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Foreword

Bangladesh Accreditation Council (BAC) has been established with the responsibility to develop quality assurance culture in higher education and to establish the process of accreditation. BAC has formulated accreditation rules, standards and criteria for accreditation and other relevant rules and regulations for awarding accreditation. Recently, BAC has received preliminary applications for accreditation of 377 academic programs from 43 universities (2024-2025). In this period, four universities have also submitted final applications for accreditation of 11 of their academic programs.

Bangladesh Accreditation Council (BAC) has formulated 'Bangladesh Accreditation Council Research Policy 2022' to conduct research to gain knowledge on higher education quality assurance and accreditation issues. Realizing the importance of creating a research management framework for the smooth execution and fruitfulness of research activities, this policy has been framed, which is consistent with BAC's vision and mission.

BAC approved nine research projects in FY 2023-24. Each research project received up to three lac taka (BDT 300,000.00) and implemented their research successfully. After reviewing the final report and evaluation report, the BAC is now ready to publish the 'Proceedings of the Workshop on Research Project 2024'.

In this connection, I would like to thank 'Research Management Committee' of BAC for their tireless effort to bring the report in the present form. Thanks, are also due to Professor Dr. Sanjoy Kumar Adhikary and Professor Dr. Syed Hafizur Rahman for their help and assistance.

Finally, it is expected that the publication of 'Proceedings of the Workshop on Research Project 2024' will strengthen the understanding of the Bangladesh Accreditation Council's research activities and its contribution in successful implementation of goals and objectives of the BAC.

Professor Dr. Mesbahuddin Ahmed
Chairman
Bangladesh Accreditation Council

Preface

In the evolving landscape of higher education, the Bangladesh Accreditation Council (BAC) remains dedicated to ensuring quality assurance and accreditation for promoting continuous improvements in higher educational standards across the country. As part of this commitment, the BAC facilitates research initiatives that address critical challenges in higher education and contribute to the enhancement of the academic ecosystem. The importance of research is immense in assessing the status of higher education curriculum, teaching process and teaching-learning activities management system in the higher education institutions (HEIs) of the country and determining what to do to improve its quality. Research on quality assurance and accreditation in the changing context will play a special role in establishing the council as an internationally recognized body.

In the 2023-24 fiscal year, the BAC received a total of 124 research project proposals from various higher education institutions. These proposals underwent a comprehensive double-blind peer review process, nine research projects were approved. According to the 'Bangladesh Accreditation Council Research Policy 2022,' Each of the nine approved research projects received a grant of up to three lac taka (BDT 300,000.00) to support their implementation, which was carried out successfully within the expected time frame. These research projects, managed by both public and private universities, focus on critical areas such as accreditation, BNQF, quality assurance, outcome-based education and the integration of educational technology etc.

The coordination and monitoring of these projects were managed by the External Affairs, Research and Publication Division of the BAC, ensuring that each project adhered to the required standards. Additionally, the 'Final Report Presentation' workshop was organized to review the progress of these projects and evaluate their impact. The discussions held at this workshop contributed significantly to refining the outcomes of the research, ensuring that they would meet the BAC's quality objectives.

As a result of this initiative, the Bangladesh Accreditation Council will publish the 'Proceedings of the Workshop on Research Projects 2024', which will encapsulate the findings and insights derived from these valuable research endeavors.

I am deeply grateful to Professor Dr. Sanjoy Kumar Adhikary and Professor Dr. Syed Hafizur Rahman to make this publication more effective. They both thoroughly reviewed the documents. I would like to thank the members of the 'Research Management Committee' of BAC who have provided consistent guidance to the researches to ensure the successful execution of the research project. My sincere gratitude goes out to the BAC authorities and colleagues who made it possible for the research fund to be disbursed in an accountable and real manner.

I extend my deepest appreciation to the Principal Researcher(s) and their research team for following the instructions of the Research Policy 2022 of BAC and completing their research projects on time. Finally, the encouragement and support extended by the Honorable Chairman Professor Dr. Mesbahuddin Ahmed of the BAC are gratefully acknowledged.

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Quality Assurance in Bangladesh Tertiary Education: A Review of Scholarly Works (2015 to 2023)

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Abstract

The meta-review examined 55 Bangladeshi quality assurance studies from 2015 to 2023. It used quantitative, qualitative and descriptive methods. It used meta-analysis, alongside, three quality assurance professionals interviewed key informants. They characterised scholarly works and selected keywords, search engines, and digital platforms for the review. This research analysed scholarly works by type, publication date and place, authorship profile, research design and techniques, and level of analysis. Finally, the examined outputs were thematically analysed into three categories: basic principles on quality assurance, specific aspects, and education program quality assurance. 81.82 percent of scholarly works were journal articles, with a steady growth from 2015 to 2023. Bangladesh (27.27%) and North America (21.82%) published many multi-author papers. These publications included 138 writers, predominantly male (72.46 percent) and Bangladeshi (90.58 percent) from Business and Economics (42.75 percent), Arts and Humanities (15.94 percent), Engineering (15.22 percent), and Physical and Medical Science (14.49 percent). The most prevalent method in twenty-three quantitative studies was surveys (87.5 percent), while twenty-two qualitative studies used interviews (54.55%). Some investigations used mixed approaches. Academic excellence (35.42 percent), feedback mechanisms (16.67 percent), and quality culture (12.50 percent) were the most covered quality assurance ideas in thematic analysis. Process management (40.00 percent), teaching, learning, and assessment (26.67 percent), and student services and facilities (22.67%) were the most popular quality assurance topics. Most studies focused on tertiary education (58.46 percent). It was important to review scholarly papers to guide quality assurance research. It also described quality assurance system comprehending trends, which inform policy decisions. The study presented six policy proposals to address practical quality assurance difficulties in higher education after examining scholarly literature.

Keywords: Higher Education; Quality Education; Meta Analysis; Thematic Analysis

Introduction

Bangladesh attained independence during the 1971 Liberation War. At that period, it solely relied on state universities for higher education. There were six universities:

four general and two specialised. The institutions comprised the University of Dhaka (founded in 1921), University of Rajshahi (founded in 1953), Bangladesh Agricultural University (founded in 1961), Bangladesh University of Engineering and Technology (founded in 1962), University of Chittagong (founded in 1966), and Jahangirnagar University (founded in 1970).

In the mid-1970s, the country began to shift away from public sector predominance as a strategy for economic development. It commenced the privatisation of state-owned firms and the reduction of import barriers. It is known that in a market-oriented strategy, the state must adopt a less interventionist and more regulatory role. As a result of these steps, international firms commenced establishing operations in the country. Given that foreign entities require a substantial pool of adept personnel possessing critical and creative skills, the nation has devised a medium to long-term strategy for workforce development. It projected a heightened demand for vocational and market-relevant degrees.

During the 1980s, the nation felt compelled to establish private universities. Due to the reluctance of most state universities to reconsider their academic strategies and expand enrolment, Bangladeshi residents sought education in India and Western nations (Alam et al., 2007). The government then urged social theorists and benefactors to create private, non-profit universities. Haque and Alam (2008) articulated that "a privately managed higher education subsystem in a developing nation enhances the subsector by introducing and/or strengthening elements of stratification/diversification, flexibility, competition, and connections to the labour market." Nonetheless, the military coup of May 1981 disrupted these objectives. Only after a decade, following the restoration of democracy, did parliament enact the Private University Act of 1992 (PRUA), which was later superseded by the Private University Act of 2010. The Act establishes the legal framework for the creation of private colleges, anticipating that they will augment governmental initiatives to satisfy the demand for higher education.

Months after its enactment, the government sanctioned the founding of the first private institution – North South institution (NSU) – authorised to confer degree-level programs. In the subsequent year, an additional four or five universities were established (Alam et al., 2007).

Figure 1 illustrates the expansion of private and public universities inside the nation. In 1997, there were twenty-seven universities, which rose six-fold to 169 by 2023; of them, 55 (32.5 percent) were public and 114 (67.5 percent) were private.
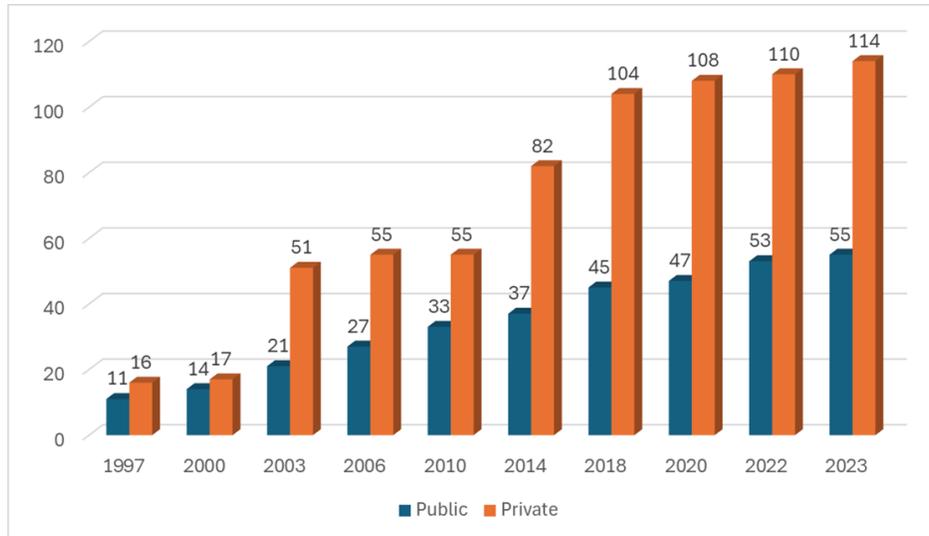
Figure 1: Number of Private and Public Universities in Bangladesh (1997 to 2023)

Source: University Grants Commission of Bangladesh website (UGC, 2024a; UGC, 2024 b)

Chowdhury (2007) cited social recognition as a primary reason for proprietors to create private institutions. Nevertheless, he also acknowledged an additional motivating force – the quest for profit while being classified as a non-profit organisation. To achieve financial sustainability, private institutions implemented a market-oriented strategy, targeting the affluent segment of society by replicating the North American educational model. Kabir (2012) elucidated that the vocational orientation of North American education empowered graduates to prevail in the work market. This technique appealed to the elite class because of their inclination towards the specified system, the exclusivity of private schooling, and the assurance of profitable employment opportunities. Monem and Baniamin (2010) noted that, in contrast to public universities, private universities can adapt to market trends, provide superior student-teacher ratios, more effectively monitor student attendance and participation, and assess student performance through continuous evaluation methods characteristic of the North American model. Private colleges initially focused on the elite population in Dhaka and urban areas. Subsequently, they broadened their market to encompass middle-income pupils from comparatively affluent districts. Due to the scarcity of public university placements, numerous accomplished secondary education graduates ultimately pursued private university education (Mohammad et al., 2008).

Higher education has distinct purposes depending on the field of study and the institution. According to Kabir (2012), parents believe that economic survival depends on market-oriented degrees. Considering the cost of private university tuition, they assess degree programs depending on their ability to produce viable employment prospects. Parents thus inspire their children to pursue education that would help them to become more suited for the business sector. They show less

respect of their children's choices, skills, and limitations. Parents claim that vocational training will lead to immediate job with better starting pay (Alam et al., 2007). More often than not, they see higher education as a method to get a certification than as an opportunity to acquire knowledge and skills (British Council, 2014). Business administration, computer science, engineering, medical, information and communication technology (ICT), and English were the most often occurring market-oriented degrees noted by Alam et al. (2007), Mohammad et al. (2008), and Kabir (2012). According to the British Council (2014), degrees in business and management remain popular among students hoping to be entrepreneurs or those hoping for jobs in banks and the private sector.

When Bangladesh had only a small public university count, quality control was not seen as a major problem. But given the explosive spread of colleges, academics have underlined the relevance of the idea. The traditional approach of depending on seasoned teachers to run universities and provide high-quality instruction was no more feasible. The emphasis on making profit clouds the search for high-quality education. Scholars with commercial sense thus quickly rose the ranks. Islam (2014) noted that the "rapid increase in enrolment coupled with insufficient infrastructure and resources, misalignment of existing capacity and absence of organisational arrangements, which may lead to a decline in academic quality and standards," has made education a major issue of concern among stakeholders.

Haque and Alam (2008) expressed great concern about the standard of instruction in public and private institutions. Regarding the previously mentioned, they claimed that "there is an emerging perception that, with few exceptions, private universities do not deliver value for money." They take advantage of the liberal policies of the State and the absence of adequately evolved control mechanisms. Some universities were not offering the services they are supposed to. For instance, they pointed out that private universities did not make use of the appropriate number of full-time senior academics in order to keep low costs. Junior teachers handle most of the teaching; so, this method negatively affects the general learning environment. Islam (2014) pointed out that at that time many private universities lacked settings fit for learning. They leased buildings that would have suited retail stores, restaurants, and other businesses.

Haque and Alam (2008) underlined in public universities the use of politically motivated university policies and projects. They claim that "the Dhaka University Order 1973 conferred significant socio-political authority upon teachers, students, and other stakeholders (including graduates, non-teaching staff, parents, the public, and politicians)," so determining more academic and administrative positions more by socio-political loyalty than by professional competency or performance. Later general institutions, like Rajshahi University, Chittagong University and Jahangirnagar University replicated the Dhaka University Order of 1973 with some amendments. Politically charged were the elections for the Senate, Syndicate, Vice Chancellor, Deans and numerous bodies. As such, political considerations—rather

than educational quality—became the main determinant of teacher choice and promotion.

Islam (2014) referenced the 39th UGC Annual Report from 2013, highlighting significant concerns with the accountability of public university faculty. The research indicates that numerous teachers fail to attend their scheduled classes consistently or are absent without prior notification to the pupils. They are not adequately present even in the practical class. A significant number of educators are not present at their place of employment. The research claimed that several public university instructors teach part-time while dedicating more time to private universities.

Haque and Alam (2008) thus promoted the creation by the State an accrediting council. To be eligible for accreditation by the proposed council, they said "universities must achieve defined essential minimum criteria for inputs, processes, and outputs". When parliament passed the Bangladesh Accreditation Council (BAC) Act 2017, the recommendation was finally realised. The University Grants Commission (UGC) had to create a framework for quality education in higher education institutions using the World Bank-funded Higher Education Quality Enhancement Project (HEQEP) before the council was established. The UGC mandated most institutions between 2016 and 2018 to establish an Institutional Quality Assurance Cell (IQAC). The IQAC's main goal was to foster a quality culture at the university, comprising improvements in governance and leadership, educational innovations, student support and progression, infrastructure and learning resources, research, consultancies and extension, teaching, learning and assessments, as well as the creation of outcome-based curricula.

The IQAC was assigned to assist each program offering organisation in preparing a self-assessment report that demonstrated compliance with UGC criteria and standards. The self-assessment report was subsequently validated by an external peer review conducted by three experts in quality assurance and/or academic disciplines. Each IQAC comprises a director, an additional director, an office administrator, a financial officer, and office personnel. It should possess a dedicated office and a conference or training space. The UGC also established its Quality Assurance Unit (QAU) to function as its direct connection with the IQAC of each university. The UGC has depended on the IQAC to execute orders and oversee activities related to quality education under this structure.

Though the BAC Act was passed by the parliament in March 2017, the nomination of full-time council members was not concluded until more than two years later. Emerging as the independent governmental agency assigned to accredit corporations running academic programs and higher education institutions was the council. It provides these bodies with guidelines, policies and standards of best practices as well as helps to carry out the national qualification system, which got approval in January 2021. Evaluated against national qualifications frameworks of

Australia, New Zealand, Malaysia and Sri Lanka was the Bangladesh National Qualifications Framework (BNQF). Inspired by the ASEAN Qualifications Referencing Framework and the European Union's main frameworks, it The BAC called the "Launching Ceremony of the BAC Accreditation Process" in July 2022 at the International Mother Language Institute after the BNQF was adopted. Attending the ceremony as the chief guest was Education Minister Dr. Dipu Moni; Emeritus Professor Dr. Tim J. Parkinson of Massey University was the keynote speaker. The BAC might start the local higher education institutions' certification procedure.

The country has made great progress in improving the standard of higher education. Following the PDCA (Plan, Do, Check, Act) quality assurance approach, it must be clear that these developments have been examined and pinpoint more areas needing constant improvement. The nation is improving the systems of quality control for higher education. Still, constant informed decision-making is necessary to forward the process. Scholars assume their role here. Policymakers can keep updated about conceptual developments and pragmatic challenges of quality assurance in higher education inside the nation by reading scholarly literature. Policymakers would have the necessary knowledge relevant to a topic of decision-making, which would help them to understand the possible outcomes, benefits, and hazards connected with every choice. At last, they would decide in line with the best interests of the country.

The project examined the principal themes addressed by academics on quality assurance in higher education in the country from 2015 to 2023. The profiles of scholars, categorised by gender, citizenship, and discipline, as well as the types of scholarly publications, research strategies, and methodologies employed, were examined. This review aimed to delineate academic publications and establish keywords for the online search of scholarly works; select appropriate search engines and digital platforms for keyword input; enumerate academic publications on quality assurance in higher education within the nation; refine the criteria and finalise the selection of the aforementioned scholarly publications; analyse the specified works for themes, output type, publication date, publication location, authorship profile, research design, and research methodology; and propose policy recommendations regarding quality assurance research for BAC.

Methodology

Since the project employed a systematic review of scholarly works, the researchers looked into (1) literature about meta-analysis or meta-reviews (its popularity, definition, and step-by-step procedure); and (2) studies applying meta-analysis (whether for a publication or an academic concept, including quality assurance). According to Paul and Barari (2022), meta-analysis was introduced in the 1970s as a method to synthesize prior research. But it is only in recent years that researchers

have accepted it as a means for advancing knowledge development, especially in business and management. In the field of medicine, Hernandez et al., 2020 observed the increased usage of the method. Lee (2019) defined meta-analysis as "a statistical method that combines and synthesizes multiple studies and integrates their results into a single conclusion," the synthesised studies may be quantitative and/or qualitative. Hansen et al., 2021, on the other hand, provided a more flexible definition to apply to many scientific fields. According to them, meta-analysis, "similar to a narrative review, serves as a synopsis of a research question or field." It may also be conducted undertaken for both existing published and unpublished works.

The study was quantitative, qualitative, and descriptive in nature. It employed meta-analysis to systematically gather, review, and synthesise research findings on quality education and quality assurance in Bangladesh. It identified trends during the study period (2015 to 2023) regarding publication date, publishing location, author nationality, author discipline, number of authors per paper, author gender, type of scholarly activity, research methodology, research design, and unit of analysis. In addition to these methods, the study employed thematic analysis to examine trends related to the subject matter and conducted key informant interviews to ascertain the approach for the meta-analysis, including the definition of academic works, identification of search engines and digital platforms, and formulation of keywords. The study ultimately identified the known and unknown aspects of quality assurance research in Bangladesh.

The researchers incorporated both quantitative and qualitative studies in their meta-analysis, so they were not obligated to strictly follow certain protocols, including impact size estimations and the establishment of connections between two target variables. These procedures were more consistent with studies concentrated exclusively on empirical and quantitative analyses (Harvey and William, 2010; Walter et al., 2018). The processes for data gathering were as follows: The primary data sources for defining academic works, finding keywords, selecting search engines and digital platforms, and creating policy recommendations were experts in quality education and assurance. The interview guide for key informants included the following sections: (1) academic publications; (2) keywords related to quality education literature; (3) search engines and digital platforms; and (4) recommendations for improving research in quality education. The selected three important informants included (Table 1):

Table 1: Study Key Informants and Designations

S/N	Name	Position/Affiliation	Interview Date
1	Mesbahuddin Ahmed	Chairman, Bangladesh Accreditation Council (BAC)	15 May 2024
2	Sanjay Kuman Adhikary	Former Member, Bangladesh Accreditation Council (BAC)	9 May 2024
3	Roger Chao	Assistant Director, Head of Education, Youth and Sports, ASEAN Secretariat	16 February 2024

The key informants (Table 1) comments about scholarly works, keywords, and digital platforms facilitated the first compilation of scholarly works on quality assurance in higher education, as well as the refinement of criteria and the finalisation of the selection process for these works. The scholarly works were evaluated regarding themes, output type, publication date, publication location, authorship profile, research design, and research method by thematic analysis. Thematic analysis comprised six distinct steps: 1) Acquaintance with data; 2) formulation of preliminary codes; 3) identification of themes; 4) evaluation of themes; 5) delineation and designation of themes; and 6) compilation of a report. Based on the analysis and preliminary input from experts, the researchers developed recommendations for policymakers concerning additional research and policy orientations in quality assurance within higher education in Bangladesh.

Results and Discussion

The project findings were divided into the following: (1) defining scholarly works; (2) identifying key words and search engines; (3) listing of scholarly works; (4) review of scholarly works; and (5) thematic analysis.

Defining scholarly works

Two key informants regarded scholarly materials as peer-reviewed, authored by an expert in the field or generated by a recognised organisation. Adhikary stated that for scholarly work, "the identification of the problem must be explicit, grounded in comprehensive research or literature review." Academic efforts must be concentrated, and the objectives must be well defined. Ahmed stated that academic members ought to engage in research. Research teams and policies should exist at both the university and departmental levels. Faculty members' research must be published in prestigious global publications. Chao, however, proposed a broader definition, asserting that scholarly works "are not confined to peer-reviewed journal articles, chapters, or books, nor to their publication venues or modes of expression." The primary characteristic of scholarly work should be the substance and messages conveyed by the author, whether through papers, literature, or artwork. Thus, for this key informant, scholarly works may encompass educational publications, artworks, musical compositions, and literary creations.

This research concentrated on the categories of academic publications endorsed by the three primary informants. These encompassed published materials, including books, book chapters, journal articles, conference proceedings, graduate theses, and policy papers. Audio-visual productions and musical compositions, despite being proposed by one important informant, were excluded.

Identifying key words and search engines

The key informants agreed on the following key words to search for research papers on quality assurance in Bangladesh: (1) academic excellence; (2) institutional accreditation; (3) institutional quality assurance cell; (4) quality assessment; (5) quality policy; (6) quality review; (7) higher education; (8) university education; (9) Bangladesh; and (10) South Asia. Ahmed also suggested key words on many aspects of quality assurance such as "teaching, learning, assessment, curriculum, facilities, and student satisfaction. It should also include good practices." Adhikary mentioned "learning environment," stating that the learning environment should be fearless and everyone should feel safe. Fairness in teaching, assessment and treatment of students should also be ensured as these are essential for quality assurance. Consequently, the research included the key words agreed upon and various aspects of quality assurance mentioned by the key informants.

In terms of search engines, the key informants listed: (1) Google Scholar; and (2) Semantic Scholar. For online academic platforms, these included: (1) Academia.edu; (2) Research Gate; (3) Journal Storage (JSTOR); and (4) Science Direct. For websites, these included: (1) Asia Pacific Quality Network (APQN); (2) International Network for Quality Assurance Agencies in Higher Education (INQAAHE); (3) ASEAN Quality Assurance Network (AQAN); and (4) ASEAN University Network – Quality Assurance (AUN-QA). In light of these, the present research included the above-mentioned search engines, online academic platforms and quality assurance websites.

Listing of scholarly works

Using the key words, the research searched for the selected types of scholarly works from 2015 to 2023 in the mentioned search engines, online academic platforms and accreditation agency websites. A total of 55 scholarly works on quality assurance in Bangladesh were found. These were then listed with the following information: (1) research title; (2) publication date; (3) author/s; (4) publication place; and (5) paper link.

Review of scholarly works

The identified academic publications were further examined according to scholarship kind, publication date, publication location, authorship profile, research design, research methodology, and level of analysis. The results were delineated below. Table 2 indicates that most scholarly publications were journal articles (81.82

percent), followed by conference proceedings (9.09 percent), book chapters (5.45 percent), white papers (1.82 percent), and graduate theses (1.82 percent). No books or book reviews were located on the subject.

Table 2: Type of Scholarly Works (2015 to 2023)

Type	Frequency	Percentage (%)
Journal Articles	45	81.82
Conference Proceedings	5	9.09
Book Chapters	3	5.45
White Papers/Policy Papers	1	1.82
Graduate Thesis	1	1.82
Total	55	100.00

Regarding the number of publications per year, Table 3 indicated an upswing with only 6 scholarly works in 2015 to 2016, increasing to 13 in 2017 to 2018 and 9 in 2019 to 2020. However, the number almost doubled to 15 in 2021 to 2022. It is on track to double once again in 2023 to 2024 given that there were already 12 scholarly works in 2023. In terms of place of publication, as shown in Figure 2, the works were published in Bangladesh with 27.27 percent; followed by North America with 21.82 percent; Europe with 18.18 percent; Asia Pacific (excluding South Asia) with 18.18 percent, South Asia (excluding Bangladesh) with 12.73 percent; and Africa with 1.82 percent. The number of authors per publication, reported in Figure 3, depicted more collaborative projects with single authorships at 40.00 percent and multiple authorships at 60.00 percent.

Table 3: Publication Date of Scholarly Works (2015 to 2023)

Publication Date	Frequency	Percentage (%)
2015 to 2016	6	10.89
2017 to 2018	13	24.32
2019 to 2020	9	16.35
2021 to 2022	15	27.30
2023	12	21.85
Total	55	100.00

Bangladesh (27%)
North America (22%)
Asia Pacific (excluding South Asia) (18%)
Europe (18%)
South Asia (excluding Bangladesh) (13%)
Africa (1.8%)
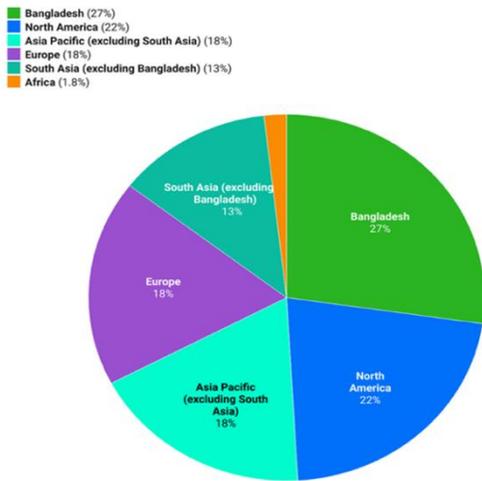
Figure 2: Place of Publication of Scholarly Works (2015 to 2023)

One Author (40%)
Two Authors (20%)
Three Authors (16%)
Four or More Authors (24%)
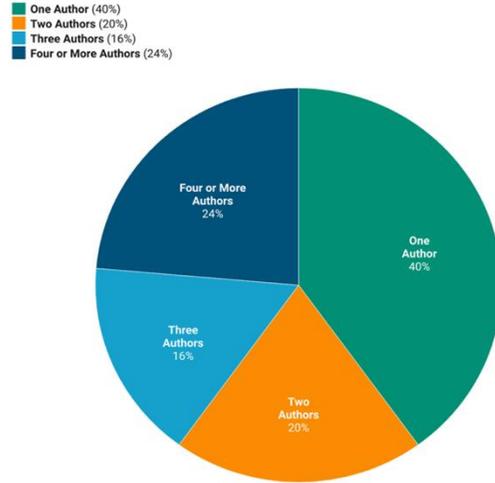
Figure 3: Number of Authors per Scholarly Work (2015 to 2023)

Female (28%)
Male (72%)
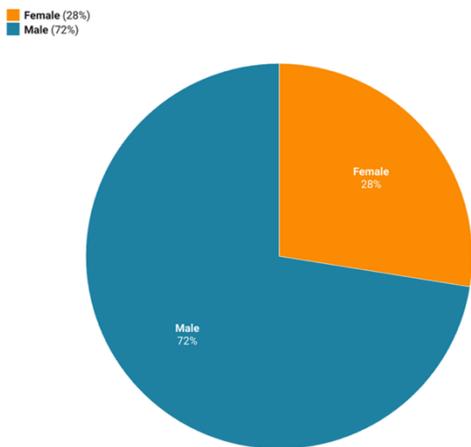
Figure 4: Gender of Authors of Scholarly Works (2015 to 2023)

Regarding the profile of authors, the bulk were male (72.46 percent) as revealed in Figure 4. The top academic backgrounds of authors, as shown in Table 4, included Business and Economics (42.75 percent), Arts and Humanities (15.94 percent), Engineering (15.22 percent), and Physical and Medical Science (14.49 percent). There were fewer outputs from the fields of Social Science (6.52 percent), Education (2.90 percent), and Agriculture (1.45 percent). Based on Table 5, almost all researchers were of Bangladeshi origin (90.58 percent). The rest were from Asia Pacific (other than Bangladesh) or European.

Table 4: Academic Backgrounds of Authors of Scholarly Works (2015 to 2023)

Background	Frequency	Percentage (%)
Business and Economics	59	42.75
Arts and Humanities	22	15.94
Engineering	21	15.22
Physical and Medical Science	20	14.49
Social Science	9	6.52
Education	4	2.90
Agriculture	2	1.45
Others	1	0.72
Total	138	100.00

Table 5: Origin of Authors of Scholarly Works (2015 to 2023)

Origin	Frequency	Percentage (%)
Bangladesh	125	90.58
Asia Pacific (excluding South Asia)	5	3.62
Europe/North America	5	3.62
South Asia (excluding Bangladesh)	3	2.17
Total	138	100.00%

Table 6: Institutional Affiliation of Authors with Bangladeshi Origin of Authors (2015 to 2023)

Institutional Affiliation	Frequency	Percentage (%)
Bangladesh University of Science and Technology	7	5.6
Patuakhali Science and Technology University	7	5.6
Hajee Mohammad Danesh Science and Technology University	6	4.8
Rajshahi University	5	4.0
Dhaka University	5	4.0
BGC Trust University	5	4.0
United International University	5	4.0
American International University Bangladesh	4	3.2
North South University	4	3.2
World Bank	4	3.2
Colonel Malek Medical College	4	3.2
Britannia University Bangladesh	3	2.4
Daffodil International University	3	2.4
Uttara University	3	2.4
Mugda Medical College	3	2.4
University of Asia Pacific	3	2.4
Others	54	43.2
Total	125	100.00%

Table 7: Institutional Affiliation Classification of Authors with Bangladeshi Origin (2015 to 2023)

Institutional Affiliation Classification	Frequency	Percentage (%)
Private University	39	31.2
Public University	31	24.8
Foreign Institutions	27	21.6
Medical College	12	9.6
Government Institutions	5	4.0
Non-government Institutions	4	3.2
Army Institution	3	2.4
Publishing Company	2	1.6
Others	2	1.6
Total	125	100.00%

Tables 6 and 7 focused on the institutional affiliations of authors with Bangladeshi origin. Authors with Bangladeshi origin were mostly affiliated with private universities (31.2 percent), public universities (21.6 percent), foreign institutions (21.6 percent) and medical colleges (9.6 percent). Among the private universities the said authors were affiliated with were BGC Trust University, United International University (UIU), American International University Bangladesh (AIUB), and North South University (NSU). Among the public universities the said authors were part of included Bangladesh University of Science and Technology (BUET), Patuakhali Science and Technology University, Hajee Mohammad Danesh Science and Technology University, Rajshahi University and Dhaka University. Several Bangladeshi authors were affiliated with foreign universities in the United Kingdom, Australia, Malaysia, Japan, India, China, and Thailand. For medical colleges, the affiliations were with Colonel Malek Medical College and Mugda Medical College.

When it came to research design, as indicated in Table 8, there were a combination with 41.82 percent of the outputs being quantitative, 40.00 percent being qualitative and 16.36 percent being mixed method. Mixed method research make use of both qualitative and quantitative methods. For quantitative methods, overwhelmingly the most popular one was the survey; as shown in Table 9 with 87.5 percent. This was followed by content analysis (9.38 percent) and trend analysis (3.12 percent). For qualitative methods, as shown in Table 10, the most utilized were interviews (54.55 percent), document/thematic analysis (18.18 percent), case studies (18.18 percent) and focused group discussions (9.09 percent). More than three-fourths of all scholarly works focused on the national level, as revealed in Table 11, with 69.09 percent. This was followed by institutional level at 21.82 percent and district/divisional at 7.27 percent.

Table 8: Research Design of Scholarly Works (2015 to 2023)

Design	Frequency	Percentage (%)
Quantitative	23	41.82
Qualitative	22	40.00
Mixed Method	9	16.36
Not Applicable	1	1.82
Total	55	100.00

Table 9: Quantitative Methods of Scholarly Works (2015 to 2023)

Method	Frequency	Percentage (%)
Surveys	28	87.50
Content Analysis	3	9.38
Trend Analysis	1	3.12
Total	32	100.00

Table 10: Qualitative Methods of Scholarly Works (2015 to 2023)

Method	Frequency	Percentage (%)
Interviews	18	54.55
Document/Thematic Analysis	6	18.18
Case Studies	6	18.18
Focused Group Discussion (FGD)	3	9.09
Total	33	100.00

Table 11: Level of Analysis in Scholarly Works (2015 to 2023)

Level	Frequency	Percentage (%)
Institutional	12	21.82
District/Divisional	4	7.27
National	38	69.09
Regional (South Asia)	1	1.82
Total	55	100.00

Thematic analysis

The study organised themes into three categories: (1) overarching ideas of quality assurance; (2) specific elements of quality assurance; and (3) quality assurance in educational programs. Table 12 illustrates that the predominant themes of generic notions of quality assurance were academic excellence (35.42 percent), feedback systems (16.67 percent), and quality culture (12.50 percent). Numerous authors concentrated on the crisis, challenges, issues, limits, and policies obstructing academic success in Bangladesh. Authors examined the influence of the HEQEP project and quality assurance as a transformative strategy for education in Bangladesh. They examined the significance of student satisfaction surveys and teacher feedback as feedback channels for institutional enhancement.

To a lesser extent, scholarly publications over the period addressed general ideas of quality assurance, including IQAC (10.42 percent), accreditation/ certification/ ranking (10.42 percent), quality control (6.25 percent), standardisation (4.17 percent), and internationalisation (4.17 percent). The Bangladesh government's objective to attract more foreign students has raised concerns regarding the volume of research on internationalisation. A Prothom Alo survey indicates a gradual decline in the number of overseas students enrolling in Bangladeshi universities. The UGC report indicated that the number of international students was 2,317 in 2020, which decreased to 2,281 in 2021 and further declined to 1,957 in 2022. A few studies have examined the influence of IQACs on higher education and their role in maintaining excellent education during the COVID-19 epidemic.

Table 12: Themes Relating to General Concepts on Quality Assurance in Scholarly Works (2015 to 2023)

Concepts	Frequency	Percentage (%)
Academic Excellence	17	35.42
Feedback Mechanisms	8	16.67
Quality Culture	6	12.50
Institutional Quality Assurance Cell (IQAC)	5	10.42
Accreditation/Certification/Ranking	5	10.42
Quality Control	3	6.25
Standardization	2	4.17
Internationalization	2	4.17
Total	48	100.00

Table 13: Themes Relating to Particular Aspects of Quality Assurance in Scholarly Works (2015 to 2023)

Aspects	Frequency	Percentage (%)
Process Management	30	40.00
Teaching, Learning and Assessment	20	26.67
Student Services and Facilities	17	22.67
Curriculum Design and Review	3	4.00
Governance	3	4.00
Research	2	2.67
Total	75	100.01%

Numerous facets of quality assurance were addressed in academic literature during that period. Table 13 demonstrates that the categories included process management (40.0 percent), teaching, learning, and assessment (26.67 percent), and student services and facilities (22.67 percent). The elements of curriculum (4.00 percent), governance (4.00 percent), and research (2.67 percent) were addressed to a significantly smaller degree. Numerous authors examined the acceptability of quality assurance by university management, the benchmarking against worldwide institutions, and the function of Internal Quality Assurance Cells (IQACs) in enhancing quality culture. Certain authors examined the execution of blended learning, online education, digital assessments, pedagogical techniques, and the use of English as the medium of instruction. Scholarly publications addressed student contentment, allegiance to the university, and student politics. Several authors examined the Outcome-Based Education (OBE) curriculum, competencies for

innovation and growth, leadership and management of quality assurance, as well as research and innovation inside institutions.

Table 14 indicated that over half (58.46 percent) of academic publications concentrated on higher education in its entirety. Outputs were recorded for particular educational institutions and programs, including private universities (18.46 percent), public universities (9.23 percent), medical schools (7.68 percent), and engineering schools (3.07 percent). Two publications analysed university education during the COVID-19 epidemic.

Table 14: Themes Relating to Education Program Type in Scholarly Works (2015 to 2023)

Education Type	Frequency	Percentage (%)
Tertiary Education in General	38	58.46
Private Universities	12	18.46
Public Universities	6	9.23
Medical Schools	5	7.68
University Education during COVID-19 Pandemic	2	3.07
Engineering Schools	2	3.07
Total	65	100.00

Limitations

The study's findings must be considered in the context of the following limitations. Initially, it examined academic publications according to a conventional definition, encompassing books, book chapters, journal articles, conference proceedings, white papers, policy papers, and student theses. It excluded instructional materials, literary manuscripts, audiovisual products, and musical compositions. Secondly, it conducted interviews with only three important informants, all employed in governmental entities. Acquiring insights from quality assurance professionals at both the topic and institutional levels may prove beneficial. Third, it exclusively sought scholarly articles online. Offline resource materials, such as those found in libraries, should be incorporated into future studies. Fourth, the paper did not explore the research paradigms and theoretical frameworks of the aforementioned scholarly publications. It did not evaluate the contributions to theoretical development and empirical testing for quality assurance. This could serve as a valuable subject for a forthcoming study endeavour. Fifth, it exclusively encompassed intellectual books authored in English. A subsequent study of quality assurance literature authored in Bangla might be beneficial. The investigation excluded papers from the HEQEP project, including Self-Assessment Reports (SARs) and External Peer Review Reports.

Conclusions

The study was a meta-review of 55 academic publications about quality assurance in Bangladesh, generated between 2015 and 2023. In preparation for the review, interviews were conducted with three key informants who are specialists in quality assurance. The informants characterised scholarly works as books, book chapters, journal articles, conference proceedings, student theses, and white papers or policy papers, while also identifying the pertinent keywords, search engines, and digital platforms for the review. The academic works were examined according to scholarship type, publishing date, publication location, authorship profile, research design, research techniques, and level of analysis. A thematic analysis was subsequently performed, encompassing the categories: (1) overarching principles of quality assurance; (2) specific facets of quality assurance; and (3) quality assurance in educational programs.

Recommendations

Upon completing the study, the authors present six recommendations to the BAC. The BAC should persist in its research grants pertaining to quality assurance. The production of only 15 academic works from 2021 to 2022 and 12 in 2023 indicates that the nine research grants awarded by BAC annually significantly augment the output on the subject. The BAC should mandate that grantees publish their articles in respected, peer-reviewed publications to ensure broad dissemination of the research findings. The statistics indicated that conference proceedings ranked as the second most prevalent form of scientific paper generated. BAC might contemplate sponsoring academics attending conferences organised by esteemed quality assurance agencies like APQN and INQAAHE. BAC should mandate participants to submit and publish in the conference proceedings of the specified agencies.

