

Structure of Polytechnic Education in India: Constraints and the Way Ahead

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Abstract

The progress of any nation is closely linked to the effectiveness of its technical education system, as it plays a vital role in developing a skilled workforce, enhancing productivity, and improving overall living standards. With continuous advancements in science and technology, the demand for competent professionals who are capable of effectively addressing the evolving needs of industry and society has been steadily rising. The long-term success of individuals, nations, societies, and industries largely depends on the availability and accessibility of adaptable, transferable skills and knowledge. Globally, countries at all levels of development recognize the importance of technical and vocational education in equipping individuals with essential skills and competencies. This paper examines the key structural dimensions of polytechnic education in India, with a primary focus on the national-level framework, setting the norms and standards, existing constraints, and measures aimed at strengthening and improving the polytechnic education system.

Keyword: Polytechnics, Polytechnic Education, Structure, Training, Technical Education

1. Introduction

Polytechnic education plays a crucial role in building students' technical and practical competencies. It provides a well-balanced combination of theoretical knowledge and hands-on skills, with a strong emphasis on core scientific principles related to emerging technologies. It also enables learners to understand industrial production processes and how society interacts with and influences these processes. Beyond delivering sound technical instruction, polytechnic education fosters professional values, enhances practical proficiency, and prepares learners for diverse career pathways. It assists students in making informed career choices and serves as a foundation for advanced and specialized education. In India, an extensive network of polytechnic institutes and related educational institutions has been established to offer competency-based, occupation-specific training, supported by programs that promote career progression (Malik, 2019).

Across the country, polytechnic institutions are administered and regulated by government authorities at various levels, including state, central, and local bodies. These institutions function as specialized centers for technical education, with a strong emphasis on skill development, catering to learners pursuing careers in engineering and applied technical disciplines. Polytechnics play a crucial role in developing the nation's engineering workforce by providing hands-on training across a wide range of technical fields and equipping students with skills aligned with industry requirements. (Singh, 2021)

The primary objective of polytechnic institutions is to provide young people with essential practical skills that enable them to establish their own enterprises or obtain gainful employment. The effectiveness of these institutions, similar to other educational organizations, largely depends on the commitment and competence of their teaching staff. Educators in technical institutions carry a critical responsibility in shaping the future workforce, as they significantly influence the skill proficiency and employability of graduates in a rapidly expanding economy such as that of India (Singh, 2021).

Polytechnic institutions are primarily designed to cultivate a skilled workforce capable of efficiently supporting field operations and shop-floor activities, serving as a critical intermediary between engineers and technicians. Diploma holders in engineering and technology play a significant role in managing shop-floor operations. Small and medium-sized enterprises often prefer recruiting diploma holders due to their specialized training and proficiency in areas such as engineering estimation, technical drawing, billing, costing, measurement, supervision, repair, testing, and maintenance.

Both public and private educational institutions in Punjab offer specialized skill development programs. The state is home to five government engineering colleges and 96 private engineering colleges. In addition, there are 124 management institutes, 34 pharmacy institutes, 128 self-financed polytechnic colleges, and 33 government polytechnic colleges. Punjab also maintains an extensive network of Industrial Training Institutes (ITIs), comprising 115 government ITIs and 234 private ITIs (ESO, 2018).

India's polytechnic institutions are categorized into three types: government, private-aided, and private.

Government polytechnics are fully funded by state governments, covering both recurring operational costs and initial capital expenditures. Private-aided institutions receive government support for up to 95 per cent of their recurring expenses, whereas self-financing institutions operate without any government funding. Many polytechnics, however, face financial constraints, with limited budget allocations restricting their capacity for development and modernization. Although centrally supported programs, such as Direct Central Assistance, provide funding to select institutions for upgrades, these measures have been insufficient to meet the needs of a substantial number of polytechnics.

2. Literature Review

Saini (2005) analyzed human resource development through vocational training in India and identified significant shortcomings in the country's vocational training policy, characterizing it as a missed opportunity. Key issues highlighted included inadequate coordination between government and non-government training providers, the absence of a unified vocational training framework, formal education reaching less than 5 per cent of the workforce, and the limited financial autonomy of vocational training programs. To address these challenges, the study proposed several measures, including the development of an improved policy framework, enhanced coordination among various skill training centers, the expansion of urban-based training programs to rural areas, and a stronger emphasis on essential skill acquisition, certification, and assessment within vocational training initiatives.

