Sustainable Development in Higher Engineering Education: A Comparative Study between Private and Public Polytechnics

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Abstract: In Bangladesh, a four-year diploma program is the highest level of technical education provided by private and public polytechnic institutions. Using representative primary data of 1372 sample sizes from Dhaka University of Engineering & Technology, Gazipur, we examined whether students graduating from private polytechnics perform worse in higher engineering education than their public school counterparts. We mainly employed a multivariate regression model and found that students from private polytechnics receive lower grades by 0.120 cumulative grade points average (CGPA) despite similar socioeconomic, academic, and demographic backgrounds. These estimated effects imply that private polytechnics fail to significantly affect sustainable engineering education. These findings suggest that policy makers increase the number of teachers and laboratory facilities for sustainable engineering education.

Keywords: private polytechnics; academic success; higher engineering education; sustainable engineering education

1. Introduction

Due to technological progress and modernization, the demand for education for economic purposes has constantly increased for socioeconomic and national development. In addition, the global community has also highlighted the importance of increased productivity of human resources and, hence, investing in education. Furthermore, technological progress and human capital efficiency have become increasingly evident. Therefore, new skills are needed, and educational institutions usually meet this demand by providing schooling and vocational training for high-level specialists [1]. In other words, technical and vocational education and training (TVET) usually teach youths hands-on skills and job readiness to integrate into labor markets [2,3]. TVET can improve young workers’ employability, productivity, and livelihoods in many developing countries. Thus, the success of a TVET institution depends on its competency in producing qualified human resources to effectively and immediately meet the operational demands in the labor market. In this study, we examined the impact of private TVET institutions, more specifically polytechnics, on further engineering education, especially in undergraduate programs. Educational attainment would be sustainable when graduates from a program succeed in subsequent academic programs or their professional careers.

In Bangladesh, the education system comprises three main streams: general, religious, and TVET. The TVET stream has four academic levels: short courses, below Secondary School Certificate (bSSC); Secondary School Certificate (SSC)-Vocational and Business Management (BM); Higher Secondary School Certificate (HSC)-Vocational; and diploma courses. Approximately 14% of students receive technical vocational education (https://...
The financial express.com.bd/views/why-technical-education-is-imperative-1580483097, accessed on 20 December 2021). Ref. [4] argues that the post-secondary level for TVET in Bangladesh is diploma engineering programs. Polytechnic institutions offer diploma engineering education under the Bangladesh Technical and Education Board (BTEB). The ultimate objective is to prepare middle-level managers and technicians for specialized sectors. Students who graduate from the Secondary School Certificate (SSC) or equivalent programs can enroll in the DE program.

According to the Bangladesh Bureau of Educational Information and Statistics (BANBEIS), 250,770 students were enrolled in 2018. The total number of diploma engineering (DE) offering institutions is 439, with 223 private polytechnics. These institutions aim to produce graduates acquiring the theoretical knowledge required in the labor market. In addition, graduates are also expected to train with hands-on expertise and technologies, including interpersonal communication and learning competencies [5–8].

Although the main objective of the DE program is to produce a mid-level technical supervisory workforce, some of these graduates want to pursue their higher studies in a Bachelor of Engineering (BSc Engineering) program. Students from general backgrounds can also pursue higher engineering programs as in other countries. Recently, Ref. [9] argued that students from lower socioeconomic backgrounds are more likely to receive lower grades in higher engineering education. They also show that the previous institutional environment or category would play an essential role in shaping graduates' professional careers.

In Bangladesh, polytechnic graduates pursue higher engineering education at the Dhaka University of Engineering and Technology (DUET), Gazipur. As these technically-proficient DE graduates are academically competent, they are highly likely to succeed in their higher education. Moreover, as engineering education is theoretical and laboratory-oriented, polytechnic institutions must offer such facilities to their graduates. Refs. [10,11] argue that a well-connected organizational structure with required equipment is essential in innovating and achieving an institution’s ultimate goal. However, some argue that most private polytechnics in Bangladesh do not have sufficient logistics to produce graduates demanded in the job market. Therefore, focusing on the academic institution, we examined whether students graduating from private polytechnics are making significant progress in further engineering education.

Engineers have played a significant role in shaping economic development, and their importance is consistently increasing at national and international levels [12]. When universities produce graduates with innovative skills, they will succeed in professional careers and create innovative technologies to meet upcoming challenges [13]. Therefore, many countries take initiatives to improve the standard of their technical education. For example, to reform academic curricula, the Singapore University of Technology and Design (SUTD) signed an academic collaboration with the Massachusetts Institute of Technology (MIT), one of the world’s leading engineering universities. In Bangladesh, Dhaka University of Engineering and Technology (DUET) is one of the largest universities that mainly offers engineering education at a higher level only for diploma graduates. As DE graduates already have a four-year engineering education, they are likely to perform better in their subsequent academic programs. Therefore, measuring their performance is essential to ensure quality education.