BAC may consider establishing an additional category in its research awards focused on collaboration with international researchers. The study indicated that the majority of scholarly papers were collaborative. Furthermore, 90.58 percent of the authors were of Bangladeshi descent, and 40.00 percent of the research papers were published in South Asia, encompassing Bangladesh. Facilitating research collaboration with international scholars may: (1) enhance the quality of research output; (2) initiate cross-national comparative studies on quality assurance; and (3) permit publication in foreign nations. Fourth, the BAC may consider offering supplementary funds and recognition ceremonies for sectors with comparatively fewer scholarly contributions, including female researchers and those in the domains of Education, Agriculture, and Social Sciences. For instance, female applicants and those from the three previously mentioned specialities will receive an additional BDT 50,000 in financing and acknowledgement ceremonies.

According to two important interviewees, a significant factor for faculty members' disengagement in research is the absence of motivation. Ahmed expressed concern that it is essential to inculcated in teachers the imperative of engaging in research. He stated that "our senior faculty members lack commitment to conducting research." They do not allocate time for research. They perceive it as an extra encumbrance. Adhikary stated that "Article 17B of the Bangladesh Constitution, enacted in 1972, stipulates that all education must fulfil the requirements of society." We require individuals who are both trained and self-motivated. Regrettably, our individuals are rarely acknowledged for their contributions. They are unacknowledged, which further diminishes their motivation to engage in their profession enthusiastically and pursue continual self-improvement.

BAC may opt to offer further incentives, such as financing, for research employing mixed methods. According to the study, hardly 16.36 percent of academic articles employed mixed approaches. The mixed method enhances study quality by offering deeper insights into a topic. Nevertheless, it is frequently more challenging to implement, necessitating additional incentives. For instance, BAC may allocate an additional BDT 50,000 if a mixed technique is employed. Consequently, the BAC may establish a cohort of mentors to assist the grantees in quantitative and qualitative methodologies, particularly in project conceptualisation and comprehensive paper presentation.

The majority of academic research concentrated on macro-level tertiary education in the country (58.46 percent) and on overall academic excellence (35.42 percent). Concerning quality assurance elements, the majority pertained to process management (40.0 percent), teaching, learning, and assessment (26.67 percent), and student services and facilities (22.67 percent). There were limited case studies on specific programs, including medical (7.68 percent), engineering (3.07 percent), and none for agriculture. Furthermore, specific quality assurance dimensions, including curriculum, governance, and research, received less examination; this also applies to subjects such as accreditation/ranking, standardisation, and internationalisation. The BAC may consider offering more incentives for research projects addressing these underexplored quality assurance themes and case studies. It may focus on issues related to internationalisation due to the decreasing number of foreign students in the country. Adhikary identified self-assessment reports (SAR), generated under the HEQEP initiative, as data sources for case studies. He stated that all self-assessment reports are accessible and serve as valuable resources for study in quality assurance. However, these are not utilised. Refer to Appendix B for the transcript. A SAR is an evaluative document that illustrates a university or program's capacity to assess its performance critically and formulate a plan for enhancement based on established standards and criteria. Throughout the HEQEP initiative, numerous programs offering organisations across multiple institutions received assistance in composing SARs. The reports were submitted to the UGC.

Acknowledgments

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Adequacy of Resources and Quality Education: A Study at Selected Public Universities of Bangladesh

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Abstract

The essential advancement of every nation relies on education, which serves as a catalyst for socio-economic progress and individual empowerment. This study seeks to evaluate the accessibility of resources and their impact on the quality of education provided at Comilla University, Barisal University, Jatiya Kabi Kazi Nazrul Islam University, and Begum Rokeya University in Bangladesh. The objective was to pinpoint deficiencies and opportunities for enhancement by a thorough evaluation of the sufficiency and application of educational resources, including infrastructure, personnel, and financial support. We have gathered primary data from the chosen public universities with a meticulously designed questionnaire. This research has assessed in resource adequacy for many objectives, encompassing human resources, physical resources, and financial and logistical assistance. The aggregate sample size was 412. The sample comprised 294 pupils and 118 teachers. This study employed structural equation modelling (SEM) to assess the influence of observable factors on latent variables. The gender ratio of the respondents indicates that there were 196 female respondents out of 412, constituting approximately 47.3% of the total, while the number of male respondents was 217 out of 412, representing about 52.7% of the total. The respondents' educational qualifications comprise 263 undergraduate students, 52 graduate students, and 78 postgraduate fellows. The number of individuals who have attained an MPhil degree is 5, while those who have obtained a PhD is 14. SEM results indicated that resource adequacy exerts a significant and favourable impact on the quality of schooling. A 1% enhancement in resource adequacy often yields a 0.87% advancement in educational excellence. The study emphasises the importance of sufficient resources for attaining educational goals by linking resource adequacy to the overall quality of education. Nevertheless, it integrated newly founded public universities into the research sector. Subsequent research could examine other established universities and juxtapose them with newly founded universities in Bangladesh.

Keywords: Financial and Logistic Support; Human Resources; Infrastructure; Physical Resources; Quality Education

Introduction

Education is the foundation of any nation's fundamental development, as it serves as a catalyst for personal empowerment and socio-economic advancement. In order to address contemporary challenges and advance Bangladesh towards sustainable development, it is imperative to pursue high-quality education, as it is in numerous developing nations. Currently, Bangladesh's higher education framework is expanding at a rapid pace to accommodate the growing demand for qualified specialists in a variety of fields. Consequently, universities across the country are encountering novel obstacles in their efforts to enhance and maintain the quality of their education. Nevertheless, the quality of education that these universities are providing is disheartening due to inadequacy and inefficient efficient use of resources, including infrastructures, staff knowledge, funds, technology assistance, and course materials. Various academic researchers have emphasised the significance of sufficient resources in the development of academic accomplishments. For instance, Ahmed et al. (2019) demonstrate the significance of the foundation in the higher education system with respect to the execution of the curriculum and the learning environment. Along these lines, Rahman and Islam (2018) underscore the significance of a competent workforce and academic support in order to guarantee the quality of education. The study on the sufficiency of resources to support quality education in specific institutions in Bangladesh is being conducted in order to address the critical relationship between resource provision and educational outcomes, as per Ogunode and Emmanuel (2023). In Bangladeshi university environments, there is a lack of comprehensive studies that investigate the efficacy of assets in promoting quality education, despite the widespread recognition of their value. In general, prior assessments have concentrated on specific aspects of asset openness, such as workforce characteristics or framework, rather than providing a comprehensive evaluation that takes into account a variety of factors. The study was to address the disparity by conducting a comprehensive assessment of the resources available to facilitate quality education (QE) in a few carefully chosen universities in Bangladesh. It employs a diverse array of methodologies to evaluate the adequacy of faculty, financial resources, administrative support, and infrastructural aspects, as well as other critical determinants of QE.

In developing countries, such as Bangladesh, the essence of tertiary education is a critical topic of discussion. Higher education in Bangladesh has expanded significantly over the past century, with the current count of publicly funded universities standing at 55. Nevertheless, the quality of tertiary education offered by these universities is still adversely affected by substantial obstacles, despite substantial progress. The nature of education in those universities has been the subject of much discussion. Despite the substantial investments made in these universities, the calibre of education they provide remains inadequate (Kabir et al., 2020). It was important to evaluate the accessibility of resources in a number of

public-funded universities in Bangladesh in order to facilitate the provision of value-based education, particularly in the early 21st century.

The research analyses the present state of education and provides suggestions for enhancement. It is imperative to understand the obstacles that these universities face in order to guarantee that their endeavours effectively deliver a high-quality education to students and equip them for future challenges. The quality of education in Bangladesh's public universities has become a significant concern due to the fact that the employability and future prospects of the graduates are contingent upon it. Bangladesh's public universities continue to offer inadequate education, regardless of their expansion. The study has the capacity to suggest strategies for quality education by examining the perspectives of students, instructors, and administrators to comprehend the obstacles they encounter and the solutions they suggest. The results of this study have offered valuable insights into various types of resources that can be used to enhance the quality of education. This information has also facilitated the development of informed policy decisions that are designed to enhance the quality of education for students in those institutions.

The primary objective of the project was to evaluate the extent to which the resources available in select public universities in Bangladesh are sufficient to facilitate the provision of high-quality education.

The specific objectives of the research were:

i.   to assess the sufficiency of human resources, teaching faculty in terms of numbers, student-teacher ratio, and higher degree, to evaluate the availability and functionality;

ii. of infrastructure, including modern classrooms, libraries, and laboratories, and to assess the financial and logistic administrative support in facilitating quality education.

Methodology

Research Design

The investigation implements a quantitative research methodology. The quantitative research design allows the researcher to acquire a comprehensive understanding of the extent to which the resources available to support the quality of education in specific public universities in Bangladesh are sufficient. Figure 1 illustrates the research method's flow diagram. This study employs a cross-sectional survey design. The investigation entails the acquisition of data from a representative sample of stakeholders in the education sector of Bangladesh. Teachers and students from chosen public universities comprise the samples. Furthermore, the quantitative research method is implemented to conduct an impartial and systematic evaluation of the circumstances. The country's tertiary education quality has been evaluated through quantitative research of Structural Equation Modelling (SEM).
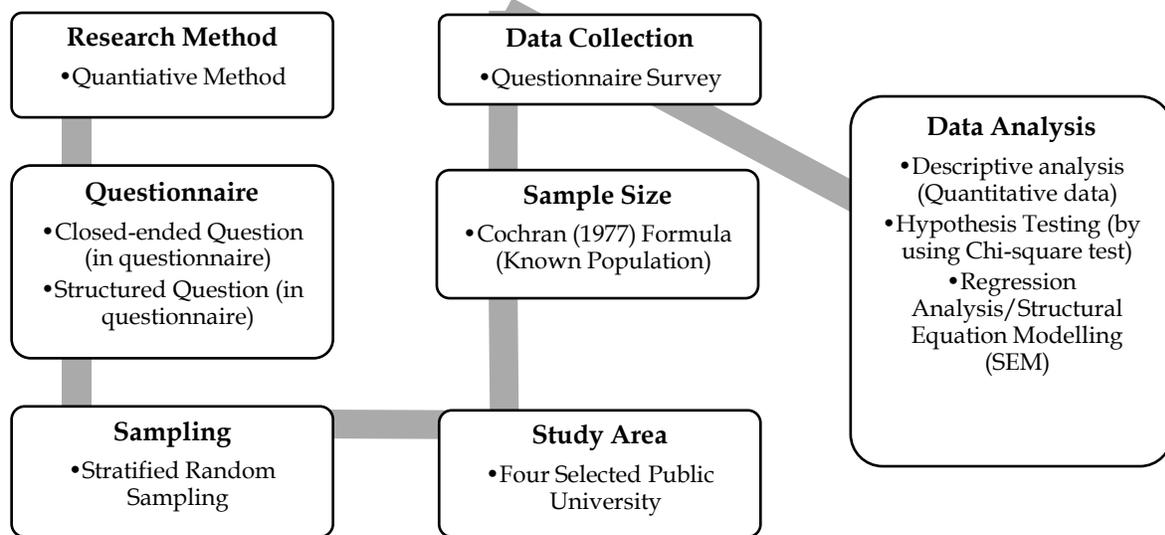
Figure 1: Flow Diagram of the Research Methods

Sample Selection

To determine the sample size for known population, we have used Cochran (1977) formula.

$$n = \frac{n_0}{1 + \frac{(n_0 - 1)}{N}}$$

Here,

$$n_0 = \frac{Z^2 \times P(1 - P)}{e^2}$$

Where n = Sample size for known population, Z = Z-score (Confidence level 95% then Z-score is 1.96), P = Population proportion for students' category (assumed 25% = 0.25) and population proportion for teacher's category (assumed 10% = 0.10), e = Margin of error (level of significance 5% = 0.05), N = population Size.

However, sample size determination for students:

$$n_0 = \frac{Z^2 \times P(1 - P)}{e^2}$$

$$= \frac{(1.96)^2 \times 0.25(1 - 0.25)}{(0.05)^2}$$

$$= 294$$

$$n = \frac{n_0}{1 + \frac{(n_0 - 1)}{N}}$$

$$n = \frac{294}{1 + \frac{293}{33641}}$$

$$= 294.01 \text{ or } 294$$

Moreover, the sample size for students was 294 and sample size determination for teachers is:

$$n_0 = \frac{Z^2 \times P(1-P)}{e^2}$$

$$= \frac{(1.96)^2 \times 0.10(1-0.10)}{(0.05)^2}$$

$$= 136$$

$$n = \frac{n_0}{1 + \frac{(n_0 - 1)}{N}}$$

$$n = \frac{136}{1 + \frac{135}{883}}$$

$$= 118.26 \text{ or } 118$$

However, the sample size for teachers was 118. In addition, total sample size was 294+118 = 412.

Sampling Technique and Study Areas

The researchers employed stratified random sampling to construct multiple strata based on the selected public universities in Bangladesh. We selected samples from each stratum (described in Table 1) based on their size, populations, and significance, as well as the sample size formula when the population was known.

Bangladesh is divided into eight divisions. The research was conducted on universities from four divisions in Bangladesh: Chattogram, Barishal, Mymenshing, and Rangpur. This study has selected four general public universities from those strata: Begum Rokeya University, Jatiya Kabi Kazi Nazrul Islam University, Barisal University, and Comilla University. Students and educators comprised the study's respondents. Figure 2 illustrates the study area in relation to the sample size.
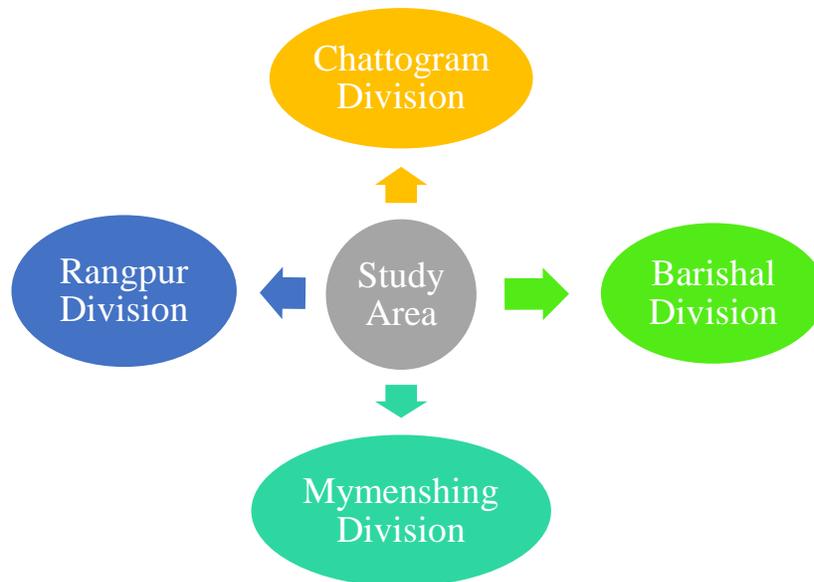
Figure 2: Study Areas (Sample Locations)

Table 1: Sampling and Sample Size Distribution

Name of the University	Numbers of Students (Around)	Numbers of Teachers	Department of the University	Per University Sample (Students +Teachers	Sample Size
Comilla University (Chattogram Division)	7141	265	19	65+37	102
Barisal University (Barishal Division)	10000	210	25	77+24	101
Jatiya Kabi Kazi Nazrul Islam University (Mymenshing Division)	8000	213	24	75+34	109
Begum Rokeya University (Rangpur Division)	8500	195	22	77+23	100
Total	33641	883	-	-	412
Total Estimated Sample Size (Students/Teachers Category)	294	118	-	-	412

Source: Authors Self Estimation

Data Collection

The research employed a quantitative methodology, utilising questionnaire surveys for data collection and analysis. Data were gathered via a self-administered questionnaire. The questionnaire was designed in accordance with the study's conceptual framework. The questionnaire has both closed and open-ended questions designed to gather input regarding the adequacy of resources for the quality of tertiary education.

Data Analysis

The data gathered from participants were evaluated utilising descriptive statistics, encompassing frequency distributions, percentages, and cross-tabulations. The data have been examined utilising inferential statistics, encompassing chi-square tests and regression analysis. The data were examined utilising the Statistical Package for the Social Sciences (SPSS) and Analysis of Moment Structures (AMOS) software. The gathered data have been utilised to estimate Structural Equation Modelling (SEM), contingent upon the model's requirements. Structural Equation Modelling (SEM) is a statistical methodology that integrates conventional regression analysis with factor analysis to examine the interrelationships among variables.

Results and Discussion

Demographic Information and Descriptive Analysis

This research administered a survey utilising a meticulously crafted questionnaire. The total number of responders was 412, comprising two categories: students (294) and teachers (118). Table 2 indicates that the total number of female respondents was 196 out of 412, constituting approximately 47.3% of the overall respondents. The total number of male respondents was 217 out of 412, constituting approximately 52.7% of the overall respondents. The age group of 18 to 25 years exhibits the highest frequency, with 324 responders, corresponding to 78.6. The age group of 46 to 55 years exhibited the lowest frequency, with two responders, corresponding to 0.5%. The marital status of the respondents indicated that around 18.9% were married, while 80.6% were single.

Table 2: Demographic Information of the Respondents

		Frequency	Percent	Valid Percent	Cumulative Percent
Gender of the Respondents					
Valid	Female	195	47.3	47.3	47.3
	Male	217	52.7	52.7	100.0
	Total	412	100.0	100.0	
Age of the Respondents					
Valid	18 to 25 Years	324	78.6	78.6	78.6
	26 to 35 Years	67	16.3	16.3	94.9
	36 to 45 Years	19	4.6	4.6	99.5
	46 to 55 Years	2	.5	.5	100.0
	Total	412	100.0	100.0	
Marital Status of the Respondents					
Valid	Married	78	18.9	18.9	18.9
	Unmarried	332	80.6	80.6	99.5
	Divorced	2	.5	.5	100.0
	Total	412	100.0	100.0	

Table 3: Educational Qualifications of the Respondents based on Faculties

		Undergraduate Student	Graduate Student	Postgraduate	MPhil.	PhD	Total
Faculties Name	Faculty of Arts and Humanities	27	10	7	0	2	46
	Faculty of Fine Arts	2	2	0	0	0	4
	Faculty of Business Studies	56	2	14	2	2	76
	Faculty of Science	86	14	38	0	3	141
	Faculty of Engineering and Technology	4	2	3	0	0	9
	Faculty of Law	4	0	2	0	0	6
	Faculty of Social Sciences	35	13	12	1	7	68
	7 & Engineering	0	1	0	0	0	1
	Faculty of Life and Earth Science	9	8	2	2	0	21
	Faculty of Bioscience	38	0	0	0	0	38
	Arts	1	0	0	0	0	1
	Statistics	1	0	0	0	0	1
Total		263	52	78	5	14	412

Table 4: Teachers Designation from the Respective Universities

	University Name				Total
Designation	Barishal University	Begum Rokeya University	Comilla University	Jatiya Kabi Kazi Nazrul Islam University	
Lecturer	7	10	7	7	31
Assistant Professor	9	4	10	18	41
Associate Professor	8	6	7	5	26
Professor	0	3	13	4	20
Total	24	23	37	34	118

To elevate educational standards, humanity is seen as the preeminent entity due to its capacity for conscience, knowledge, wisdom, and compassion. A robust education establishes the basis for honesty, ethics, loyalty, compassion, and excellent character. The necessity of high-quality education in building a flourishing nation and promoting human resource development is paramount. Swami Vivekananda contends that every pupil possesses innate, limitless potential that must be

awakened. The teachers' assiduous endeavours in surmounting obstacles and attaining excellence foster the comprehensive development of the learner's life and character. The educator promotes autonomy by delivering effective instruction within the academic sphere. Advancement in education is crucial for the development of every nation and its populace. To elevate educational standards, it is essential to ensure the delivery of high-quality education. The nation possesses an adequate quantity of higher education institutions. There is just a lack in either the availability or quality of schooling. The quality of education will improve due to the quality of teachers. The teacher's principal duty is to elevate the quality of instruction. Educators are also obligated to notify parents.

Table 5: Research Profile and Publications Details of Teachers Group

	Frequency	Percent	Valid Percent	Cumulative Percent
Publication Preferences				
No Opinion	34	28.8	28.8	28.8
National Journals	22	18.6	18.6	47.5
International Journals	62	52.5	52.5	100
Total	118	100	100	
Papers Published in International Journals				
No Opinion	48	40.7	40.7	40.7
0	1	0.8	0.8	41.5
1 to 3	34	28.8	28.8	70.3
4 to 6	15	12.7	12.7	83.1
7 to 10	5	4.2	4.2	87.3
11 and above	15	12.7	12.7	100
Total	118	100	100	
Scopus Indexed Research Papers				
Yes	45	38.1	38.1	38.1
No	73	61.9	61.9	100
Total	118	100	100	
Numbers of Scopus Indexed Papers				
0	67	56.8	56.8	56.8
1 to 3	29	24.6	24.6	81.4
4 to 6	12	10.2	10.2	91.5
7 to 10	2	1.7	1.7	93.2
11 and Above	8	6.8	6.8	100
Total	118	100	100	

The educator must exhibit authenticity in doing their duties. Educators ought to teach with an approach defined by empathy and comprehension. Educators must diligently endeavour to effect societal transformation. The calibre of education depends on the expertise, strategies, and abilities of educators who utilise contemporary teaching methods in the classroom. Quality education is essential for the advancement of any nation, with no feasible alternative. To ensure educational achievement, it is imperative to provide consistent, equitable, sophisticated, and systematic instruction from teachers in the classroom. Delivering high-quality, modern, effective, and consistent education in the classroom produces substantial advantages for students, represents a great achievement and source of satisfaction for educators, and results in considerable success and accomplishment.

The educational credentials of the respondents and the faculties are displayed in Table 3. The table includes categories of degrees such as Undergraduate Student, Graduate Student, Postgraduate, MPhil, and PhD. The respondent possesses qualifications in several disciplines, such as arts and humanities, and social sciences. The number of responders who are undergraduate students is 263, graduate students is 52, and postgraduate students is 78. The number of responders who have achieved an MPhil degree is 5, while those who have done a PhD is 14.

The designations of teachers at the selected universities are detailed in Table 4, which indicates that Barishal University has 24 responses, comprising 7 lecturers, 9 assistant professors, and 8 associate professors. Begum Rokeya University, Rangpur, has a total of 23 responses, consisting of 10 lecturers, 4 assistant professors, 6 associate professors, and 3 professors. Comilla University comprises 37 responses, including 7 lecturers, 10 assistant professors, 7 associate professors, and 13 professors. Jatiya Kabi Kazi Nazrul Islam University has 34 responses, comprising 7 lecturers, 18 assistant professors, 5 associate professors, and 4 professors. The respondents' research profiles are displayed in Table 5, which includes national, international, and Scopus choices.

Structural Equation Model (SEM) Analysis: Combined Perspective of Teachers and Students

Cronbach's Alpha provides a quantitative framework for evaluating the reliability and consistency of subjective judgements and perceptions typically assessed in business, psychological evaluations, educational assessments, and social sciences. Maintaining consistency is especially vital in longterm studies or research with different observers (Johan & Rahmawati, 2023). Reliability testing, demonstrated through Cronbach's Alpha, is essential for improving the dependability of research outcomes. Researchers can guarantee the precision of their results in representing the constructs they intend to test by confirming the internal consistency of their measurement instruments. Reliability testing is an essential component in guaranteeing methodological rigour in research. It aids in improving accuracy and uniformity in the interpretation of research results.

Table 6: Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.920	0.919	24

Table 6 displays the reliability statistics (Cronbach's Alpha), while Table 9 illustrates the Kaiser-Meyer-Olkin (KMO) and Bartlett's test for sample adequacy. Statistical metrics such as Cronbach's Alpha, the Kaiser-Meyer-Olkin (KMO) test, and Bartlett's Test of Sphericity are crucial in research and data analysis. These criteria are crucial for assessing the reliability and precision of data, ensuring that the findings derived from statistical analyses are robust and reliable. Cronbach's Alpha is a statistical measure that evaluates the level of internal consistency reliability, frequently utilised for survey instruments or scales. It assesses the extent of similarity within a set of elements, ensuring that the items on a scale measure the same underlying notion.

Table 7: ANOVA with Cochran's Test

		Sum of Squares	df	Mean Square	Cochran's Q	Sig
Between People		4025.6	411	9.8		
Within People	Between Items	1168.3	20	58.4	1261.8	.000
	Residual	6461.2	8220	.8		
	Total	7629.5	8240	.9		
Total		11655.1	8651	1.3		
Grand Mean = 2.98						

Table 8: Hotelling's T-Squared Test

Hotelling's T-Squared	F	df1	df2	Sig
611.205	29.1	20	392	.000

A high Cronbach's Alpha indicates strong internal consistency, providing assurance in the reliability of the data. Experts and evaluators commonly employ Cronbach's Alpha to assess and enhance the reliability of their measurement tools, hence improving the quality of data analysis. The KMO test is utilised in factor analysis to evaluate the suitability of data for this statistical method. The example adequacy metric assesses the suitability of the variables for factor analysis. A high Kaiser-Meyer-Olkin (KMO) score indicates significant strengths in the inconsistency among the components, affirming their suitability for factor analysis. The KMO test is employed by analysts to ascertain whether the data meets the assumptions of factor analysis, hence enhancing the accuracy and validity of the resulting factors.

Table 9: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.9
Bartlett's Test of Sphericity	Approx. Chi-Square	4646.6
	df	276
	Sig.	0.000

The importance of employing Cronbach's Alpha, the KMO test, and Bartlett's Test is in ensuring the quality and reliability of data in statistical analyses. These boundaries serve as safeguards, enabling analysts to make well-informed decisions regarding the suitability of their data for certain analytical methods. These tests enhance the validity of review findings by ensuring internal consistency, assessing sufficiency, and evaluating significant interrelationships among variables. This enables specialists and analysts to draw reliable conclusions from their data. Employing Cronbach's Alpha, the KMO test, and Bartlett's Test is essential for ensuring the integrity and validity of empirical assessments. These measurements enable scientists to evaluate the reliability of measurement instruments, verify the validity of component analysis, and validate the correlations among variables. Integrating these tests into the examination cycle enhances the precision and reliability of the findings, hence facilitating the progression of knowledge across several domains. Nevertheless, the dependability statistics are shown by Cronbach's Alpha in Table 6. The value of Cronbach's Alpha is 0.920, indicating its appropriateness for conducting SEM. Table 7 presents the ANOVA results with Cochran's test, revealing that the retrieved values of Cochran's Chi-square are significant at the 1% level, indicating the absence of inconsistency among the selected variables. Table 9 displayed an adequate KMO value of 0.933, signifying an appropriate sample size for conducting SEM.
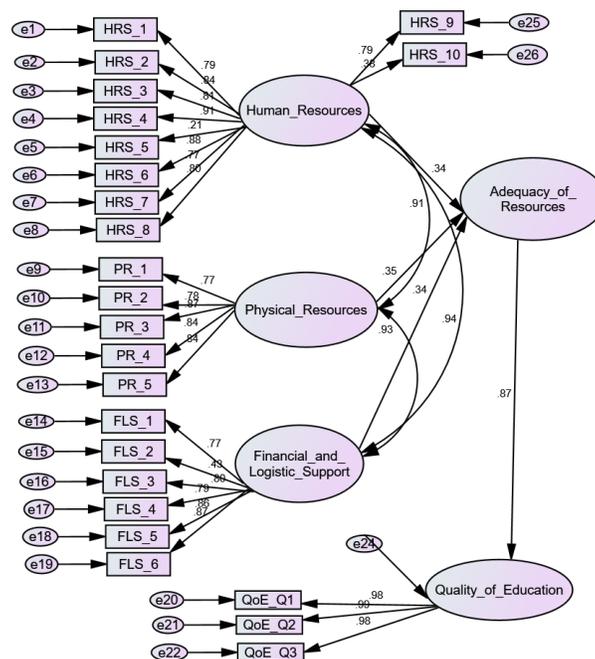

Figure 3: Impact of Adequacy of Resources on Quality of Education (Students and Teachers Combined)

Table 10: Model Fit Evidence

Criteria	Statistics/ Value	Decision
Chi-square	Value =1684.8 Prob= 0.00	Acceptable
CMIN/df	2.6	Acceptable
CFI	0.7	Acceptable
NFI	0.6	Acceptable
RMSEA	0.1	Partially Acceptable
ECVI	4.440 (LO 90_4.133- HI 90_4.765)	Acceptable

We have estimated the model (shown in Figure 3) by analysing the responses of both students and teachers (total sample of 412) to assess the influence of observable variables on latent variables. To assess the influence of resource adequacy on the quality of tertiary education, resource adequacy is evaluated through three observed variables: human resources, physical resources, and financial and logistical assistance within the university. The coefficient of human resources is 0.34. A one percent increase in human resources can enhance resource adequacy by 0.34%. The outcome is illustrated in Figure 7. A recent study underscores the significant impact of pedagogical competence on student performance. A recent study by Zhang and Kim (2022) demonstrated a positive association between the percentage of full-time, tenured faculty members at institutions and enhanced student performance, together with increased graduation rates. Faculty must participate in ongoing professional development to maintain teaching excellence and adapt to new educational technologies. Robinson et al. (2022) conducted a study revealing that organisations allocating resources for ongoing training and development initiatives for their employees have enhanced levels of student engagement and improved learning outcomes. Zhang and Kim (2022) confirmed that student advancement is highly influenced by full-time, tenured faculty members. Bettinger and Long (2010) also observed that students achieve superior academic performance when instructed by full-time faculty, underscoring the importance of personnel stability and excellence. Chalmers and Gardiner (2015) also highlighted the significance of expert development in enhancing teaching effectiveness and student satisfaction. Thompson et al. (2022) demonstrated a favourable correlation between increased levels of academic and support staff and enhanced student retention and satisfaction. Tinto (2006) emphasised the significance of comprehensive student support services at institutions, highlighting their potential to enhance retention and graduation rates. An all-encompassing system that integrates highly skilled personnel, continuous professional growth, and adequate support staff is essential. According to an evaluation conducted by the World Bank Report (2022), institutions that demonstrate exceptional performance in these specific areas achieve substantial enhancements in both overall educational standards and student academic

achievements. The 2018 World Bank report similarly highlighted the importance of implementing a comprehensive strategy to ensure that colleges possess sufficient resources. This method should align with the holistic perspective of momentum research findings.

The coefficient of the variable representing physical resources is 0.35. A 1% increase in physical resources guarantees a 0.35% enhancement in resource adequacy. The coefficient for financial and logistic support has been increased in this part, now standing at 0.34, which is comparatively similar to the variable of human resources. A 1% increase in financial and logistical support can enhance resource adequacy by 0.34%. Scott and Guan (2023) and Mireku and Bervell (2024) assert that financial and logistical support enhances the quality of education, particularly at the tertiary level.

The covariance among the observed variables has been quantified, with a covariance of 0.91 between human resources and physical resources, 0.93 between physical resources and financial and logistic support, and 0.94 between human resources and financial and logistic support. The results are robust and nearly identical to the prior estimation. It is straightforward to deduce that the expected outcome exhibits no discrepancies among the projected models. In support of these findings, Smith and Jackson (2023) executed a comprehensive survey of 150 public colleges. The findings indicated that students at schools with superior facilities, including state-of-the-art classrooms and well-equipped laboratories, attained higher GPAs and graduation rates compared to those at universities with obsolete or inadequate infrastructure. Nguyen et al. (2022) have similarly affirmed that the inherent attributes of learning environments substantially influence student performance. Their investigation revealed a direct correlation between investing in classroom enhancements and campus facilities and the enhancement of student engagement and academic success. According to Wright et al. (2023), the framework plays a crucial role in accommodating various learning styles and activities. Their review revealed that institutions with adaptable learning environments and state-of-the-art libraries experienced a significant enhancement in student engagement and creative thinking. Garcia and Lee (2023) examined the relationship between tangible resources and student satisfaction. They discovered that prioritising high-quality facilities and athletic amenities significantly enhanced the overall university experience for students. Their investigation reveals that well-maintained grounds significantly influence student motivation and well-being. Hassan et al. (2022) confirmed similar findings, suggesting that universities allocating resources to enhance campus aesthetics and improve facilities typically experience increased levels of student satisfaction and reduced rates of student attrition. Brown and Thompson (2023) discussed the significance of specialised resources in contemporary tutoring. Their analysis indicates that colleges equipped with cutting-edge technological infrastructure, including virtual learning environments and high-speed internet access, had superior academic achievements and enhanced students' readiness for the job market. According to Kim and Park (2022), the integration of contemporary

innovations in educational environments, such as interactive whiteboards and digital learning platforms, markedly enhanced student engagement and the efficacy of learning. Williams and Patel (2023) examined the impact of current climate conditions on staff education. It was observed that educators in prestigious colleges reported more job satisfaction and had enhanced effectiveness in their teaching responsibilities. Moreover, established offices enabled educators to employ a broader array of instructional methods, resulting in enhanced student learning. Cheng et al. (2022) found that improving physical resources, such as creating comfortable and well-equipped staff rooms and professional development centres, led to a reduction in teacher burnout and turnover. This consequently cultivated a more consistent and efficient teaching atmosphere.

The empirical validation of this model is illustrated in Table 10, where the Chi-square value is 1684.842, significant at the 1% level. The CMIN/DF disparity threshold is 2.633, which is deemed acceptable. The comparative fit index (CFI) is 0.680, whereas the normed fit index (NFI) is 0.645. The ECVI value has been sustained within the specified range of 4.440 (LO 90_4.133 - HI 90_4.765). Furthermore, the comprehensive study reveals that a comparable pattern of outcomes is seen. The analysis of combined effects indicates that the coefficient values are similar, eliminating any distinction among the coefficients of the observed variables.

Implications

Theoretical Implications

The study adds to a number of theoretical frameworks and models in educational research and policy analysis by looking at how many resources are available at these universities.

Resource-based Theory: This study clearly demonstrates the application of Resource-based Theory in higher education. This idea says that an educational institution's tools, like its buildings, money, staff, and technology, are crucial to how well it can teach. Vasudevan (2021) supported the study's results, which indicate that insufficient resources can negatively impact students' academic success. This supports the idea that effective management and distribution of resources are necessary for excellent education. This theoretical view encourages lawmakers and educational leaders to make sure that there are enough resources as a central part of planning for the future of higher education. Theories of Educational Quality and Equity: The study also touches on ideas about the quality and fairness of schooling. Mallillin and Laurel (2022) assert that people often conceptualize quality education in various ways, including the availability of tools, the effectiveness of teaching and learning, and the outcomes students attain. The study reveals that there are gaps in the available resources and how they affect the quality of education. This shows how important it is to have a complete plan for making sure that education is good,

which includes making sure that resources are enough. The study also found that universities do not share their resources equally. Equity theories align with this, advocating for equitable distribution of educational resources to ensure equal opportunities for all students. Theory of Institutions and Government: From the point of view of institutional theory, the study shows how governance and administrative practices affect how universities handle their resources. According to institutional theory, the structures, policies, and ways of running educational organizations have a big effect on how well they do their jobs. Henrekson and Wennström (2022) attribute the problems and inefficiencies in resource allocation and use to bureaucracy. Better government and management are necessary to optimize resource utilization and enhance educational quality. This theoretical conclusion advocates for implementing changes in university operations to enhance transparency, accountability, and strategic resource planning.

The crucial question that rises is what it means for theories of educational development. Finally, the study contributes to broader theories of educational growth that examines the impact of education spending on social and economic progress. The study suggests that investments in school buildings, teacher education, and academic supplies are important for the growth of the higher education sector as a whole because they demonstrate how important resources are for providing a good education. This point of view fits with ideas that say education is a main part of national development. This implies that ensuring universities have an adequate number of resources can immensely affect Bangladesh's social and monetary development. Focusing on the accessibility of resources in Bangladeshi universities provides valuable insights into the factors that shape the nature of education and the wider implications for strategy and development in education.

Practical and Social Implications

This research has social and practical implications. The inquiry of whether Bangladeshi universities have adequate resources to deliver outstanding education has significant social and practical repercussions. This research addresses societal concerns including educational equality and social mobility. The research shows that children from varied socioeconomic origins have uneven access to excellent education due to resource distribution disparities. This insight may lead to initiatives to level the playing field so all kids, regardless of income, can benefit from a quality learning environment. By improving curriculum and resources, universities can empower graduates. These graduates can improve their communities and advance the nation. The findings may also promote more inclusive educational methods for rural and disabled students, creating a fairer and more equitable society.

Practically, this study's findings are crucial. The findings of this research may help policymakers allocate resources to the most important regions for high-quality education. Foundations may realize they need to upgrade laboratories, libraries, and

equipment to help students study. We may start or upgrade personnel advancement programs to boost academic performance and instructor expectations. We may also improve the educational curriculum to meet contemporary organizational demands and prepare students for their responsibilities. Innovation in the homeroom may also improve students' access to online learning gadgets and resources. This might boost student wellbeing, advising, and career advice, enhancing well-being and academic achievement. It is possible to encourage partnerships with businesses and other countries, which can bring more resources, knowledge, and a global perspective to the learning setting. Finally, setting up regular monitoring and assessment systems based on the study's results can help ensure that resources are always available and that the quality of education keeps improving. This encourages decision-making that makes university operations more efficient. Looking into whether Bangladeshi universities have enough resources to support high-quality education can lead to big steps forward in society and useful changes for everyday life.

Limitations

This study accesses the impact of adequacy of resources on quality of education in four selected public universities in Bangladesh which are established in this century. Other universities also require such comprehensive studies for identifying their barriers to quality education. Further studies could be considering those universities and comparing with established and newly established universities in Bangladesh.

Conclusions

The empirical findings indicated a human resource coefficient of 0.34. A 1% augmentation in human resources results in a 0.34% enhancement in resource adequacy. The coefficient for the variable denoting physical resources is 0.35. A 1% augmentation in physical resources ensures a 0.35% enhancement in resource adequacy. In this part, we have elevated the coefficient for financial and logistical support to 0.34, a figure that is approximately equivalent to the human resources variable. A 1% augmentation in financial and logistical support can improve resource adequacy by 0.34%. Nonetheless, the measurement demonstrates that physical resources exert a greater influence than other factors. The adequacy of resources substantially enhances the quality of education. The resource adequacy coefficient is 0.87, signifying the extent of elucidation regarding educational quality. An increase in resource adequacy implementation typically yields a 0.87% enhancement in school quality.

The study emphasised the importance of sufficient resources for attaining educational goals by linking resource adequacy to the overall quality of education. It underscores the vital significance of resources in establishing a conducive learning environment, augmenting instructional efficacy, and promoting student outcomes. This study offers distinct insights and practical recommendations for improving

higher education in Bangladesh, therefore making a significant contribution to educational research and policy development.

Recommendations

Adequate resources in terms of physical resources, human resources, financial resources etc. and access to resources are very critical to ensure quality education in the universities. Many of them have been already addressed in BAC standards and criteria for program accreditation. Regarding the resources, BAC may consider to address rest of the findings of the study during formulation of BAC standards amd criteria for institution accreditation.