Alpysbay et al. (2016) examined several critical aspects of the Technical and Vocational Education (TVE) system, emphasizing the need to improve staff training conditions, develop innovative quality assessment methods based on environmental interactions, and ensure alignment with employer requirements. The study highlighted the importance of adopting a modern, market-oriented approach to TVE, advocating a transition from a static 'one-stage quality estimation' model to a more dynamic 'quality assurance process' supported by effective administration. A major challenge identified was the absence of adequate support structures at both local and institutional levels.

UNESCO-UNEVOC (1996) emphasized that governments should continuously invest in Technical and Vocational Education (TVE) using public revenue, as they bear the primary responsibility for human resource development in the country. State support remains the most reliable and consistent source of funding for TVE. While diversifying financing mechanisms can generate additional resources to expand training opportunities, it alone cannot fully address the challenges associated with TVE financing. Effective solutions require optimizing existing resources by eliminating inefficiencies, improving organizational structures, enforcing greater accountability, and utilizing new information technologies for enhanced resource management. The report also highlights the potential for gradually shifting TVE funding from predominantly state support to increased contributions from beneficiaries and industry stakeholders.

Amedorme and Fiagbe (2013) investigated the challenges facing Technical and Vocational Education and Training (TVET) in Ghana. The study identified several key issues, including a limited number of technical education institutions, scarcity of instructional materials and facilities, shortage of qualified teachers, inadequate training infrastructure, and restricted opportunities for career advancement. The authors concluded by recommending targeted strategies to address these challenges, with the aim of enhancing the operational efficiency and effectiveness of TVET institutions in Ghana.

Dasmani (2011) examined the challenges faced by students in technical institutes in the Upper Eastern region of Ghana in acquiring applied skills. The study identified several issues, including low female enrollment, large class sizes, inadequate instructional materials, ineffective teaching methods, and insufficient training facilities. A major factor contributing to the inefficiency of student training was the lack of local industrial linkages, which led to an emphasis on passing final examinations rather than acquiring practical experience. Consequently, graduates often encounter difficulties in the workplace due to the poor quality of practical training received. The study recommended several measures to address these issues, including increased stakeholder support for government provision of training resources, encouraging students to acquire personal tools, and offering incentive packages for female students. Additionally, it advocated the implementation of industrial attachment programs, instructor training to enhance teaching quality, and student tool-acquisition initiatives to ensure that graduates possess the practical skills required in the workforce.

Ismail and Hassan (2013) observed that several Asian countries, including Malaysia, were rapidly adopting modern and emerging technologies across various sectors. These technologies require a more advanced educational foundation and a diversified framework to develop essential technical skills. This transition has significant implications for employment, education, and the training of technical personnel, particularly within the TVET sector. The development of a skilled workforce is crucial for progressing up the value chain and achieving a high-income economic status. Accordingly, expanding enrollment in TVET programs is essential to enhance the overall quality of training. Addressing these challenges requires a comprehensive and integrated strategy, involving careful planning and effective implementation to ensure the success of strategic interventions. The TVET systems of advanced economies, such as Germany, Japan, and Hong Kong's polytechnic university

model, have served as important references for guiding and advancing the development of Malaysia's TVET framework.

Usman et al. (2013) examined the developmental challenges of Technical and Vocational Education (TVE) in Nigeria. The study identified several critical issues, including: (1) insufficient funding for procuring materials and equipment for practical training; (2) poorly equipped workshops and laboratories; (3) inadequate research and library facilities; (4) a shortage of teachers and a lack of competent instructors in technical institutions; (5) absence of in-service training programs to enhance teachers' technical skills; and (6) low incentives and salaries for technical institute educators. Additionally, the study noted that many students lacked intrinsic motivation to pursue technical courses. Consequently, technical institutions were largely ineffective in delivering essential skills and struggled to meet the demands and challenges of the workplace.

3. Research Design and Methodology

The data for this study were collected from the All India Council for Technical Education (AICTE), the Department of Technical Education and Industrial Training, Government of Punjab; the Punjab State Board of Technical Education and Industrial Training (PSBTE), Chandigarh; as well as from relevant research papers, official government websites, and reports published by other organizations.