Ref. [14] shows that DE graduates have limited opportunities for higher engineering education in the public education systems. For example, only one public institution offers a BSc education, while the other four engineering universities provide the same programs for general students. In addition, most science and technology universities offer BSc Engineering programs for general students. Furthermore, other public universities, such as Dhaka and Rajshahi University, offer engineering programs, and DE graduates do not even qualify for admission. On the other hand, DUET only offers further engineering academic programs, regardless of private or public polytechnic type. Ref. [15] shows that students in private universities have a higher level of perception, knowledge, attitudes, and practices.
toward sustainability than their public school counterparts. Other studies, such as [16], show that private university students emphasize reputation values, selectivity, personal interaction, facilities, and cost. In contrast, public university students valued programs, athletics, reputation, cost, housing, and location. More recently, educators emphasized creating a scientific environment to adapt to corporate responsibility in higher education. Furthermore, students in private institutions are more engaged with learning legal, ethical, and philanthropic practices than their public school counterparts [17].

In this study, we examine how DE graduates from private polytechnics perform in higher engineering education compared to their public school counterparts. The findings suggest that students from private polytechnics receive lower grades in the higher engineering program than their public school counterparts. The results also reveal that private polytechnics have insufficient quality teachers. In addition, most polytechnic students, teachers, and other stakeholders urge the recruitment of more quality teachers. Quality polytechnic education would offer sustainable technical and vocational education, ultimately leading to sustainable engineering practices. Therefore, this study significantly contributes to identifying the problems in private polytechnics and then providing possible solutions. Furthermore, as educational institutions are the most prominent stakeholders in training individuals on technological development, this study will offer policy recommendations for promoting productivity, innovation, and economic activities.

Following the United Nations as a follow-up action plan of the millennium development goals (MDGs) 2015, Bangladesh also wants to achieve the sustainable development goals (SDGs) by 2030. TVET and skills development have become prime policy priorities for many governments to address youth unemployment, required for the advancement of globalization and new technologies. Our findings offer a comprehensive scenario of the existing polytechnics and potential avenues to provide quality technical education for building skilled human resources, and therefore, to achieve the sustainable development goals.

The study is organized as follows. Section 2 describes the research statement and a brief description of the technical education in Bangladesh. Section 3 describes the data collection process with a detailed sampling strategy and provides the empirical model to examine the effect of private polytechnics on higher engineering education performance. Section 4 reports and discusses the findings. Section 5 concludes, and finally, Section 6 discusses the potential limitations of the study.

2. Background

2.1. Research Statement

As education and socioeconomic backgrounds supplement each other [18], their relationship is reciprocally symbolic. For example, education increases individuals’ incomes, which usually improves their social and economic conditions. Education is considered the most crucial component of economic and social development [19]. A well-informed education system resolves the discriminatory scenario raised from an ongoing practice privileged by socioeconomic backgrounds [9]. Education has three main provisions, primary, secondary, and higher education, which are globally recognized, and their roles in shaping the world are identified and demarcated. After completing secondary education, many individuals enroll in a higher education program. In the United Kingdom (U.K.), higher education institutions used to be divided into two categories, universities and polytechnics [20]. These institutes primarily aim to produce skilled human capital in the labor market [21, 22]. The education system in most former British colonial states mostly follows the U.K. system [23, 24].

Ref. [25] argues that the university’s primary purpose is to produce elite leaders to run a country, while polytechnics concentrate on training specific skilled-based professionals, such as engineers and doctors. Leaders created by universities usually belong to a socioeconomically privileged background [26]. On the other hand, individuals with middle and lower socioeconomic backgrounds are often neglected by their university counterparts. Within the British colonial settings, leaders produced in the university system mainly ruled
polytechnic institutions and their graduates’ professional careers. Studies have found that a smaller proportion of polytechnic graduates went to conventional universities. For example, compared with the traditional system, a negligible amount of polytechnic graduates went to university for further education in the U.K. At the same time, some countries under former British colonial rule did not allow their polytechnic graduates to enroll in conventional universities [26].

In the late 1990s, the U.K. system transformed its polytechnics into universities. Many former British colonies established specialized engineering universities to access polytechnic graduates. However, these polytechnic graduates cannot enroll in conventional or elite universities by legislation. In contrast, they provide access to a socially privileged group, and not individuals from lower socioeconomic backgrounds [9]. This practice indicates that the higher education model for polytechnic graduates in these British colonial regions does not entirely follow the British system.