Acknowledgments

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Opportunities and Challenges of Accreditation in Ensuring Quality Education at Business Schools in Bangladesh

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Abstract

This study analyses the opportunities and problems encountered by business schools in Bangladesh in seeking accreditation from the Bangladesh Accreditation Council to improve the quality of higher education. The research aims to address a significant gap in comprehending the significance of accreditation in guaranteeing quality education. Data were gathered from 210 respondents, comprising deans, chairpersons, and regular faculty members from 14 business schools in Bangladesh. Multiple linear regression and logistic regression analyses were utilised to evaluate hypotheses concerning BAC standards and business school accreditation preparation. Principal findings indicate that although numerous business schools are keen to get BAC certification, they encounter considerable obstacles, such as infrastructural deficiencies and insufficient financial backing from senior management. Surmounting these obstacles could elevate institutional reputation, fortify international networks, expand student career opportunities, and augment overall program excellence. Assistance from the Bangladesh Government, the University Grants Commission (UGC) of Bangladesh, and the Internal Quality Assurance Cell (IQAC) is crucial to tackle these difficulties. This research provides significant insights for policymakers, educational leaders, and prospective scholars, offering theoretical, practical, and policy recommendations to enhance higher education in Bangladesh.

Keywords: Higher education; B-schools; IQAC; UGC; BAC standards

Introduction

Different organisations in Bangladesh continually pursue quality in both production and services, whereas educational institutions have only recently adopted to pursue quality assurance in both program and institutional level. Ensuring quality in higher education is essential to satisfying both national and global needs. It is crucial for attaining sustainable development objectives and mitigating socioeconomic inequalities. Accreditation is essential for ensuring the quality and legality of educational institutions, acting as a standard for universities, vocational schools, and

specialised organisations (Perrier & Egan, 2015). Although numerous colleges in Bangladesh provide business education, the scarcity of certified business schools has resulted in disparities in educational quality and graduate employability (Top 10 Business Schools in Bangladesh, 2022).

When a university guarantees quality or achieves external accreditation, it generates extensive opportunities, helping individuals across the nation. Accreditation for business schools provides several options at individual, community, and international levels. Accredited business schools provide students with numerous advantages, including a high-quality, industry-standard education that enhances employment opportunities and career progression (Ulker & Bakioglu, 2019; Hakim & Suharto, 2019; Mati, 2018). Accreditation ensures that faculty, curriculum, and resources adhere to rigorous standards, facilitating a comprehensive business education; financial aid alternatives, including loans, grants, and scholarships, enhance accessibility; and degrees from esteemed institutions may augment international recognition (Mahaffey, 2012). Furthermore, it improves international career mobility (Ulker & Bakioglu, 2019; Eid, 2014). Accredited business schools enhance economic and community development by promoting innovation and entrepreneurship, hence facilitating job creation and the establishment of new businesses (Mahaffey, 2012). They engage with local enterprises via research initiatives, consulting, and internships, thereby benefiting the community (Hunt, 2014; Ulker & Bakioglu, 2019; McKenzie Jr et al., 2019). Globally recognised business schools leverage their esteemed reputation to attract talent, forge alliances, establish collaborations, and enrol overseas students. They frequently possess diversified teacher and student populations, establishing a global alumni network that facilitates individual and corporate prospects internationally (Shiffler, 2011).

Business schools in Bangladesh must engage in a resource-intensive accreditation process that requires considerable time and financial investment to comply with the standards. To ensure quality in business education educational institutions must reconcile academic independence and creativity with the stringent mandates of certifying bodies. Institutions, educators, and personnel are compelled to meet evolving standards, as accreditation is an ongoing process rather than a singular achievement. Engaging academics and staff in the certification process and ensuring adherence to standards can be arduous, particularly when extensive documentation and data management are required. Moreover, managing these varied standards can be difficult as schools sometimes seek multiple accreditations, each with distinct requirements (Uziak et al., 2014).

The quality of higher education can be characterised from both an output and an input-output standpoint. From an output standpoint, educational objectives and results align with the organization's mission or vision (Schindler et al., 2015). From

the input-output perspective, quality is assessed as an output (such as graduate employment) relative to specific inputs (including faculty, staff, and curriculum).

The quality of higher education is significant since it may impact individuals' lives, advance society, foster creativity, and contribute to country development in an evolving global landscape. A diverse array of research investigations has been undertaken regarding quality as an accrediting outcome (Ulker & Bakioglu, 2019; Hakim & Suharto, 2019). The perspective of 'Accreditation as the Product of Quality' posits that organisations prioritising and consistently fulfilling quality standards intrinsically qualify for accreditation. Ulker and Bakioglu (2019) discovered that accreditation has a substantial effect on newer higher education institutions (1-20 years old), but schools over 40 years typically depend on established reputation, industry recognition, and internal quality controls instead of accreditation for quality assurance. The older organisations endorse the "time-based relevance" of accreditation while eschewing it due to its substantial costs and resource requirements, opting to allocate resources to alternative areas.

The quality of higher education, especially in business schools, relies on a robust curriculum, proficient faculty, academic research, enough physical resources, and effective governance. Accreditation standards frequently correspond with these components, necessitating schools to offer thorough, current curricula backed by qualified faculty whose knowledge enriches teaching and research (Mati, 2018). Optimal learning settings necessitate physical resources such as laboratories, libraries, and career centres. A definite objective and strong institutional governance ensure alignment in curriculum development, faculty recruitment, and student admission. The accreditation council will also associate higher education with supplementary requirements, including business affiliations, internationalisation, executive training, and community engagement (Hodge, 2010; Dumond & Johnson, 2013). Skilled and engaged students, together with industry affiliations, augment a school's reputation, which accreditation bodies assess alongside factors such as student support and admission criteria (Hunt, 2014; MacKenzie Jr et al., 2019). Effective governance, openness, and an emphasis on quality rather than quantity are essential for achieving accreditation criteria and maintaining excellence Mahaffey (2012). A report by Forbes Advisor (2023) indicates that the robust reputation of a B-education institution, the admission eligibility criteria for students, consistent quality assurance, employer recognition, industry exposure, the university's location, and quality certifications from local authorities are crucial factors in obtaining program accreditation. The Bangladesh Accreditation Council standards and criteria are also aligned with these. In light of the aforementioned factors, it is asserted that a reputable business school should prioritise quality over number.

The objectives of the research were:

i.   to investigate the prospects of business schools following accreditation;
ii. to evaluate the challenges faced by higher education institutions in pursuing accreditation; and
iii. to examine the existing state of B-school accreditation in Bangladesh.

Methodology

Conceptual Framework

The conceptual structure of this study (Figure 1) posits that the independent variable is B-Schools Accreditation, which serves as a setting or condition for guaranteeing quality education. The dependent variables encompass the challenges encountered in the effective implementation of accreditation (e.g., resource limitations, procedural complications, stakeholder alignment) and the opportunities afforded by accreditation for enhancing quality education (e.g., elevated standards, improved reputation, industry connections). Industry demand and governmental regulation influence the relationship between accreditation and high-quality education.
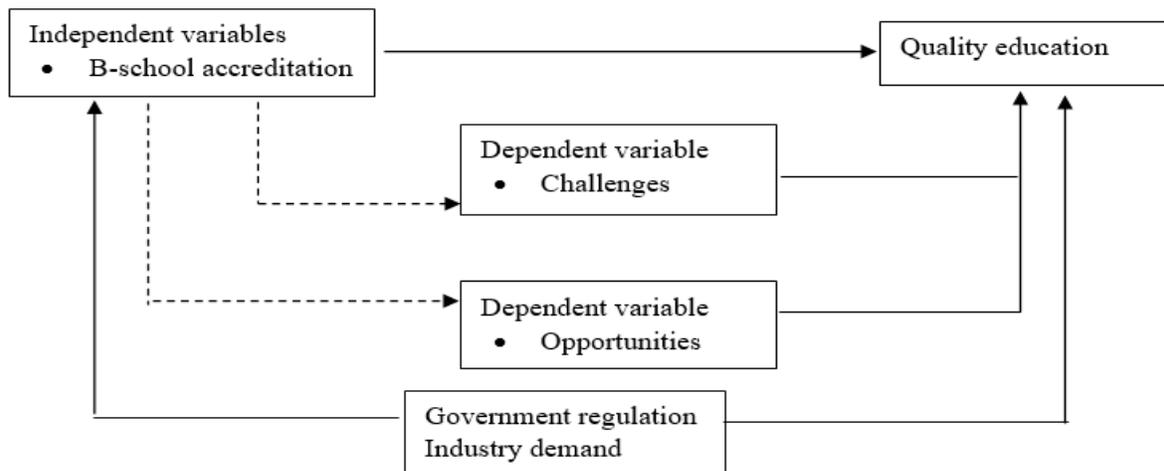
Figure 1: Conceptual framework

Hypotheses

Null hypotheses were formulated to assess BAC requirements (Table 1) and the preparedness of B-schools for BAC accreditation (Table 2) following an exhaustive literature review.

Table 1: List of null hypotheses for measuring BAC standards

Null hypothesis	Hypothesis statements
H_{01}	The governance practiced in B-schools do not match the BAC accreditation standards.
H_{02}	The leadership, responsibility and autonomy practiced in the B-schools do not match the BAC accreditation standards.
H_{03}	The institutional integrity and transparency practiced by the B-schools do not match the BAC accreditation standards.
H_{04}	The curriculum practiced by the B-schools do not match the BAC accreditation standards.
H_{05}	The teaching-learning assessment practiced by the B-schools do not match the BAC accreditation standards.
H_{06}	The student admission policies and support services practiced by the B-schools do not match the BAC accreditation standards.
H_{07}	The policies connected with faculty and staff practiced by the B-schools do not match the BAC accreditation standards.
H_{08}	The facilities and resources available at B-schools do not match the BAC accreditation standards.
H_{09}	The research and scholarly practices in B-schools do not match the BAC accreditation standards.
H_{010}	The monitoring, evaluation and continual development practices in B-schools do not match the BAC accreditation standards.

Table 2: List of null hypotheses for measuring B-schools readiness for BAC accreditation

Null hypothesis	Hypothesis statements
H_{01}	All the independent variables (like BNQF awareness, BAC procedure, BAC criteria, and following BAC criteria in your department) do not significantly contribute to predicting whether B-schools are ready to get BAC accreditation.

Research Design

The study employs an exploratory methodology due to the scarcity of existing research and theoretical foundations, especially in the setting of Bangladesh. The research employed projective approaches, performed face-to-face interviews, and utilised secondary data.

Population, Sample, and Sample size

According to the UGC, there are 115 registered private universities. Seven institutions were assigned red scores due to deficiencies, including unapproved campuses and legal issues. A further source, "Top private universities in Bangladesh," dated February 2023, indicated that the UGC had ranked 103 private universities. Thirty universities garnered popularity among students, categorised into A, B, C, and D based on their price range, the quality of their faculty and

student body, and their effectiveness in job placement (Table 3). For this study, twelve business schools were chosen from Dhaka city, one from Rangpur district, and another from Chittagong district (Figure 2). Faculty members from the business departments of these universities were chosen as model units. The intended population size was 785, while the sample size was 210 (Table 4). Probability Proportional to Size (PPS) sampling was employed to guarantee that larger clusters had a higher likelihood of being selected. Fifteen respondents were selected from each business school for an interview, comprising twelve regular faculty members and three individuals occupying leadership roles: the dean, the chairperson or head of the department, and the coordinator or director.
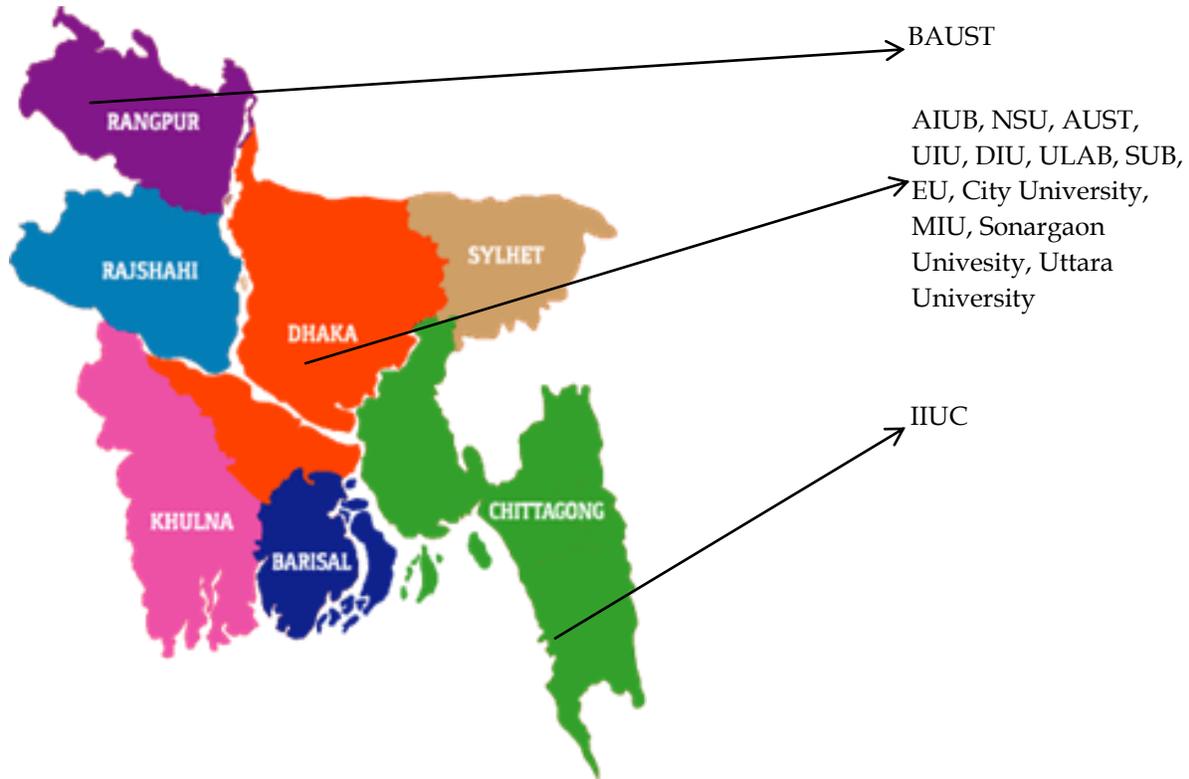
Figure 2: Sample Sites

Table 3: Sample size

Sampling unit	General faculty members	Dean/Chairperson/ Coordinators/Directors	Respondents
Category A (5 B-schools)	5×12 = 60	5×3 =15	75
Category B (4 B-schools)	4×12 = 48	4×3 = 12	60
Category C (3 B-schools)	3×12 = 36	3×3 = 9	45
Category D (2 B-schools)	2×12 = 24	2×3 = 6	30
Total respondents			210

Research Instrument

Data was acquired from both primary and secondary sources. A face-to-face interview was undertaken for primary data collection. A semi-structured questionnaire was created. Two sets of questionnaires were administered. One set of questions was designated for ordinary faculty members, while the other was intended for deans, chairpersons, and coordinators. The questionnaire designed for general faculty members concentrated on the elements influencing accreditation. The questionnaire for deans, chairpersons and coordinators was designed to assess the future accreditation status of the universities. A diverse array of literature advocates for the utilisation of multiple sets of questionnaires to facilitate triangulation and cross-validation, augment data depth and breadth, encompass varied perspectives, and mitigate bias, thereby enhancing the overall reliability and validity of research findings (Flick, 2018; Creswell & Clark, 2017).

Data Analysis Technique

SPSS 16 was utilised for data analysis. Data analysis employed descriptive statistics, multiple linear regression, and the Hosmer-Lemeshow test (HL regression analysis).

Reliability and Validity Test

Descriptive analytics, reliability and validity assessments, and multicollinearity analysis were employed at various phases for data screening. Cronbach's Alpha was employed to assess reliability. The alpha values of 0.854 and 0.735 indicate that the items exhibit internal consistency in assessing the same underlying construct. Per Wilson's (2010) criterion, $\alpha = 0.8$ is deemed good, $\alpha = 0.7$ is considered acceptable, and $\alpha = 0.6$ is seen as dubious. While reliability is crucial for the study, it is inadequate unless paired with validity (Wilson, 2010). The questionnaire's face validity was evaluated through prior literature and the BAC Accreditation Manual 2022. The criterion validity of the questions was assessed using Pearson correlation, with results displayed on all labels. (2-tailed), indicating that the enquiries posed by the respondents were also valid. The majority of correlations were statistically significant (p-value < 0.05) and exhibited moderate to high strength (ranging from 0.4 to 0.7), indicating a relationship among the items.

Results and Discussion

The analysis of the results is segmented into three components: initially, a frequency table was employed to illustrate the present status of accreditation among B-schools in Bangladesh, alongside their opportunities and challenges; subsequently, linear regression was utilised for hypothesis testing concerning the implementation of various BAC standards in B-schools. This section aims to demonstrate the alignment

of B-schools with BAC criteria. Finally, the HL regression analysis was employed to forecast B-schools' likelihood of obtaining accreditation from BAC in the future.

Part 1: Demographic Results

Present status of B-school accreditation in Bangladesh

Figure 3, entitled 'Current Status of B-School Accreditation in Bangladesh,' illustrates the distribution of B-schools in Bangladesh classified by their accreditation status.
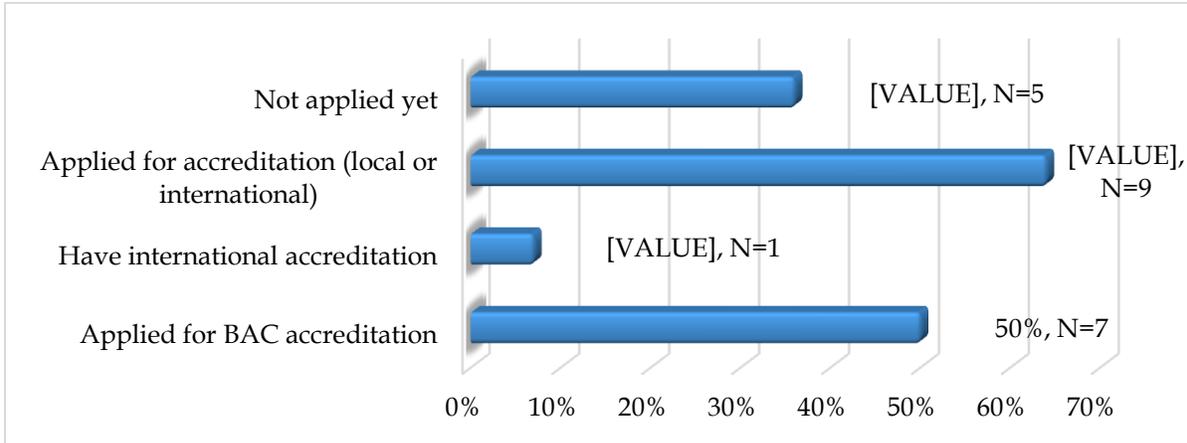
Figure 3: Present status on B-school accreditation in Bangladesh

Among the 14 analysed business schools, 64% (N=9) have sought accreditation either domestically or internationally, whilst 36% (N=5) have yet to pursue this process. Fifty percent (N=7) of business schools have submitted applications to the Bangladesh Accreditation Council (BAC). Nonetheless, hardly one (7%, N=1) has obtained overseas accreditation. Significantly, the majority of non-accredited institutions have existed for over a decade; nevertheless, insufficient finance, minimal research, and infrastructural challenges impede their pursuit of certification. A significant mental barrier that complicates development is the perception among certain institutions that the pursuit of accreditation may diminish due to governmental changes.

Challenges face by B-schools in the path of accreditation

Business schools pursuing or preparing to pursue BAC accreditation are encountering several challenges. Figure 4 delineates the diverse challenges encountered by business schools (B-schools) in their quest for accreditation.
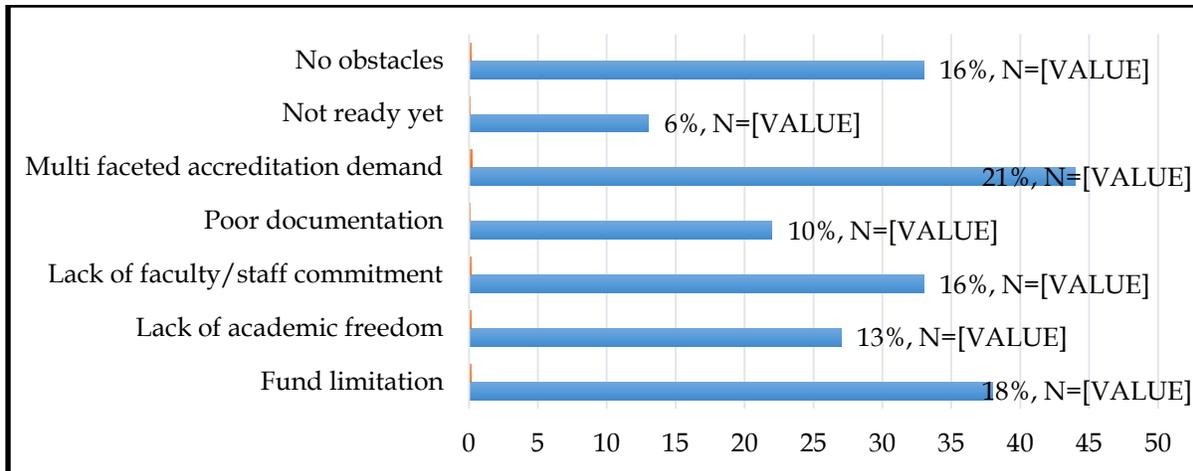
Figure 4: Challenges face by B-schools in the path of accreditation

Business schools have considerable obstacles in the certification process, with 21% identifying the complex accreditation requirements as a major concern. Principal problems encompass sustaining ideal class sizes, dependence on internal recruitment, and the senior faculty's hesitance to adopt novel pedagogical methods. Inferior-tier business schools frequently lack resources such as adequately equipped libraries and international publications. To reduce expenses, smaller institutions frequently emphasise internal recruitment, circumventing the lengthy external hiring process, which may restrict faculty diversity and the requisite skills for accreditation (Johnson & Thompson, 2018). Smith & Chang (2015) posited that internal hiring can enhance morale, decrease turnover, and promote institutional stability, potentially benefiting accreditation initiatives indirectly.

The research indicates that the majority of private business schools impose a 72 hour deadline for faculty to evaluate and offer comments on students' assignments, while some faculty members occasionally fail to meet this timeframe. Prompt, constructive feedback is essential for improving student learning, performance, and happiness, and it aligns with accrediting standards for student engagement and outcomes (Richardson, 2019; Carless and Boud, 2020). While fast feedback is beneficial, the aforementioned papers indicated that the quality and clarity of feedback are much more crucial for students' success.

Typically, younger faculty members, more so than their senior counterparts, endeavour to implement innovative teaching methodologies, such as case studies, role-playing, and debates, in their business courses to ensure students remain informed about the contemporary business landscape. Beghetto and Kaufman (2021) contend that conventional, structured pedagogical approaches, such as direct instruction, frequently surpass creative methodologies in effectiveness, particularly for novices or in intricate, sequential disciplines like programming, physics, or domains such as engineering and healthcare, where precision is paramount.

This study highlights excessive workloads, administrative responsibilities, and inadequate research facilities as significant impediments to academic research, consistent with O'Meara & Culpepper (2021). Nevertheless, study by Teichler Höhle (2013) indicated that schools with constrained time or resources might still fulfil accreditation criteria by emphasising partnerships, collaborative initiatives, or applied research.

Faculty frequently require assistance in reconciling teaching and research, with 18% of respondents seeing budgetary limitations as an obstacle to facilitating accreditation. Insufficient wages, excessive workloads, and non-academic responsibilities further diminish faculty engagement. Accreditation expenses are exorbitant for most institutions, particularly in developing nations (Chowdhury el. al., 2013; Murray & Hazeldine, 2015). Notwithstanding these costs, several schools regard certification as a valuable investment for enhancing reputation and enrolment (Elliott & Goh, 2013). This study revealed that numerous business schools expressed interest in BAC accreditation as a more economical alternative to international accreditation, despite its inherent costs.

Organisational challenges, including inadequate paperwork (10%, N=22) and restrictions on academic freedom (13%, N=27), hinder the certification process. A minority (6%, N=13) of business schools perceive themselves as unprepared for certification, however some indicate encountering less obstacles in their accreditation process.

Potential opportunities associated with BAC accreditation

Figure 5 illustrates the principal advantages of BAC accreditation, with 32% (N=62) of respondents identifying improved institutional reputation as a notable benefit resulting from compliance with quality criteria. Accreditation guarantees contemporary, high-calibre programs (25%, N=12) and facilitates international networking and collaborations (22%, N=46). Simultaneously, merely 9% (N=19) acknowledged professional chances for students, while 12% (N=25) regarded reputation, quality, and networking with similar importance.
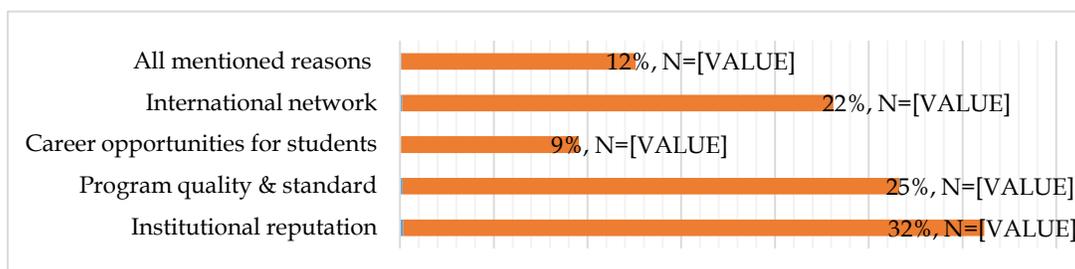
Figure 5: Opportunities associated with BAC accreditation

This study is consistent with prior research on accreditation in higher education. Mahaffey (2012) underscored its influence on institutional reputation, whilst Uziak et al. (2014) accentuated its contribution to enhancing program standards. Shiffler

(2011) examined the influence of accreditation on global networking and employment opportunities for students. Elliott & Goh (2013) observed that accreditation is occasionally regarded as a quality indicator, as employers and students may prioritise elements such as faculty expertise or alumni achievements. Elliott & Goh (2013) cautioned that accreditation can result in uniformity devoid of differentiation, fostering a "check-the-list" attitude that emphasises compliance above authentic quality enhancement.

Part 2: *Measuring BAC standards in B-schools in Bangladesh*

Table 5 displays a multiple regression model forecasting "Readiness for BAC Accreditation." Key predictors encompass 'Leadership,' 'Admission Policies,' and 'Curriculum.' The model accounts for 42% of the variance in preparedness ($R^2 = 0.4$). The ANOVA findings (Appendix D: D1) indicate a substantial model effect ($F = 14.4$, $p < 0.05$), validating the model's predictive capability.

Table 4: Testing 10 hypothesis using regression model

	Unstandardized coefficients			Collinearity statistics					
	B	Std. Error	t	Sig.	Tolerance	VIF	R	R^2	Adjusted R^2
(Constant)	-2.5	.4	-7.0	.00					
Governance	0.2	.0	1.3	.2	.7	1.3			
Leadership	.1	.0	5.1	.00	.7	1.4			
Institutional integrity	-.0	.0	-.4	.7	.4	2.3			
Curriculum	.1	.0	2.8	.00	.5	2			
Teaching learning	-.0	.0	-.7	.5	.5	2.1	.6a	.4	.4
Admission policies	.1	.0	5.5	.00	.5	2.0			
Faculties & staff	-.0	.0	-1.6	.1	.5	1.2			
Facilities	-.1	.0	-.5	.6	.5	1.8			
Research	.01	.0	.6	.5	.4	2.4			
Monitoring	.01	.0	.5	.6	.6	1.7			

Here, H_0: $\beta1 = \beta2 = \beta3 = \beta4 = \beta5 = \beta6 = \beta7 = \beta8 = \beta9 = \beta10 \neq 0$

Where:

- $\beta1$ = coefficient for governance
- $\beta2$ = coefficient for leadership (significant relationship)

- β3 = coefficient for institutional integrity
- β4 = coefficient for curriculum (significant relationship)
- β5 = coefficient for teaching-learning
- β6 = coefficient for admission policies (significant relationship)
- β7 = coefficient for faculty & staff
- β8 = coefficient for facilities
- β9 = coefficient for research
- β10 = coefficient for monitoring

So, null hypothesis for β2, β4, and β6 are rejected.

Part 3: Projection on B-schools of getting BAC accreditation

This analysis was conducted to evaluate the influence of many aspects (including BNQF knowledge, BAC procedure, BAC criteria, and adherence to BAC standards within your department) on the prospects for B-schools to achieve BAC accreditation.

Table 5 illustrates that, with an odds ratio of 22.7, 'Following BAC criteria in the program' is the strongest predictor (strong positive impact) of achieving the outcome. Specifically, a one-unit increase in 'Follow BAC criteria in your program' is associated with a significant increase of the dependent variable 'Opportunity for getting BAC accreditation' by B = 3.1 or 23% (Exp = 22.7). BNQF awareness (p = 0.00) is the significant predictor, with the odds of the outcome being 3.51 times higher. Positive correlations between the other variables (BAC procedure awareness, p = 0.04 and BAC criteria awareness, p = 0.04) indicate moderate increases in outcome likelihood with higher awareness.

Table 5: Readiness for BAC accreditation

Variables in equation		B	S.E.	Wald	df	Sig.	Exp (B)
Step 1ᵃ	BNQF awareness	1.3	.4	82	1	.00	3.5
	BAC procedure awareness	.9	.4	4.3	1	.04	2.4
	BAC criteria/standard awareness	.9	.4	4.1	1	.04	2.4
	Following BAC criteria in the program	3.1	.4	55.9	1	.00	22.7
	Constant	-3.6	.6	43.2	1	.00	.03
a.Variable(s) entered on step 1: BNQF awareness, BAC procedure awareness, BAC criteria/standard awareness, Following BAC criteria in the program.							

The model summary finds that the model explains between 39.8% (Cox & Snell) and 53.0% (Nagelkerke) of the variance in the dependent variable, which suggests a moderately strong model.

Here, H$_0$: $\beta1=\beta2=\beta3=\beta4 \neq 0$

Where:

- $\beta1$ = coefficient for BNQF awareness (significant predictor)
- $\beta2$ = coefficient for BAC procedure (significant predictor)
- $\beta3$ = coefficient for BAC criteria (significant predictor)
- $\beta4$ = coefficient for follow BAC criteria in your program (strongest predictor)

The null hypothesis is rejected because some variables are highly predictive of the result.

Implications

Theoretical implications

The study indicates that social and educational attributes affect business school accreditation in Bangladesh. Urban business schools generally possess a greater capacity to meet accreditation standards than their rural equivalents, owing to economic disparities. The absence of a regulatory framework and inconsistent enforcement obstructs accrediting efforts. Conventional educational institutions often demonstrate minimal interest in accrediting activities, shaped by labour market concerns, institutional autonomy, and cultural perspectives. Bureaucratic impediments hinder public universities with little authority from meeting accreditation standards. These findings offer novel perspectives to enhance current theories.

Managerial implications

Business schools can enhance their deficiencies by understanding the financial, research, and infrastructural obstacles to accreditation. Accreditation can impact improvements in pedagogical approaches, faculty development, and curricular design. Policymakers ought to utilise the study's findings to enhance educational quality and potentially reinforce national accreditation criteria, particularly for public universities and their affiliated business schools.

Limitations

To ensure validity and reliability, all studies must acknowledge research limits. Research constraints include Data collection, processing, and reporting were all time sensitive. Time constraints left the research team with little qualitative data, which may have limited their conclusions. Second, non-cooperation from respondents—like faculty—hampered data collection. Non-cooperation was due to boredom, time constraints, and privacy and repercussion concerns. Data collectors had to go through lengthy and onerous processes to get B-school approval at some universities due to bureaucratic issues.

Conclusions

This study analysed the challenges and potential benefits of certification, focussing on the opportunities and obstacles encountered by Bangladeshi business schools during the accreditation process. The study assessed the current operational status of business schools in relation to BAC standards and criteria, highlighting the difficulties associated with obtaining accreditation and the requirements of the process. Research reveals that business schools in Bangladesh face many challenges that hinder their accreditation opportunities. Prevalent obstacles encompass an emphasis on internal recruitment, inadequate promptness in providing feedback on student achievement, dependence on conventional teaching methodologies, and insufficient time designated for research endeavours. A further substantial obstacle is the deficiency of financial resources required to obtain accreditation. Notwithstanding these hurdles, respondents conveyed optimism that obtaining BAC accreditation would bolster institutional reputation, promote international networking, generate employment prospects for students, and elevate program quality.

The research indicated that, subsequent to the formation of BAC, hardly 50% of business schools in Bangladesh have sought BAC certification. To comply with BAC standards, business schools must synchronise their programs with essential domains, including governance, institutional integrity, pedagogical approaches, faculty and staff services, infrastructural support, and criteria for research and evaluation. Despite the familiarity of most business schools with the Bangladesh National Qualification Framework (BNQF) standards, BAC standards, and BAC procedures, their business programs frequently fail to comply fully with these requirements, so constraining their readiness for accreditation.

The study highlights that local accreditation can enhance educational standards for the advantage of students and the educational ecosystem. This research offers an extensive analysis of the policies and practices in the accreditation landscape, as articulated by department leaders and scholars. The study provides significant insights into educational certification by identifying areas for enhancement in institutional practices and informing policy development to elevate the quality of higher education in Bangladesh.

Recommendations

Recommendation 1: BAC has accreditation standards for capacity building based on the criteria mentioned above. However, due to its non-compulsory nature, many universities and programs need to pay more attention to accreditation. To improve the situation, BAC can work with the University Grant Commission (UGC) to incentivize accreditation with a tax break or a reduction in fees (such as licensing or regulatory charges) for organizations that have accredited programs. Additionally, UGC can identify accredited programs for extra benefits, such as increased funding allocations, eligibility for public contracts, or student scholarships linked to

accredited programs. Moreover, since the UGC can limit or extend programs, BAC may work with UGC to ensure that new program approvals and growth are subject to accreditation to support general quality improvement in higher education.

Recommendation 2: A program accreditation requires TK. 5 lakh to TK. 6 lakh investment, on average. Medium- to small-range business schools are unwilling to spend so much on accreditation when the credential is only valid for five years. To make the accrediting process financially feasible in such circumstances, BAC can reduce or subsidize accreditation fees for small and underfunded universities, especially those in categories C and D. Alternatively; BAC may provide a discounted rate for the certification of multiple programs from the same department. Additionally, implementing an integrated digital platform for accreditation applications, documentation submission, and communication will reduce paperwork and travel costs, expedite processes, and ensure transparency.

Recommendation 3: Since accreditation is optional, several B-schools are not interested in becoming accredited. Generally, IQAC oversees quality assurance activities in programs or institutions. To address inactive or ineffective IQACs, BAC can require IQACs to provide periodical reports outlining their efforts to promote accreditation within their universities. These reports should list the programs pursuing accreditation, their difficulties, and their advancements. By providing this kind of information, IQACs would be held responsible for their part in furthering accreditation initiatives. Suppose these reports must be submitted, or there is no indication of activity supporting accreditation. In that case, BAC may conduct additional assessments to review the IQAC's performance and, if necessary, suggest corrective measures. Alternatively, some business schools have obtained international accreditation but have not sought national accreditation. BAC should work to bring these institutions under the local accreditation system.

Recommendation 4: To sustain the benefits of accreditation, BAC can collaborate with accredited B-schools to promote their status through co-branded marketing, alumni and faculty success stories, and showcasing how accreditation drives growth and quality improvement.

Acknowledgments

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Assessing the Quality of Undergraduate Business Education Using Higher Order Thinking Skills: Evidence from Selected Universities in Bangladesh

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Abstract

Undergraduate business education in Bangladesh is often criticised for lacking practical skills such as problem-solving, analytical thinking, and creativity. This study assesses the quality of business education using Higher-Order Thinking Skills (HOTS), focusing on mark distribution and students' acquisition of business-specific skills. The study analysed 309 undergraduate business examination question papers from 2023 across 10 public and private universities that follow outcome-based curricula. Using content analysis, key action verbs and cognitive domain levels were identified. A checklist was developed to classify six cognitive levels and evaluate mark distribution patterns, comparing public and private universities across four academic levels. Findings reveal a significant undervaluation of HOTS, including analytical, evaluative, problem-solving, decision-making, and creative skills. This imbalance between Lower-Order Thinking Skills (LOTS) and Higher-Order Thinking Skills (HOTS) leaves graduates underprepared for real-world business challenges, stifling innovation and problem-solving abilities. To address these gaps, curriculum reforms should integrate HOTS into learning objectives, emphasise project-based learning, and enhance faculty training. Policy interventions should prioritise active learning strategies and stakeholder-driven continuous improvement. Implementing these recommendations will better equip graduates with critical thinking, problem-solving, and innovation skills essential for success in the 21st-century business environment.

Keywords: Curriculum Assessment; Lower Order Thinking Skills; Higher-Order Thinking Skills; Tertiary Education; Quality Education

Introduction

Sustainable economic development relies on quality education, which develops the workforce, promotes innovation, entrepreneurship, and social and economic resilience. Investing in education helps nations adapt to changing economic environments, promote inclusive growth, and address poverty and social inequities. Higher education is vital to research, entrepreneurship, and social progress by developing skilled and innovative workers.

Bangladesh has 55 public and 114 private universities to attempts to boost higher education. Most of the universities in the country were formed in the recent two decades with a view to generate a trained workforce that can promote economic diversity, social responsibility, and national economic sustainability.

Until recent industries in Bangladesh mostly depend on foreign workers especially for executives, illustrating the shortage of necessary practical skills. In 2021-22, the Bangladesh Investment Development Authority (BIDA) issued 15,128 work visa applications, up 87.32% from the previous year, to meet skilled workforce demand (Mirdha & Chakma, 2023). This tendency highlights a disparity between educational institutions' skills and those desired by employers, with 45% of respondents in a recent poll dissatisfied with graduates' preparation (Bhuiyan & Rommo, 2024). University graduates generally have outstanding academic scores, but their commercial preparation is questionable.

UNICEF (2000) defines quality education as the ability learners to address difficulties comprising knowledge, skills, and attitudes that support national education goals and positive social involvement. Quality business education prepares students for the fast-paced corporate world with theoretical knowledge, practical skills, and ethical values for innovation, leadership, and decision-making promoting teamwork, communication, critical thinking, and problem-solving (AACSB International, 2022). Complex problem-solving, critical thinking and innovation are valued by top employers.

The Institutional Quality Assurance Cells (IQACs) of the universities have been promoting to establish a culture of quality in higher education through academic training programs that emphasise outcomes-based education, Bloom's Taxonomy, and good governance at universities (UGC, 2015). The Bangladesh National Qualifications Framework (BNQF) also recommends reassessing graduate capabilities due to rapid social development and changing workplace demands (BNQF, 2021). It promotes skill integration across four learning outcome domains—fundamental, social, thinking, and personal—aligned with the World Economic Forum recommended skills. BNQF (2021) intends to better equip graduates for the fourth industrial revolution (4IR).

Traditional education emphasised memorisation and fundamental literacy (Zohar & Dori, 2003) while modern educational aims prioritise higher cognitive talents and skill-based learning for real-world application, rather than memory (Zohar & Dori, 2003). Thus, all educational settings must develop advanced cognitive skills to foster critical thinking, problem-solving, and analysis (Bransford et al., 2000; Zohar & Dori, 2003).