4. Basic Structure of Polytechnic Education

The Ministry of Human Resource Development (MHRD) and the Ministry of Labour and Employment (MOLE) are the central government departments responsible for overseeing formal technical education in India. The MHRD coordinates the operations of technical education institutions, including certificate, diploma, and degree programs offered by polytechnics, technical institutes, and universities. In contrast, the MOLE promotes and coordinates technical education through Industrial Training Centers and Industrial Training Institutes (ITIs). Formal vocational training programs typically require a minimum educational qualification. Under the MHRD-administered system, this usually corresponds to a higher secondary education level, whereas MOLE-administered training programs may require only a middle school-level education. Consequently, individuals with lower educational attainment may have limited access to formal vocational education. To address industry training demands, particularly at the supervisory level, polytechnic institutes also offer diploma-level courses (Chattopadhyay, 2011).

A polytechnic is an educational institution dedicated to providing technical education and vocational training. It plays a pivotal role within the technical education system by emphasizing the development of specialized skills, technical competencies, and practical knowledge. The primary objective of polytechnics is to equip individuals with the expertise required for technical occupations, offering education that extends beyond the high school level without leading to a full academic degree.

Polytechnics nationwide offer structured three-year diploma programs in traditional disciplines, including civil, electrical, and mechanical engineering. Over time, these programs have expanded to include emerging fields such as computer science, electronics, hospital engineering, medical laboratory technology, and other specialized areas. Several women's polytechnics provide courses in domains such as beauty culture, garment technology, library science, and textile design. In addition, specialized institutions have been established in areas including Sugar Technology, Leather Technology, Textile Design, and Beauty Culture. Polytechnics have also introduced advanced diploma and post-diploma programs, typically spanning 1–2 years, across various technical fields. Furthermore, many polytechnics and related institutions offer a broad range of technical and competency-based career development programs in diverse sectors, including Textile Design, Fashion Technology, Gems and Jewellery, Business Management, Journalism, Plastics, Footwear Technology, Construction Management, Food Processing, and others (Kang, 2001).

4.1 Establishment of National-Level Body

4.1.1 All India Council for Technical Education (AICTE)

The All India Council for Technical Education (AICTE), established in 1987 through an Act of Parliament, serves as the principal regulatory authority for technical education in India. As a regulatory body, it is responsible for facilitating, planning, and overseeing technical education across the country. The standards and regulations governing polytechnic institutions are formulated and enforced by the AICTE and must be adhered to by state boards responsible for delivering technical education. The AICTE is mandated to perform the following functions:

1. Conducting needs assessments of the current and future technical workforce.
2. Addressing and improving mismatches between the supply of and demand for skilled personnel.
3. Coordinating and integrating management and developmental plans for technical education at both central and regional levels.
4. Enhancing quality and effectiveness through faculty training, scientific curriculum development, and the creation of instructional materials and resources.
5. Formulating improved standards, periodically reviewing staff, resources, and programs, and adjusting

norms and regulations accordingly.

6. Establishing guidelines to promote innovation, development, and research.
7. Developing guidelines for allocating funding to priority areas.
8. Implementing mechanisms to maintain and uphold established norms and standards.
9. Accrediting and recognizing institutions and programs.
10. Continuously evaluating and monitoring planned projects.

4.2 Creation of State-Level Regulatory Bodies

4.2.1 State Boards of Technical Education

State boards responsible for delivering technical education generally operate under the oversight of the AICTE and function through the State Directorates of Technical Education. Each state has established its own dedicated technical education board, such as the Board of Technical Education in Rajasthan and the Himachal Pradesh Technical Education Board. In Punjab, the Punjab State Board of Technical Education and Industrial Training (PSBTE&IT) was established. Following the enactment of The Punjab State Board of Technical Education and Industrial Training Act, 1992, the PSBTE&IT became a statutory autonomous body vested with the authority to manage academic standards, regulate technical education institutions, and conduct examinations and admissions for industrial training institutes and polytechnics. The board's management, comprising distinguished individuals from the fields of education, industry, and government, is responsible for making key policy decisions.

The state boards of technical education perform the following functions:

1. Developing and updating the curriculum.
2. Setting norms and standards for technical education.
3. Administering examinations.
4. Awarding diplomas, advanced diplomas, and post-diploma qualifications.
5. Ensuring the maintenance of quality in training and education within polytechnic institutes.