The beginning of engineering education has a historical base in Bangladesh. During the British colonial period, the Ahsanullah School of Engineering (ASE) was the foremost institute established in the Bengal region for engineer-related job training. This ASE institute was later converted into a polytechnic institution [27]. After the British colonial period, the ASE was transformed into an engineering university and renamed the East Pakistan University of Engineering and Technology (EPUET). After its independence in 1971, it was further renamed Bangladesh University of Engineering and Technology (BUET). After its transformation into a university, its rules and regulations were entirely changed. One of the changes was that polytechnic graduates are not now eligible for higher education at BUET. BUET and its affiliated or similar institutions, such as the Bangladesh Institute of Technology (BIT), now allow only higher secondary graduates from the science cluster [27]. The BITs started to become engineering universities in 1999 following an ordinance. Five engineering universities offer engineering degree programs leading to Bachelor’s, Master’s, and Ph.D. qualifications. However, only higher secondary graduates can apply for four-year Bachelor’s programs in these universities [27]. On the other hand, graduates from polytechnic institutions, sometimes called diploma engineers, cannot qualify for admission to Bachelor’s programs in these elite universities.

These diploma graduates can enroll only in BIT, Dhaka, for further education. In 2003, BIT, Dhaka, was transformed into a university and later renamed the Dhaka University of Engineering and Technology (DUET). Other BITs are also renamed as Chittagong University of Engineering and Technology (CUET), Khulna University of Engineering and Technology (KUET), and Rajshahi University of Engineering and Technology (RUET). Like other engineering universities, DUET offers degree programs leading to Bachelor’s, Master’s, and Ph.D. qualifications. The difference is that only diploma engineers are allowed to apply to DUET. Graduate engineers from DUET already completed a four-year engineering degree in polytechnics, indicating that eight years are needed to become a Bachelor of Engineering graduate. In contrast, graduates from other engineering universities, such as BUET and CUET, spend only four years completing the same engineering programs.

Studies such as [28–31] consistently show the relationship between socioeconomic status and educational achievements. Refs. [32,33] argue that students from lower-income families are more likely to face academic challenges. Although it is not unanimously clear, many studies explain such effects ranging from the inequitable distribution of resources and opportunities to variations in the family’s day-to-day interactions [34,35]. Ref. [36] argues that schools with higher average socioeconomic status tend to receive a higher average score than their whole intake. In other words, a group of high-SES students in a school usually offer an environment associated with even better attainment than an individual student’s SES alone. For example, parental educational status and family income are positively correlated with better academic expectations for their children [37–41]. Ref. [36] also argues that the opposite is true for students with lower socioeconomic status. Therefore, when students with lower socioeconomic status are grouped in a school, their lower educational attainment could be exacerbated. For example, Refs. [38,39] argue that lower-SES parents
usually have fewer expectations than their high-SES counterparts and are less likely to invest in their child’s learning.

Most previous studies compare students with higher SES with lower SES assuming similar academic credentials. Recently, [9] examined the effect of SES in higher engineering education. As a prior engineering program likely offers an absolute advantage to undergraduate students, they are more likely to overcome the effects of SES in their subsequent program in the same disciplines. Despite a more comprehensive education in similar academic programs and socioeconomic backgrounds, few studies argue that private or public technical institutions remain critical in academic and professional engineering education achievements. In this study, we examine the impact of private polytechnics on furthering higher engineering education.

2.2. Technical Education and Economic Development

While the university usually produces systematic scientific knowledge, vocational education training offers hands-on training with expertise for a specific occupation [42]. Therefore, the success of a university depends on its contributions to the respective scientific discipline, while the success of vocational education is concerned with the ability of students to accomplish useful work. In addition, socioeconomic and political components could also affect the development of the university and vocational education establishment process [43,44]. Therefore, beyond compulsory education, many educational institutions, including elite higher education, polytechnics, and different levels of vocational institutions, simultaneously work to train doctors, teachers, and lawyers in countries around the globe. For example, Germany and the United Kingdom operate capitalist economies but have different approaches to higher education and TVET [45]. Higher education in Germany is more vocationally oriented than the U.K., with specific skills tied closely to a particular occupation. In contrast, in the U.K., higher education is generally not concentrated on specific occupational fields since it is considered reasonable for individuals to invest in developing general and transferable skills. However, they have a wide range of highly specialized, short-term programs offering vocational qualifications.

Despite the different vocational programs in many countries, they always significantly contribute to national development. This is because these institutions highly concentrate on knowledge creation, basic societal problem identification, and efficient solutions. Moreover, in the fourth industrial era, engineering education institutions in developed countries revised their academic curricula to meet the upcoming challenges and ensure the desired economic growth [46].

2.3. Sustainable Development Goal 4: A New Outlook to TVET

TVET and skills development have become a prime policy priorities for governments to address youth unemployment, skills mismatch, skilled migration, and new skill requirements for globalization and new technologies. Therefore, the national TVET reform initiative has received global recognition for skills development and lifelong learning. Moreover, following the Sustainable Development Goals (SDGs), TVET and lifelong learning have been given the highest priority in global educational development agendas, serving to improve their current status to international standards https://unesdoc.unesco.org/ark:/48223/pf0000246300, accessed on 18 December 2021. More specifically, SDG 4 aims to ensure inclusive and equitable quality education and promote lifelong learning opportunities for everyone.

