploma engineer successfully fulfills the demand of NTVQF/BNQF-6 skill level requirements, do you think that the graduates of TVET polytechnic are skilled as BNQF-6 requirements*?* (Give your opinion based on student's industrial attachments or employment in your industry).**

➢

********** *Thank you for giving us your valuable time.* **********

Signature: ……

Date: ……..

//