HOTS-based learning methodologies in business education prepare students for future issues (Sinage et al., 2020; Tyas & Naibaho, 2021) that help assess and evaluate complicated business issues, argue, and provide creative solutions (Tyas & Naibaho, 2021; Kusuma et al., 2017; Cao, 2018). In university education (Yee et al.,

2015), HOTS encourage logical, systematic, and analytical reasoning to solve problems using current knowledge (Sinage et al., 2020). This method is crucial for educating pupils for industrial and digital changes (McMahon, 2007).

Majority studies on quality education in Bangladesh mostly did focusing physical resources, curricular quality, and governance rather on student skills and capabilities (Monem, 2007; Naser, 2008). Infrastructure and resources are important, but they don't guarantee young people have the skills to succeed in business. Few studies have assessed education quality based on students' opinions and attitudes, and even fewer have examined business education's integration of Higher-Order Thinking Skills (HOTS). This lacuna in the literature underlines the need for a comprehensive assessment of undergraduate business education in Bangladesh that emphasises real-world competencies.

This study evaluated undergraduate business education in Bangladeshi public and private universities, focussing on higher-order thinking skills. The objectives were:

i.   to analyse the distribution of marks for Lower-Order Thinking Skills (LOTS) and Higher-Order Thinking Skills (HOTS) in past undergraduate business examination papers;

ii. to assess whether students are developing sufficient analytical, evaluative, decision-making, problem-solving, and creative skills; and

iii. to compare the quality of undergraduate business education in terms of graduates' thinking skills.

Methodology

Population and Sample

This study includes 10 universities—5 public and 5 private—that offer business education and have outcome-based undergraduate curriculum. Convenience sampling was utilised to choose a representative mix of public and private universities for the study.

Sources of Data and Data Collection Techniques

309 question papers of continuous assessment, mid-term, and semester-end final exams for undergraduate business courses were collected from the selected universities. The study examined how undergraduate business education exams assigned scores for lower- and higher-order thinking skills. Content analysis was used to identify, organise, and assess cognitive levels of Bloom's taxonomy. Key action verbs for each level in the question papers were grouped.

This approach was streamlined by creating a checklist (Atiullah et al. 2019; Krathwohl, 2002; Muhayimana et al., 2022; Virranmäki, 2021; and Mitani, 2021). This checklist listed thinking skills (LOTS and HOTS), the six cognitive levels, and the essential action verbs utilised in each exam paper (Table 2).

The primary action verbs for each cognitive level were "A" for recalling, "B" for comprehending, "C" for applying, "D" for analysing, "E" for evaluating, and "F" for producing. The total marks distribution for each cognitive domain level across examination papers was calculated by extracting marks from each question paper.

The sample universities' ongoing assessments, midterm exams, and semester-end final exams had different mark distributions. The percentage of marks allocated to each cognitive domain level was used to balance marks across exam modalities.

Table 2: Thinking Skills and Cognitive Domain Levels of the Revised Bloom's Taxonomy: Key Action Verbs

Thinking skills	Cognitive domain levels	Key action verbs (Krathwohl, 2002; Clark, n.d.; Muhayimana et al., 2022; Virranmäki et al., 2021; Mitani, 2021)
Lower-Order Thinking Skills (LOTS)	Recalling/Remembering	Define, Find, How, List, Match, Name, Select, Show, What, When, Where, Which, Who, Why, State.
	Comprehending/Understanding	Classify, Compare, Contrast, Demonstrate, Explain, Illustrate, Infer, Interpret, Describe, Discuss.
	Applying	Apply, Build, Construct, Plan, Develop, Select, Experiment with, Organize, Solve, Calculate, Utilize, Demonstrate, Sketch.
Higher-Order Thinking Skills (HOTS)	Analysing	Analyse, Examine, Discuss.
	Evaluating	Assess, Evaluate, Criticize, Comment.
	Creating	Advise, Develop, Design, Formulate, Recommend.

Data Analysis

Before analysing with Statistical Package for the Social Sciences (SPSS) 25.0, data were organised and documented. First, descriptive statistical tools like minimum, maximum, mean, and standard deviation were used to determine mark distribution patterns for cognitive domain levels (e.g., recalling, understanding, applying, analysing, evaluating, and creating) and thinking skills. These estimates revealed how many marks each question paper's thinking skill and cognitive domain level received at different academic levels (first to fourth).

Inferential analysis began with an independent samples t-test to assess if there was a statistically significant difference in LOTS and HOTS marks between public and private colleges in undergraduate business program question papers. The study formulated the following null hypothesises:

H$_o$: There is no statistically significant difference in mark distributed for LOTS in the question papers of undergraduate business education between public and private universities.

H$_o$: There is no statistically significant difference in mark distributed for HOTS in the question papers of undergraduate business education between public and private universities.

The independent sample t-test was performed in the following manner:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{S} \sqrt{\frac{n_1 n_2}{n_1 + n_2}}$$

Where t is the t-test statistic of an independent sample, $\bar{x}_1$ and $\bar{x}_2$ are the sample means of LOTS/HOTS of public and private universities, respectively. n_1 and n_2 are the sample sizes of public and private universities.

To evaluate if public and private university mean LOTS and HOTS differences are statistically significant at the 5% level, the t-test statistic was compared to a crucial value from the t-distribution. The null hypothesis is rejected at 5% if the t-test p-value is less than 0.05, indicating statistically significant mean differences. The effect size for t-tests using Cohen's d was evaluated to determine the magnitude of the difference in LOTS and HOTS between public and private colleges, providing a more meaningful interpretation than statistical significance. The Cohen's d value was determined in the following manner:

$$d = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{(\sigma_1^2 + \sigma_2^2)}{2}}}$$

Where $\bar{x}_1$ and $\bar{x}_2$ are the sample means of LOTS/HOTS of public and private universities, respectively. σ_1 and σ_2 are the standard deviations of LOTS/HOTS of public and private universities, respectively.

A one-way analysis of variance (ANOVA) test was used to determine statistically significant mean differences in LOTS and HOTS mark distribution among the four academic levels (First Year, Second Year, Third Year, and Fourth Year) in undergraduate business degrees at public and private universities. The study formulated the following null hypotheses:

H$_0$: There are no statistically significant mean differences in mark distribution for LOTS among the four academic levels (First Year, Second Year, Third Year, and Fourth Year) in undergraduate business degrees at public and private universities.

H$_0$: There are no statistically significant mean differences in mark distribution for HOTS among the four academic levels (First Year, Second Year, Third Year, and Fourth Year) in undergraduate business degrees at public and private universities.

One-way ANOVA test was also performed in the following way:

$$F = \frac{MSB}{MSW}$$

Where F is the test statistic (F-ratio). MSB is the mean square of LOTS/HOTS between academic levels. MSW is the mean square of LOTS/HOTS within academic levels.

ANOVA's F-ratio was compared to the F-distribution's critical value to assess if public and private colleges' four academic levels' means differed significantly. The null hypothesis is rejected if the p-value is less than 0.05 because at least one group mean is statistically different. The effect size in ANOVA using Eta Squared (η^2) was assessed to determine the extent of variance in LOTS and HOTS marks distribution due to differences among academic levels, showing their strength. The η^2 was determined in the following manner:

$$\eta^2 = \frac{SS_{between}}{SS_{total}}$$

Where $SS_{between}$ is the sum of squares between groups, which refers to the variance in marks distribution for LOTS and HOTS that is explained by the differences between the four academic levels (First Year, Second Year, Third Year, and Fourth Year). SS_{total} is the total sum of squares, which represents the total variance in marks distribution for LOTS and HOTS across all levels combined (without considering the academic levels as separate groups).

Finally, the Tukey HSD (Honestly Significant Difference) test was used to compare the mean differences in LOTS and HOTS percentages across academic levels in undergraduate business exam question papers from private and public Bangladeshi universities. The test was performed in the following manner:

$$HSD = q\sqrt{\frac{MSW}{n}}$$

Where HSD is the Tukey's honest significant difference, q is the critical value from the Studentized range distribution table. MSW is the mean square within the four academic levels (or error mean square) from the ANOVA. n is the number of observations in each academic level.

Tukey HSD (Honestly Significant Difference) was used to compare the four academic level means. Any mean difference between academic levels that surpassed the HSD was statistically significant. At the 5% significance level, mean LOTS and HOTS scores between any two academic levels were statistically significant with a p-value less than 0.05.

Robustness Tests

This study compared public and private university exam questions with unequal samples of 215 and 94 items, which may invalidate comparisons. The sample size of

309 is smaller than the recommended 384 for unknown populations, which may cause issues. Systematic down sampling and bootstrapping were used to overcome these difficulties and validate the results' robustness.

To equalise public and private university sample sizes, systematic sampling was utilised to lower public university samples from 215 to 107. A sampling interval of 2 was used to select every second question following a random starting point, maintaining dataset integrity and assuring approximately equal questions from both types of colleges.

Second, the findings were tested for robustness using bootstrapping, a non-parametric resampling method. Drawing 1000 random samples with replacement created "bootstrap samples" equivalent to the dataset. This strategy balanced comparisons between public and private colleges' different sample sizes, improving the study's reliability and validity.

Results and Discussion

This study investigated the quality of undergraduate business education in Bangladesh by analysing the distribution of marks across cognitive domains and thinking skills, particularly focusing on the development of higher-order thinking skills (HOTS) in examination question papers. The findings are discussed thematically, integrating descriptive statistics, inferential analysis, and their implications.

Descriptive statistics: Distribution of marks across cognitive domain levels in examination question papers

Table 3 and Chart 1 present the distribution of marks across cognitive domain levels in examination question papers for public and private universities. For the "Remembering" domain, public universities allocate a mean of 22.5%, while private universities allocate a lower mean of 13.9%, with the combined mean at 19.9%. The "Understanding" domain is the most emphasised, with public universities allocating a mean of 44.4% and private universities 54.2%, leading to a combined mean of 47.4%. The "Applying" domain shows similar allocation, with public universities at 21.8% and private universities at 19.4%, resulting in a combined mean of 21.1%. For higher-order cognitive skills, "Analysing" and "Evaluating" are given minimal emphasis, with public universities allocating 3.2% and 6.8%, respectively, compared to private universities' 0.9% and 9.6%. The "Creating" domain receives the least attention, with public universities allocating 1.1% and private universities 1.8%, resulting in a combined mean of 1.3%. Chart 1 visually confirms a stronger focus on "Understanding" across both types of universities, while higher-order skills such as "Analysing," "Evaluating," and "Creating" receive limited attention.

Table 3: Distribution of marks across cognitive domain levels in examination question papers

Cognitive domain levels	Public universities				Private universities				Combined (private and public universities)			
	Mean	*SD*	*Min.*	*Max.*	*Mean*	*SD*	*Min.*	*Max.*	*Mean*	*SD*	*Min.*	*Max.*
Remembering (%)	22.5	14.4	0	78.5	13.9	12.1	0	68.0	19.9	14.3	0	78.5
Understanding (%)	44.4	22.5	0	93.7	54.2	27.7	0	100.0	47.4	24.6	0	100.0
Applying (%)	21.8	26.3	0	95.2	19.4	27.0	0	92.0	21.1	26.5	0	95.2
Analysing (%)	3.2	5.0	0	23.9	0.9	3.8	0	20.0	2.5	4.8	0	23.9
Evaluating (%)	6.8	7.9	0	45.0	9.6	10.8	0	51.9	7.6	8.9	0	51.9
Creating (%)	1.1	3.2	0	18.3	1.8	4.6	0	20.0	1.3	3.7	0	20.0

Note: SD = Standard Deviation, Min. = Minimum, Max. = Maximum.

Chart 1:   Marks ditribution accross the cognitive domain levels in examination question papers

■ Public Universities   ■ Private Universities   ■ Combined (Public and Private Universities)
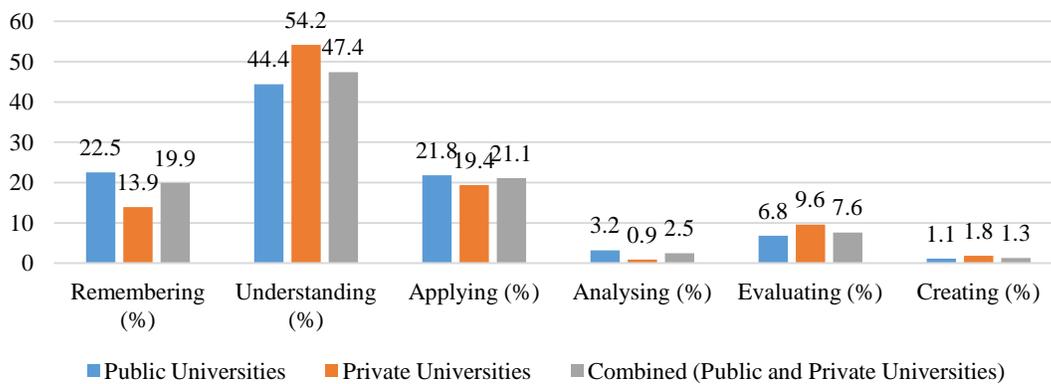
Descriptive statistics: Average marks distribution across thinking skills in examination question papers

Table 4 and Chart 2 show the distribution of marks across different thinking skills (LOTS and HOTS) in undergraduate business education examination question papers from public and private universities. Public universities emphasise LOTS, with a high mean score of 88.8%, focusing on basic understanding, knowledge recall, and application. In contrast, HOTS has a significantly lower mean score of 11.1%, indicating limited emphasis on analysing, evaluating, and creating knowledge. Private universities also focus primarily on LOTS, with a mean score of 87.6%, similar to public universities. The mean score for HOTS is slightly higher at 12.3%, indicating a marginally greater inclusion of higher-order thinking questions. The combined mean scores of 88.4% for LOTS and 11.5% for HOTS reflect a strong focus on lower-order thinking skills and limited attention to higher-order thinking skills. Chart 2 confirms this dominant focus on LOTS, with minimal attention to HOTS.

Table 4: Distribution of marks across thinking skills in examination question papers

Thinking skills	Types of universities	Mean	SD	Min.	Max.
LOTS (%)	Public Universities	88.8	9.3	50.0	100.0
	Private Universities	87.6	11.6	48.0	100.0
	Combined (Public and Private Universities)	88.4	10.1	48.0	100.0
HOTS (%)	Public Universities	11.1	9.3	0.0	50.0
	Private Universities	12.3	11.6	0.0	51.9
	Combined (Public and Private Universities)	11.5	10.1	0.0	51.9

Note: SD = Standard Deviation, Min. = Minimum, Max. = Maximum.

Chart 2:   Average marks distribution across thinking skills in   examination question papers
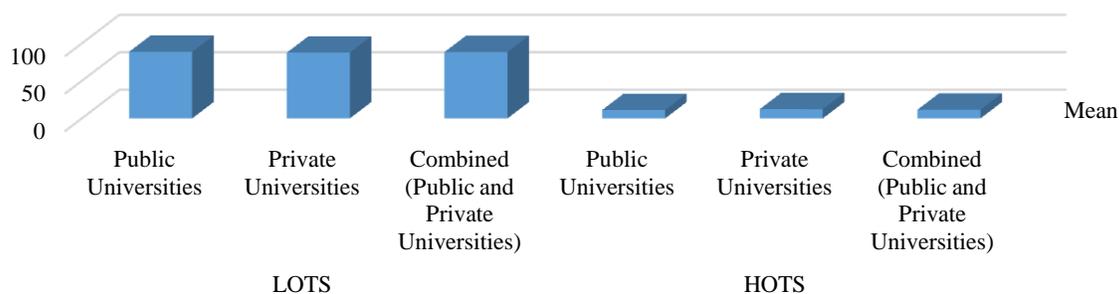
Parametric test results: Independent sample t-test

Table 5 presents the results of independent sample *t*-tests comparing the distribution of LOTS and HOTS in examination question papers between public and private universities. For LOTS, the *t*-test shows no significant difference between the two university types (t = -0.05, p = 0.95), with a very small mean difference of -0.07 and a negligible effect size (Cohen's d = 0.11). Similarly, for HOTS, there is also no significant difference (t = 0.09, p = 0.92), with a mean difference of 0.10 and a very small effect size (Cohen's d = -0.11). These results indicate that there is little to no difference in the emphasis on LOTS and HOTS in examination question papers between public and private universities.

Table 5: Estimations of independent sample t-test: Comparing the distribution of lots and hots in examination question papers between public and private universities

Thinking skills		Levene's test for equality of variances		*t*-test for equality of means				Effect size (Cohen's d)
		F	*Sig.*	*t*	*df*	*Sig. (2-tailed)*	*Mean diff*	
LOTS (%)	Equal variances assumed	0.46	0.49	-0.05	307.00	0.95	-0.07	0.11
	Equal variances not assumed			-0.05	181.69	0.95	-0.07	
HOTS (%)	Equal variances assumed	0.73	0.39	0.09	307.00	0.92	0.10	-0.11
	Equal variances not assumed			0.09	182.82	0.92	0.10	

Note: F = *F*-statistics, Sig. = Significance, *t* = *t*- statistics, df = Degrees of Freedom, Mean diff = Mean Difference.

The descriptive statistics reveal a predominant emphasis on LOTS over HOTS across both types of university. The mean scores for LOTS—recalling, understanding, and applying knowledge—are significantly higher than those for HOTS, indicating that examinations primarily assess students' ability to recall and comprehend information rather than their critical thinking and creativity. Independent sample *t*-tests further show no significant differences in LOTS and HOTS distribution between public and private universities, suggesting a systemic issue prioritizing LOTS.

Results of analysis of variance (ANOVA): Lower-order thinking skills (LOTS)

The data in Table 6 and Chart 3 illustrate that students across all academic levels consistently demonstrate high lower-order thinking skills (LOTS), with first-year students achieving the highest mean score of 89.70%. The second-year, third-year, and fourth-year students have slightly lower mean scores, ranging from 87.48% to 88.50%. The overall mean LOTS score is 88.48%. While most students perform well, there is noticeable variability in the scores, with the minimum score across all levels being 48.08% and the maximum score being 100%, indicating some differences in performance within each academic year. Chart 3 visually confirms a consistent emphasis on LOTS across the four academic levels, with little variation between them.

Table 6: Descriptive statistics for LOTS by academic levels

Lower-order thinking skills (LOTS) (%)				
Academic levels	Mean	Standard deviation	Minimum	Maximum
First Year	89.70	7.68	65.00	100.00
Second Year	87.48	9.46	50.00	100.00
Third Year	88.50	11.52	50.00	100.00
Fourth Year	88.03	11.31	48.08	100.00
Total	88.48	10.11	48.08	100.00

Chart 3: Mean of LOTS by academic levels
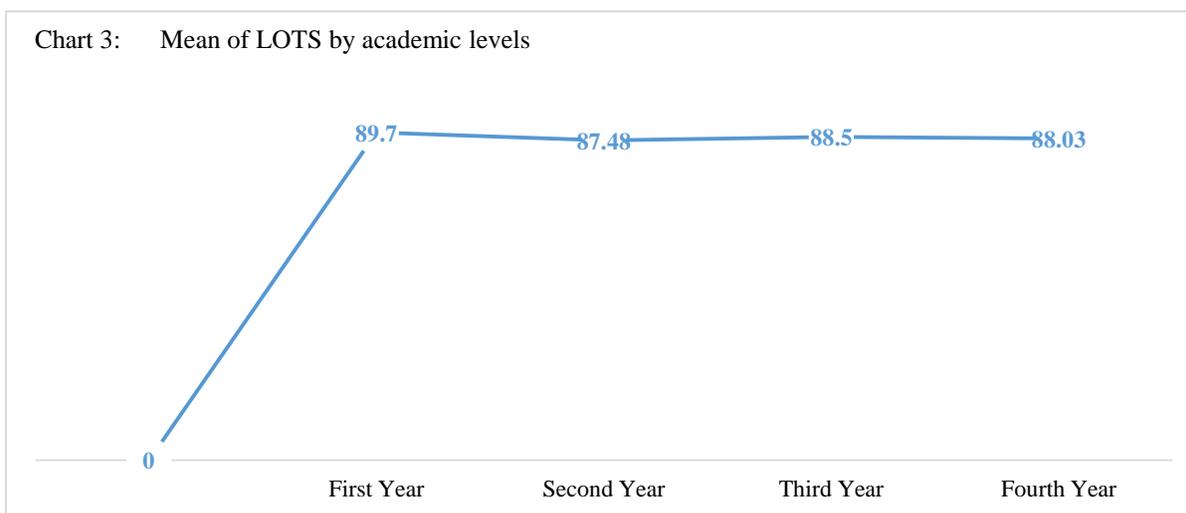
Table 7 presents ANOVA results for LOTS percentages across four academic levels. The *F*-value (0.675) indicates no statistically significant difference in mean LOTS scores across first- to fourth-year academic levels ($p > 0.05$). The results failed to reject H_{03}. With an eta squared (η^2) of 0.007, the effect size is minimal, suggesting that only 0.7% of LOTS variance is explained by academic level differences, indicating a consistent distribution of LOTS marks across both public and private universities.

Table 7: ANOVA estimation: Differences in marks distribution for LOTS across academic levels

	Sum of squares	df	Mean square	F	Sig.	Effect size (η^2)
Between Groups	207.34	3	69.11	0.67	0.56	0.007
Within Groups	31247.55	305	102.45			
Total	31454.90	308				

Note: df = Degrees of freedom, F = *F*-statistics, Sig. = Significance

Table 8 shows the results of the Tukey HSD test for multiple comparisons of lower-order thinking skills (LOTS) across academic levels in undergraduate business exams at private and public universities in Bangladesh. All *p*-values exceed 0.05, indicating no statistically significant differences. Mean differences are minimal, and all 95% confidence intervals include zero, further supporting that these differences are not statistically significant. These findings suggest that LOTS scores do not significantly vary across academic levels, with similar levels of lower-order thinking skills observed across the years.

Table 8: Tukey HSD test estimation: Multiple comparisons of LOTS across academic levels

Dependent variable: lower-order thinking skills – LOTS (%)					
Academic levels (I)	**Academic levels (J)**	**Mean difference (I-J)**	**p**	**95% confidence interval**	
				Lower bound	**Upper bound**
First Year	Second Year	2.22	.55	-2.13	6.58
	Third Year	1.19	.88	-3.00	5.39
	Fourth Year	1.67	.69	-2.28	5.64
Second Year	First Year	-2.22	.55	-6.58	2.13
	Third Year	-1.02	.93	-5.53	3.48
	Fourth Year	-0.54	.98	-4.84	3.74
Third Year	First Year	-1.19	.88	-5.39	3.00
	Second Year	1.02	.93	-3.48	5.53
	Fourth Year	0.47	.99	-3.65	4.61
Fourth Year	First Year	-1.67	.69	-5.64	2.28
	Second Year	0.54	.98	-3.74	4.84
	Third Year	-0.47	.99	-4.61	3.65

Results of analysis of variance (ANOVA): Higher-order thinking skills (HOTS)

Table 9 and Chart 4 present the descriptive statistics for higher-order thinking skills (HOTS) across different academic levels. The mean HOTS scores range from 10.30% in the first year to 11.68% in the fourth year, with the total mean across all levels being 11.25%. Scores for all academic levels show a wide range, from 0% to 35%, indicating significant variability in students' higher-order thinking skills. While there is a slight increase in the mean scores as students' progress through the years, the overall focus on HOTS remains relatively low across all academic levels. Chart 4 also confirms the results.

Table 9: Descriptive statistics for HOTS by academic levels

Higher-order thinking skills – HOTS (%)				
Academic levels	**Mean**	**Standard deviation**	**Minimum**	**Maximum**
First Year	10.30	7.68	.00	35.00
Second Year	12.24	8.54	.00	35.00
Third Year	10.96	10.06	.00	35.00
Fourth Year	11.68	10.55	.00	35.00
Total	11.25	9.31	.00	35.00

Chart 4:   Mean of HOTS by academic levels
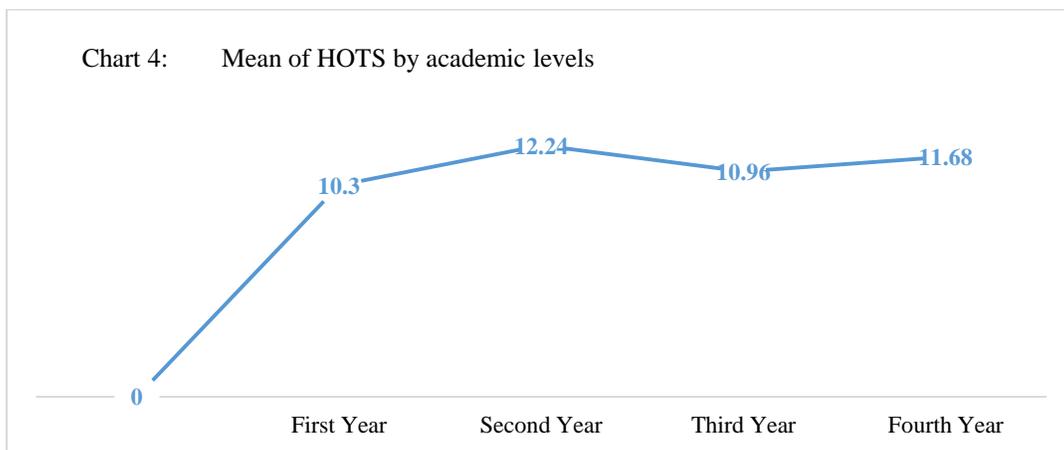
Table 10 presents the ANOVA results showing no significant differences ($p > 0.05$) in mean HOTS scores among academic levels in undergraduate business examination papers from public and private universities in Bangladesh. This result failed to reject H_{04}. The between-group sum of squares is 160.85, indicating variation due to academic level differences, while the within-group sum is 26,519.68. The *F*-statistic is 0.61, indicating small variance between group means. The effect size ($\eta^2 = 0.006$) is minimal, indicating that only 0.6% of the variance in HOTS marks is attributable to academic level differences, suggesting little to no practical impact on HOTS scores.

Table 10: ANOVA estimation: Differences in marks distribution for HOTS across academic levels

	Sum of squares	**df**	**Mean square**	**F**	**Sig.**	**Effect size (η^2)**
Between Groups	160.85	3	53.61	.61	.60	0.006
Within Groups	26519.68	305	86.95			
Total	26680.54	308				

Note: df = Degrees of freedom, F = *F*-statistics, Sig. = Significance

In Table 11, the Tukey HSD results show small mean differences in HOTS scores between academic levels. All *p*-values exceed 0.05, indicating no statistically significant mean differences. The 95% confidence intervals for mean differences are zero, confirming no significant differences across academic levels. Overall, the analysis suggests that HOTS scores do not significantly differ between the academic levels, indicating a relatively consistent level of higher-order thinking skills across the years.

Table 11: Tukey HSD test estimation: Multiple comparisons of HOTS across academic levels

Dependent variable: Higher-order thinking skills – HOTS (%)					
Academic levels (I)	Academic levels (J)	Mean difference (I-J)	p	95% confidence interval	
				Lower bound	Upper bound
First Year	Second Year	-1.94	.59	-5.96	2.06
	Third Year	-0.66	.97	-4.53	3.20
	Fourth Year	-1.38	.76	-5.03	2.27
Second Year	First Year	1.94	.59	-2.06	5.96
	Third Year	1.27	.85	-2.87	5.43
	Fourth Year	0.56	.98	-3.39	4.51
Third Year	First Year	0.66	.97	-3.20	4.53
	Second Year	-1.27	.85	-5.43	2.87
	Fourth Year	-0.71	.96	-4.52	3.09
Fourth Year	First Year	1.38	.76	-2.27	5.03
	Second Year	-0.56	.98	-4.51	3.39
	Third Year	0.71	.96	-3.09	4.52

ANOVA results reveal no substantial differences in LOTS or HOTS marks across academic levels. This indicates a constant trend of HOTS being neglected throughout the undergraduate business programs. The Tukey HSD test results further reveal that there are statistically lower mean LOTS and HOTS scores across academic levels. The constantly low levels of HOTS usage, however, concern about how adequate the educational experience is in helping out the students to tackle real-life business challenges.

It is true that some variability in HOTS scores exists, but these differences are too small to attain statistical significance. Higher educational levels are usually associated with more emphasis on HOTS because of the complexity of content dealt with in courses; however, this is not the case within Bangladeshi universities. The fact that students place minimal significance on skills such as 'Analyzing' indicates unpreparedness among students with the capacity to decompose complicated issues

or data deep, which is important in market or strategic analysis. In addition, they do not put enough emphasis on skills such as 'Evaluating' and 'Creating' that are important when making decisions and fostering innovation, respectively. This deficiency in HOTS indicates an educational environment focused on rote learning rather than critical and creative thinking.

The low level of HOTS marks reflects smart curricular work that hardly develops and evaluates adequately critical or problem-solving abilities. It implies that the students may not receive sufficient challenges to develop these important skills, which limit their capability to address real business problems. The outcomes conform to Hossain and Hossain (2014), who observed similar trends of drawbacks in graduates' analytical and evaluating capabilities, and with the findings of Bhuiyan and Rommo (2024), who indicated that significant problem-solving skills have been lacking amongst recent graduates.

According to AACSB International (2022), quality education is not only seen in the ability to pass information but is also defined by critical thinking, problem-solving, creativity, and ethical reasoning. However, the results suggest that undergraduate business education in Bangladeshi universities predominantly focuses on knowledge transmission and technical skills with little concern for higher-order thinking skills.

Overall, undergraduate business education in Bangladeshi universities is more focused on the LOTS, such as recall value of information or comprehension and application, while HOTS, like analysis, evaluation, and creation ability of knowledge, remain underutilized. The findings indicate a significant gap in preparing students for the dynamic business environment. Students do not receive inadequate teaching on how to analyze business problems and come up with new business concepts, which makes them unprepared to face the challenges of the 4.0 Industrial Revolution.

Robustness and sensitivity analyses

The study found similar mean cognitive domain levels, thinking skills, and independent sample *t*-test results using the systematic down sampling method. Reducing the sample size of public universities' questions to match private universities' did not impact the main findings, indicating that the original larger sample from public universities did not introduce significant sampling bias. The reduced sample still captured overall data patterns, indicating that differences in sample size did not influence the results.

The bootstrapping method, which involves re-sampling with replacement, also yielded results similar to the main results, indicating stable statistics across multiple datasets. This robustness ensures the observed results are not sensitive to specific sample compositions, enhancing the reliability of the findings.

The combination of findings obtained after down sampling and bootstrapping methods also shows consistency and reliability of these findings and stable distributions in LOTS and HOTS between public and private universities.

Implications

This study impacts business education in Bangladesh and other developing nations. Critical thinking, problem-solving, and creativity should be HOTS objectives in courses due to the LOTS-HOTS imbalance. HOTS-orientated courses, different views, and active learning methods like case studies and simulations may help students adjust to workplace changes.

Authentic evaluations like firm reports and presentations increase HOTS measurement, and faculty development programmes can reinforce these goals through active learning. Continuous curriculum review with alumni and corporate partners meets industry needs. This HOTS-centred strategy prepares students for challenging business jobs by encouraging creativity, entrepreneurship, and sustainable economic growth. Bangladesh competes globally, attracts investment, and grows economically with talented analytical and creative graduates.

Limitations

Although imperfect, this study reveals Bangladeshi university undergraduate business education and HOTS integration. Sample size was 309 question papers from 10 universities, limiting general is ability. Future research should include varied universities. Second, the study did not distinguish between basic and advanced courses, making LOTS and HOTS distribution patterns unclear. Tests may obscure other curriculum design and teaching strategies that affect HOTS growth. Student learning research should include more aspects. Studying data from one academic year limits trend finding; longitudinal research is advised. Finally, the study did not analyse why LOTS was emphasised over HOTS, suggesting qualitative research with education stakeholders through interviews or focus groups is needed.

Conclusions

The quality of undergraduate business education shapes future business professionals' talents. This study examined Bangladeshi public and private universities' undergraduate business education and HOTS development. Exam question papers focused heavily on LOTS and less on HOTS such analytical, evaluative, problem-solving, decision-making, and creativity. This imbalance between LOTS and HOTS suggests that Bangladeshi undergraduate business education focusses on memorisation and comprehension, lacking critical analysis and evaluation skills for the dynamic business world. Universities are failing to educate students business data analysis, motives, and persuasive writing. In addition, innovative problem-solving and innovation are not encouraged, leaving students unprepared for the 4.0 Industrial Revolution.

Recommendations

To improve undergraduate business education in Bangladesh, the Bangladesh Accreditation Council (BAC) should incorporate HOTS and LOTS including critical thinking, analytical reasoning, problem-solving, and creativity and constantly evaluate and adjust these criteria to meet corporate needs. Current assessments favour LOTS and propose activities that challenge students' higher-order cognitive processes. BAC must mandate faculty professional development. BAC must involve industry experts, alumni, and employers in HOTS accreditation standard development and evaluation. The studies also encourage curriculum relevance policy stakeholder input from industry experts and alumni. Critical thinking, problem-solving, and creativity are stressed in the curriculum to prepare graduates for the 4.0 Industrial Revolution and a fast-changing workplace.

Acknowledgments

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Status of the Culmination of Program Outcomes Considering Complex Engineering Problems in Outcome-Based Education: A Study on Selected Public and Private Universities, Bangladesh

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Abstract

The Outcome-Based Education (OBE) system is a comprehensive approach that integrates Program Educational Objectives (PEOs), Program Outcomes (POs), Course Outcomes (COs), and Continuous Quality Improvement (CQI), absent in conventional education. It ensures higher education institutions provide quality services meeting stakeholder expectations. The Bangladesh Accreditation Council (BAC), in alignment with the Bangladesh National Qualification Framework (BNQF) mandated OBE implementation in 2020. The University Grants Commission (UGC) of Bangladesh directed universities to revise curricula, teaching, and assessment to comply with OBE, emphasizing skills such as complex problem-solving, a key BNQF component. The Board of Accreditation for Engineering and Technical Education (BAETE) requires 12 POs, including 7 Complex Engineering Problems (WP), 8 Knowledge Profiles (WK) and 5 Complex Engineering Activities (EA). Prominent universities have worked with BAETE over the past six years to adopt OBE, improving their evaluation processes for POs, COs, and PEOs. This includes addressing CEPs and incorporating a CQI cycle. This study explores faculty members' understanding of PO attainment related to CEPs in OBE systems. A survey of 312 engineering educators from six public and six private universities was conducted. Quantitative analysis using multiple linear regression and correlation-based feature selection revealed that CEPs are more frequently addressed in assignments or projects than in exams. Complex engineering activities were integrated into Final Year Design Projects (FYDP), Capstone Projects, and laboratory courses. The findings offer valuable insights into faculty perspectives on PO culmination considering CEP attributes and OBE practices, suggesting improvements for teaching and learning activities, designing of course-curriculum and assessment methods. This study proposes a PO culmination framework considering CEP, where Performance Indicators (PIs) are extracted from each PO for effective culmination. This research can be extended to other universities to assess their preparedness in implementing CEP in the OBE system.

Keywords: Program Outcomes; Complex Engineering Problems; Continuous Quality Improvement; Linear Regression; Machine Learning

Introduction

Instead of focussing on the teacher as in a traditional teaching and learning system, the implementation of Outcome Based Education (OBE) has been focussing on the creation and advancement of a student-centric learning environment. According to Milon, et al. (2024), OBE is a worldwide revolution in teaching and learning methods that attempts to increase the ability of students, industries and other stakeholders to actively engage in the acquisition of knowledge, skills, and attitudes that will enable them to meet the challenges of the twenty-first century, 4IR, and Sustainable Development Goals.

Outcome-Based Education (OBE) in Bangladesh originated in the early 2000s, when the country recognised the need for a transformative change in its higher education system. The report offers policy recommendations to enhance the national framework and execution of OBE in Bangladesh's tertiary education system, based on a thorough examination of the data (Saha & Reza, 2023). The relevant policy framework has motivated higher education institutions in Bangladesh to initiate a revolutionary shift towards the implementation of Outcomes-Based Education (OBE) as a guiding principle. The OBE method is predicated on performance, focussing specifically on Course Outcomes (CO), Program Outcomes (PO), and Program Educational Objectives (PEO), which are assessed according to the learning outcomes attained. The OBE framework encompasses both direct and indirect assessments of learning outcomes, pedagogical strategies, evaluation methods, methodologies, instruments, stakeholder feedback, student engagement, and Continuous Quality Improvement (CQI) processes.

The twelve Graduate Attributes (GA) for engineering programs, as delineated by the Washington Accord under the International Engineering Alliance (Paul, et al., 2015), are essential for fostering student participation in the educational process. These traits are integrated into 12 Program Outcomes (PO) that address seven Complex Engineering Problems (WP), five Complex Engineering Activities (EA), and eight Knowledge Profiles (WK). BAETE in Bangladesh mandates that engineering programs at both public and private universities integrate these features. Complex engineering problems are characterised by the requirement for comprehensive analysis, substantial expertise, awareness of specific challenges, applicability outside conventional codes, engagement of multiple stakeholders, and significant interconnection. The specifications are contradictory. The curriculum must align with these criteria, ensuring it is thorough and suitable for the engineering discipline. All WP, EA, and WK qualities must be incorporated into the OBE-based curriculum. Engineering schools can address CEP through assignments or projects, including final year design projects, integrated design projects, laboratory courses, and theoretical courses, as opposed to conventional examinations. It is essential to shift the viewpoint of faculty and administration to properly deploy OBE by providing extensive assistance and a thorough comprehension of its learning outcomes. This enables the selection of suitable teaching techniques, assessment instruments, and rubrics that match with the program outcomes, taking into account

WP, EA, and WK. The engineering programs at public and private institutions in Bangladesh today face a deficiency in visual representation about the applications, experiences, strengths, limitations, problems, and areas for enhancement related to the implementation of CEP and OBE. Therefore, additional inquiry is required (Syeed et al., 2022). Furthermore, an assessment of students' learning outcomes utilising fuzzy logic in the context of Outcome-Based Education has been established (Aziz & Hashem, 2022). Nonetheless, an assessment based on machine learning is essential for obtaining sharper insights. This study sent a survey to non-accredited engineering programs at six public and six private universities to address this issue. This study garnered extensive insights into the OBE system in public and private universities through the application of data analytics and machine learning for data analysis. This inquiry subsequently employed the explainable AI tools Shapash and Eli5 to validate the machine learning model's results.

OBE shows students' skills, knowledge, and mindset at graduation, according to William Spady (Spady, 1994). Besides the main components of OBE, PO, CO, PEO, and CQI, the World Economic Forum (The 10 skills you need to thrive in the Fourth Industrial Revolution, 2024) found that complex engineering problem solving is the most important skill and expertise for the 4IR and beyond. The IEA program outcomes (PO) (Graduate Attributes and Professional Competencies, 2013) and the BAETE, Bangladesh, Institution of Engineers, Bangladesh (IEB) accreditation standard (BAETE Accreditation Manual for undergraduate programs, 2022) highlighted solving complex engineering problems. BAETE mandates accredited engineering degree programs to educate graduates for future technological and social changes and to learn new skills, techniques, and technologies. Engineering students frequently face classroom-based difficulties rather than industry-specific ones (Jonassen et al., 2006). Complex engineering difficulties arise in design-based projects (Johri & Olds, 2011). These projects rarely include industrial environmental issues, and engineering teachers sometimes fail to create hard engineering problems to assess students' skill mastery (Liew et al., 2020).