The United Nations, through SDG 4.4, aims to significantly increase the number of youth and adults with relevant skills, including technical and vocational skills, for employment, decent jobs, and entrepreneurship. In addition, the objective is to ensure equitable access to quality TVET programs with increased and diversified learning opportunities. Similarly, beyond work-specific skills, the UN emphasizes developing high-level cognitive and non-cognitive skills, such as problem-solving, critical thinking, creativity, teamwork, communication skills, and conflict resolution, to use across various occupational fields.
Although it is recognized that effective TVET policies strengthen long-term and inclusive economic growth [47], this system remains underdeveloped and poorly managed in many countries [47, 48].

2.4. Technical Education in Bangladesh

Technical education has contributed to human resource development since the 1870s. During the British colonial period, the School of Engineering was first established in 1874 as the center for technical education in Assam and undivided Bengal (This School of Engineering is currently operating as the Bangladesh University of Engineering and Technology (BUET)). Later, one private and 21 public technical institutions offered technical education during the British colonial period. After the partition of this subcontinent, according to the Council of Technical Education report in Pakistan in February 1949, two polytechnic institutes were established in Karachi and Dhaka. Then, using financial assistance from the Ford Foundation of America, East Pakistan Polytechnic Institute was established, which is currently named Dhaka Polytechnic Institute.

Figure 1 shows the technical educational structure. Students can enroll in vocational programs at the secondary level after completing the eighth grade. These programs are the SSC and Dakhil vocational. After completing these 10th grade-equivalent programs, they can enroll in higher secondary or diploma programs. These diploma programs mainly offer education in engineering and technology. However, after completing a four-year engineering program, graduates can be admitted to only one government-operated engineering university, Dhaka University of Engineering and Technology (DUET), Gazipur. This university was established exclusively for diploma graduates. Therefore, higher secondary graduates are not allowed to apply for DUET admission. Similarly, diploma students cannot earn admission to other publicly financed engineering universities. However, diploma graduates can pursue engineering programs at private universities.

Figure 1. Technical education structure in Bangladesh. BM = business management, B. Sci. = Bachelor of Science, HSC = higher secondary certificate, SSC = secondary school certificate. Dakhil General and Dakhil Vocational are equivalent to SSC General/Voc in madrasah. Madrasah refers to religious schools for the study of the Islamic religion. Source: BTEB.
After the independence in 1971, 33 public and 20 private technical institutions were established until 1990. However, the number of technical and vocational institutions was not significantly increased compared to the previous 24 years’ regime under the Pakistan period. Some pointed out the political instability during this period. However, between 1991 and 1999, the number of institutions rose remarkably. About 17 public and 248 private technical institutions were established during that period.

In the 2000s, the government realized that students graduating from different academic programs do not obtain their desired employment opportunities and paid more attention to promoting vocational and technical education. Therefore, the government began to widen the specialized educational institutions throughout the country. As a result, 126 public technical institutions were established, and 746 private technical institutions were approved around the country. From 2001 to 2005, 37 public technical institutions were founded, and 1554 private technical institutions were permitted. However, the ratio of students and teachers in both sectors was not increased proportionally due to the negative conceptions of technological education sectors.

Since establishing the BTEB in 1969, it has helped meet the increased demand for technically skilled workers. In addition, TVET has experienced growth and diversification. For example, several government ministries have become involved, private organizations have created internship training opportunities, and NGOs have provided training. Furthermore, in 2004, polytechnic institutes raised the duration of the Diploma in Engineering program from a three-year program to a four-year program. However, students showed little interest in studying at the polytechnic institutes. For example, an estimated 135,000 seats remain empty across the country. Approximately 127,976 of the 185,055 seats at the 511 private polytechnic institutes were vacant in 2019–2020. At the 49 government institutes and 64 technical schools and colleges, 7127 of 56,170 seats were vacant. To overcome this situation, BTEB admits SSC graduates with 2.50 CGPAs as the minimum qualification. To implement Vision 2041, the government aims to promote youth’s skilled human resources in the technological and industrial era. Therefore, the government plans to establish 576 public technical institutions, approve 390 private technical institutions, and recruit more teachers. However, not all schools will offer Diploma in Engineering programs.