4.2.2 Punjab State Board of Technical Education and Industrial Training (PSBTE & IT)

Polytechnic education in Punjab is overseen and managed by the PSBTE&IT. The board holds the authority to regulate technical education, including designing the curriculum, conducting examinations, determining the courses offered, and managing other key functions necessary for the effective delivery of technical education in the state.

4.2.3 Committees of the Board

The Punjab State Board of Technical Education and Industrial Training has four statutory committees:

1. **Accreditation and Affiliation Committee:** Responsible for granting affiliation to new institutes and approving new courses for existing institutions.
2. **Examination Committee:** Assists in the formulation of policies related to the conduct of examinations.
3. **Academic Committee:** Oversees the design of curricula for new and existing courses, revises curricula, and monitors their implementation in polytechnic institutions.
4. **Finance Committee:** Develops financial policies, with a particular focus on budget allocation.

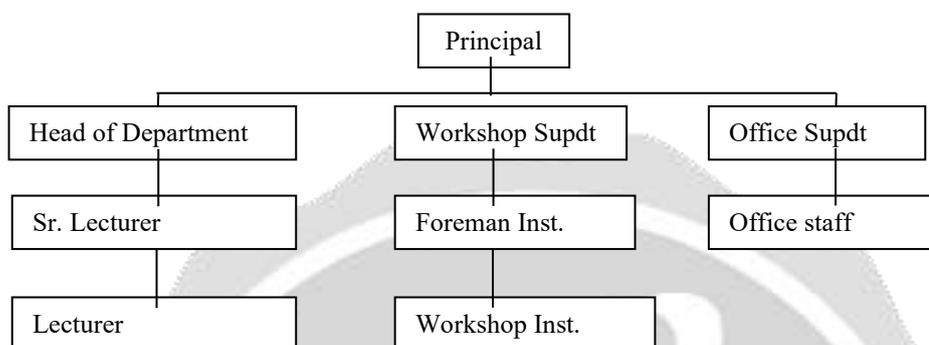
4.2.4 Activities of the Board

The Board carries out some critical activities:

1. **Admissions:** The Board primarily conducts student admissions to various courses across different polytechnics. It also manages admissions for the Diploma in Modern Office Practice and the Diploma in Pharmacy.
2. **Student Registration:** A key function of the Board is registering students. Photo registration cards are issued to bona fide students of polytechnics and ITIs.
3. **Conduct of Examinations:** The Board organizes semester examinations twice a year, in May and December, including supplementary examinations. All answer scripts are evaluated at the Board's office by a selected panel of teachers, and results are announced within two months.
4. **Certification of Graduates:** Students who successfully complete their courses are awarded diploma certificates. Approximately 25,000 certificates are issued to polytechnic students and around 30,000 certificates to ITI students annually.
5. **Curriculum Revision:** The Board periodically updates the curricula of all courses at scheduled intervals or as required, reflecting changes in various industries. Emphasis is placed on enhancing practical training when revising the curriculum.

The structural framework of Punjab's polytechnic education system, as implemented in each district-level polytechnic college, is illustrated in Chart 1 to clearly depict the hierarchical organization. At the top of the organizational structure, the Principal holds the highest authority and is responsible for the overall functioning and outcomes of the polytechnic. Directly below the Principal, the Head of Department, Workshop Superintendent, and Office Superintendent occupy the same level in the hierarchy, holding equal standing. The subsequent tier comprises the Senior Lecturer, Foreman Instructor, and office staff, who are positioned at an equivalent rank. At the base of the hierarchy are the Lecturer and Workshop Assistant, forming the foundational level of the organizational structure.

Chart 1: Organizational Structure of Polytechnic Institutions



Source: Department of Technical Education and Industrial Training, Government of Punjab

4.3 Setting the Norms and Standards

The following outlines the key standards and norms for polytechnic institutions as established by the All India Council for Technical Education (AICTE):

4.3.1 Schedule for Work on a Weekly Basis

The AICTE has recommended the following weekly work timetable for polytechnic institutions: As per AICTE guidelines, polytechnics are required to adhere to a weekly schedule of 40 hours (Table 1). Of this, students' formal learning accounts for 33–36 contact hours per week, while the remaining 4–6 hours are allocated for other student-related activities, including seminars, library work, guidance, and counseling.