To provide top-notch education and accredit university programs in Bangladesh, the Bangladesh Accreditation Council (BAC) was founded in 2017 (Bangladesh Accreditation Council Act 9, 2017). The Bangladesh National Qualifications Framework (BNQF), an internationally benchmarked tool, is used by BAC to support the development, enhancement, and recognition of students' and graduates' abilities, knowledge, and attitudes. In order to encompass all post-higher secondary degrees in Bangladesh, the BNQF lays out a streamlined, simplified, and integrated outcome-based education system. To facilitate ongoing development in the areas of cognitive, professional and personal skills, attitude, and lifelong learning, the structure includes a variety of learning domains (Bangladesh National Qualification Framework: Part B, 2021). As a result, students are required to develop their critical thinking skills, leadership role and responsibility, inventive and creative qualities, and entrepreneurial capability in order to meet future difficulties (Hassan, 2012). Higher education institutions set up Institutional Quality Assurance Cells (Sawant, 2016) in order to

implement the OBE system in accordance with UGC requirements. These cells ensure that the curriculum is standardised, that challenging engineering challenges are applied to ensure effective teaching, learning, and assessment strategies, that sufficient resources, facilities, faculty development, and research opportunities are provided, that the institutional infrastructure is sustainable, and more.

Evaluation of the Culmination of Program Outcomes at the level of Solving Complex Engineering Problems for Outcome-Based Education in Engineering Programs in Public and Private Universities of Bangladesh was the project's main goal. The specific goals were to identify the engineering programs in OBE application across Bangladeshi universities that use CEP for POs attributes, create appropriate PO attainment frameworks that address CEP attributes of the engineering programs, look into the challenges of incorporating CEP of the engineering programs into POs assessment, and, finally, identify strategies to overcome the obstacles to OBE implementation while taking complex problem solving into account in program outcomes assessment.

Methodology

Study Area and Source of Data

Data for the investigation came from the OBE-based non-accredited engineering programs at six public and six private universities in Bangladesh. Dhaka City had eight universities, Khulna City had two, Rajshahi City had one, and Chittagong City had one chosen. The selection of universities was based on their reputation, degree of accreditation, and openness to sharing information. Table 1 lists the names of a few public and private colleges' non-accredited engineering programs. The BAETE database was taken into consideration and used to identify the data.

Table 1: Selected Public Universities and Private Universities.

Public Universities	Accredited Programs	Private Universities	Accredited Programs
Dhaka University (DU)	None	American International University Bangladesh	EEE
Jagannath University (JNU)	None	BRAC University	EEE
Chittagong University of Engineering and Technology (CUET)	None	University of Liberal Arts Bangladesh	EEE
Khulna University of Engineering and Technology (KUET)	CE, ME, EEE	Southeast University	None
Khulna University	None	University of Asia Pacific	CE
Rajshahi University of Engineering and Technology (RUET)	None	Green University of Bangladesh	None

Nature of the study

The study was exploratory. There is no theory to compare the actual situation because the research is very new in Bangladesh. As part of its exploratory examination, the study focused on primary and secondary data.

Intended population and sampling

The attention on non-accredited engineering programs at particular universities was brought forth by faculty members' misunderstandings and concerns regarding PO culmination in light of CEP. The only people chosen to collect data were the engineering faculty. 720 people was the target population size. Purposively, the study's willing participants were faculty members from a few colleges' non-accredited engineering departments. There are 312 people in the sample.

Data collection Technique

The semi-structured survey comprises two primary sections to collect extensive data. Section A addresses respondents' demographic information, whereas Section B evaluates faculty comprehension of diverse elements pertaining to engineering programs, encompassing learning domains, the implementation of Outcome-Based Education (OBE), the OBE practice framework, and the integration of Program Outcomes (PO) in the context of solving Complex Engineering Problems (CEP). It also analyses the Continuous Quality Improvement (CQI) process and pedagogical assessment methodologies. Participants assess items utilising a 5-point Likert scale, with 1 denoting "Strongly Disagree" and 5 indicating "Strongly Agree." This systematic method facilitates detailed understanding of faculty perceptions. Furthermore, pertinent material including program syllabi, curriculum, and self-assessment reports is examined for manual interpretation and comparison. A comprehensive literature analysis substantiates the appropriate conclusion of Program Outcomes at the Course Evaluation Process level to guarantee effective Outcomes-Based Education implementation. The courses are aligned with Outcome-Based Education (OBE) concepts by consulting the guidelines and frameworks of the Bangladesh Accreditation Council (BAC), Bangladesh National Qualifications Framework (BNQF), and the University Grants Commission (UGC). Additionally, the BAETE database is employed to evaluate the reputation and accreditation status of engineering schools at designated universities. The dataset comprises 312 cases, offering a thorough insight.

Data Analysis and Processing

Figure 1 demonstrates that frequency tables were employed to analyse the status of engineering programs at Bangladeshi universities. To identify and evaluate pertinent information concerning diverse OBE implementation strategies, guidelines, and frameworks, as well as PO culminating procedures considering CEP in engineering programs, multiple linear regression was employed for predictive analysis. Correlation-based Feature Selection (CFS) was employed to discover and

analyse potential indicators of obstacles in implementing Outcome-Based Education (OBE) and achieving Program Outcomes (POs) in connection to the Curriculum Enhancement Plan (CEP). Shapash Explainable AI (XAI) was utilised to elucidate the model's outcomes. Neutral, disagree, and strongly disagree responses may signify a deficiency in perception, confusion, and comprehension of OBE, PO, and CEP principles and practices, which could hinder successful implementation; thus, CFS was utilised in conjunction with XAI.
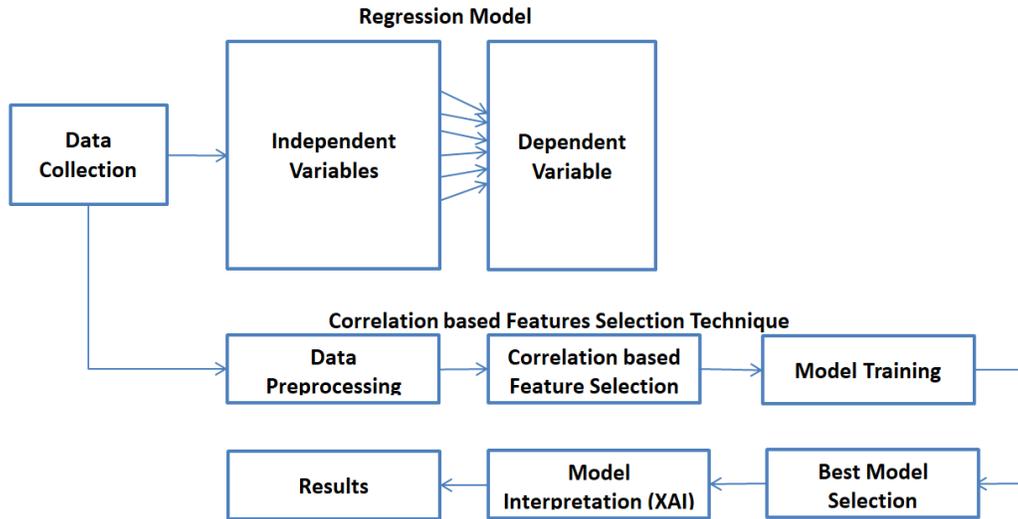
Figure 1: Conceptual Framework

Descriptive Analytics, Reliability, Validity, Data Screening and Multicollinearity analysis

Prior to executing statistical analysis, data screening entails the cleansing and sanitisation of data. The objective was to assess the dependability, utility, and correctness of various data sources. The term "reliability" denotes the accuracy of an instrument's measurements, yielding consistent and error-free results. This study analyses Cronbach's Alpha Composite Reliability. Validity verifies the precision of measuring scales and signifies the concept's engagement.

Data Pre-processing Technique

The essential technique is conducted during the data preprocessing phase to guarantee data quality and readiness for analysis. Label Encoding, as delineated by equation (1), systematically transforms categorical qualities into numerical representations.

$$f(m_i) = n_i \tag{1}$$

Where f = encoding function, m_i = category, n_i = associated numerical identifier.

Machine Learning Models

Ridge Classifier (RC)

A form of logistic regression that incorporates L2 regularisation to reduce overfitting. It mitigates coefficient influence by imposing penalties on big values, hence enhancing model stability, particularly in the presence of multicollinearity or multiple features.

Logistic Regression (LR)

A binary classification model utilising the logistic (sigmoid) function to predict class membership. It assigns coefficients to attributes, generating a probability that is subjected to thresholding for classification purposes.

Stochastic Gradient Descent (SGD)

An optimisation technique that incrementally modifies model parameters to minimise the loss function, use updates derived from the negative gradient.

Categorical Boosting (Cat)

An optimisation technique that incrementally modifies model parameters to minimise the loss function, use updates derived from the negative gradient.

Adaptive Boosting (ADB)

A method of ensemble learning that integrates weak learners to create a robust classifier. The ADB modifies weights to enhance predictions, producing a weighted sum for increased accuracy.

Extreme Gradient Boosting (XGB)

A gradient boosting variation that improves performance through regularisation (L1 and L2) and an approach for handling missing values. XGB builds sequential trees to minimise errors, employing parallel processing for efficiency.

Random Forest (RF)

An ensemble technique that enhances predictive accuracy through the aggregation of numerous decision trees. It randomly selects attributes and samples, then aggregating predictions, usually employing majority vote for classification.

Explainable Artificial Intelligence

Shapash

Python package Shapash improves machine learning model interpretation. Users may visualize, interpret, and explain model performance using Shapley values, permutation feature significance, and partial dependency plots.

Feature Selection

Co-relation based Feature Selection (CFS)

The CFS will decide which feature is the best in accordance with the relationships between a feature and its paired features and between a feature and its assigned

category. The equation for identifying out which attribute is most correlated is shown in equation (2):

$$\beta_{kc} = \frac{g(\overline{\beta_{kl}})}{\sqrt{g + g(g-1)\,\overline{\overline{\beta_{ll}}}}} \tag{2}$$

Evaluation Metrics

Precision: Precision is defined as the proportion of correctly predicted positive observations to the total number of predicted positives. It assesses the degree of accuracy of the optimistic projections. Precision is calculated by equation (3):

$$Precision = \frac{\sum_{k=1}^{k}(TP)}{\sum_{k=1}^{k}(TP + FP)} \tag{3}$$

Recall: Recall is the proportion of all the observations taken during the actual class to the precisely predicted positive observations. It evaluates the capacity of the model to incorporate every pertinent cases. Recall is given by equation (4):

$$Recall = \frac{\sum_{k=1}^{k}(TP)}{\sum_{k=1}^{k}(TP + FN)} \tag{4}$$

F1-Score: The harmonic mean of Precision and Recall is known as the F1-Score. It provides a solitary metric that achieves equilibrium between accuracy and retention. F1-Score is depicted below in equation (5),

$$F1 - score = 2 * \frac{Precision.\,Recall}{Precision + Recall} \tag{5}$$

Accuracy: The proportion of accurately predicted observations to the total number of observations. It is the most often used and intuitive performance metric. Equation (6) illustrates how it is generated,

$$Accuracy = \frac{\sum_{k=1}^{k}(TP + TN)}{\sum_{k=1}^{k}(TP + TN + FP + FN)} \tag{6}$$

Results and Discussion

Status of the Implementation of OBE System and PO Culmination considering CEP in Engineering Programs across Bangladeshi Universities: Table 2 presents the aggregate number of public, private, and international universities in Bangladesh based on data obtained from the UGC, while Table 3 illustrates the universities in Bangladesh that have sought BAETE accreditation for their engineering programs.

Table 2: Universities in Bangladesh

Public University	Private University	International University	Total University
55	114	3	172

Table 3: Universities in Bangladesh have been applied for BAETE accreditation for their engineering program.

Public University	Private University	International University	Total University
8	21	1	30

During the consultation of BAETE and its database and published material, it has been found that only 30 universities have applied for accreditation for their engineering programs, which is 17.44% of total universities shown in Figure 2(a).

Among the 55 public universities, merely 8 have pursued BAETE certification for their engineering programs, constituting 14.55% of the total. The result is depicted in Figure 2(b). Out of 114 private institutions, merely 21 have pursued BAETE certification for their engineering programs, accounting for 18.42% of the total. The result is depicted in Figure 3(a). In Figure 3(b), one of the three international universities has pursued BAETE certification for its engineering curriculum, accounting for 33.33% of the total.
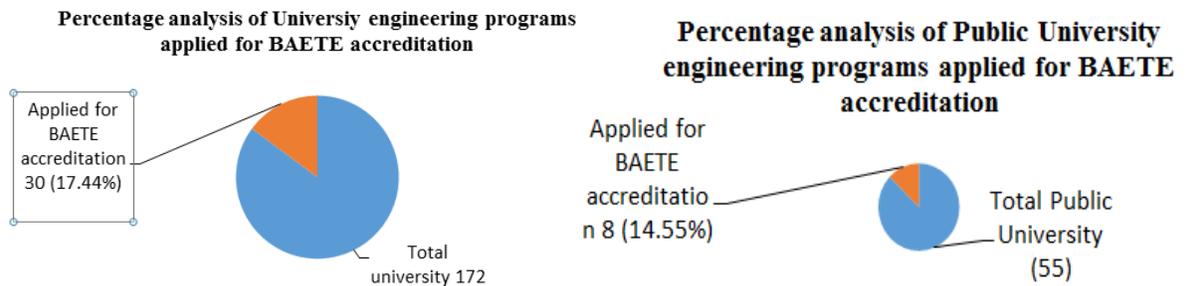
Figure 2: (a) Percentage analysis of university engineering programs applied for BAETE accreditation (b) Percentage analysis of Public University engineering programs applied for BAETE accreditation.
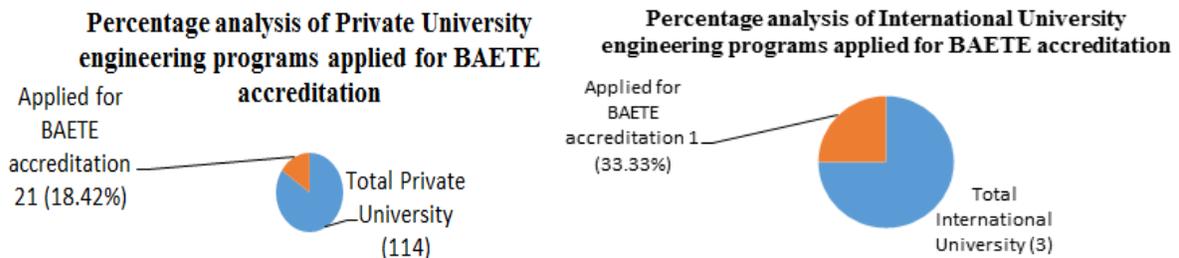
Figure 3: (a)Percentage analysis of Private University engineering programs applied for BAETE accreditation, (b) Percentage analysis of International University engineering programs applied for BAETE accreditation.

The OBE Framework for Attaining Program Outcomes Aligned with Solving Complex Engineering Problems Attributes

The formulation of effective Program Outcomes (PO) for engineering programs, in alignment with CEP attributes, involves identifying essential characteristics such as technical expertise, problem-solving abilities, ethical standards, communication skills, collaboration, lifelong learning, and social consciousness. This guarantees that these properties are aligned with specific POs and associated Performance Indicators (PIs), thereby ensuring thorough coverage. Technical proficiency may pertain to the use of essential engineering knowledge, whereas communication skills may correspond to the successful dissemination of information to diverse audiences. To measure these POs, both direct approaches (examinations, projects, apprenticeships) and indirect methods (surveys, peer evaluations) may be employed. To align educational objectives with industry standards and social needs, explicit performance criteria and targets are developed, such as a designated percentage of pupils achieving a particular score, to evaluate success.

It was suggested that an OBE framework, illustrated in Figure 6, that maps POs and their accompanying PIs to the properties of complex engineering problems (CEP). The proposed matrix would effectively match courses with the related Program Outcomes while evaluating through the Continuous Evaluation Process.

Figure 4 encapsulates the requirements of Program Outcomes (PO) related to Knowledge Profiles (WK), Complex Engineering Problems (WP), and Complex Engineering Activities (EA). When the POs are properly matched with CEP, the implementation guidelines are as follows:

This work has been proposed to delineate and analyse each program outcome (PO) into three to four observable and quantifiable performance indicators (PIs) to effectively evaluate the achievement level of students about POs, referred to as summative assessment, in consideration of CEP. The suggested method for quantifying the achievement of POs can be more accurate, unequivocal, and user-friendly for the evaluator. Principal Investigators may direct and ensure uniformity in assessment, communicate expectations to students, discern the strengths and weaknesses in student learning, and contribute to evidence-based decision-making and program enhancement. PIs can furnish faculty members with sufficient clarity for the strategic organisation of course delivery and evaluation techniques, resulting in significant achievement of POs. Rubrics must be constructed to evaluate the extent of achievement of course objectives (COs) using performance indicators (PIs) as assessment criteria. WPs must be incorporated in courses achieving PO(a) to PO(h). WP1 is mandatory, and a minimum of two from WP2 to WP7 must be incorporated. Educational Assistants are designated for courses pertaining to PO(j). At least two of EA1 through EA5 are mandatory.

Course Code: Name	COs	CO Statement	Program Outcomes (POs) and PO Components (Performance Indicators-PIs)												PO Culmination	Knowledge Profile (WK)		Complex problem solving (WP)		Complex activities (EA)	Teaching Strategies	Assessment Methods	
			PO(a)	PO(b)	PO(c)	PO(d)	PO(e)	PO(f)	PO(g)	PO(h)	PO(i)	PO(j)	PO(k)	PO(l)	Complex Engineering Problem / Engineering Activities (Yes or No)	K1 K2 K3 K4 K5 K6 K7 K8		P1 P2 P3 P4 P5 P6 P7		A1 A2 A3 A4 A5	Lecture, Lab Work, Presentation, Group Work, Discussion, Tutorial	Class Test, Midterm Exam, Final Examination	Assignment, Project (Rubrics)
			PI1(a) PI2(a) PI3(a)	PI1(b) PI2(b) PI3(b)	PI1(c) PI2(c) PI3(c)	PI1(d) PI2(d) PI3(d)	PI1(e) PI2(e) PI3(e)	PI1(f) PI2(f) PI3(f)	PI1(g) PI2(g) PI3(g)	PI1(h) PI2(h) PI3(h)	PI1(i) PI2(i) PI3(i)	PI1(j) PI2(j) PI3(j)	PI1(k) PI2(k) PI3(k)	PI1(l) PI2(l) PI3(l)									
CSE###	CO1	Statement of CO1	X												No	K3: X					Lecture, Discussion	Class Test, Midterm and Final Exams	
	CO2	Statement of CO2			PI3(c): X										No			P2: X			Lecture, Discussion	Class Test, Midterm and Final Exams	
	CO3	Statement of CO3			PI3(c): X										Yes			P2: X		A1 X A2 X A3 X	Lecture, Group Work, Presentation, Discussion	Final Exam	Project
	CO4	Statement of CO4					PI3(e): X								Yes			P5: X		A1 X A2 X A3 X	Lecture, Group Work, Presentation, Discussion		Project
	CO5	Statement of CO5											PI1(k): X		No			P2: X			Lecture, Group Work, Presentation, Discussion		Project

PO(a) to PO(h): [WP1] + ≥ 2 [WP2-WP7]; WP1: ≥ 1 [WK3-WK6, WK8]; PO(i): ≥ 2 [EA1-EA5];
PO(a), PO(b): [WK1-WK4], PO(c): [WK5], PO(d): [WK8], PO(e): [WK6], PO(f), PO(g), PO(h): [WK7]

Figure 4: Proposed Framework for program outcomes (POs) culmination considering CEP attributes

Data representation on variables required for effective OBE implementation, PO culmination considering CEP: Multiple Linear Regression Analysis

The IBM Software Package for Social Studies (SPSS) version 23.0 was utilised to evaluate the data gathered for regression analysis. Table 4 summarises the outcomes of a multiple linear regression model forecasting "Program Preparedness on PO conclusion considering CEP." Utilise the t-test and significance test to evaluate the null hypothesis that the corresponding coefficient (B) is equal to zero. A low p-value (often below 0.05) signifies that the association between the independent variable and the dependent variable is statistically significant. The table indicates that "OBE practicing guidelines," "PO Framework," "PO-CEP using lab," "PO-CEP using FYDP," "Collaboration with industry," "Admin supports," "Courses assessment methods," "Seminar, workshop," "Industry collaboration," and "CQI process" exhibit statistically significant correlations with "Program preparedness for PO culmination considering CEP in OBE."

Table 4: Sig and VIF values (Coefficients) of all independent variables

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	4.871	.603		8.075	.000		
	OBE_Practicing_Guideline	-.484	.119	-.168	-4.082	.000	.812	1.231
	CEP_Understanding	-.135	.100	-.051	-1.347	.179	.966	1.036
	PO_CEP_Culmination_Framework	-.407	.116	-.135	-3.495	.001	.920	1.086
	Curriculum_Design	-.191	.106	-.080	-1.799	.073	.689	1.452
	PO_CEP_Theory_Courses	-.048	.046	-.045	-1.048	.296	.752	1.330
	PO_CEP_Lab_Courses	.169	.061	.118	2.746	.006	.742	1.348
	PO_CEP_FYDP	-.517	.062	-.364	-8.282	.000	.713	1.403
	PO_CEP_Assessment_Methods	.172	.055	.127	3.128	.002	.833	1.201
	Facility_Resources	.140	.087	.072	1.602	.110	.686	1.457
	Seminar_Workshop	.535	.064	.325	8.346	.000	.906	1.104
	Industry_Collaboration	.727	.131	.222	5.535	.000	.853	1.172
	Admin_Support	-.298	.067	-.172	-4.424	.000	.905	1.105
	CQI_Process	-1.059	.151	-.277	-7.012	.000	.878	1.139

a. Dependent Variable: Program_Prepare_PO_CEP_Culmination

b. Predictors: (Constant), CQI_Process, CEP_Understanding, Facility_Resources, PO_CEP_Lab_Courses, PO_CEP_Culmination_Framework, Seminar_Workshop, Admin_Support, OBE_Practicing_Guideline, Industry_Collaboration, PO_CEP_Assessment_Methods, PO_CEP_Theory_Courses, PO_CEP_FYDP, Curriculum_Design

This Table 5 provides evidence that the regression model we described has a statistically significant effect on predicting "Program preparedness for PO, CEP in OBE" as the F Change (33.017>1) is high, and the Sig. value (0.000) is very low, indicating the model is statistically significant ($p < 0.05$).

Table 5: Sig., F Change value of all independent variables with model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.768ᵃ	.590	.572	1.02966	.590	33.017	13	298	.000

a. Dependent Variable: Program_Prepare_PO_CEP_Culmination

b. Predictors: (Constant), CQI_Process, CEP_Understanding, Facility_Resources, PO_CEP_Lab_Courses, PO_CEP_Culmination_Framework, Seminar_Workshop, Admin_Support, OBE_Practicing_Guideline, Industry_Collaboration, PO_CEP_Assessment_Methods, PO_CEP_Theory_Courses, PO_CEP_FYDP, Curriculum_Design

ANOVA Table 6 demonstrates that the regression model discussed has a statistically significant impact on forecasting "Program preparation for PO, CEP in OBE." The F-statistic (33.004>1) is elevated, and the significance value (0.000) is markedly low, signifying that the model is statistically significant ($p < 0.05$).

Table 6: Statistical significance through ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
	Regression	455.056	13	35.004	33.017	.000ᵇ
1	Residual	315.941	298	1.060		
	Total	770.997	311			

a. Dependent Variable: Program_Prepare_PO_CEP_Culmination

b. Predictors: (Constant), CQI_Process, CEP_Understanding, Facility_Resources, PO_CEP_Lab_Courses, PO_CEP_Culmination_Framework, Seminar_Workshop, Admin_Support, OBE_Practicing_Guideline, Industry_Collaboration, PO_CEP_Assessment_Methods, PO_CEP_Theory_Courses, PO_CEP_FYDP, Curriculum_Design

Challenges in Program Outcomes Culmination within the Context of Complex Engineering Program Attributes

Responses of "Neutral," "Disagree," and "Strongly Disagree" when evaluating Complex Engineering Program (CEP) Attributes may indicate difficulties in achieving CEP-related Program Outcomes (PO), thereby obstructing the success of Outcome-Based Education (OBE). Responses from faculty are gathered by a questionnaire, subjected to preprocessing via Label Encoding, and subsequently analysed using a correlation-based feature selection (CFS) method. Essential characteristics include training models such as Ridge Classifier, Logistic Regression, and Random Forest, with an analysis of the predictions from the highest-performing model conducted by SHAPASH XAI to discern the elements affecting PO evaluation in relation to CEP qualities.

Difficulties in CEP understanding

The "Neutral" (19.2%) and "Strongly Disagree" (5.2%) replies indicate difficulties in comprehending and executing Complex Engineering Problems (CEPs). Neutral comments may indicate doubt, whereas "Strongly Disagree" signifies substantial challenges, potentially arising from curricular deficiencies or pedagogical approaches. Machine learning algorithms discern critical variables impacting CEP understanding, with Shapash XAI elucidating crucial factors, thereby informing targeted tactics to mitigate these challenges.

Feature Selection Result

Our research discovered critical aspects that improve comprehension of Complex Engineering Problems (CEP). Table 7 indicates that "Thesis/Project Incorporating Industry Demand" (0.4617) is the most significant element, succeeded by "Curriculum Design" (0.3479) and "PO Culmination Framework with CEP Attributes" (0.2762). Furthermore, "Strategies to Overcome Challenges" (0.2597) and "CEP Practicing and CQI Process" (0.2551) underscore the significance of organised curriculum and ongoing quality enhancement.

Table 7: Correlation with CEP understanding

Feature	Co-relation Value
Thesis/Project Incorporating Industry demand	0.4617
Curriculum design	0.3479
PO Culmination framework with cep attributes	0.2762
Strategies to overcome the challenges	0.2597
CEP Practicing and CQI Process	0.2551
Admin difficulties while implementing CEP	0.2409
Challenges and weaknesses of POs culmination	0.2185
Thesis/Project Selection	0.2119
PO-CEP-FYDP	0.2095
Facilities Resources	0.1938
Common Classroom Problems	0.1373
programs preparedness	-0.0156
Well established CQI	-0.0502
Collaboration with industry, academia	-0.0650
Seminar, workshop	-0.0759
OBE Practicing guidelines	-0.1449
PO-CEP-Theory courses	-0.1454
Course Regular Session	-0.1681
PO-CEP-Lab Courses	-0.4633

Model Performance

Table 8 juxtaposes machine learning models for comprehending Complex Engineering Problems (CEP). XGBoost demonstrates an accuracy of 99.20%, precision of 99.90%, recall of 99.20%, and an F1-score of 99.5. Random Forest and CatBoost exhibit commendable performance, with accuracies of 98.38% and 98.06%, respectively. Logistic Regression and Stochastic Gradient Descent exhibit inferior and less equitable metrics. XGBoost demonstrates the highest reliability for precision and recall in CEP analysis.

Table 8: The Effectiveness of Various Machine Learning Models in the Understanding of CEP

Algorithm	Precision	Recall	F1-Score	Accuracy
RC	77.70%	80.14%	78.57%	80.93%
LR	74.01%	89.66%	78.87%	90.05%
SGD	72.31%	88.94%	77.03%	88.76%
RF	94.80%	96.13%	95.45%	98.38%
Cat	92.91%	96.69%	94.69%	98.06%
ADB	87.71%	91.66%	82.63%	93.32%
XGB	99.90%	99.20%	99.5	99.20%

Explainable AI result

In Figure 5(a), "CEP Practicing and CQI Process" is the predominant factor influencing neutral replies on CEP comprehension, highlighting practical components. Key characteristics encompass "Common Classroom Problems" and "Thesis/Project Selection," whilst "Curriculum Design," "PO-CEP-FYDP," and "Challenges in Implementation" hold moderate significance. The influence of "Facilities and Resources" is negligible, indicating that practical and curriculum elements shape neutral attitudes more significantly than logistical considerations. Figure 5(b) illustrates "Thesis/Project Incorporating Industry Demand" as the predominant component in "Strongly Disagree" replies, underscoring project evaluation challenges. The "PO-CEP-FYDP" and "PO Culmination Framework with CEP Attributes" likewise elicit apprehensions. "Common Classroom Problems" and "Challenges in POs Culmination" exert a moderate impact, whereas "Thesis/Project Selection," "Strategies to Overcome Challenges," and "Facilities and Resources" have a lesser effect.

Features Importance
Response: 1

	Mean absolute Contribution
20. CEP Practicing and C...ess	
14.Thesis/Project Selection	
16.Common Classroom Problems	
18.Thesis/Project Incorp...and	
5.Curriculumn design	
10.PO-CEP-FYDP	
6.Challenges and weaknes...ion	
4.PO Culmination framewo...tes	
13.Admin difficulties wh...CEP	
7.Strategies to overcome...ges	
11.facilities-resources	

Features Importance
Response: 3

	Mean absolute Contribution
18.Thesis/Project Incorp...and	
10.PO-CEP-FYDP	
4.PO Culmination framewo...tes	
6.Challenges and weaknes...ion	
16.Common Classroom Problems	
20. CEP Practicing and C...ess	
5.Curriculumn design	
11.facilities-resources	
13.Admin difficulties wh...CEP	
14.Thesis/Project Selection	
7.Strategies to overcome...ges	

Figure 5: (a) Feature Importance for Neutral Responses on CEP Understanding, (b) Feature Importance for 'Strongly Disagree' Responses on CEP Understanding

Obstacles in executing the PO-CEP completion through the FYDP and Capstone Project

The "Neutral," "Disagree," and "Strongly Disagree" responses indicate difficulties in reconciling Program Outcomes (PO) with the Continuous Evaluation Process (CEP) via Final Year Design Projects (FYDP). Neutral responses imply ambiguity, whereas disagreement signifies problems that may hinder effective execution. Faculty feedback informs the selection of features utilised in training machine learning models. Shapash XAI elucidates the results, emphasising determinants that affect forecasts and offering ideas to enhance the congruence between final year projects and program outcomes.

Feature Selection Result

Table 9 displays the relationships among elements influencing the effectiveness of Program Outcomes (PO), Continuous Evaluation Process (CEP), and Final Year Design Projects (FYDP). The most significant positive correlations are "Strategies to

overcome hurdles" (0.5450) and "Administrative issues in CEP" (0.5271), emphasising the necessity of curricular modifications and administrative assistance for aligning POs with FYDP. Additional significant elements are "Industry demand in thesis/projects" (0.4074) and "Facilities-Resources" (0.4109). Negative correlations, exemplified by "Curriculum Design" (-0.0054) and "PO-CEP-Theory courses" (-0.4108), signify opportunities for enhancement. Emphasising advantageous elements can improve coherence among POs, FYDP, and CEP.

Table 9: Correlation with PO-CEP-FYDP

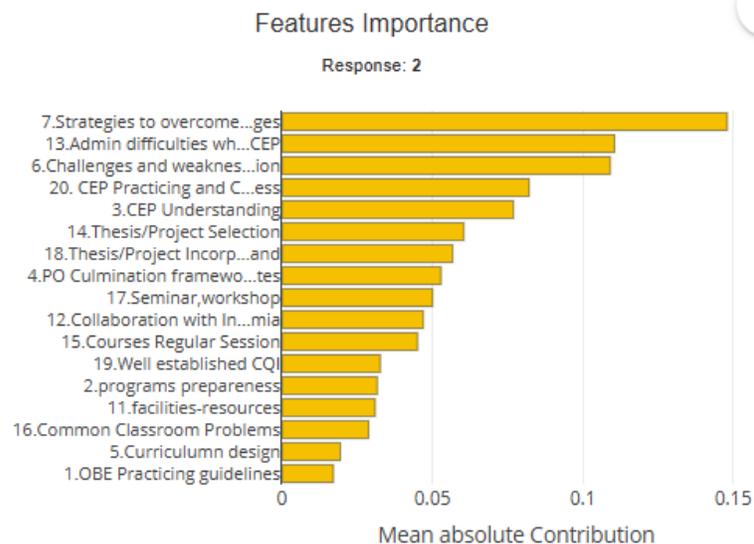| Feature	Co-relation Value
Strategies to overcome the challenges	0.5450
Admin difficulties while implementing CEP	0.5271
Facilities-Resources	0.4109
Thesis/project incorporating industry demand	0.4074
CEP practicing and CQI process	0.3662
Program preparedness	0.3608
Seminar, workshop	0.3529
Thesis project selection	0.2393
Well established CQI	0.2311
Strategies to overcome the challenges	0.2282
Challenges and weaknesses of POs culmination	0.2119
CEP Understanding	0.2095
OBE Practicing Guidelines	0.1786
Common classroom problems	01296
Course Regular Session	0.0509
PO Culmination framework with cep attribute	0.0395
Curriculum Design	-0.0054
PO-CEP-Lab Courses	-0.3807
PO-CEP-Theory courses	-0.4108

Model Performance

Table 10 compares machine learning models in predicting Program Outcomes (PO), Complex Engineering Problems (CEP), and Final Year Design Projects (FYDP). Random Forest (RF) leads with 99.80% accuracy, followed by XGBoost (XGB) at 99.30%.

Table 10: Performance of Different Machine Learning Model for PO-CEP-FYDP

Algorithm	Precision	Recall	F1-Score	Accuracy
RC	88.70%	88.70%	88.70%	88.70%
LR	74.01%	89.66%	78.87%	90.05%
SGD	72.31%	88.94%	77.03%	88.76%
RF	99.80%	99.80%	99.80%	99.80%
Cat	92.91%	96.69%	94.69%	98.06%
ADB	87.71%	91.66%	82.63%	93.32%
XGB	99.30%	99.30%	99.30	99.30%

Explainable AI Result

Figure 6(a) delineates the principal factors affecting faculty members' "Neutral" comments concerning Program Outcomes (PO), Continuous Evaluation Process (CEP), and Final Year Design Projects (FYDP). The fundamental component is "Strategies to overcome challenges," signifying ambiguity in resolving issues. Additional significant variables are administrative challenges and perceived deficiencies in PO completion. Figure 6(b) illustrates the criteria contributing to "Disagree" comments about the program's exhibition of PO culmination via CEP features. The principal issue is "CEP Understanding," which indicates clarity deficiencies in Complex Engineering Problems (CEP), as well as shortcomings in the integration of CEP into Project Objectives (POs) and the alignment of projects with industry requirements. Figure 6(c) delineates factors influencing "Strongly Disagree" comments about PO integration with CEP qualities in projects. Principal concerns encompass deficiencies in the "PO Culmination framework," obstacles in POs, and administrative challenges. The necessity for enhanced techniques and apprehensions regarding program readiness indicate scepticism about the program's capacity to prepare students for real-world issues associated with CEP.

Features Importance

Response: 2

Features Importance

Response: 1

Mean absolute Contribution

Features Importance

Response: 4

Mean absolute Contribution
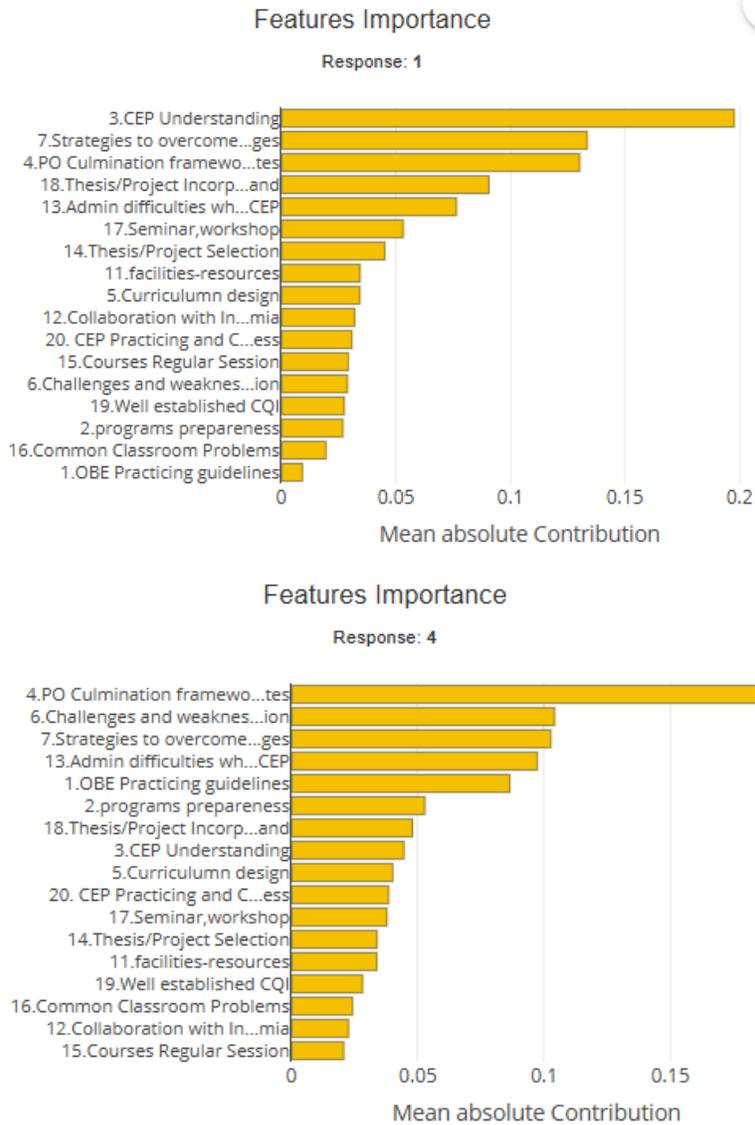
Figure 6: (a) Feature Importance Contributing to Neutral Faculty Responses on PO-CEP-FYDP Implementation, (b) Feature Importance Contributing to Disagree Faculty Responses on PO-CEP-FYDP Implementation (c) Feature Importance Contributing to Strongly Disagree Faculty Responses on PO-CEP-FYDP Implementation

Difficulties in Developing Collaboration with Industry, academia

Neutral responses may indicate obstacles in industry-academia collaborations within Complex Engineering Program Attributes, suggesting barriers to effective OBE application. This uncertainty points to weak support systems or unclear guidelines for integrating industry connections into the curriculum and CQI processes. The analysis identifies key features and trains machine learning models, selecting the best one based on evaluation metrics. Using Shapash XAI, results are interpreted to highlight influential factors, providing insights into collaboration challenges and guiding targeted solutions.

Feature Selection Result

Table 11 shows the correlation between industry-academia collaboration and various features. Strong positive correlations are observed with "courses regular session" (0.8268) and "programs preparedness" (0.8419), highlighting their importance in effective collaboration. Conversely, negative correlations with "Thesis/Project Selection" (-0.1288) and "PO-CEP-Lab Courses" (-0.2043) indicate challenges in fostering partnerships. The emphasis is on enhancing positively correlated features to improve collaboration effectively.