3. Research Design
3.1. Data and Sampling Framework

We collected primary data from Dhaka University of Engineering and Technology (DUET), the only public university that offers higher engineering education for DE graduates. In addition, we collected data from students of all departments: Civil Engineering (CE), Computer Science and Engineering (CSE), Electrical and Electronics Engineering (EEE), Mechanical Engineering (ME), Textile Engineering, Architecture, Industrial and Production Engineering, Materials and Metallurgical Engineering (MME), and Chemical and Food Engineering (CFE). The survey duration for the study was November 2021 to February 2022. As this study focuses on academic success, we considered students who completed at least one semester. The main reason for considering students who completed one semester is that the subsequent institution evaluates the student’s academic success. Furthermore, we assumed the CGPA to measure academic success. To determine the representative sample size, we mainly employed the [49] formula:

\[ n = \frac{N}{1 + N(e)^2} \]

where \( n \) is the sample size, \( N \) is the total number of graduates, and \( e \) is the significance level or the level of precision. Table 1 shows the department-wise sample distribution. The four largest departments have 120 students in each session, while TE has 60, and other departments have 30 students. As the MME program started in the 2020–2021 academic session, it has only two batches with 60 students.
Table 1. Sample distribution among departments in DUET.

| Department                                      | Population Size | Sample Size |
|-------------------------------------------------|-----------------|-------------|
| Civil Engineering (CE)                          | 480             | 218         |
| Computer Science and Engineering (CSE)          | 480             | 218         |
| Electrical and Electronics Engineering (EEE)    | 480             | 218         |
| Mechanical Engineering (ME)                     | 480             | 218         |
| Textile Engineering (TE)                        | 240             | 150         |
| Industrial and Production Engineering (IPE)      | 120             | 92          |
| Architecture (Arch)                              | 150             | 109         |
| Materials and Metallurgical Engineering (MME)    | 60              | 52          |
| Chemical and Food Engineering (CFE)              | 120             | 92          |
| **Total**                                        | **2610**        | **1369**    |

We also used qualitative data to validate the results from the quantitative data. Given the nature of the research questions, we collected data from the professors at DUET, instructors at polytechnics, administrators, and BTEB officials. We mainly used semi-structured interviews. Some questions were also open-ended. To maintain confidentiality, we coded each of the respondents. Following the department abbreviation, we use codes for each respondent. For example, for the first respondent of the ME department, we use the code ME01. This coding was made in the interest of respondents’ anonymity and to meet the ethical and confidentiality requirements in research. We also reviewed government documents, newspapers, and other published reports to validate quantitative and qualitative data results.

3.2. Methodology

We mainly employed the following multivariate regression model:

$$y_i = a_0 + a_1 x_i + a_2 z_i + e_i,$$  \hspace{1cm} (2)

where $y_i$ is the GPA of student $i$ in a BSc program; $x_i$ is a binary indicator for private polytechnics; $z_i$ represents the other factors, including sibling or parental education income, hours of study, and urban areas; and $e_i$ is the error term. The leading coefficient of interest, $a_1$, is expected to be positive and statistically significant, indicating that private polytechnics positively impact academic achievements at higher levels. Depending on other influencing factors, the sign for the $a_2$ would be different. This study considers DE GPA, study hours, peer effects, and socioeconomic backgrounds as control variables. Socioeconomic background might have an impact on students’ academic attainment. This study considers family income and urban status as socioeconomic backgrounds. Family monthly income is measured in Bangladeshi Taka. We use a binary indicator of whether students come from urban areas for urban status. The study duration is measured in total weekly hours spent on learning, except the class hours in DUET. We use females as a binary indicator for female students for demographic status. The peer effects are measured in academic attainment in the same class.

For the qualitative study, we interviewed respective departmental chairs in DUET and DEs. For each respondent, we use an anonymous code following their department abbreviation. For example, we use EEE01 to refer to the first respondent from the EEE department. We briefed them on the research purpose, focus, and confidentiality before the interviews. Each interview lasted 45–60 min. We also allowed each interviewee to share their experiences or observations openly, revealing additional useful information. The sequence of the interview questions was altered ad hoc to maintain a friendly discussion.
4. Results Analysis

4.1. Descriptive Statistics

Figure 2 shows the percentage distribution of surveyed students with their government and private polytechnic institutions. Only 5.78% of the total students came from private institutions pursuing higher engineering education in higher engineering programs. Approximately 98% of them said that the main reason for the lower enrollment is lower motivation to pursue higher engineering education. Their ultimate goal is to enter the job market after graduating from the diploma programs.

![Figure 2: Percentage distribution of students with polytechnic backgrounds.](image)

We also examined the percentage distribution of students with their demographic location. Following the urbanization scale, this study mainly considers location under five categories: capital, city corporation, districts, sub-districts or Upazila, and villages or unions. Approximately 80% of the total students came from a village or union. About 3.17% of the students came from government institutes, while 4.17% were from private technical institutions.