Table 1: Polytechnic Weekly Hours Schedule

Various Activities	Hours
Institution Total Hours every week	40
Contact Hours for Students in Formal Learning	33 – 36
Activities Related to Students (Seminars, Library Studies, Guidance and Counselling, etc.)	04 – 06

Source: AICTE Norms and Standards, 1995

4.3.2 Class Size and Group

Table 2: Number of Teachers Allocated for Students for Various Educational Classes

Various Classes	Students	Teacher
Lecture/Theory class	40 – 60	1
Tutorials	20	1
Workshop/ Laboratory Practice /Drawing Work	20	1
Work-Related to projects	5	1

Source: AICTE Norms and Standards, 1995

Class size plays a crucial role in enhancing the effectiveness of the teaching and learning process. Table 2 presents the recommended teacher-to-student allocations for different types of educational activities in polytechnic institutions. For lecture or theory classes, the class size is limited to 40–60 students per teacher; for tutorials, it is 20 students; and for workshop, laboratory, or drawing classes, the recommended size is also 20 students per teacher. In project-based work, one teacher should be assigned for every five students. Maintaining smaller class

sizes is essential, as the delivery of technical education requires substantial personal attention and direct interaction between students and teachers.

4.3.3 Distribution of Workload

Table 3 presents the weekly workload of various faculty members. The data indicate that Senior Lecturers and Lecturers have the highest contact hours, ranging from 16 to 20 hours per week, while the Head of Department (HOD) handles approximately 12 hours weekly, and the Principal is engaged in teaching for around 4 hours per week. For activities related to research, administration, and institutional development, the majority of hours—29 to 33 per week—are assigned to the Principal, whereas Senior Lecturers and Lecturers are allocated the least time, approximately 8 hours per week.

Table 3: Number of Weekly Hours of Faculty Lectures

Sr. No.	Activity	Hours/ Week		
		Principal	HOD	Sr. Lecturer and Lecturer
1.	Contact Hours (Instruction)	4	12	16–20
2.	Assessment, Preparation, Evaluation	3	6	12
3.	Research, Administration, Development Activities, Guidance and Counselling, etc.	29–33	18–22	8
	Total	36–40	36–40	36–40

Source: AICTE Norms and Standards, 1995

To support the comprehensive development of technical training, the Department of Technical Education and Industrial Training (DTE&IT) was formally established on June 10, 1977. This reorganization involved separating the Technical Education Wing from the Punjab Public Works Department (PWD) (B&R) and the Industrial Training Wing from the Department of Industries. Both wings, each with a history exceeding 50 years, were consolidated under a single administrative authority. The DTE&IT comprises two distinct divisions: The Technical Education Wing, which oversees degree- and diploma-level polytechnic institutes in Punjab in accordance with the standards, guidelines, and directives of the All India Council for Technical Education (AICTE), and the Industrial Training Wing, which manages the Industrial Training Institutes (ITIs) across the state.

The Tenth Five-Year Plan emphasizes the importance of integrating technical education as a distinct component within the secondary education framework, rather than delivering it exclusively through separate institutions. This integration aims to strengthen the link between vocational training and academic education, providing learners with pathways for upward mobility. Consequently, students seeking to pursue advanced professional programs in polytechnics, universities, and engineering colleges should be able to transition smoothly from their vocational education background (Chattopadhyay, 2011).

Basant and Chandra (2007) emphasize the significant role of India's structured technical education system in promoting the development of both the private and public sectors. This system has effectively fostered a range of professional skills within the workforce, thereby enhancing India's industrial capacity. However, Vrat (2009) highlights concerns regarding the current state of technical education in the country, particularly with respect to quality and graduate employability. Improving technical education in India requires the active collaboration of all stakeholders to position the nation as a leader in knowledge sharing and in addressing common challenges.

While overall expenditure on general education has increased, budget allocations for technical education have not grown proportionally. For example, in the 2009–10 budget, education accounted for 20 per cent of the total budget, yet the portion allocated to technical education remained approximately 14 per cent of the total education budget (Sharma and Sharma, 2014).

Polytechnics in India have limited engagement with the industries that employ their graduates, and formal mechanisms for industry involvement in curriculum design, institutional governance, student assessment, and instructional processes are largely absent. Additionally, linkages across different levels of technical education—such as diploma programs, certificate courses, and engineering degrees—remain weak, hindering the alignment of polytechnic education with industry requirements and expectations (Bhayana, 2003). To address this, polytechnics should prioritize practical training over purely theoretical instruction, ensuring that students acquire the essential skills demanded by industries. Strengthening collaboration with industry is crucial for institutional development, and involving highly qualified professionals from research laboratories and industrial sectors in the teaching process can significantly enhance the quality of education (Government of India, 2007).