Table 11: Correlation with Collaboration with Industry, academia

Feature	Co-relation Value
programs preparedness	0.8419
Courses Regular Session	0.8268
Seminar, Workshop	0.6347
OBE Practicing guidelines	0.4477
Curriculum design	0.3251
PO-CEP-FYDP	0.2282
facilities-resources	0.2146
PO Culmination framework with cep attributes	0.2069
Thesis/Project Incorporating Industry demand	0.1973
Admin difficulties while implementing CEP	0.1363
CEP Practicing and CQI Process	0.0981
Strategies to overcome the challenges	0.0899
PO-CEP-Theory courses	-0.0532
CEP Understanding	-0.0650
Common Classroom Problems	-0.0715
Thesis/Project Selection	-0.1288
Well established CQI	-0.1341
Challenges and weaknesses of Pos culmination	-0.1382
PO-CEP-Lab Courses	-0.2043

Model Performance

Table 12 presents machine learning model performance in evaluating industry and academia collaboration. Random Forest led with 99.38% accuracy, followed by XGBoost and CatBoost at 98.06%. AdaBoost had lower precision (77.71%) despite high recall (91.66%). Ridge Classifier and Logistic Regression were less effective. Overall, Random Forest is the top model, with CatBoost and XGBoost as strong alternatives.

Table 12: **Performance of Different Machine Learning Model for Collaboration with Industry, academia.**

Algorithm	Precision	Recall	F1-Score	Accuracy
RC	88.70%	91.14%	91.57%	92.93%
LR	84.01%	85.66%	88.87%	91.05%
SGD	92.31%	88.94%	91.03%	91.76%
RF	97.80%	98.13%	98.45%	99.38%
Cat	92.91%	96.69%	94.69%	98.06%
ADB	77.71%	91.66%	82.63%	92.32%
XGB	93.90%	95.20%	94.54%	98.06%

Explainable AI Result

Figure 7 illustrates the significance of various features in predicting a "neutral" response to whether CEP practices enhance collaboration with industries, improve student competencies, facilitate curriculum updates, and support Continuous Quality Improvement (CQI). It ranks factors based on their mean absolute contribution, highlighting "curriculum design" as the most influential feature. Following this, "PO-CEP-FYDP" (Program Objectives in CEP-Final Year Design Project) indicates that specific educational objectives also significantly shape perceptions. Other contributing factors include "PO Culmination framework," "Programs preparedness," and "Courses Regular Session," which all reflect their roles in shaping opinions on CEP's impact. Overall, the figure underscores that the design and implementation of educational programs, aligned with industry standards, are critical in determining neutral responses regarding the efficacy of CEP practices.
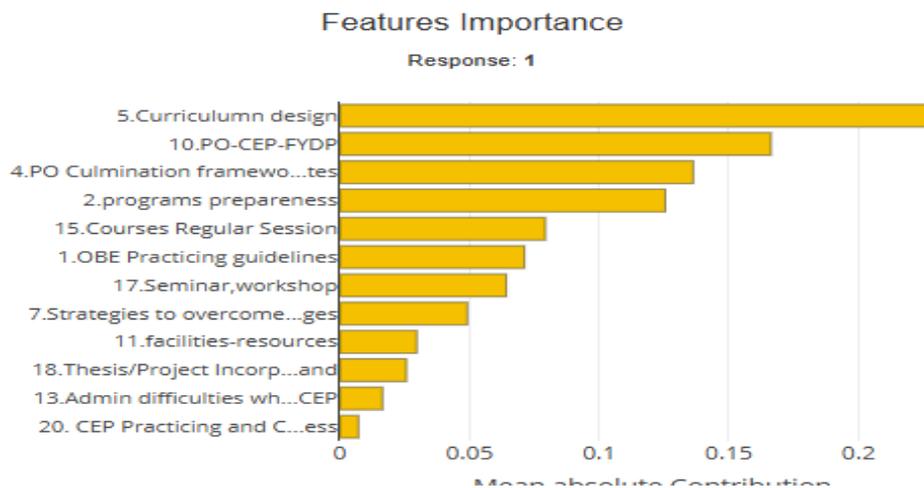

Figure 7: Feature Importance Contributing to Neutral Faculty Responses on collaboration with industry, academia

Difficulties faced in implementing the culmination of PO considering CEP using course regular assessment methods

Faculty responses indicate challenges in designing complex exam problems due to time and resource constraints. Of the respondents, 87 were neutral, suggesting uncertainty about current assessment methods, while 44 disagreed, including 15 who strongly disagreed, highlighting concerns over the lack of support for higher-order thinking skills. These challenges informed machine learning models predicting obstacles in Collaborative Educational Practices (CEP), with Shapash XAI used to interpret the models and identify key factors hindering effective course delivery.

Feature Selection

Table 13 displays correlations between "Course Regular Session" efficacy and features. The strongest correlations are with "Programs Preparedness" (0.803879) and "Collaboration with Industry, Academia" (0.826847). Significant positive correlations are also found with "Seminars, Workshops" (0.505717) and "OBE Practicing Guidelines" (0.578348), while "Curriculum Design" (0.277992) and "Common Classroom Problems" (0.155040) show weaker correlations. The study aims to enhance positively correlated factors for better course implementation.

Table 13: Correlation with Course Regular session

Feature	Co-relation Value
Collaboration with Industry, academia	0.826847
Programs preparedness	0.803879
OBE Practicing guidelines	0.578348
Seminar, Workshop	0.505717
Curriculum design	0.277992
PO culmination framework with CEP attributes	0.222201
Common classroom problems	0.155040
Facilities-resources	0.132318
CEP Practicing and CQI Process	0.075466
Thesis/ Project Incorporating Industry demand	0.061707
PO-CEP-FYDP	0.050931
Admin difficulties while implementing CEP	0.030519
Strategies to overcome the challenges	-0.025261
PO-CEP-Lab courses	-0.080290
Well established CQI	-0.103369
CEP Understanding	-0.168100
Challenges and Weakness of Pos culmination	-0.192328
PO-CEP-Theory Courses	-0.204169
Thesis/ Project Selection	-0.209442

Model Performance

The "Course Regular Session" effectiveness is assessed using machine learning models (see Table 14). Random Forest (RF) scores 100% in all metrics, while XGBoost (XGB) and CatBoost (Cat) achieve F1-Scores of 94.54% and 95.67%, and Accuracies of 98.06% and 97.45%. Stochastic Gradient Descent (SGD) and Ridge Classifier (RC) perform well, and Logistic Regression (LR) averages 85%. AdaBoost (ADB) has high Recall but lower Precision. RF, XGB, and CatBoost are the top models.

Table 14: Performance of Different Machine Learning Model for course regular session

Algorithm	Precision	Recall	F1-Score	Accuracy
RC	90.02%	91.14%	90.57%	93.45%
LR	85%	85%	85%	85%
SGD	92.31%	88.94%	91.03%	91.76%
RF	100%	100%	100%	100%
Cat	95.67%	95.68%	95.67%	97.45%
ADB	77.71%	91.99%	82.63%	92.32%
XGB	93.90%	95.20%	94.54%	98.06%

Explainable AI Result

Figure 8(a) highlights that the primary factor predicting a "Disagree" response regarding course session efficacy is "Common Classroom Problems," suggesting faculty dissatisfaction stems from daily challenges. Other influential factors include "CEP Practicing and CQI Process," "Collaboration with Industry and Academia," "PO-CEP-FYDP," "Program Preparedness," and "Curriculum Design," indicating a complex interplay affecting perceptions. Figure 8(b) reveals that "Collaboration with Industry" is the key factor influencing neutral responses about the suitability of assessments for designing complex problems, with "Common Classroom Problems" and "Curriculum Design" also playing significant roles. In Figure 8(c), "Programs Preparedness" is the most critical factor predicting a "Strongly Disagree" response about assessments' suitability, alongside "Collaboration with Industry and Academia," "Seminar and Workshop Participation," and other factors, emphasizing the need for enhanced assessment design and institutional support.
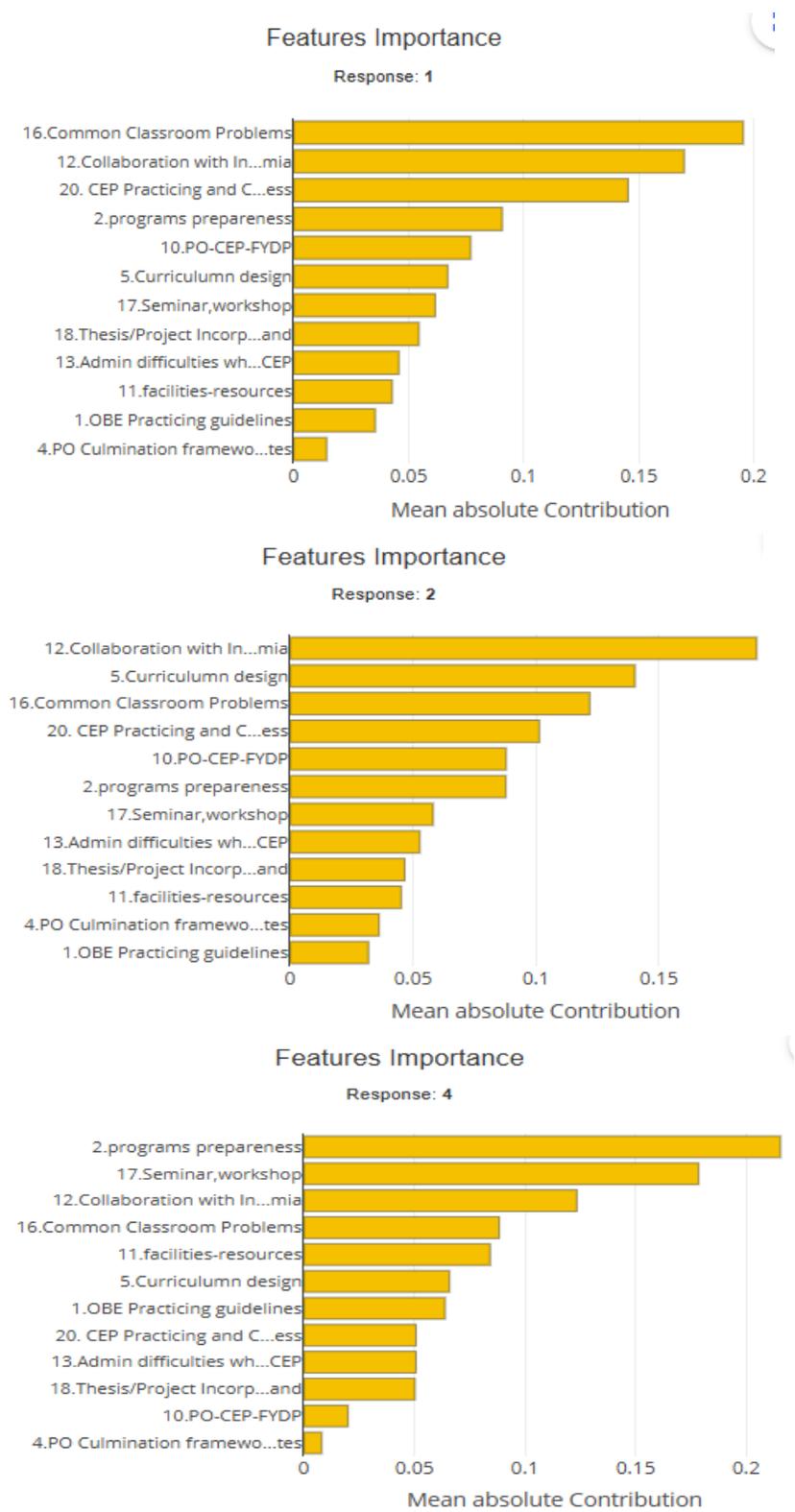
Figure 8: (a) Feature Contributions Leading to "Disagree" Response on course regular session, (b) Feature Contributions Leading to "Neutral" Response on course regular session, and (c) Feature Contributions Leading to "Strongly Disagree" Response on course regular session.

Main Findings

In Bangladesh, only 17.44% (30 out of 172) engineering programs have applied for BAETE accreditation, with 14.55% (8 of 55) from public universities, 18.42% (21 of 114) from private universities, and 33.33% (1 of 3) from international universities, indicating low awareness/preparedness of accreditation. However, 39.74% (31 out of 74) of the programs from these universities successfully achieved BAETE accreditation based on the OBE system. Lack of proper OBE based PO culmination framework and guidelines considering CEP solving.

This study revealed that knowledge on CEP understanding has significant relationship with the practical implementation OBE considering PO and CEP attributes. From the respondent, of 46.7% were agreed with this perspective followed by 29% strongly agreed and 19.2%neutral. The culmination of Program Outcomes (POs) through Final Year Design Projects (FYDPs) shows a significant correlation with program preparedness regarding OBE_PO_CEP attributes. Survey results indicated that 27.91% agreed, 53.31% strongly agreed, 8.99% were neutral, 5.16% disagreed, and 4.63% strongly disagreed with this statement.

Adequate facilities, resources, tools, teaching strategies, and assessment methods significantly correlate with program preparedness concerning CEP attributes. Among respondents, 47.88% agreed, 37.04% strongly agreed, 9.92% were neutral, and 5.16% disagreed with this statement. Collaboration with industries and academia enhancing competency level of students to solve complex engineering problems has a significant relationship to the dependent variable. Study revealed that 37.70% of respondents agreed with this statement, 42.86% strongly agreed, and 19.44% were neutral.

A well-defined Continuous Quality Improvement (CQI) process that highlights strengths, weaknesses, and improvement priorities for the OBE system in relation to CEP attributes significantly impacts the dependent variable. The study found that 48.02% agreed, 42.06% strongly agreed, 4.76% were neutral, and 5.16% disagreed.

Implications

The status of the culmination of Program Outcomes (PO) has been evaluated at the level of Solving Complex Engineering Problems (CEP) for Outcome-Based Education (OBE) in Engineering Programs in selected Public and Private Universities of Bangladesh.

An adequate PO attainment framework has been developed that address CEP attributes of the engineering programs. The strategies to overcome the challenges towards implementation of OBE considering complex problem solving in programs' outcomes assessment have been determined.

Limitations

Faculty members' were too relaxed or not well motivated to participate in the survey questionnaire that related to the improvement of the quality of OBE and solving CEP.

Stakeholders including students, industry representatives, and lab assistants were not included in the study.

Conclusions

This study examined critical objectives related to the execution of Outcome-Based Education (OBE) and the attainment of Program Outcomes (POs) in engineering programs in Bangladesh, emphasising CEP features. The initial assessment examined the present condition of Outcome-Based Education (OBE) and the incorporation of Continuous Evaluation and Progress (CEP) principles in evaluating Program Outcomes (POs), uncovering issues including faculty preparedness and resource limitations. The research highlighted the necessity for comprehensive PO achievement frameworks that fit with industry requirements to improve graduates' problem-solving abilities. Furthermore, it highlighted discrepancies in PO evaluation techniques among universities, underscoring the necessity for standardised approaches. Strategies to surmount these challenges encompass promoting interdisciplinary collaborations, offering faculty training, and augmenting curricular flexibility. Ultimately, resolving these difficulties will enhance the quality and pertinence of engineering education in Bangladesh. The incorporation of CEP features could be enhanced by merging quantitative PO achievement statistics with qualitative perspectives from students and industry stakeholders using mixed-method approaches.

Recommendations

Bangladesh Accreditation Council (BAC) may organise seminars, workshops, and training for educators focused on outcome-based curricula, particularly regarding CEPs. BAC may develop and enforce appropriate policies and guidelines for PO culmination in collaboration with BAETE.

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Status of Implementation of Outcome-Based Education in Bangabandhu Sheikh Mujib Medical University

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Abstract

This research investigated the introduction of outcome-based education at Bangabandhu Sheikh Mujib Medical University. Participants were selected using convenience sampling in this cross-sectional study. Following permission from the BSMMU Institutional Review Committee, the trial commenced with 74 participants from six faculties, including departmental faculty who completed a pre-tested self-assessment questionnaire. The average age of the participants was 47.46 years (± 6.4), and the average teaching experience was 9.62 years (± 6.6). More than 50% of participants submitted their curricula to the Institutional Quality Assurance Cell (IQAC) of BSMMU. Among the attendees, 43% participated in the outcome-based education program once, 40% attended two or more times, and 16.2% have not yet participated in any training or seminar. Participants with two or more OBE training sessions had higher mean scores compared to those with one training session and those who did not attend. A notable difference ($p \leq 0.05$) was detected in the knowledge of implementing outcome-based education in course curricula, aligning pedagogical methods with professional competencies, facilitating resident learning, fostering a collaborative environment, and assessment strategies between participants who attended training sessions once or twice and those who did not. No substantial differences were observed in individuals' views, emotions, preparedness, or acceptance about OBEs. Regarding learning outcomes, teaching methodologies, and assessment strategies, no substantial differences were observed between groups, except for variations in assessment instruments, resident knowledge, skills, and values between participants trained once versus those trained two or more times and between those trained two or more times versus those with no training. Faculty members of BSMMU are competent and passionate about employing OBE in lectures and courses; nonetheless, further practical training is necessary to enhance OBE implementation.

Keywords: Teaching-Learning; Higher Education; Curriculum; IQAC; Learning Outcomes

Introduction

Education provides pupils with essential knowledge, skills, abilities, and values necessary for cultivating a proficient workforce and a robust nation capable of global

competition (Biggs & Tang, 2010). The swift transformations propelled by technology and economics necessitate the cultivation of proficient workers equipped to satisfy stakeholders/employer expectations. In response to the problems of modern society, higher education institutions (HEIs) are restructuring their academic frameworks. The emphasis is on learner-centred education, prioritising learning outcomes.

Outcome-based education (OBE) signifies a transition from an "Edu-centric Paradigm" to an "Empowerment Paradigm", which empowers and motivates all learners for future achievement (Spady, 1988). Faizah (2008) asserts that Outcome-Based Education (OBE) necessitates quantifiable learning outcomes, enabling students to exhibit their achievements. Killen (2000) characterises OBE as a methodology that prioritises the cultivation of essential skills and competencies in students, aligning curricular objectives to guarantee that all students achieve their maximum potential upon graduation. He also observes that OBE might be seen as a theory, framework, or methodology within the classroom.

In recent decades, higher education systems in Europe, Australia, the United States, and Canada have implemented Outcome-Based Education (OBE) to guarantee credential quality, transparency, and interoperability. In the contemporary knowledge-driven economy, outcomes-based learning represents the optimal pedagogical framework for market-orientated post-secondary institutions (Harrison, 2017; Lennon, 2010; Pichette & Watkins, 2018). Developing countries have also included outcome-based education in their educational frameworks.

Bangabandhu Sheikh Mujib Medical University (BSMMU) intends to implement outcome-based education to align its curricula complying Bangladesh National Qualifications Framework (BNQF). Their objective is to deliver a high-quality, industry-orientated educational environment and cultivate globally competitive students through Outcomes-Based Education (OBE), monitoring of the teaching and learning processes, and quality assurance measures. The Institutional Quality Assurance Cells (IQACs) offers OBE system training to five faculty members from each private and public university to implement OBE across all institutions. These faculty members instructed a minimum of two supplementary educators from each department to restructure the program. Additionally, each university conducted multiple workshops on outcome-based education through their respective quality assurance cells. Furthermore, universities conducted numerous workshops on outcome-based education via their own quality assurance units. The quality assurance cell at BSMMU conducted eight workshops to guarantee comprehensive understanding of Outcome-Based Education (OBE) among all educators.

This study examined faculty members' perceptions of the implementation of Outcome-Based Education (OBE). The primary aim of the study was to investigate the status of outcome-based education via the lens of teachers' experiences with its implementation. The project specifically examined faculty members' knowledge, beliefs, emotions, preparedness, and acceptance of OBE and assessed the status of OBE implementation based on their experiences.

Methodology

Study Area

Bangabandhu Sheikh Mujib Medical University plays a significant role in the postgraduate medical education system in Bangladesh. The university's teaching members are committed to academic excellence, critical thinking, and student growth, providing a superior education.

Research Approach: Cross-sectional study

A cross-sectional study was conducted to gather quantitative data utilising a structured questionnaire as the principal instrument.

Data collection tool

A semi-structured questionnaire was employed for data collection. The questionnaire was formulated based on various literature studies (Ortega et al. (2016); Tungpalan et al. (2021); Villaluz (2017); Ortega-Dela (2022) and refined through multiple consultations with education specialists. The questionnaire comprised three sections: background information, attitudes towards OBE, and OBE implementation.

Section I: Background Characteristics – Age, Gender, Designation, Teaching Experience, Faculty, Submission of Curriculum to IQAC of BSMMU, Participation in OBE Training/Seminar.

Section II: Attitude towards Outcome-Based Education – Knowledge, belief, emotion, preparedness, acceptance.

Section III: Issues Pertaining to OBE Implementation – Formulation of Learning Outcomes, Teaching and Learning Processes, and Assessment.

We employed a 5-point Likert scale to classify the responses: Strongly Disagree, Disagree, Agree, Strongly Agree, and Don't Know.

Pre-test

Prior to data collection, pretesting of the questionnaire was done to detect necessary adjustments, issues encountered by respondents, or any required revisions to the questionnaire. Faculty members from one department at BSMMU who were not the

respondents for primary data were invited for pre-testing, and questionnaire was revised accordingly to finalise.

Sampling Population

All faculty members from various departments of Bangabandhu Sheikh Mujib Medical University, Dhaka, regardless of their attendance at the workshop on outcome-based education.

Sampling Technique

The researcher employed a convenience sampling method in our research. The sample size was determined via the subsequent formula:

$$n = Z^2 pq$$

Where, n = sample size, z = e^2 value of the standard normal distribution at 5% level of significance and 95%, Confidence interval; z= 1.96, p= it is the assumed target population. Here, p=50% So, p=0.5 and q=0.5, e = acceptable error = 0.12.

The sample size for this study was n = 66.69, We round up the sample size to 70. Thus, the sample size for faculty members of BSMMU was 70.

Data Collection Procedure

Following the acquisition of approval from the institutional review board (IRB), the researcher initiated the data collection process. Data collectors were appointed for full-time positions. Data collectors received practical training on the data collection method until they demonstrated satisfactory performance. Initially, the researcher sought authorisation from the Deans of each faculty for data collecting. BSMMU comprises seven faculties: Faculty of Basic and Para Clinical Science, Faculty of Medicine, Faculty of Surgery, Faculty of Paediatrics, Faculty of Dentistry, Faculty of Preventive and Social Medicine, and Faculty of Nursing. The nursing faculty was excluded due to prior pretesting completed on this group. The researcher compiled a list of all faculty members at BSMMU, categorising them as trained and non-trained, sourced from the Institutional Quality Assurance Cell (IQAC) of BSMMU. Subsequently, the researcher commenced our data collection. The researcher sought all faculty members from each department for data collecting who were available at that time. A total of 74 faculty members from various departments across six faculties were involved in this study. Data was gathered by a self-administered questionnaire. The study participants were informed about the study's goal and method and were given an informed consent form to get their written consent.

The initial segment enquired about participants' demographic characteristics, followed by the second segment, which comprised 5-point Likert scale questions addressing attitude-related and OBE implementation-related matters.

Data Analysis

Subsequent to data gathering, data analysis was performed. Prior to performing statistical analysis, data screening entails the cleansing and sanitisation of data. The objective was to assess the dependability, utility, and correctness of various data sources.

Data were analysed using IBM Statistical Package for the Social Sciences (SPSS Version 26). Statistical inference was conducted based on the characteristics of the variables. For descriptive analysis, frequency, percentage, arithmetic mean and standard deviation were calculated. Descriptive statistics were employed to characterise the distribution of research variables among the respondents. ANOVA test was applied for inferential analysis. Data was presented using tabulations, graphs, and charts. Statistical inference will be conducted based on the characteristics of the variables.

Result and Discussion

Section 1: Background information of participants

The background variables are explained in Table 1. A total of 74 participants were included in this study; among them, 51.4% were male and 48.6% were female. The mean age of the participants was 47.46 (± 6.4). Most were assistant professors (43.2%), followed by associate professors (40.5%) and professors (16.2%). The mean of the teaching experience was 9.62 (± 6.6) years. Most of the participants were from medicine (32.4%) and basic & para-clinical sciences (27%), while pediatrics, dental, and preventive & social medicine had fewer participants (each around 5-7%). About most (67.6%) said their department had submitted an OBE curriculum, but 18.9% had not, and 13.5% didn't know. About 43% had attended OBE training once, 40.5% had gone twice or more, and 16.2% had never attended.

Table 1: Demographic variables and background characteristics

S. N.	Variables	Categories	Frequency (n)	Percentage (%)
1	Gender	Male	38	51.4
		Female	36	48.6
2	Age	Minimum- 35 Maximum- 65 Mean- 47.46 (± 6.4)		
3	Designation	Professor	12	16.2
		Associate Professor	30	40.5
		Assistant Professor	32	43.2
4	Teaching experience	Minimum- 1 Maximum- 29 Mean- 9.62 (± 6.6)		
5	Faculty	Basic & para clinical science	20	27.0
		Medicine	24	32.4
		Surgery	17	23.0
		Pediatrics	5	6.8
		Dental	5	6.8
		Preventive and social medicine	3	4.1
6	Is outcome based curriculum submitted from your department to Institutional Quality Assurance Cell of BSMMU?	1= Yes	50	67.6
		2= No	14	18.9
		3= Don't know	10	13.5
7	How many times you have participated in outcome-based education seminars/training?	1= 1 time	32	43.2
		2= ≥ 2 times	30	40.5
		3= Not attended yet	12	16.2

Section 2: Attitude towards Outcome-Based Education

This section presents an analysis of faculty members' attitudes toward OBE based on their knowledge, beliefs, feelings, readiness, and acceptance. The data is categorized into five aspects: knowledge, belief, feelings, readiness, and acceptance.

Table 2: Distribution of participants according to knowledge towards OBE

S. N.	Statements	Disagree n (%)	Agree n (%)	Don't know n (%)
Knowledge				
1	I know how to apply OBE in course curriculum.	4 (5.4)	58 (78.4)	12 (16.2)
2	I know how to align teaching methods to real-world professional skills.	5 (6.8)	57 (77.0)	12 (16.2)
3	I know how to facilitate the residents' learning to enhance knowledge and skills into a high-level performance.	4 (5.4)	64 (86.5)	6 (8.1)
4	I know how to create a cooperative and goal-oriented environment in my OBE class	9 (12.2)	55 (74.3)	10 (13.5)
5	I know the assessment techniques in OBE well.	10 (13.5)	53 (71.6)	11 (14.9)

F. N.: n= number of participants, S. N= Serial Number

In the knowledge domain of Outcome-Based Education (OBE), most teachers (78.4%) understand how to apply OBE in their courses, and 77% can align teaching with real-world skills. A high percentage (86.5%) feels confident in enhancing student learning, while 74.3% know how to create a cooperative classroom. However, knowledge of OBE assessment methods was mixed - 71.6% agreed they understood them, but 13.5% disagreed and 14.9% were unsure. This indicates strong overall OBE understanding but reveals gaps in assessment techniques and classroom implementation (Table 2).

Table 3: Distribution of participants according to belief towards OBE

S. N	Statements	Disagree n (%)	Agree n (%)	Don't know n (%)
Belief				
1	I believe that OBE will enhance residents' academic performance.	1(1.4)	72(97.3)	1(1.4)
2	I believe that OBE will allow me to use different teaching methods in a more flexible way in my class.	3(4.1)	69(93.2)	2(2.7)
3	I believe that my teaching experience will help me to adjust with OBE teaching and learning.	-	73(98.6)	1(1.4)
4	I believe that the OBE will give every resident equal chance to learn.	1(1.4)	68(91.9)	5(6.8)

F. N.: n= number of participants, S. N= Serial Number

Table 3 shows strong belief for OBE among participants. Nearly all (97.3%) believe OBE improves residents' academic performance, while 93.2% agree it allows flexible

teaching methods. Almost everyone (98.6%) feels their teaching experience helps them adapt to OBE, and 91.9% think OBE provides equal learning opportunities for all residents. Only a very small number (1.4–6.8%) disagreed or were unsure, indicating widespread belief in OBE's benefits.

Table 4: Distribution of participants according to feelings towards OBE

S. N	Statements	Disagree n (%)	Agree n (%)	Don't know n (%)
Feelings				
1	I feel that OBE requires teachers to take more responsibility than traditional teaching	2(2.7)	71(95.9)	1(1.4)
2	I feel that OBE would not be a waste of time.	3(4.1)	70(94.6)	1(1.4)
3	I feel using traditional method (pen and paper test) to assess what residents know, might not always be appropriate for them	2(2.7)	72(97.3)	0
4	I feel that OBE is the best way to learn.	2(2.7)	64(86.5)	8(10.8)

F. N.: n= number of participants, S. N= Serial Number

Most participants (95.9%) felt OBE requires more teacher responsibility than traditional teaching, and nearly all (94.6%) agreed it wouldn't be a waste of time. An overwhelming 97.3% believed traditional pen-and-paper tests may not always suit resident assessments, while 86.5% considered OBE the best learning approach, with only 2.7% disagreeing. A small fraction (10.8%) remained unsure about OBE's superiority (Table 4).

Table 5: Distribution of participants according to readiness towards OBE

S. N	Statements	Disagree n (%)	Agree n (%)	Don't know n (%)
Readiness				
1	I am ready to organize my daily schedule for OBE.	8(10.8)	62(83.8)	4(5.4)
2	I am ready to use any available resources to present my lesson related to OBE.	9(12.2)	60(81.1)	5(6.8)
3	I am ready to read a lot about OBE to learn more and understand it better.	9(12.2)	63(85.1)	2(2.7)
4	I am ready to attend seminars and training sessions about using OBE at BSMMU.	1(1.4)	72(97.3)	1(1.4)

F. N.: n= number of participants, S. N= Serial Number

Over 80% of participants indicated their preparedness to structure their daily OBE schedule, utilising available resources, extensively researching OBE, and predominantly (97.3%) expressing readiness to attend seminars and training

sessions on OBE. Conversely, a minor percentage of participants exhibited disagreement (approximately 10%), while less than 10% were uncertain about their readiness.

Table 6: Distribution of participants according to acceptance of OBE

S. N	Statements	Disagree n (%)	Agree n (%)	Don't know n (%)
Acceptance				
1	I am willing to deliver the written curriculum according to OBE.	1(1.4)	70(94.6)	3(4.1)
2	I am willing to use different assessment methods and tools to evaluate residents' progress.	1(1.4)	72(97.3)	1(1.4)
3	I am willing to shift from the traditional approach (content-based) to OBE approach.	0	72(97.3)	2(2.7)

F. N.: n= number of participants, S. N= Serial Number

The majority of participants (almost 100%) expressed their readiness to implement the written curriculum in accordance with Outcome-Based Education (OBE), demonstrated a desire to employ diverse evaluation methods, and indicated a transition from traditional to OBE approaches; nevertheless, there were also some dissenting replies.

The above findings show faculty members strongly support OBE, with high confidence in applying it to curricula, aligning teaching with real-world skills, and guiding students effectively. Most believe OBE improves learning outcomes and are ready to adopt it over traditional methods. Similar studies (Ortega & Cruz, 2016) also found positive faculty attitudes toward OBE, highlighting its growing acceptance.

Section 3: Implementation status-related statements about Outcome-Based Education

Table 7: Distribution of participants according to the formulation of learning outcome of OBE

S.N.	Formulation of learning outcome	Disagree n (%)	Agree n (%)	Don't know n (%)
1	I construct the programme educational objectives based on mission of the university.	8(10.8)	58(78.4)	8(10.8)
2	I formulate the program learning outcomes.	12(16.2)	48(64.9)	14(18.9)
3	I formulate the course learning outcomes.	14(18.9)	49(66.2)	11(14.9)
4	I am able to align program learning outcome with program educational objectives.	6(8.1)	53(71.6)	15(20.3)
5	I am able to align course learning outcome with program learning outcome.	8(10.8)	50(67.6)	16(21.6)

F. N.: n= number of participants, S. N= Serial Number

Approximately 70% of participants concurred on the creation of program and course learning goals and the alignment of these results with the educational objectives. Simultaneously, a discernible fraction (10% to 20%) of participants equally chose the 'disagree' and 'don't know' options for the formulation of learning outcomes.

Table 8: Distribution of participants according to teaching learning process of OBE

S.N.	Teaching-learning process	Disagree n (%)	Agree n (%)	Don't know n (%)
1	I deliver instruction through student centered learning approach.	5(6.8)	63(85.1)	6(8.1)
2	I align the teaching-learning activities with the intended learning outcomes.	8(10.8)	60(81.1)	6(8.1)
3	I align the teaching-learning activities with the assessment task.	8(10.8)	65(87.8)	1(1.4)
4	I facilitate the learning activities for different types of learners in a diverse environment.	9(12.2)	62(83.8)	3(4.1)

F. N.: n= number of participants, S. N= Serial Number

In the teaching-learning process, over 80% of participants concurred on the implementation of a student-centred learning approach, the alignment of teaching activities with intended learning objectives, and the assessment tasks that facilitate these learning activities for diverse learners. Nevertheless, approximately 10% of participants expressed disagreement, and fewer than 10% were uninformed regarding the statements related to the teaching and learning processes of OBE.

Table 9: Distribution of participants according to assessment systems of OBE

S.N.	Assessment	Disagree n (%)	Agree n (%)	Don't know n (%)
1	I use different assessment tools to evaluate residents' progress.	10(13.5)	64(86.5)	
2	I assess residents' knowledge.	9(12.2)	60(81.1)	5(6.8)
3	I assess residents' skills and competencies.	9(12.2)	57(77.0)	8(10.8)
4	I assess residents' values and attitudes.	9(12.2)	57(77.0)	8(10.8)
5	I assess the level of residents' performance compared with the intended learning outcomes.	7(9.5)	59(79.7)	8(10.8)
6	I am willing to assess residents' progress using rubrics.	7(9.5)	50(67.6)	17(23.0)

F. N.: n= number of participants, S. N= Serial Number

Approximately 86.5% of participants concurred on employing various evaluation instruments to measure residents' growth, encompassing their knowledge, skills, attitudes, and performance levels. Approximately 10% of participants expressed disagreement and unawareness regarding the assertions, with the exception of the statement concerning the use of rubrics to evaluate residents' development, where 10% disagreed, 68% agreed, and 23% were oblivious of the statement.

Section 4: Difference in mean of frequency of trainings of OBE in terms of attitude towards OBE

A Bonferroni post hoc test indicates significant differences in the knowledge of OBE application in the curriculum, alignment of teaching methods, and facilitation of knowledge enhancement between the one-time training group and the group that did not attend any training, as well as between the group that attended two or more times and the group that did not attend any training. A notable difference was seen between the groups that attended assessment procedures two or more times and those that had not yet participated in the establishment of a goal-orientated environment and awareness of evaluation methods.

Table 10: Knowledge status in terms of mean difference of trainings

Knowledge	Mean (SD)			Significant level between mean of dependent variables among different trained groups		
	1 time	≥ 2 times	NAY*	1 Vs ≥ 2 times	≥ 2 times Vs NAY*	NAY* Vs 1 time
I know how to apply OBE in course curriculum.	2.56	3.13	1.50	.151	.000 s	.021s
I know how to align teaching methods to real-world professional skills.	2.56	3.03	1.50	.312	.000 s	.020 s
I know how to facilitate the residents' learning to enhance knowledge and skills into a high-level performance.	2.97	3.33	1.92	.393	.000 s	.004 s
I know how to create a cooperative and goal-oriented environment in my OBE class	2.50	2.97	1.83	.303	.011s	.237
I know the assessment techniques in OBE well.	2.28	3.00	2.00	.047	.037s	1.000

F.N.: NAY*= Not Attended Yet, SD= Standard Deviation, s= significant p value ≤ 0.05

No significant differences were observed among the groups of participants who attended training once, those who went two or more times, and those who had not yet attended any training in the belief domain. However, an examination of

individual means revealed that participants who attended OBE training or seminars more than twice exhibited a favourable disposition towards OBE, including beliefs in its capacity to enhance academic performance, the flexibility of employing diverse teaching methods, the utility of prior teaching experience, and equitable learning opportunities compared to the other two groups.

Table 11: Belief status in terms of mean difference of trainings

Belief	Mean (SD*)			Significant level between mean of dependent variables among different trained groups		
	1 time	≥ 2 times	NAY*	1 Vs ≥ 2 times	≥ 2 times Vs NAY*	NAY* Vs 1 time
I believe that OBE will enhance residents' academic performance.	3.44	3.50	3.08	1.000	0.198	0.341
I believe that OBE will allow me to use different teaching methods in a more flexible way in my class.	3.03	3.43	3.33	0.183	1.000	0.859
I believe that my teaching experience will help me to adjust with OBE teaching and learning.	3.28	3.57	3.33	0.242	0.854	1.000
I believe that the OBE will give every resident equal chance to learn.	2.94	3.47	2.83	0.099	0.170	1.000

F.N.: SD= Standard Deviation; NAY= Not Attended Yet

Comparable results can be observed in emotions regarding belief status. While no substantial variations in sentiments were observed among participants with 1 training session, those with 2 or more sessions had a more favourable disposition towards OBE compared to the other two groups.

Table 12: Feelings status in terms of mean difference of trainings

Feelings	Mean (SD)			Significant level between mean of dependent variables among different trained groups		
	1 time	≥ 2 times	NAY*	1 Vs ≥ 2 times	≥ 2 times Vs NAY*	NAY* Vs 1 time
I feel that OBE requires teachers to take more responsibility than traditional teaching	3.38	3.63	3.33	0.493	0.686	1.000
I feel that OBE would not be a waste of time.	3.16	3.40	3.17	0.530	1.000	1.000
I feel using traditional method (pen and paper test) to assess what residents know, might not always be appropriate for them	3.28	3.37	3.33	1.000	1.000	1.000
I feel that OBE is the best way to learn.	2.81	3.17	3.08	0.718	1.000	1.000

F.N.: SD= Standard Deviation; NAY= Not Attended Yet

The Bonferroni Post Hoc Test indicated no significant correlation among the groups; nevertheless, as illustrated in Table 4.4, participants who attended training sessions more than twice exhibited higher averages compared to those who attended once and the non-trained participants. The group with ≥ 2 times was better prepared to implement OBE than the other groups.

Table 13: Readiness status in terms of mean difference of trainings

Readiness	Mean (SD)			Significant level between mean of dependent variables among different trained groups		
	1 time	≥ 2 times	NAY*	1 Vs ≥ 2 times	≥ 2 times Vs NAY*	NAY* Vs 1 time
I am ready to organize my daily schedule for OBE.	2.94	3.33	2.83	.334	.402	1.000
I am ready to use any available resources to present my lesson related to OBE.	2.84	3.13	2.42	.791	.125	.649
I am ready to read a lot about OBE to learn more and understand it better.	3.03	3.30	3.08	.690	1.000	1.000
I am ready to attend seminars and training sessions about using OBE at BSMMU.	3.38	3.57	3.33	.785	.926	1.000

F.N.: SD= Standard Deviation; NAY= Not Attended Yet

Participants who attended two or more training sessions exhibited a superior acceptance level compared to those who attended only once or were not instructed, as evidenced by their higher mean scores relative to the other groups. The maximum mean score recorded in the acceptance level statement was 3.43. Concurrently, no substantial differences were seen among them.