Table 2 summarizes the statistics of the surveyed students. The mean cumulative grade point average (CGPA) in DUET for students from public institutions is 3.23 on a scale of 4.00, and 3.22 for students from private polytechnics. The CGPAs of former public and private students in the DE programs are 3.63 and 3.71, respectively. Additionally, the standard deviation for both averages of CGPAs is almost similar, indicating that students from both institutions are likely to be identical in their overall academic backgrounds. Table 2 also shows that their average daily study time is almost 6 h. The average family income for the government polytechnic students is 18,206 Bangladeshi Taka (BDT) and 19,478.99 for the students from private institutions. Although students of private institutions came from relatively economically stable families, they are still below the nationally represented family income.

These statistics indicate that most students who attended diploma programs are mainly from lower socioeconomic backgrounds.

Most students received private tutoring to gain admission to DUET. Table 2 shows the average number months of tutoring for private and public students, approximately 18 months and 16 months, respectively. They usually attend private tutoring centers after completing their seventh semester of the DE programs. Most of them completed their industrial attachment by staying near DUET. They also argue that the educational system in the DE programs is not the same as that required for a successful DUET admission. This indicates that the programs are not synchronized in academic curricula and practices. Table 2 also shows a higher percentage of female students from government institutions enrolled in higher education programs.
Table 2. Summary of statistics.

| Variable                                | Number of Observations | Mean    | Standard Deviation |
|-----------------------------------------|------------------------|---------|--------------------|
| **Panel A: Government Polytechnic Institutions** |                        |         |                    |
| DUET GPA                                | 1543                   | 3.23    | 0.40               |
| DE GPA                                  | 1764                   | 3.63    | 0.29               |
| Study hours                             | 1769                   | 5.59    | 2.77               |
| Family income                           | 1718                   | 18,206.34 | 17,823.10       |
| Urban                                   | 17                     | 0.56    | 0.67               |
| Number of industrial tours              | 1752                   | 2.49    | 1.69               |
| Months of private tutoring received for DUET admission | 1785 | 17.51 | 7.53 |
| Female                                  | 1794                   | 0.10    | 0.29               |
| **Panel B: Non-Government Polytechnic Institutions** |                        |         |                    |
| DUET GPA                                | 103                    | 3.22    | 0.42               |
| DE GPA                                  | 120                    | 3.71    | 0.19               |
| Study hours                             | 118                    | 5.62    | 2.76               |
| Family income                           | 119                    | 19,478.99 | 13,560.82       |
| Number of industrial tours              | 120                    | 2.98    | 1.70               |
| Months of private tutoring received for DUET admission | 121 | 16.38 | 7.35 |
| Female                                  | 121                    | 0.03    | 0.18               |

4.2. Empirical Estimation Results

Using the regression model in Equation (2), Table 3 shows the impact of private polytechnics on academic achievement in higher education programs. Column 1 shows the average difference in DUET CGPAs between private and public students. Similarly, Column 2 shows the same effect of the private polytechnics on DUET CGPAs, incorporating family income as a control variable. However, the estimates of the non-government polytechnics are not statistically significant at 10%. These findings make sense, as only the institutional backgrounds do not significantly affect academic attainments. In Column 2, the family income estimates are insignificant. This implies that the types of polytechnics do not have impacts when no control or income is considered as a control variable. However, academic CGPAs do not only depend on parental income. Many other socioeconomic and individual characteristics could have an impact on educational attainment. Columns 3 and onwards of Table 3 show the estimated effects considering more control variables. Individual ability could impact students’ CGPAs. Column 3 incorporates students’ ability to use their previous academic attainment as a representative proxy. In such a case, private polytechnics’ estimated effect is \(-0.111\), and it is significant at 1%. The impact of ability is also significant. These results imply that students from private polytechnics could receive lower grades than their government institution counterparts.

Column 4 shows the estimated effects considering the study hours in the model. This study assumes the study hours per day. The estimated coefficient of study hours is also positive and significant at 1%. The findings imply that students spending more time on their studies receive higher academic attainment. The estimated effect of private polytechnics is also negative and statistically significant. Demographic characteristics, such as gender and location, could also impact educational attainment. Columns 6 and 7 in Table 3 show a negative effect of gender, female, on academic achievement. These findings imply that female students receive lower grades than male students. In each case, the estimated impacts of private polytechnic experience are statistically significant.
Table 3. Impact of attending private polytechnics on academic achievement in higher education programs.