5. Major Constraints in Technical Education in India

Polytechnic education in Punjab faces numerous constraints, as highlighted in this study. A review of the literature indicates that polytechnics across India encounter several challenges, including a widening demand–supply gap, insufficient training programs for women and socially marginalized groups, and a shortage of centers of excellence for skill development. Additional issues include a limited number of technical education institutions, scarcity of instructional materials and facilities, restricted opportunities for career progression, low female enrollment, large class sizes, and ineffective teaching methods. Other significant constraints involve inadequate funding for procuring materials and equipment for practical work, poorly equipped workshops and laboratories, insufficient research and library facilities, a shortage of qualified teachers and instructors, lack of in-service training programs for technical faculty, and low incentives and salaries for technical educators. The absence of local industrial linkages has been a major factor contributing to the inefficiency of student training, as the focus often remains on passing final examinations rather than acquiring practical experience. Consequently, graduates frequently face challenges in the workplace due to the poor quality of practical training received.

6. Recommendations to Strengthen Technical Education in India

To address these challenges, several recommendations have been proposed. These include the development of an improved policy framework and enhanced coordination among various skill training centers, as well as the expansion of urban-based training programs to benefit rural areas. A strong emphasis should be placed on essential skill acquisition, certification, and assessment within vocational training programs. It is also recommended to adopt a modern, market-oriented strategy for Technical and Vocational Education (TVE) and to transition from a static ‘one-stage quality estimation’ approach to a dynamic ‘quality assurance process’ supported by effective administration. Stakeholders should actively support government efforts by providing training resources, and offering incentive packages for female students. Furthermore, conducting instructor training programs to enhance teaching quality, and introducing student tool-acquisition initiatives are essential to ensure that learners acquire the practical skills required for the workforce.

To address these challenges effectively, efforts should focus on optimizing existing resources by eliminating inefficiencies, improving organizational structures, enhancing accountability, and utilizing modern information technologies for more efficient resource management. The paper also recommends exploring the potential for shifting TVE funding from predominantly state support to increased contributions from beneficiaries and industry. To overcome these issues requires a comprehensive and integrated strategy, encompassing careful planning and systematic implementation to ensure the successful execution of the proposed solutions.

7. Conclusion

Polytechnic education is designed to provide students with foundational knowledge, practical skills, and the appropriate professional mind-set in their chosen disciplines, while fostering a commitment to lifelong learning. The Ministry of Human Resource Development (MHRD) and the Ministry of Labour and Employment (MOLE) are the central government departments responsible for overseeing formal technical education in India. The MHRD coordinates the operations of technical education institutions, including certificate, diploma, and degree programs offered by polytechnics, technical institutes, and universities. Formal vocational training typically requires a minimum level of education; under MHRD-administered systems, this generally corresponds to a higher secondary education level. Additionally, polytechnic institutes offer diploma-level courses to meet industry training requirements, particularly for supervisory roles (Chattopadhyay, 2011). In India, polytechnics are administered and managed by authorities at both the state and central government levels. Polytechnics across the country offer structured three-year diploma programs in traditional disciplines, including civil, electrical, and mechanical engineering. Over time, these programs have been expanded to include emerging fields such as computer science, electronics, hospital engineering, medical laboratory technology, and other specialized areas. Additionally, many women’s polytechnics provide courses in domains such as beauty culture, garment technology, library science, and textile design.

Polytechnics have also introduced advanced diploma and post-diploma programs, typically spanning 1–2 years, in various specialized fields. To support the comprehensive development of technical training, the Department of Technical Education and Industrial Training (DTE&IT) was formally established on June 10, 1977. Despite these initiatives, polytechnics in India maintain limited collaboration with the industries that employ their graduates. Structured mechanisms for industry involvement in curriculum development, institutional governance, student assessment, and instructional processes are largely absent. Furthermore, linkages across different levels of technical education—including diploma programs, certificate courses, and engineering degrees—remain weak, hindering the alignment of polytechnic education with industry requirements and expectations (Bhayana, 2003). To address this gap, polytechnics should prioritize practical training alongside theoretical instruction, ensuring that students acquire the essential skills demanded by industries. Strengthening collaboration with industry is critical for the advancement and effectiveness of these institutions.

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