Table 14: Acceptance status in terms of mean difference of trainings

Acceptance	Mean (SD*)			Significant level between mean of dependent variables among different trained groups		
	1 time	≥ 2 times	NAY*	1 Vs ≥ 2 times	≥ 2 times Vs NAY*	NAY* Vs 1 time
I am willing to deliver the written curriculum according to OBE.	3.16	3.40	3.00	0.762	0.494	1.000
I am willing to use different assessment methods and tools to evaluate residents' progress.	3.25	3.43	3.33	0.813	1.000	1.000
I am willing to shift from the traditional approach (content-based) to OBE approach.	3.38	3.40	3.17	1.000	1.000	1.000

F.N.: SD= Standard Deviation; NAY= Not Attended Yet

Participants who had not attended any training on OBE exhibited a lower level of learning outcome formulation compared to those trained once and those trained more than twice, as indicated by the means presented in Table 4.6. No substantial differences were identified. The most advanced formulation of learning outcomes was noted in the construction of programme educational objectives aligned with the university mission (3.07) among participants who attended training more than twice.

Table 15: Learning outcome formulation status in terms of mean difference of trainings

Formulation of learning outcome	Mean (SD*)			Significant level between mean of dependent variables among different trained groups		
	1 time	≥ 2 times	NAY*	1 Vs ≥ 2 times	≥ 2 times Vs NAY*	NAY* Vs 1 time
I construct the program educational objectives based on mission of the university	2.50	3.07	2.75	0.140	1.000	1.000
I formulate the program learning outcomes.	2.38	2.70	1.75	0.949	0.094	0.449
I formulate the course learning outcomes.	2.44	2.83	2.08	0.613	.225	1.000
I am able to align program learning outcome with program educational objectives.	2.25	2.63	2.50	0.806	1.000	1.000
I am able to align course learning outcome with program learning outcome.	2.28	2.68	2.08	1.000	.805	1.000

F.N.: SD= Standard Deviation; NAY= Not Attended Yet

The implementation of teaching and learning activities associated with Outcome-Based Education (OBE) was notably effective among participants who attended more than twice compared to other groups, however no significant relationships were seen among or between them. The highest mean score recorded for connecting teaching and learning activities with assessment tasks (3.20) was found in groups that attended training more than twice.

Table 16: Teaching learning process status in terms of mean difference of trainings

Teaching-learning process	Mean (SD*)			Significant level between mean of dependent variables among different trained groups		
	1 time	≥ 2 times	NAY	1 Vs ≥ 2 times	≥ 2 times Vs NAY*	NAY* Vs 1 time
I deliver instruction through student centered learning approach.	2.69	3.10	2.42	.279	.118	1.000
I align the teaching-learning activities with the intended learning outcomes.	2.81	2.97	2.33	1.000	.178	.444
I align the teaching-learning activities with the assessment task.	2.84	3.20	3.25	.133	1.000	.252
I facilitate the learning activities for different types of learners in a diverse environment.	2.81	3.13	2.50	.356	.070	.756

F.N. SD= Standard Deviation, NAY= Not Attended Yet

Utilising several assessment instruments to measure residents' development and knowledge revealed a substantial difference between those who attended training once and those who attended more than twice. In the assessment of residents' skills, competences, values, and attitudes, notable disparities were seen between individuals who attended training two or more times and those who did not receive training. The remaining two statements—evaluating performance levels and employing the Rubrics method—demonstrated no significant correlation.

Table 17: Assessment status in terms of mean difference of trainings

Assessment	Mean (SD)			Significant level between mean of dependent variables among different trained groups		
	1 time	≥ 2 times	NAY	1 Vs ≥ 2 times	≥ 2 times Vs NAY*	NAY* Vs 1 time
I use different assessment tools to evaluate residents' progress.	2.84	3.30	2.92	0.015s	0.226	1.000
I assess residents' knowledge.	2.59	3.17	2.50	0.037s	0.089	1.000
I assess residents' skills and competencies.	2.63	3.07	2.08	0.307	0.023s	0.396
I assess residents' values and attitudes.	2.69	3.00	2.08	0.784	.0048s	0.314
I assess the level of residents' performance compared with the intended learning outcomes.	2.59	2.93	2.42	0.624	0.464	1.000
I am willing to assess residents' progress using rubrics.	2.38	2.40	2.25	1.000	1.000	1.000

F.N.: SD= Standard Deviation, s= Significant p value ≤ 0.05; NAY= Not Attended Yet

The collected data indicates that faculty members possess a favourable disposition towards Outcome-Based Education (OBE), reflecting their knowledge, beliefs, emotions, acceptance levels, and preparedness to implement OBE in both classroom settings and course curricula. This study indicates that participants with greater exposure to OBE training had enhanced knowledge, beliefs, emotions, acceptance levels, and preparedness in implementing OBE in both classroom settings and course curricula according to Ortega et al. (2016).

Furthermore, participants who underwent training more than twice exhibited superior mean scores compared to the other two groups. The group with the highest mean score more effectively implemented the formulation of learning outcomes, the teaching-learning process, and the evaluation method. The findings closely resembled those of many studies conducted in the Philippines during different historical periods {Tungpalan et al. (2021); Villaluz (2017); Ortega-Dela (2022)}. The overall mean score for knowledge, belief, feeling, readiness, and acceptance among participants with more than two training exposures was higher than the mean score for the formulation of learning outcomes, teaching-learning processes, and assessment systems.

Implications

The overall results of this study have depicted the current status of Outcome-Based Education at Bangabandhu Sheikh Mujib Medical University. The results indicated that faculty members held a positive attitude towards Outcome-Based Education; however, enhanced training is necessary for more successful implementation of OBE. The findings of this study will provide essential data for stakeholders to initiate improvements in the effective and quality implementation of Outcome-Based Education.

This study employs a systematic methodology to discern obstacles to efficient technology integration. The methodology encompasses quantitative surveys targeting academics and students to evaluate institutional and individual determinants affecting technology uptake.

Limitations

1. **Data collection challenges:** It was difficult to gather information from faculty members because they are very busy with teaching and administrative work.

2. **Limited perspective**: The study only looked at faculty views and did not include student opinions or challenges faced by the university administration.

3. **Self-reporting bias:** Since faculty provided their own answers, their responses might have been influenced by personal opinions or a desire to give socially acceptable answers.

Conclusions

Participants with extensive training demonstrated superior knowledge in implementing Outcome-Based Education (OBE) in the classroom, facilitating learning, fostering a goal-oriented environment aimed at enhancing academic performance, employing diverse teaching methodologies, leveraging teaching experience, and ensuring equitable learning opportunities for all. The majority of participants said that Outcome-Based Education (OBE) necessitates greater accountability from educators compared to traditional methods, and they are prepared to structure their OBE schedules, engage in extensive reading on the subject, and attend relevant seminars. Although they had a positive attitude towards OBE, concerns regarding implementation challenges were apparent.

The overall average of implementation status, which includes learning outcome formulation, teaching-learning processes, and evaluation, was significantly lower than the attitude towards Outcome-Based Education (OBE). Our faculty members are competent and enthusiastic in effectively applying Outcome-Based Education (OBE) in both classroom settings and course curricula; nevertheless, more efficient and practical training needs to be undertaken. OBE requires robust institutional

commitment to the ongoing professional development of teaching members to effectively serve its primary stakeholders, the students.

Recommendations

Based on the findings, the following recommendations are proposed for the Bangladesh Accreditation Council (BAC) to strengthen OBE adoption and ensure its effective implementation across universities:

1. **Expand OBE training:** Offer more hands-on workshops, especially for untrained faculty, and involve experienced faculty as mentors.

2. **Strengthen institutional support:** Provide guidelines, funding, and incentives for OBE implementation. Ensure IQACs monitor progress regularly.

3. **Reform curriculum & assessment:** Develop standardized OBE frameworks and promote diverse assessment methods (e.g., rubrics, portfolios).

4. **Increase awareness & collaboration:** Organize national symposiums and engage stakeholders to align OBE with industry needs.

5. **Address challenges:** Reduce faculty workload, tackle resistance, and establish feedback mechanisms for continuous improvement.

6. **Support research:** Fund studies on OBE's long-term impact and benchmark against global best practices.

Acknowledgments

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Assessing Willingness of Some Selected Universities to Comply with the Requirements of Accreditation

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Abstract

Accreditation acts as a vital indicator of quality and accountability in higher education, ensuring standards and performance of academic institutions. This research intends to assess the readiness of the universities in Bangladesh to comply to accreditation requirements for quality assurance. Employing a sequential explorative mixed-approaches strategy under the pragmatism research paradigm, qualitative and quantitative methods were merged to attain this purpose. 10 In-depth interviews (IDI) were performed with pertinent respondents involved in quality assurance and accreditation procedures at Dhaka University, Rajshahi University of Engineering and Technology, and Jagannath University using purposive sampling technique. Subsequently, a structured survey questionnaire was constructed based on literature study and IDI outcomes, obtaining 260 useable responses out of 265 received utilising convenience sampling technique. From the demographic data for 260 respondents including gender, age, designation and academic subjects and sample universities association, male respondents made up over 80% of the sample and the rest 20% are the females. 30.76% respondents are the age range of 35-40 and 28.85% are 40-45 aged. Professors (38.46%), associate professors (25.38%) and assistant professors (19.23%) make up the majority of the sample. Business and management (18.46%), Pure Sciences (17.69%) and Social Sciences (12.31%) dominate respondent's academic backgrounds. About 36.92% of respondents are from University of Dhaka, while 32.31% and 30.77% are from Jagannath University and Rajshahi University of Engineering Technology respectively. The qualitative data, transcribed from interviews, were evaluated alongside quantitative data using regression analysis and the chi-square test to explore the complex dynamics driving institutions' compliance behaviour. Results emphasised the value of accreditation in enhancing institutional reputation and competitiveness, despite problems in achieving complicated requirements, resource limits, and competing agendas. Strategies such as capacity building, stakeholder involvement, and strategic planning were recognised as facilitators of compliance. The report presents practical recommendations for BAC and UGC to create a quality culture in higher education institutions. Overall, this research advances awareness of the multifaceted structure of accrediting processes and their effects on institutional efficacy and legitimacy.

Keywords: Accreditation; Quality Assurance; Higher Education Institutions; Bangladesh

Introduction

An increasingly competitive global marketplace puts pressure on higher education institutions (HEIs) to provide quality education. This demand has increased the focus on quality assurance (QA) methods, which are vital for educational success, especially as students, teachers, and academic programs move across international networks (Phillips, 2022). Quality in higher education has evolved from its industrial roots to include quantifiable and measurable standards (Hillman & Baydoun, 2019), making HE quality improvement a crucial part of internationalisation efforts that impact social and economic prosperity (De Wit & Altbach, 2021). Any nation's socioeconomic success depends on high-quality education's development of skilled human capital (Indrawati & Kuncoro, 2021).

The post-1991 development of higher education in Bangladesh has sparked worries about academic standards due to rising enrolment and insufficient resources (UNESCO, 2005). The Strategic Plan for Higher Education (2006–2026) and National Education Policy (2010) emphasise strategic reforms to improve HE quality. The Private University Act, 2010 and Higher Education Quality Enhancement Project (HEQEP) strengthened quality assurance mechanisms and ensured educational standards. The Draft Education Law (DEL, 2013) proposes an Accreditation Council to formalise QA procedures in public and private institutions.

Quality assurance relies on accreditation to assess institutions' compliance with standards and norms. Accreditation is essential for evaluating academic programs, teachers, facilities, and the learning environment in Bangladesh and elsewhere (Rahnuma, 2020).

Accrediting agencies evaluate academic programs based on infrastructure, student support services, and curriculum design (Makhoul, 2019). Beyond academic success, accreditation boosts universities prestige and visibility domestically and internationally (Altbach & Knight, 2007). Accredited institutions attract staff and students, create industry relationships, and facilitate cross-border cooperation (Deem & Brehony, 2005). Accreditation also lets institutions compare their performance to standards, identify areas for improvement, and enact policies to improve education and student outcomes (Makhoul, 2019).

To successfully adopt QA systems, one must recognise institutional readiness concerns and gaps. This study analyses quality gaps and institutional hurdles to assess Bangladeshi HEIs' readiness to adopt formal quality assurance techniques. The research compares existing methods with QA standards to help HEIs integrate into formal QA frameworks and improve Bangladeshi higher education.

To understand QA in higher education, one must consider its institutional, historical, and sociological circumstances. Quality is contextual and user-perceived (Harvey & Green, 1993). Educational results depend on local relevance, graduate employability, and instructional quality (Khalifa et al., 2016; Kumar, 2020). Stakeholder needs and expectations are driving accreditation's role in higher education accountability and improvement (Khalil, 2021).

Despite these advances, Bangladeshi universities QA compliance and accreditation readiness are still unclear. This study examines Bangladeshi universities accreditation compliance to close these gaps. It examines stakeholder perspectives, compliance considerations, and accreditation challenges and incentives. This research seeks to improve educational quality and institutional effectiveness by clarifying Bangladeshi higher education's quality assurance and accreditation landscape.

Methodology

Research Design and Data Collection Method

This research uses sequential exploratory mixed-methodologies, integrating qualitative and quantitative methods within the pragmatism research paradigm, to achieve its goals. In-depth interviews (IDIs) with quality assurance and accreditation participants utilising semi-structured questionnaires comprised the qualitative component. University administrators and faculty participated.

Document review of pertinent policies and reports supplemented qualitative data collecting. The data came from Dhaka University (DU), Rajshahi University of Engineering and Technology (RUET), and Jagannath University. The PI used IDIs to collect qualitative data on themes, topics, and factors. These insights helped write the succeeding questionnaire's clear and thorough questions and response alternatives.

The researcher also made sure the questionnaire covered issues that were important to study participants, which improved the relevance and content validity of the quantitative measures produced from the qualitative data. A thorough literature study and IDI findings informed a constructed survey questionnaire. An appropriate sample of faculty, administrators, and staff from the designated universities (DU, RUET, and JnU) respectively received this survey.

Sampling Technique and Sample Size

The investigator conducted in-depth interviews using purposive sampling in the qualitative phase. This method used personal interactions, following White et al. (2012). Fugard and Potts (2015) remark that qualitative research sample size is relative and cannot be decided by computations or power analyses. For homogeneous or essential case sampling, 10 is usually enough (Sandelowski, 1995). Investigator completed 10 IDIs through personal connections. Table 1 shows field research interviewee profiles.

Table 1: Demographic Profile of the Respondents

Respondents Code	Gender	Age (Years)	Designation	Institution	Experience (Years)	Education	Interview Date & Time
1	M	55	Director IQAC	RUET	35	PhD	29.12.23; 12.00 PM
2	M	57	Dean	JnU	28	PhD	30.12.23; 3.30 PM
3	F	48	Dean	DU	16	PhD	01.01.24; 2.30 PM
4	M	43	Professor	DU	15	MBA; PGD	02.01.24; 3.30 PM
5	F	52	Professor	JnU	24	MSS	03.01.24; 2.00PM
6	M	48	Professor	JnU	20	PhD	04.01.24; 1.30 PM
7	M	54	Professor	DU	24	PhD	05.01.24; 12.30 PM
8	M	42	Professor	JnU	14	PhD	06.01.24; 10.30 AM
9	M	45	Professor	RUET	18	PhD	09.01.24; 10.30 AM
10	F	38	Associate Professor	RUET	12	MS	12.01.24; 10.00 AM

Table 1 lists demographic and professional details of ten qualitative research study respondents. These responders work at DU, JnU, and RUET in academic and administrative roles. The interviews lasted two weeks, from December 29, 2023, to January 12, 2024. The PI used convenience sampling for the quantitative survey. The researcher uses convenience sampling, also known as judgemental sampling, to verify a standard through sample analysis (Bagozzi & Yi, 1988). The current study used this method. Face-to-face and Google Forms structured questionnaires yielded 265 replies, 260 of which were usable. Table 2 shows survey respondent profiles.

Table 1: Descriptive Analysis of Demographic Data of the Respondents

Demographic Data	Frequency (N=260)	Percentage (%)
Gender		
Male	213	81.92%
Female	47	18.08%
Age		
25 - 30 Years old	30	11.54%

Demographic Data	Frequency (N=260)	Percentage (%)
30- 35 Years old	50	19.23%
35- 40 Years old	80	30.76%
40- 45 Years old	75	28.85%
45- 50 Years old	15	5.77%
50 and Above Years	10	3.85%
Designation		
Vice Chancellor	1	0.38%
Pro- Vice Chancellor	2	0.77%
Dean	2	0.77%
Chairman	5	1.92%
Professor	100	38.46%
Associate Professor	66	25.38%
Assistant Professor	50	19.23%
Lecturer	34	13.08%
Academic Disciplines		
Arts and Humanities	30	11.54%
Life Sciences	12	4.62%
Business and Management	48	18.46%
Agricultural Science	16	6.15%
Engineering and Technology	20	7.69%
Social Sciences	32	12.31%
Law	15	5.77%
Pure Sciences	46	17.69%
Aquaculture and Fisheries	8	3.08%
Earth Science	11	4.30%
Earth and Environmental Science	8	3.08%
Biological Sciences	5	1.92%
Geosciences	7	2.69%
Sample University		
DU	96	36.92%
RUET	80	30.77%
JnU	84	32.31%

Table 2 shows demographic data for 260 respondents, including gender, age, designation, academic subjects, and sample university association. Male respondents made up over 80% of the sample. 30.76% of respondents are 35-40 and 28.85% are 40-45, indicating a high proportion of mid-career professionals. Professors (38.46%), Associate Professors (25.38%), and Assistant Professors (19.23%) make up the majority of the sample. Business and Management (18.46%), Pure Sciences (17.69%), and Social Sciences (12.31%) dominate respondents' academic backgrounds. About 36.92% of responders are from DU, while 32.31% and 30.77% are from JnU and RUET respectively.

Data Analysis Tools and Techniques

Transcribing the interviews utilising mobile record verbatim and interview notes was the first step in qualitative data analysis. Use content analysis to evaluate the collected data. Content analysis involved carefully reviewing interview transcriptions to find relevant phrases or themes to create the quantitative questionnaire. Quantitative survey aimed to determine factors affecting universities accreditation compliance. This analysis included descriptive, regression, and factor analysis.

Questionnaire Development

In the qualitative phase of this research, the investigator and participants shared views using a semi-structured interview questionnaire. Literature review informed the semi-structured questionnaire. Creating a survey questionnaire to examine universities accreditation compliance requires multiple processes. First, the PI reviewed literature to identify higher education accreditation topics and variables (Table 3). Using a literature review and field study of 10 IDIs, identify the main constructs (willingness to comply as the dependent variable and institutional characteristics, financial resources, leadership commitment, and perceived barriers to compliance as independent variables). Pretest 10 respondents similar to the target group (excluding the 260). Use pretest feedback to finish the questionnaire. Make sure it's reasonable and includes all major concepts. The PI created a survey questionnaire to test each component using a 7-point Likert scale (1 = Strongly Disagree, 7 = Strongly Agree) and a 6-point scale (1=Not at all 6=Very Much).

Table 3: Research Measurement Instrument

Constructs	Items	Source
Standard 1: Governance	8	Haq et al., 2018 & and field study IDI
Standard 2: Leadership, Responsibility and Autonomy	2	Alam et al., 2019 & and field study IDI
Standard 3: Institutional Integrity and Transparency	6	Schnackenberg et al., 2021; Alam et al., 2019 & and field study IDI
Standard 4: Curriculum	8	Wiley & Berry, 2015; Dicker et al., 2018 & and field study IDI
Standard 5: Teaching-Learning & Assessment	7	Sultan et al., 2023; Bhullar et al., 2019; Veiga et al., 2013 & and field study IDI
Standard 6: Student Admission & Support Services	7	Sultan et al., 2023; Swartz et al., 2021; Latif et al., 2019 & and field study IDI
Standard 7: Faculty and Professional Staff	8	Latif et al., 2019 & and field study IDI
Standard 8: Facilities & Resources	5	Veiga et al., 2013; Latif et al., 2019 & and field study IDI
Standard 9: Research & Scholarly Activities	4	Swartz et al., 2021; Latif et al., 2019 & and field study IDI
Standard 10: Monitoring, Evaluation & Continual Improvement	4	Bhullar et al., 2019
Others	7	Alam et al., 2019; Haq et al., 2018; Latif et al., 2019; Sultan et al., 2023 and field study IDI

Results and Discussions

The respondents' perceptions regarding their readiness to comply with accreditation standards emphasize governance, strategic alignment, and stakeholder engagement. Findings indicate that while many stakeholders recognize the alignment between the university's vision and societal needs, significant gaps in awareness and communication exist, particularly regarding governance policies on complaints and class sizes. A mixed perception of policy effectiveness may hinder compliance efforts, highlighting the need for improved communication strategies. Additionally, there are varying levels of stakeholder confidence in university-industry collaborations, resource management, and recruitment transparency. A strong departmental leadership that promotes accountability and transparency is essential for enhancing accreditation readiness. The survey reveals that while many respondents agree on the clarity of roles and responsibilities, there is room for improvement, particularly in diversity and social responsibility efforts. The study also identifies areas in curriculum design and teaching practices that require enhancement, such as greater industry engagement and more systematic review processes. Despite positive responses on assessment fairness, the need for prompt

feedback mechanisms and improved transparency in grievance procedures is evident. In terms of faculty qualifications and resource allocation, there is a notable dissatisfaction with salary structures and professional development opportunities, indicating a need for policies that align with accreditation standards. The effectiveness of research activities and stakeholder engagement in disseminating findings are also critical areas requiring attention to maximize societal impact.

The survey data received from university teachers regarding compliance with accrediting standards reveals a complex perception of the university's adherence to these standards. The opinions are quite spread out across the spectrum from 'Not at all' to 'Very much', indicating diverse perceptions among the faculty.

Table 4: Perception of the University's adherence to Accreditation Standards

Response	DU	RUET	JnU
Not at All	4.2%	0.00%	9.5%
Not Really	6.3	10.0	11.9
Undecided	2.1	2.5	14.3
Somewhat	60.4	55.0	50.0
Much	18.8	10.0	4.8
Very Much	8.3	22.5	9.5
Total	100.0%	100.0%	100.0%

The table 4 presents the majority (60.4%) respondents of the DU feels that their university somewhat adheres to accreditation standards, suggesting a generally positive perception. A total of 26.5% (18.8% much and 8.3% very much) also express higher confidence in adherence. While 55.0% respondents of the RUET also report somewhat adhering, a significant 32.5% (10% much and 22.5% very much) express stronger confidence compared to DU, indicating a favorable perception among its stakeholders. Among the respondents of the JnU 50.0% of respondents feel that their university somewhat complies, with a notably lower percentage (4.8% much and 9.5% very much) indicating strong confidence in adherence. However, the data suggests a mixed but generally positive view of the university's compliance with accrediting standards, with the majority leaning towards some level of compliance.

Faculty involvement in matching instructional methods with accreditation criteria is vital for ensuring that educational practices fulfill the required benchmarks. This shows a substantial level of participation among professors in matching their teaching approaches with accreditation standards.

Table 5: Faculty Involvement in Accreditation Alignment

Response	DU	RUET	JnU
Not at All	22.9%	12.5%	21.4%
Not Really	4.2	5.0	7.1
Undecided	2.1	7.5	19.0
Somewhat	54.2	52.5	26.2
Much	10.4	20.0	19.0
Very Much	6.3	2.5	7.1
Total	100.0%	100.0%	100.0%

Table 5 presents data on faculty involvement in aligning with accreditation requirements at three universities: DU, RUET, and JnU. A significant portion (54.2%) of respondents of DU report that faculty involvement is 'somewhat' aligned with accreditation. This indicates a moderate level of faculty engagement. However, 22.9% feel that faculty involvement is 'not at all' present, highlighting a notable concern. Similarly, 52.5% of respondents of RUET indicate that faculty involvement is 'somewhat' aligned. However, only 12.5% feel there is "not at all" involvement, suggesting more confidence compared to DU. A lower percentage (26.2%) believe faculty involvement is 'somewhat' aligned, while a relatively high 21.4% say 'not at all.' This suggests significant challenges in faculty engagement at JnU.

When questioned about the university's overall alignment with accrediting requirements, the opinions are fairly distributed, with a leaning towards recognizing some level of impact from the university's alignment with accrediting requirements. The opinions are distributed across the spectrum, with a significant lean towards recognizing some level of alignment with accreditation requirements.

Table 6: Perceived Alignment with Accreditation Requirements

Response	DU	RUET	JnU
Not at All	14.6%	10.0%	14.3%
Not Really	4.2	10.0	7.1
Undecided	4.2	10.0	21.4
Somewhat	37.5	32.5	23.8
Much	27.1	32.5	26.2
Very Much	12.5	5.0	7.1
Total	100.0%	100.0%	100.0%

Table 6 provides insights into the perceived alignment of the universities with accreditation requirements. A notable 37.5% of respondents of DU feel that their university somewhat aligns with accreditation requirements. Additionally, 27.1% report that alignment is much, indicating a generally positive perception of DU's compliance. Similar to DU, RUET shows that 32.5% believe there is some alignment, with an equal percentage (32.5%) expressing a strong sense of alignment (much). This reflects a solid perception of RUET's adherence to accreditation standards. In contrast, JnU has the lowest percentage of respondents indicating that the university somewhat aligns (23.8%). While 26.2% feel there is much alignment, the overall perception of alignment appears less favorable compared to the other two universities.

The opinions are spread across the spectrum, with a significant leaning towards recognizing a positive impact of accreditation criteria on improving university operations and quality.

Table 7: Impact of Accreditation Standards on University Operations

Response	DU	RUET	JnU
Not at All	18.8%	7.5%	2.4%
Not Really	4.2	7.5	9.5
Undecided	35.4	7.5	9.5
Somewhat	41.7	37.5	40.5
Much	18.8	30.0	38.1
Very Much	0.00	10.0	0.00
Total	100.0%	100.0%	100.0%

Table 7 presents the perceived impact of accreditation standards on university operations across the sample universities. A substantial 41.7% of respondents of DU feel that accreditation standards somewhat impact university operations. However, there is a significant level of uncertainty, with 35.4% undecided about the impact, which suggests that many stakeholders may be unclear about how accreditation influences operations. Notably, 18.8% believe there is no impact at all. The result of RUET shows a similar pattern, with 37.5% stating somewhat and only 7.5% undecided. The percentage of respondents indicating no impact (7.5%) is lower than that of DU, suggesting a slightly more positive view of the impact of accreditation standards on operations. In case of JnU a majority (40.5%) of respondents also perceive a somewhat positive impact from accreditation standards. However, a very low percentage (2.4%) indicates no impact at all, suggesting a more favorable view compared to DU and RUET.

Faculty trust in the university's capacity to regularly achieve accreditation standards indicates a variegated landscape.

Table 8: Confidence in Meeting Accreditation Standards

Response	DU	RUET	JnU
Not at All	10.4%	12.5%	14.3%
Not Really	14.6	10.0	4.8
Undecided	0.00	7.5	21.4
Somewhat	52.1	40.0	33.3
Much	22.9	20.0	21.4
Very Much	0.00	10.0	4.8
Total	100.0%	100.0%	100.0%

Table 8 presents data on the confidence levels of respondents at sample universities regarding their universities' ability to meet accreditation standards. A strong majority (52.1%) of respondents feel somewhat confident in their university's ability to meet accreditation standards. However, a notable portion (10.4%) expresses complete lack of confidence ('Not at All'), indicating some concerns among stakeholders. Similar to DU, RUET has 40.0% of respondents who are somewhat confident, with a higher percentage (12.5%) stating they have no confidence at all. This suggests some skepticism, though the overall confidence appears relatively stable. The highest percentage of respondents of JnU (33.3%) express somewhat confidence, but 14.3% indicate no confidence at all, showing a critical view of their institution's readiness. Additionally, 21.4% are undecided, indicating significant uncertainty regarding JnU's ability to comply with standards.

The opinions are distributed across the spectrum, with a notable number of respondents recognizing some level of acknowledgment from external stakeholders.

Table 9: External Stakeholders' Acknowledgment of Compliance

Response	DU	RUET	JnU
Not at All	18.8%	7.5%	11.9%
Not Really	8.3	7.5	9.5
Undecided	0.00	5.0	14.3
Somewhat	33.3	52.5	40.5
Much	29.2	25.0	21.4
Very Much	10.4	2.5	2.4
Total	100.0%	100.0%	100.0%

In the above table 9, in case of DU, a significant percentage of external stakeholders (33.3%) feel that the university somewhat complies with accreditation standards. However, 18.8% express that there is no acknowledgment of compliance at all, indicating some skepticism among stakeholders. RUET has a more positive perception, with 52.5% of respondents believing there is some acknowledgment of compliance. The percentage of those stating no acknowledgment (7.5%) is lower than that of DU, suggesting greater confidence in RUET's compliance. With 40.5% acknowledging somewhat compliance, JnU falls in between DU and RUET. However, the presence of 11.9% of respondents saying there is no acknowledgment reflects a level of concern about compliance.

Table 10: Readiness to Comply with Accreditation Standards

Response	DU	RUET	JnU
Not at All	20.8%	17.5%	14.3%
Not Really	8.3	7.5	4.8
Undecided	2.1	5.0	11.9
Somewhat	41.7	37.5	35.7
Much	20.8	30.0	28.6
Very Much	6.3	2.5	4.8
Total	100%	100.0%	100.0%

Table 10 presents data on the perceived readiness of the three to comply with accreditation standards. 41.7% of respondents of DU feel that their university is somewhat ready to comply with accreditation standards. However, a notable percentage (20.8%) express that they believe there is no readiness at all, which raises concerns about the institution's preparedness. A similar pattern is seen, with 37.5% of respondents indicating somewhat readiness. The percentage of those stating no readiness (17.5%) is lower than that of DU, suggesting a more favorable view of RUET's preparedness. JnU has 35.7% of respondents feeling somewhat ready, with the lowest percentage of respondents indicating no readiness at all (14.3%). This suggests a relatively positive outlook among stakeholders regarding JnU's readiness.

Hypothesis Formulate and Testing

Hypothesis 1: Faculty Perception of Compliance

Faculty members who are more involved in aligning their teaching methods with accreditation standards perceive higher overall compliance of the university with these standards.

H1o: There is no significant difference in the perception of compliance between faculty members with different levels of involvement in aligning teaching methods.

H1a: There is a significant difference in the perception of compliance between faculty members with different levels of involvement in aligning teaching methods.

Table 11: Hypothesis on Faculty Perception of Compliance

Correlations			
		1	2
How compliant do you observe your university to be with accreditation standards?	Pearson Correlation	1	.517**
	Sig. (2-tailed)		.000
	N	260	260
To what extent are you involved in aligning your teaching methods with accreditation standards	Pearson Correlation	.517**	1
	Sig. (2-tailed)	.000	
	N	260	260
**. Correlation is significant at the 0.01 level (2-tailed).			

Testing Hypothesis 1:

The purpose of the study was to investigate the relationship between faculty perceptions of the university's compliance with accreditation standards and their own engagement in coordinating instructional strategies with these standards. The Pearson correlation analysis results show a strong positive association (r =0.517, p <.001) between faculty perceptions of the university's compliance and how involved they are in matching their instructional strategies to accrediting standards.

This strong link implies that faculty members perceive better levels of compliance inside the university as they become more involved in matching their teaching practices to accreditation standards. This result is consistent with earlier studies that emphasize the value of faculty participation in accrediting procedures.

Moreover, it is probable that faculty members' alignment of their pedagogical approaches with accrediting criteria cultivates an environment of ongoing enhancement and quality control. Faculty members who actively participate in accrediting processes are more likely to absorb quality standards and incorporate them into their teaching strategies. This strengthens the institution's adherence to accreditation requirements and enhances teaching practices as a result.

A moderate to strong association is indicated by the study's significant correlation (r =0.517), which suggests that faculty engagement is essential to meeting and sustaining accreditation standards. Stakeholder theory also provides an interpretation for the favorable association between faculty involvement and compliance perception.

This study's results support the idea that faculty members' perceptions of the university's comprehensiveness improve when they are involved in ensuring that

teaching methods are in line with accreditation standards. This emphasizes how important it is for educational institutions to actively involve professors in the accrediting process in order to promote continual improvement and a quality culture.

Hypothesis 2: Impact of Accreditation on University Operations

There is a positive correlation between faculty perceptions of the impact of accreditation standards on university operations and their confidence in the university's ability to meet these standards consistently.

H2o: There is no significant correlation between the impact of accreditation standards and confidence in meeting these standards.

H2a: There is a significant correlation between the impact of accreditation standards and confidence in meeting these standards.

Table 12: Impact of Accreditation on University Operations

Correlations			
		1	**2**
How impactful do you think accreditation standards have been on improving the university's overall operations and quality?	Pearson Correlation	1	.396**
	Sig. (2-tailed)		.000
	N	260	260
How confident are you in the university's ability to consistently meet accreditation standards?	Pearson Correlation	.396**	1
	Sig. (2-tailed)	.000	
	N	260	260
**. Correlation is significant at the 0.01 level (2-tailed).			

Testing Hypothesis 2

This study looked at the relationship between the perception of how accrediting criteria affect the university's overall operations and quality and the university's perceived ability to regularly satisfy these standards. There is a substantial positive connection (r =0.396, p <.001) between these variables, according to the Pearson correlation analysis results. The observed link suggests that confidence in the university's capacity to regularly achieve accreditation standards rises in tandem with perceived improvements in the impact of these standards on operations and quality. This result is consistent with previous research that highlights the beneficial impact of accreditation on stakeholder confidence and institutional quality. Accreditation procedures, in the opinion of Kumar et al. (2020), act as a stimulant for methodical quality improvement and operational effectiveness in postsecondary educational establishments, which in turn builds stakeholders' and faculty's trust in the institution's ability to uphold compliance.

Furthermore, although the perceived impact of certification requirements strongly increases confidence levels, other factors might also be at play, according to the moderate strength of the correlation ($r = 0.396$). Ahrens & Khalifa's (2015) earlier research shows that perceptions of the impact of accreditation and compliance confidence are significantly shaped by institutional culture, leadership commitment, and resource allocation. Consequently, it is conceivable that these extra variables also influence the general level of confidence in the university's capacity to regularly achieve accreditation requirements.

The relevance of efficient accreditation procedures is highlighted by the strong correlation found between the perceived impact of accreditation and compliance confidence. When properly used, accreditation standards offer a framework for responsibility and ongoing improvement, which improves operational quality and stakeholder trust (Temponi, 2005). The findings are consistent with the quality assurance theory in higher education, which holds that accreditation is a means of both internal and external improvement (Mursidi et al., 2019). The study's positive connection supports the idea that institutions are more confident in their capacity to uphold and improve quality when they believe that certification criteria have an impact.

From a practical standpoint, these results indicate that academic institutions have to concentrate on optimizing the favorable influence of accrediting criteria on their functions and caliber. Transparent procedures, proactive involvement from stakeholders, and ongoing assessment of quality control methods can all help achieve this. Improving the way that stakeholders and faculty view accreditation will probably increase their confidence, which will help to maintain adherence to accreditation requirements.

Hypothesis 3: Support for Faculty Development

Universities with comprehensive policies supporting faculty development (e.g., advanced studies, attending conferences) report higher perceived compliance with accreditation standards.

H3$_0$: There is no significant difference in perceived compliance between universities with different levels of faculty development support.

H3$_a$: There is a significant difference in perceived compliance between universities with different levels of faculty development support.

Table 13: Impact of Accreditation on University Operations

Correlations		1	2	3	4
To what extent do you believe the university aligns with accreditation requirements across various aspects?	Pearson Correlation	1	.139	.243**	.140
	Sig. (2-tailed)		.115	.005	.112
	N	260	260	260	260
S7.4: The department/ university supports faculty to attend seminar, training workshop, conference, and academic visits at home and abroad	Pearson Correlation	.139	1	.483**	.259**
	Sig. (2-tailed)	.115		.000	.003
	N	260	260	260	260
S7.3: The department/ university has policy to support the faculty for further enhancement of academic excellence through advanced studies	Pearson Correlation	.243**	.483**	1	.306**
	Sig. (2-tailed)	.005	.000		.000
	N	260	260	260	260
S7.2: The university maintains a standard salary structure to retain the qualified manpower	Pearson Correlation	.140	.259**	.306**	1
	Sig. (2-tailed)	.112	.003	.000	
	N	260	260	260	260

**. Correlation is significant at the 0.01 level (2-tailed).

Examining the Third Hypothesis

Analyzing Hypothesis 3, which suggests that assessments of faculty support are strongly connected with the perception of the university's compliance with accreditation requirements, finds interesting relationships. According to the data analysis, there is a moderately favorable connection (r =0.243, p =.005) between the availability of policies encouraging faculty members' advanced academic endeavors and their perceived alignment with accreditation standards. This finding is consistent with other research that indicates strong faculty development programs, which have a direct impact on academic production and teaching quality, are essential for institutional alignment with accrediting standards.

Furthermore, it was shown that there was a positive but not statistically significant association (r =0.139, p =.115) between the support for faculty attending seminars, training workshops, conferences, and academic visits and the perceived compliance with accreditation criteria. This implies that although chances for professional development are crucial, their influence on the perception of adherence to certification requirements might be less direct or mediated by other elements, like the real application and use of the knowledge acquired from them.

Similarly, there was a positive but not statistically significant association (r =.140, p =.112) with keeping a conventional compensation structure to retain qualified labor. This suggests that while paying competitive salaries is necessary to draw and keep talented faculty, which helps the accreditation process along, the real impact on alignment with accreditation may involve more intricate dynamics like job satisfaction, institutional support, and faculty involvement.

Significant intercorrelations between the faculty support measures themselves are also revealed by the data. Significantly, there is a considerable association (r =.483, p =.000) between policies for promoting academic quality through advanced studies and encouragement for faculty to participate in professional development activities. The interdependence of faculty development programs is highlighted by this link, since comprehensive support systems have a tendency to reinforce one another, improving teacher performance overall and institutional quality.

The multidimensional strategy needed for institutional transformation is further highlighted by the positive and significant connection (r =0.306, p =.000) between policies encouraging faculty academic achievement and maintaining a standard compensation structure. A key component of faculty development is adequate compensation, which guarantees that instructors are capable of supporting the academic purpose of the university and are motivated to do so.

In summary, the results corroborate the hypothesis that measures of faculty support are linked to the perception of alignment with accrediting criteria; however, the degree and importance of these relationships differ. The policies that facilitate the academic enhancement of faculty members have the strongest link with the perceived alignment of accreditation, highlighting the crucial role that ongoing academic development plays. Though significant, the impact of compensation and professional development opportunities may be altered by other factors that call for more research. These revelations add to a more sophisticated knowledge of the ways in which institutional compliance with accrediting standards might be strategically improved through faculty assistance initiatives.

Hypothesis 4: Readiness of universities to comply with accreditation standards

Lack of financial support and inadequate infrastructure significantly impact the readiness of universities to comply with accreditation standards.

H4$_0$: Insufficient financial support negatively impacts the readiness of universities to comply with accreditation standards.

H4$_a$: Inadequate physical infrastructure negatively impacts the readiness of universities to comply with accreditation standards.