|                | (1)     | (2)     | (3)     | (4)     | (5)     | (6)     | (7)     |
|----------------|---------|---------|---------|---------|---------|---------|---------|
| Non-government | −0.019  | −0.035  | −0.108 ***| −0.111 ***| −0.112 ***| −0.122 ***| −0.120 ***|
|                | (0.040) | (0.041) | (0.037) | (0.037) | (0.037) | (0.037) | (0.036) |
| Family income  | −0.011  | 0.008   | 0.010   | 0.008   | 0.011   | 0.016   |         |
|                | (0.013) | (0.012) | (0.012) | (0.012) | (0.012) | (0.011) |         |
| DE GPA         | 0.642 ***| 0.640 ***| 0.640 ***| 0.639 ***| 0.509 ***|         |         |
|                | (0.030) | (0.030) | (0.030) | (0.030) | (0.034) |         |         |
| Study hours    | 0.010 ***| 0.010 ***| 0.010 ***| 0.010 ***| 0.009 ***|         |         |
|                | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) |         |         |
| Urban          | 0.070   | 0.080 * | 0.091 **| 0.091 **|         |         |         |
|                | (0.044) | (0.044) | (0.044) | (0.043) |         |         |         |
| Female         | −0.097 ***| −0.102 ***|         |         |         |         |         |
|                | (0.033) | (0.032) |         |         |         |         |         |
| Peer effect    | 0.378 ***|         |         |         |         |         |         |
|                | (0.029) |         |         |         |         |         |         |
| Constant       | 3.234 ***| 3.336 ***| 0.839 ***| 0.774 ***| 0.783 ***| 0.765 ***| 0.646 ***|
|                | (0.010) | (0.128) | (0.163) | (0.165) | (0.165) | (0.165) | (0.170) |
| Observations   | 1646    | 1572    | 1541    | 1518    | 1518    | 1513    | 1372    |
| R-squared      | 0.000   | 0.001   | 0.231   | 0.237   | 0.238   | 0.241   | 0.336   |

The dependent variable in all columns is the CGPA in DUET. Standard errors are in parentheses. ***, **, and * represent significance levels at 1%, 5%, and 10%, respectively.

Academic institutional quality sometimes seems to be judged on students’ excellence rather than on the quality of teaching or other educational logistics. Therefore, many argue that the background and abilities of students must influence their achievements at school. Academic literature measures the consequences of social interactions between pupils, termed peer group effects. Students meet new and unfamiliar peers when they go to school. Column 7 in Table 3 incorporates the peer effects into the model. The estimated impact of peer effects is positive and statistically significant, indicating that students with higher-ability peers have higher attainment. The estimated impact of private polytechnic attendance is −0.120 and is statistically significant. These imply that students from private polytechnics receive lower grades than their public school counterparts. Considering socioeconomic, academic, and demographic backgrounds, Table 3 shows that government polytechnic students perform better, although they have similar educational qualifications.

4.3. Discussion

The relationship between socioeconomic factors and academic attainment is one of the critical issues in the literature. For example, according to the Colman Report, schools usually have a limited effect on students’ academic outcomes compared to students’ abilities embodied before coming to school. Furthermore, disparities inherited from the home, neighborhood, and peer groups create inequalities in students’ post-school professional career. Table 2 shows that the average income of private students’ families is higher than their public school counterparts. However, in Table 3, family income does not significantly impact academic attainment. Students’ location backgrounds are also similar. Regardless of the originating location, most students came from rural areas.

Besides theoretical knowledge, engineering students should have technical laboratories and have experimental opportunities or hands-on training on the different technologies. Moreover, they should have practical experience on all the topics covered in their syllabi and needed in the labor market. Figure 3 shows the percentage distribution of the experimental equipment. Almost 60% of the surveyed private students complain that they only have 0–10% of the total required laboratory equipment.
Students surveyed in this study argue that most private polytechnic students are not admitted to DUET for higher education programs. Instead, they come from the same institutions every year, such as Mirpur Polytechnic Institute, Shyamoli Ideal Polytechnic Institute, and National Polytechnic Institutes. Although there are more than 380 private polytechnics across the country, most DUET students have mainly come from particular private institutions. The findings suggest that approximately 98% of the total DUET students graduated from only 10% of the country’s total polytechnic institutions. These statistics indicate that the remaining 90% of private institutions are presented in the empirical analysis.

We conducted a qualitative survey at some of these institutions to complement this result. Most of these institutions do not even have teachers for each subject, regardless of permanence. For example, a teacher of a private polytechnic, PTE11, reported to the Business Standard that they have 210 students per teacher for a total of 2100 students (https://www.tbsnews.net/bangladesh/education/polytechnic-institutes-are-shambles, accessed on 2 February 2022). He further noted that:

“We are trying to provide a world-class education for our students. But we sometimes fail because we have an inadequate number of teachers.”

Moreover, there is no minimum state or BTEB requirement for the number of teachers for each subject, premises, and other academic logistics. For example, teachers must also carry out clerical work.

One of the professors at DUET, ME01, who used to work as an instructor in polytechnic institutions, said that he had to teach more than 58 h of classes weekly. In addition, the teacher earlier interviewed in the Business Standard further asked a question:

“How can we teach such a large number of students when there are so few teachers?”

We also used government, non-government, and other newspaper documents to validate the qualitative findings. Figure 4 shows the summary of technical education in Bangladesh. More than 220 out of 387 private institutions do not have a permanent building to conduct their classes. For example, the Bangladesh Institute of Technology has six teachers and over 500 students in a survey reported in the Business Standard. Furthermore, they have only one teacher with a permanent position. On the other hand,
the average student–teacher ratio is 120:1 for public polytechnics. This information is also validated by students surveyed in each department.

![Figure 4. A summary of polytechnic institutions in 2018. Source: The Business Standard.](image)

To complete the diploma program, a student must complete eight semesters. According to the rule, the respective institutes control the first three semesters. The Bangladesh Technical Education Board conducts examinations for the subsequent four semesters, and the remaining semester is the industrial attachment. In addition, practical examinations are a mere formality in most institutions, where students only need to be present at the exam centers. One of the principals of a private polytechnic, PTE021, told the Business Standard that his institution has good connections with officials of the technical board. Hence, the principal argued:

“This makes everything easy for us. We can even manipulate the practical test scores of the students. We control everything as I was the Chemical and Food Department chief at a Public Polytechnic Institute. A student can get a certificate if they attend some lectures and follows our guidance.”

A former Dean of the Faculty of Mechanical Engineering at DUET (ME19) advised to appoint an assessor of the polytechnic exam instead of the current system. He has considerable experience with technical education both in DUET and DE. He pointed out that the existing evaluation does not motivate students to learn and build themselves human resources, regardless of pursuing further education or going to the job market.

More than 80% of private institutions and 60% of public institutions were founded between 2001 and 2017. However, only a few have classrooms and other laboratory facilities. In a conversation with the Business Standard, one of the Bangladesh Private Polytechnic Owners Association secretaries said that the lack of strong supervision from the government is the main reason for poor quality education in many private polytechnic institutes (https://www.tbsnews.net/bangladesh/education/polytechnic-institutes-are-shambles, accessed on 2 February 2022). He noted that

“Some private institutes are doing better than the government ones. However, a good number of private institutes only have signboards. They get the attention of potential students by advertising the technical board’s approval.”
He further added:

“However, after admission, the students have to do nothing. Only a strong monitoring system from the government can help improve the quality of education in these institutes.”

We also validated the above findings with other faculty members in DUET. We also interviewed faculty from other institutions such as BUET and CUET to validate the results. Some of them argue that academic collaboration between DUET and polytechnics is essential. As DUET is the only public university to offer higher engineering education for DE graduates, they are familiar with the strengths and weaknesses of the polytechnics. Studies such as [50–52] emphasize academic collaboration to design technology support for knowledge creation to face the contemporary challenges in academia and industries. The collaborative activities would allow diploma institutions to become familiar with cutting-edge engineering education and produce technically skilled human resources required for the job market.

5. Conclusions

Technical and vocational education prepares human resources to promote economic development, explain employment and production opportunities, and improve employment quality. In Bangladesh, two types of polytechnic institutions offer technical and vocational education. In this study, we examined how private institutions perform compared to their public school counterparts. Examining academic attainment in higher engineering program, we found that students graduating from private polytechnics perform worse than their public school counterparts. This study also finds that private polytechnics have a lower number of teachers and laboratory facilities.

While most previous studies argue about students’ perceptions, the findings of this study comprehensively incorporate both perspectives. For example, using students’ perception in a five-point Likert scale questionnaire, Ref. [15] argues that private universities in China have a better reputation than their public school counterparts. In contrast, using a more rigorous multivariate regression method, this results of this study indicate that private polytechnic students do not perform as well as their public school counterparts. In addition, we used CGPA as a measure of academic achievement, a widely accepted standard for educational attainment. The study findings also emphasize that private polytechnics have limited academic logistic support. As the results are validated by the demand and supply perspective of the polytechnic graduates, they are more comprehensive. Ref. [53] identified similar challenges in New Zealand, including constraints for academic staff, lack of time, high workloads, insufficient support, and inadequate resources. The findings of this study are important for policy makers. One of the main objectives of the current government is Vision 2041 to achieve developed country status by 2041. The government also wants to achieve the SDGs by 2030. Therefore, newly implemented policies and other development programs are linked to these objectives. This study also offers a comprehensive scenario of the existing polytechnics and potential avenues to provide quality technical education for building skilled human resources.

6. Limitation and Further Extension

Although we used a representative sample size from DUET students for this study, they may not represent all private polytechnics across the country. For example, only 6% of students came from private polytechnics, and most come from the same institute each academic year. Therefore, a country-wide study would offer a more comprehensive investigation. Furthermore, this study is the first attempt to examine the effect on private polytechnics in the context of Bangladesh. Therefore, it would be interesting to make an international comparison. Finally, the findings were obtained solely based on the academic success of the polytechnic students. However, some graduates may not pursue higher education; instead, they may pursue professional careers. Therefore, it would be interesting to examine how students of private polytechnics perform in their professional careers compared to their public school counterparts.
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