Table 14: Readiness of universities to comply with accreditation standards

Coefficients[a]								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	2.836	.787		3.605	.000	1.279	4.393
	S2.3: The department has sufficient autonomy with financial support to introduce innovative approaches	.047	.147	.027	.319	.750	-.244	.337
	S8.4: Necessary physical facilities are in good condition and accessible	.600	.151	.339	3.968	.000	.301	.900
a. Dependent Variable: How would you rate the readiness of your university to comply with accreditation standards?								

The goal of the current study was to investigate the factors that influence a university's ability to meet accreditation requirements, with a particular emphasis on the significance of adequate infrastructure and financial support. The dependent variable in the regression study was the university's perceived preparedness to adhere to accreditation norms (O11.7). The department's independence with funding to implement novel strategies (S2.3) and the state and accessibility of the required physical facilities (S8.4) were the independent factors. According to the research, compliance readiness was not significantly predicted by financial autonomy for implementing innovative techniques (S2.3) (β = 0.027, p = 0.750). According to this research, the perception of preparedness for accreditation cannot be greatly improved by the mere availability of funding for creative projects. The predictor's lack of significance emphasizes the need for prudent financial resource allocation and management in order to have a significant impact on accreditation readiness. This is consistent with recent research showing that in order to actually impact compliance readiness; financial support must be a component of a larger, well-integrated plan that includes other elements like administrative effectiveness and stakeholder involvement.

On the other hand, S8.4, which deals with the accessibility and state of physical facilities, showed substantial predictive power for compliance preparedness (β = 0.339, p < 0.001). Universities with better-maintained and easily accessible facilities are thought to be more equipped to meet accreditation standards, according to the considerable positive link. This result emphasizes how important infrastructure is to

overall accreditation readiness. Excellent physical facilities offer the conditions required for successful research, teaching, and learning-all crucial elements of accreditation criteria. There are multiple reasons why infrastructure sufficiency has such a significant impact on compliance readiness. Facilities that are kept up-to-date improve learning outcomes, create a favorable learning atmosphere, and facilitate the use of cutting-edge teaching strategies. Furthermore, a university's dedication to providing high-quality education is frequently demonstrated by its facilities, which can enhance stakeholders' opinions of the school and their confidence in its capacity to fulfill accreditation requirements.

The results of this study have significant policy and administrative ramifications for universities. First, it is suggested that colleges should give priority to investing in their physical facilities due to the substantial influence that adequate infrastructure has on compliance readiness. Maintaining these facilities can improve the learning environment and help meet certification requirements. They should also be easily accessible. Second, even though financial independence has advantages, it should be a component of a larger plan that also addresses institutional goals and efficient resource management. In order to be accredited-ready, universities must take a comprehensive approach that incorporates financial support with other essential elements, including administrative procedures, infrastructure, and stakeholder involvement. This strategy will raise the educational institution's general effectiveness and quality while also increasing compliance readiness.

A regression study verifies that while a shortage of funds, when not strategically handled, does not significantly predict readiness on its own, it does significantly affect compliance preparedness. These results highlight how crucial it is to maintain excellent physical facilities and implement a thorough plan for allocating financial resources. Universities can raise the overall caliber of education they offer and improve their preparedness for accreditation by concentrating on these areas.

Key Factors Influencing the Willingness of Universities

To identify the key factors influencing the willingness of universities to align with accreditation requirements, a Factor Analysis has been conducted. The results of the factor analysis reveal several critical insights into the factors influencing the willingness of universities in Bangladesh to comply with accreditation requirements. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.777, indicating that the sample was suitable for factor analysis, while Bartlett's test of sphericity was significant (χ^2 = 1874.925, df = 630, p < .001), confirming that the correlation matrix was appropriate for this analysis. Eleven factors with eigenvalues greater than one were extracted, explaining 66.2% of the total variance, and were subsequently rotated using Promax with Kaiser Normalization to facilitate interpretation.

Strategic alignment emerged as a pivotal factor, underscoring the necessity for the vision, mission, and objectives of the universities to be well-understood by all stakeholders. The moderate communalities (Initial: 0.361, Extraction: 0.286) reflect a need for improved communication of these elements. The significance of well-communicated strategic plans was highlighted by a high factor loading of 0.737, indicating their role in guiding institutional goals towards accreditation compliance. The curriculum and learning outcomes were also critical, with specific, measurable, attainable, relevant, and time-bound program learning outcomes showing a strong loading of 0.873. This finding underscores the importance of clear and standardized learning outcomes in the accreditation process. Additionally, compliance with the BNQF exhibited a significant loading of 0.573, further emphasizing the role of standardized curriculum frameworks.

Teaching and learning practices were found to be influential, with systematic, innovative, and practice-oriented methods showing strong factor loadings of 0.775, indicating their impact on accreditation compliance. The availability of course plans and outlines to students was also significant, with a loading of 0.788, reflecting the importance of transparency in teaching methods. Faculty and staff policies were highlighted as essential, with transparent recruitment policies and clear responsibilities within the organizational structure having moderate factor loadings of 0.500. The presence of KPIs for evaluating faculty performance was also significant, with a loading of 0.432, indicating the need for clear and measurable performance criteria.

Student support and development mechanisms were crucial, with well-communicated admission policies, orientation sessions, and career counseling and guidance showing moderate to high loadings. Specifically, career counseling and guidance had a significant loading of 0.736, underscoring their importance in student development and accreditation compliance. Research and industry collaboration were highly influential, with encouragement for faculty to conduct need-based research and collaborate externally showing very high loadings of 1.019. This finding highlights the critical role of research in meeting accreditation standards. Policies for disseminating research findings to industry and other stakeholders were also significant, with a loading of 0.749, emphasizing the need for active engagement with the broader academic and professional community.

Finally, the formal systems for collecting and managing stakeholder feedback were found to be highly significant, with loadings of 0.861, indicating their role in continuous quality improvement. This underscores the necessity of robust feedback mechanisms to ensure ongoing alignment with accreditation standards and continuous institutional improvement. Overall, the study identifies several key areas, including strategic alignment, curriculum frameworks, teaching practices, faculty policies, student support mechanisms, research collaboration, and feedback systems, that are critical for universities to focus on in order to align with accreditation requirements. Addressing these factors will enhance the readiness and

ability of universities in Bangladesh to meet the quality assurance criteria set by the Accreditation Council, leading to improved educational standards and outcomes.

Table 15: Key Factors Influencing the Willingness of Universities

Pattern Matrixa											
	Factor										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
S1.1: The vision, mission, and objectives of the department/ university are familiar to all stakeholders	.387	.387	.387	.387	.387	.387	.387	.387	.387	.387	.387
S1.3: The department has well communicated strategic plan										.737	
S1.4: The strategic plan of the department guides to achieve the vision, mission, and objectives of the university					.368					.587	
S1.7: The department/ university maintains appropriate class size						.808					
S2.1: Organizational structure of the department/ university contains clear responsibilities					.500						
S2.2: The department/ university maintains a set of values to foster social responsibility, diversity and inclusivity					.498						
S3.1: The department/ university maintains a well-communicated transparent policy for recruitment of both faculty and professional staff											
S3.5: The department/ university has a well-designed and informative website with easy access									.494		
S3.6: The department/ university has well-communicated policy to redress student grievances and complaints					.750						
S4.1: The curriculum committee ensures the participation of the industry/employers and alumni					.365						

Pattern Matrixa											
	Factor										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
S4.4: Program learning outcomes (PLOs) are align with graduate profile and goals of the department	.650										
S4.4: PLOs are specific, measurable, attainable, relevant and time-bound	.873										
S4.5: The Curriculum complies with BNQF	.573										
S4.6: The department maintains documented course file to attain course learning outcomes (CLOs)	.535				.319						
S5.1: The teaching learning practices method is systematic, innovative, practice oriented								.775			
S5.2: The teaching, learning, and assessment practices encourage practical evidence and critical thinking								.687			
S5.4: The department follows fair, valid, and appropriate assessment method for students progress							.596				
S5.5: Course plan/outlines are available to the students							.788				
S6.1: The department/ university maintains a well-communicated and transparent admission policy to select potentials and capable students											.664
S6.3: The department/ university organizes orientation and various awareness sessions						.484			.401		
S6.4: The department/ university organizes career counseling and guidance sessions									.736		
S6.6: The department has a well-organized alumni association]						.330					
S6.7: The department maintains student progress and achievement monitoring system						.398					
S7.3: The department/ university											

Pattern Matrixa											
	Factor										
	1	2	3	4	5	6	7	8	9	10	11
has policy to support the faculty for further enhancement of academic excellence through advanced studies											
S7.5: Existence of key performance indicators (KPIs) to evaluate faculty performance											.432
S7.7: The department/ university maintains provision to appoint guest faculty/adjunct faculty					.311						
S8.1: The department maintains a policy for student enrollment in a class/semester on the basis of capacity		.548									
S8.2: Facilities & Resources [The department/ university has library managed by appropriate library management software and well-trained qualified library professionals		.580									
S8.3: Adequacy of laboratory facilities and IT resources for effective teaching and research		.611									
S8.4: Necessary physical facilities are in good condition and accessible		.656									
S9.2: The department/ university encourages faculty to do need-based research with external collaboration			1.019								
S9.3: The department/ university maintains a policy to disseminate and transfer the research findings to the industry/community/stakeholders			.749								.400
S9.4: The department produces high-quality intellectual contributions that impact on the development of the society			.553								
S10.2: The department maintain a formal system for collecting and managing stakeholder feedback				.861							

Pattern Matrixa											
	Factor										
	1	2	3	4	5	6	7	8	9	10	11
S10.3: The department utilized stakeholders feedback for continual monitoring, evaluation, and improvement				.749							
S10.4: The department/ university maintains university industry collaboration for mutual benefits and improvement				.520							
Extraction Method: Principal Axis Factoring. Rotation Method: Promax with Kaiser Normalization.											
a. Rotation converged in 13 iterations.											

The combined data collected from the three universities reveals significant perceptions among faculty members and stakeholders regarding the university's adherence to and alignment with accrediting standards. Faculty members' perceptions of the university's overall alignment with accreditation requirements show a range of opinions. Approximately 5% of respondents felt that the university did not align at all, and 9% felt it did not align much. However, 32% and 12% believed that the university aligned much and very much, respectively, with accreditation standards. This variation indicates that while a significant portion of faculty perceives strong alignment, there is still a notable percentage that is uncertain or disagrees. During the qualitative field study respondents no 2 and 6 expressed a stronger confidence in compliance. One remarked, *'I feel that the university aligns significantly with accreditation standards'*. Furthermore, another respondent emphasized, '*I think we align very much with the accreditation criteria'*.

The involvement of faculty in aligning instructional methods with accreditation criteria is crucial. The survey shows that 39% of faculty felt they were much involved, while 8% felt very much involved. However, 17% were undecided, and a combined 7% felt not involved at all. This suggests that while there is a core group of faculty actively engaged in these processes, there remains a significant portion that may not feel as involved or aware. In my in-depth interviews with faculty members, a prevalent sentiment emerged regarding the alignment of instructional methods with accreditation criteria. Respondents # 3, 7 and 9 mentioned,

'While a core group appears actively engaged in these alignment processes, there exists a significant portion that may not share the same level of involvement or awareness. This highlights a potential gap that institutions should address, ensuring that all faculty members are adequately informed and engaged in fulfilling accreditation criteria'.

When asked about the impact of accreditation criteria on improving university operations and quality, faculty responses were largely positive. About 32% felt accreditation had a significant impact, and 12% felt it had a very significant impact. However, 18% were undecided, and 14% felt it had little to no impact. This suggests a general acknowledgment of the benefits of accreditation, although some skepticism or lack of awareness persists. Respondents # 1, 5 and 10 mentioned such statements and according to them,

'The presence of skepticism or uncertainty indicates a need for institutions to foster clearer communication and understanding among faculty regarding the role and benefits of accreditation'.

The study also examined faculty trust in the university's capacity to regularly achieve accreditation standards. The results were optimistic, with 38% indicating much confidence and 5% indicating very much confidence. Nonetheless, 13% were undecided, and 17% expressed low confidence levels. This indicates a general sense of readiness, tempered by some uncertainty or lack of confidence among a portion of the faculty. During the in-depth interviews with respondents, PI delved into their perceptions of the university's capacity to consistently meet accreditation standards. The respondents # 4 and 8 during the field study also argued that,

'The presence of uncertainty and low confidence levels among a portion of the faculty underscores the importance of ongoing efforts to bolster trust and assurance in the institution's ability to meet these critical benchmarks'.

Moreover, external stakeholders' perceptions were also considered. About 29% of respondents believed that external stakeholders acknowledged the university's compliance much and 5% felt they acknowledged it very much. However, 21% were undecided, and 14% felt there was little to no acknowledgment. This highlights the need for better communication and transparency with external stakeholders to enhance their awareness and support, such opinions were also expressed by the almost respondents during the field study in-depth interviews. They mentioned that,

'By enhancing awareness and fostering a clearer understanding of the university's commitment to accreditation standards, institutions can garner stronger support and recognition from these stakeholders, ultimately benefiting the institution as a whole'.

The purpose of this study was to determine how eager certain universities in Bangladesh were to comply with the accrediting council's standards for quality assurance. Comprehensive data collection from teachers, administrators, and academic leaders at public universities revealed some important insights about the motivations, obstacles, and readiness for accreditation compliance.

According to the study, perceived preparedness depends critically on how well the university's vision, mission, and objectives meet the needs of its stakeholders. Strategic planning and open communication have come to light as important

components of an institution's accreditation readiness. It was also discovered that the availability of sufficient financial resources and well-kept physical facilities were crucial factors in determining compliance readiness.

The impact of infrastructure on preparedness was shown via regression analysis, highlighting the necessity for institutions to make investments in their organizational and physical environments. The results also demonstrated the significance of clear recruitment procedures, creative and methodical teaching methods, and extensive career counseling services in cultivating a culture of excellence compliant with accreditation requirements.

Universities confront many difficulties even with their recognition of the advantages of accreditation, especially with regard to adequate infrastructure and financial assistance. In order to overcome these obstacles, institutional capacities must be strengthened through external partnerships and collaborations, strategic planning, and resource allocation.

The study's overall findings emphasize the complexity of accreditation compliance, which includes stakeholder interaction, resource management, and strategy alignment. Universities in Bangladesh can improve their accreditation readiness and, consequently, their reputation for providing high-quality education by focusing on these areas. The suggestions made provide universities with a road map for successfully navigating the accreditation process, guaranteeing long-term quality improvements and adherence to set standards.

Implications

Several suggestions might be made to improve Bangladeshi universities' willingness and ability to adhere to accreditation requirements in light of the research's findings.

First and foremost, universities must make sure that their goals, mission, and vision are clearly articulated and in line with the demands of society and stakeholders. According to the findings, stakeholders' perceptions of their organization's readiness for accreditation are greatly impacted by a distinct and coherent institutional vision. As a result, universities should constantly assess their strategic goals and share them with all relevant parties, making sure that they meet the needs of the modern educational and social landscape.

Secondly, having sufficient infrastructure and financial backing are essentials. A regression study showed that perceived readiness to meet accreditation norms is significantly predicted by the state of physical facilities. Resources for upkeep and modernization of physical infrastructure must be given top priority at universities. This involves making certain that classrooms, labs, libraries, and other spaces are accessible and in good working order. Furthermore, ensuring departments have enough financial support and authority to implement novel strategies can help create an environment that is favorable to adhering to accreditation criteria.

This report also emphasizes how crucial it is to have clear, open procedures, particularly when it comes to hiring teachers and providing students with career counseling and support. These components are essential for creating a strong institutional framework that backs up accrediting initiatives. In order to draw and keep talented faculty members, universities should create and uphold open recruitment practices. Furthermore, offering thorough career counseling services can improve the educational experience for all students and match academic objectives with business demands, which will help maintain accreditation compliance.

The methodical, creative, and practice-focused teaching approaches are another important component that has been found. In order to help faculty members, embrace and incorporate these teaching strategies, universities should make investments in their ongoing professional development. This investment raises the standard of education overall while also meeting accreditation standards.

Strategies must be implemented to address issues, including poor infrastructure and a lack of funding. To address these issues, universities should create comprehensive action plans that include partnerships and outside funding applications. In this context, industry and alumni collaboration can be advantageous as well, offering extra resources and insights to improve infrastructure and educational programs.

Lastly, universities ought to understand the reasons for accreditation pursuits and make use of them. It is important to foster the idea that accreditation standards have a positive effect on enhancing university operations. Universities can accomplish this by aggressively marketing the advantages of accreditation, including increased stakeholder satisfaction, better educational quality, and a higher institutional reputation.

In summary, universities in Bangladesh should prioritize aligning their strategic objectives with stakeholder needs, ensuring adequate financial and infrastructural support, maintaining transparent policies, adopting innovative teaching practices, and strategically addressing identified challenges in order to improve their readiness and willingness to comply with accreditation standards. By doing this, businesses can greatly improve the general caliber and efficacy of their educational programs, in addition to achieving accreditation compliance.

The theoretical contribution of this study lies in advancing our understanding of institutional willingness and readiness to comply with accreditation standards in higher education. Specifically, this study contributes to the literature on quality assurance and institutional behavior by exploring the factors influencing universities' motivations, challenges, and strategies related to accreditation. The study's recommendation policy on phased implementation and capacity-building strategies contribute to change management literature, suggesting practical methods for managing large-scale compliance initiatives. These insights may inspire further research into adaptive change strategies that align regulatory requirements with institutional goals, particularly in settings with limited resources. Policymakers can

use the findings to design more supportive and flexible regulatory frameworks that align with the capacities of higher education institutions. By coordinating with the UGC and other regulatory bodies, policymakers can harmonize standards to avoid conflicting requirements, ensuring consistent expectations across all institutions. This study highlights the need for a supportive policy environment that encourages quality improvements without overwhelming universities, which can ultimately enhance the higher education sector's contribution to sustainable development.

Limitations

This study may suffer from sample selection bias if the chosen universities are not representative of the broader population of institutions seeking accreditation. This could limit the generalizability of the findings. The assessment may not encompass all aspects of accreditation requirements, potentially overlooking certain crucial criteria or standards. The evaluation of willingness to comply with accreditation requirements may be subjective and prone to interpretation, impacting the reliability and validity of the results. The study may be limited by time constraints, preventing a comprehensive analysis of each university's readiness to comply with accreditation requirements. Resource constraints such as funding, access to data, and expertise hindered the thoroughness and depth of the assessment process. Future research could conduct a comparative analysis of universities across larger sample or with varying institutional characteristics to explore how willingness to comply with accreditation requirements varies. Longitudinal studies could track universities' progress in complying with accreditation requirements over time, providing insights into the effectiveness of interventions and strategies aimed at improving compliance. Future research could incorporate perspectives from other stakeholders, including students, and accrediting bodies, to provide a more comprehensive understanding of the dynamics at play. Research could investigate the impact of accreditation compliance on various outcomes, such as academic quality, student outcomes, institutional reputation, and financial sustainability, to assess its overall effectiveness and value.

Conclusions

Through implementing the NQF, the BAC has established standards for higher education institutions and academic programs in Bangladesh to ensure quality and accreditation. Universities nationwide have undertaken quality assurance initiatives based on these standards, with some institutions already achieving program accreditation. However, many participants in this study suggested a phased implementation of the National Qualifications Framework across universities to enable more manageable and sustainable quality assurance.

BAC could explore Public-Private Partnerships (PPP) to foster collaborations between the government, the private sector, and international organizations for

sharing expertise and resources; encourage industry engagement to align university curricula with industry needs and enhance practical learning; and facilitate international partnerships to benchmark best practices and align with global standards.

Furthermore, BAC could introduce mechanisms to: (i) promote academic freedom and institutional autonomy to foster innovation and creativity; and (ii) establish robust accountability systems to ensure universities uphold quality standards. In collaboration with universities, the BAC could also: (i) conduct public awareness campaigns highlighting the importance of accreditation and its benefits for students and society; (ii) engage with media outlets to disseminate information about accreditation and address misconceptions; and (iii) involve key stakeholders-students, parents, alumni, and employers-in the accreditation process to gather feedback and meet their needs.

Recommendations

BAC and UGC can strengthen their cooperation to mitigate the existing gaps regarding policy matters specially BNQF provisions. BAC can boost up relationships with the universities to enhance quality assurance and accreditation culture. Still there are weaknesses in writing SA report addressing BAC format and provisions. More attention is needed for BAC in this regard. Industry-academia relationship is critical to mitigate gaps between university and real life learning. BAC can take initiatives to establish active cooperation between university and industry.

Acknowledgments

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Determinants to Raise Awareness about Fourth Industrial Revolution (4IR): Realities and Pathways to Ensure Quality of Tourism and Hospitality Management Graduates

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Abstract

This study examined the key factors influencing awareness of the Fourth Industrial Revolution (4IR) among graduates of Tourism and Hospitality Management (THM). The research aimed to assess overall awareness levels and analyse the impact of various determinants. A mixed-method approach was employed to collect data from 432 respondents through a questionnaire survey. The findings revealed, while few THM graduates understand 4IR fully, many possess partial knowledge, and a substantial number are either unaware or unsure about it. Only 10% of graduates reported a full understanding, highlighting the need for more comprehensive education on the topic. The study identified government policies and regulations, social influences, and personal factors as significant contributors to raising awareness. These results emphasise the necessity of a coordinated policy approach to effectively promote 4IR awareness and integration. Interestingly, organisational factors and supportive facilities did not exhibit a direct impact on awareness, suggesting their role may be more indirect or supplementary. Overall, this study the highlights the crucial determinants of 4IR awareness among THM graduates and underscores the need for curriculum reforms to better equip them for the evolving industry landscape. Future research should explore these determinants across different contexts, investigate the link between awareness and skill development, and examine innovative educational strategies for enhancing 4IR awareness.

Keywords: 4IR Awareness; Curriculum Reform; Tourism and Hospitality Management; Tertiary Education

Introduction

The Fourth Industrial Revolution (4IR), also known as Industry 4.0, represents a technological shift that brings both opportunities and challenges. It influences economic, political, and sociocultural aspects of society (Schwab, 2017). While 4IR might seem like an evolution within social sciences, its core components—artificial intelligence, robotics, digitalisation, automation, and biotechnology—are fundamentally technological (Papadopoulou, 2020). These advancements significantly impact social and behavioural sciences, shaping both demand and supply dynamics. From a demand perspective, 4IR enhances human lives through

digitisation, automation, and product innovation. On the supply side, it drives productivity, efficiency, and economic growth by improving market innovation, cost reduction, communication, and supply chain management (Bousdekis & Mentzas, 2019).

However, economists Erik Brynjolfsson and Andrew McAfee argue that 4IR could lead to societal inequality by disrupting workforce skills (Schwab, 2017). The growing gap between technological advancements and human labour requirements may result in widespread job displacement. Automation and digitalisation will reduce the need for traditional labour while creating demand for new skills such as digital marketing, big data analytics, drone operation, chatbot management, content development, network security, and revenue analysis (Habib, 2020). This shift poses challenges for both current employees and new graduates entering the job market.

A study by Habib et al. (2020) identifies six key industries in Bangladesh—readymade garments and textiles, agro-food, furniture, tourism and hospitality, food & beverage, and leather & footwear—where emerging skills will be crucial due to 4IR. Without those skills, graduates may struggle to find employment, leading to negative consequences such as industrial decline, rising unemployment, foreign workforce dominance, GDP loss, and capital outflow. The only way to mitigate these risks and leverage 4IR's potential is to equip graduates with the necessary competencies. Increasing awareness about 4IR among students and related stakeholders is essential for ensuring skill development and excellence. Therefore, assessing graduates' awareness levels and identifying key factors that influence this awareness can help bridge existing gaps and formulate effective policies.

The tourism and hospitality management (THM) sector, a rapidly growing industry, will experience significant disruptions due to 4IR. This industry comprises various interconnected sectors, including tour operations, travel agencies, lodging, airlines, cruises, restaurants, catering, event management, and recreation. Consequently, the impact of 4IR is expected to be particularly pronounced in THM. Research suggests that by 2040, more than 25,000 employees in this sector could lose their jobs (Habib et al., 2019). However, job recovery is possible if graduates acquire new skills relevant to the evolving industry.

Emerging skills required in THM include knowledge management, data analytics, chatbot operations, network security, IoT, digital marketing, and revenue analysis. Specific areas such as front office management, housekeeping, sales, and food and beverage production will demand expertise in electronics, mechanics, computation, and communication (Habib et al., 2019). However, it remains unclear whether THM graduates of are aware of these evolving skill demands or possess the necessary expertise. Given that 4IR is a relatively new concept in Bangladesh, this study aims to assess THM graduates' awareness and identify key determinants influencing their understanding.

This research seeks to evaluate awareness levels, determine factors affecting awareness, and propose strategies to enhance skill development among THM and other graduates. By addressing these gaps, institutions can better prepare students for 4IR, enabling them to navigate challenges and seize emerging opportunities in the job market.

Methodology

Research Design

This study employs a mixed-methods approach, integrating qualitative and quantitative research. A preliminary conceptual framework for raising awareness about 4IR was developed from the literature and later refined through qualitative research. The qualitative approach explores 4IR awareness, while the quantitative study examines factor relationships influencing awareness.

Target Population

The study focuses on Tourism and Hospitality Management (THM) graduates from three representative public universities in Bangladesh—Dhaka University (DU, Islamic University (IU), and Bangabandhu Sheikh Mujibur Rahman Science and Technology University (BSMRSTU)—selected based on their establishment year and student population. Given that THM graduates will face 4IR-driven challenges, participants include students from the first year to the MBA level.

Sample Size and Selection

The study used Chen and Yung's (2023) guideline of five respondents per parameter in structural equation modelling (SEM) and systematic random sampling to select 240 respondents for its 48-item questionnaire, while Lincoln and Guba's (1985) theoretical sampling approach was used for qualitative research.

Questionnaire Development

The questionnaire was based on existing literature and preliminary field studies. Initially, it comprised 50 items across six factors. Pre-testing identified redundancies and ambiguities, leading to refinements and a final version with 48 items, including demographic questions.

Data Collection

Data were collected using semi-structured questionnaires and in-depth interviews. The qualitative phase aimed to identify key determinants of 4IR awareness, while face-to-face surveys provided quantitative data. The researcher visited the selected universities to conduct surveys and interviews.

Data Analysis

Content analysis and continual comparative methods identified key themes and subthemes in qualitative data (Yin, 2003; Sardar et al., 2022). After validation among respondents, emerging themes were integrated into quantitative analysis.

To investigate hypothesised associations, bootstrapping was used to analyse quantitative data from 432 valid replies (excluding 18 incomplete surveys). PLS-SEM measured variable associations, including collinearity (variance inflation factor), reliability (CR), validity (AVE), and heterotrait-monotrait (HTMT) ratio. The structural model's prediction power and effect size were assessed (Hair Jr et al., 2019; Henseler, 2015).

Determinants to Raise Awareness of the Fourth Industrial Revolution (4IR)

Organizational Factors

Awareness of the 4IR and quality tourism and hotel management graduates depend on organisational factors. University, company, and industry collaboration affects individuals' readiness to adopt 4IR technologies and practices (Yilmaz & Özdagoglu, 2020). Researchers say colleges and training institutions must prepare graduates for 4IR's problems and prospects (Vu & Van Huong Dong, 2019). Institutions must collaborate with industry stakeholders to adapt educational programs to changing skill needs (Lộc & Thanh, 2020).

Organisational culture, leadership, and strategic direction greatly impact 4IR technology adoption and integration (Sarı et al., 2020; Wang et al., 2020; Yilmaz & Özdagoglu, 2020). Organisational readiness levels vary by size and structure, emphasising the necessity of organisational preparedness in 4IR implementation (Kiana & Mabeifam, 2020).

Personal Factors

Personal attributes, skills, attitudes, and motives influence how tourism and hospitality management graduates view and engage with the 4IR. An individual's talents, weaknesses, flexibility, and cognitive agility are essential for managing technology advances and industry transformations (Flores et al., 2018).

Research shows that handling dynamic and uncertain circumstances requires self-discipline, resilience, and adaptation (Akparobore et al., 2020; Khin & Kee, 2022; Sant'Anna, 2022). Developing these competencies requires ongoing education (Lamb et al., 2017). Studies show that students' mindsets and skill sets strongly affect firms' big data use, highlighting the importance of individual knowledge in technological growth (Flores et al., 2018). Research on how employees and young professionals view automation-related developments emphasises the importance of career guidance and mentorship in improving employability and adaptability (Asif et al., 2022). Digital literacy is also important for developing personal and soft skills, especially in the 4IR era (Yanzi et al., 2019).

Personal attributes, abilities, and attitudes significantly impact workers' and managers' ability to comprehend and adopt Industry 4.0 technology. Continuous self-improvement is crucial for young professionals to stay competitive in the job market due to gaps in 4IR knowledge, abilities, and awareness (Lộc & Thanh, 2020).

University students' 4IR awareness and readiness studies stress the need to fill skills and knowledge gaps to prepare them for the workforce (Ujakpa et al., 2020). In a dynamic technology context, encouraging curiosity, enthusiasm, and a willingness to learn about 4IR concepts and tools is crucial for individual preparation and awareness.

Supportive Facilities

Tourism and hospitality management graduates need supportive facilities to handle the 4IR. Educational tools, training programmes, digital infrastructure, and collaborative networks promote learning and skill development (Lamb et al., 2017). Implementing sophisticated technologies like IoT and Big Data requires interoperability, security, and privacy (Flores et al., 2018).

Supportive facilities are important, but budget, space, and knowledge deficiencies might make them ineffective (Kayembe & Nel, 2019). Industry groups, employers, and training providers help create skill development and job transition settings (Asif et al., 2022). Sarac et al. (2020) found that infrastructure, tools, software, and digital services greatly impact Industry 4.0 adoption and readiness levels.

Educational institutions are key to 4IR knowledge and skills. Universities and training centres must update curricula and implement creative teaching methods to meet industrial demands (Lộc & Thanh, 2020). Industry 4.0 awareness and readiness require collaboration between universities, research organisations, and industry players (Safar et al., 2020).

National policies, strategic alliances, and comprehensive education and training programmes should raise awareness and encourage 4IR technology adoption. Well-developed supportive facilities shape the preparation and flexibility of future tourism and hospitality workers.

Government Policy and Regulations

Economic and social sectors depend on government policies and regulations. These policies shape stakeholder readiness and adaptability in the context of the 4IR and its effects on tourism and hospitality management. They set emerging technology legal and operational rules, industry standards, investment incentives, and regulatory compliance (Flores et al., 2018).

Government action can promote 4IR technology adoption in tourism and hospitality by providing infrastructure, financial support, and regulatory frameworks (Sarı et al., 2020). Government policies also shape stakeholders' 4IR awareness, attitudes, and actions, which drives technology improvements (Safar et al., 2020). Misalignment with national development plans, policy implementation issues, and the need for targeted support remain major obstacles. The 4IR age requires regulatory adaptation due to these difficulties (Akparobore et al., 2020). Despite these obstacles, legislative improvements may help close gaps and foster technical innovation (Khin & Kee, 2022).

Furthermore, government-led programs enhancing graduates' digital competencies highlight the state's responsibility in adapting education and training systems to 4IR demands (Lộc & Thanh, 2020). Thus, well-structured policies and regulations help tourism and hospitality management professionals understand and prepare for 4IR technologies.

Social Factors

In the 4IR, social influence refers to how cultural norms, interpersonal relationships, community interactions, and institutional frameworks shape people's knowledge, attitudes, and behaviours towards technology. These social elements shape how individuals view and respond to 4IR's chances and difficulties.

Intercultural competence, empathy, ethical awareness, and social responsibility promote 4IR technology inclusivity and acceptance (Lamb et al., 2017). Research emphasises the need for comprehensive studies and supportive policies to mitigate negative consequences and maximise benefits of 4IR, including job creation, job displacement, social connectivity, and environmental sustainability (Asif et al., 2022; Flores et al., 2018; Sarı et al., 2020).

The impact of social media and digital media on public awareness and understanding of 4IR is enormous, with both positive and negative effects on knowledge diffusion and disinformation (Lộc & Thanh, 2020). As 4IR research examines social justice and equitable access to technology, ethics, fairness, and sustainability are also important societal issues (Safar et al., 2020).

The importance of educators and professionals in promoting digital literacy, decreasing the digital gap, and providing equal access to information and technology resources highlights 4IR's societal impact (Akparobore et al., 2020; Khin & Kee, 2022). Social variables influence 4IR awareness and preparedness in tourism and hospitality management.

4IR Awareness

Recognition of the 4IR emphasises how sophisticated technologies change businesses, especially tourism and hospitality. Robotics, AI, and big data are changing how people work, travel, and experience the world (Doecke & Maire, 2019). Innovation relies on government infrastructure, finance, and policies (Flores et al., 2020). To succeed in 4IR, personal awareness requires new skills including digital competency and adaptability (Khin et al., 2021). Tourism graduates need education and training (Loc et al., 2022). Social awareness involves comprehending employment, inclusion, and moral impacts (Safar et al., 2020). To remain competitive, industries must adopt 4IR technologies, while stakeholder awareness promotes quality graduates and innovation (Yilmaz & Özdagoglu, 2020; Alonso et al., 2024).

Proposed Conceptual Framework

This framework, based on literature and theory, identifies key determinants influencing 4IR awareness among THM graduates. Awareness is shaped by personal traits, university support, external influences (industry, government, NGOs), and social surroundings. Organisational factors affect internal practices and learning environments (Gangwar et al., 2015; Mishra et al., 2014). Personal factors shape knowledge, attitude, and cognitive abilities. Supportive factors create environments that enhance awareness (Hew et al., 2015; Razak et al., 2018). Social surroundings (family, peers, media) play a key role (Razak et al., 2018; Abbas et al., 2019).

Government policies provide incentives, regulations, and initiatives (Díaz-García et al., 2015). The combined impact of these factors enables graduates to recognise 4IR technologies, skills, and concepts (Figure 1). This research tests the framework's validity in raising 4IR awareness.
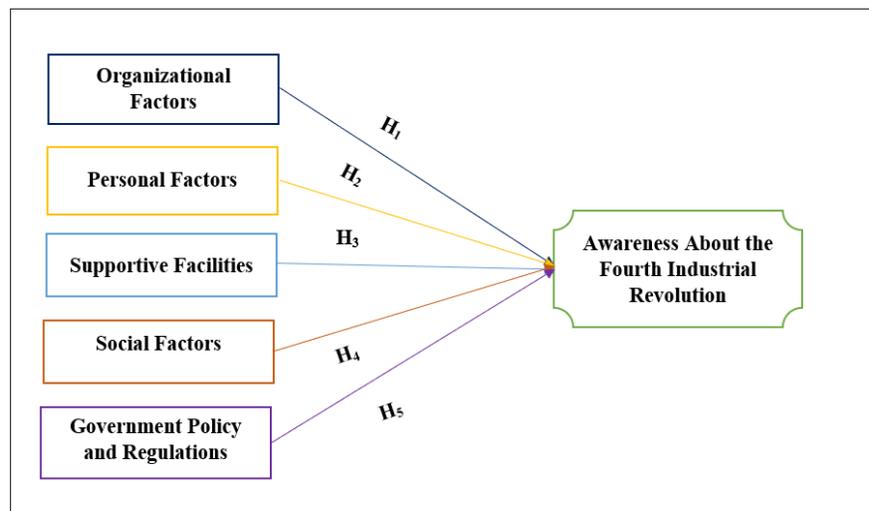
Figure 1: Proposed Conceptual Framework of Raising Awareness About the Fourth Industrial Revolution. (Source: Developed by the Authors)

Results and Discussion

Demographic Profile of the Respondents

The demographic profile of the 432 respondents shows a fairly even distribution across three universities: DU (34.7%), IU (34.5%), and BSMRSTU (30.8%). The study level is equally distributed among 1st to 4th-year students (20.8% each), with MBA students comprising 16.7%. There's a slight gender imbalance, with 58.1% male and 41.9% female participants. Age-wise, the vast majority (96.8%) fall within the 21-25 years range, with only small percentages below 20 years (2.8%) or between 26-30 years (0.5%). The result focused that the sample was primarily composed of undergraduate students from three different universities, with a slight male majority and an overwhelming concentration in the early-to-mid-twenties age group.

Objective 1. Present 4iR-focused knowledge and skills of the THM graduates.

For analyzing the awareness scenario of the THM graduates on 4IR, this research surveyed an open-ended questionnaire. This research asked the THM graduates of three public universities whether they understood the concept of 4IR Fully or not at all. Among the 432 respondents, the majority (237) indicated a partial understanding of 4IR, suggesting a foundational grasp of its concepts. However, a notable portion of respondents (88) reported not hearing about 4IR, indicating a potential gap in exposure or communication channels regarding this transformative phenomenon within the industry. Only 43 respondents claimed to fully understand 4IR, showcasing a segment of graduates well-versed in its intricacies, and possibly equipped to leverage its opportunities within the tourism and hospitality sector. But this portion is very low, only 10% of the total respondents. This comprehensive analysis underscores the varying levels of awareness and comprehension among THM graduates regarding 4IR, suggesting avenues for targeted education and awareness initiatives to ensure holistic industry preparedness.

In the era of the Fourth Industrial Revolution (4IR), soft skills are more crucial than ever for tourism and hospitality graduates. While technical skills and industry-specific knowledge remain important, soft skills play a pivotal role in ensuring success and competitiveness in this rapidly evolving sector. Researchers (Nguyen et al., 2021) focused on nine (09) soft skills that are required for the future job market. This research also asked students about the required soft skills in the era of 4IR. The results of Figure 2 of understanding the level of required soft skills in the era of the Fourth Industrial Revolution (4IR) among graduates from DU, IU, and BSMRSTU provide valuable insights into the perceptions and awareness of these competencies. Problem-solving emerges as one of the most emphasized soft skills across all institutions, with a total of 71 responses. This underscores the recognition of the importance of analytical thinking and problem-solving abilities in navigating complex challenges characteristic of the 4IR era. Similarly, leadership and management skills are deemed significant, with 51 responses overall, suggesting an acknowledgment of the need for effective leadership in driving innovation and managing teams in dynamic environments. Adaptability and critical thinking are also highlighted as essential soft skills, although there are variations in the responses across institutions. While adaptability is recognized by 38 respondents, critical thinking garners 37 responses. These skills are crucial for thriving in the face of rapid technological advancements and changing workplace dynamics characteristic of the 4IR.

Creativity is another important soft skill, with 35 responses indicating its recognition as an asset in fostering innovation and problem-solving. However, there appears to be a disparity in the emphasis placed on teamwork, with only 33 responses overall. Given the collaborative nature of many 4IR initiatives, fostering effective teamwork skills is essential for driving collective progress and achieving shared goals. Judgment and decision-making skills, emotional intelligence, conflict resolution, and

negotiation are also recognized as important soft skills, albeit to a lesser extent. These competencies are crucial for navigating interpersonal dynamics, resolving conflicts, and making informed decisions in complex and ambiguous situations characteristic of the 4IR era. The presence of "No Response" in a significant number of cases, totaling 107, suggests a potential lack of awareness or understanding regarding the importance of soft skills among some respondents. In addition, very few respondents mentioned the skill of conflict resolution and negotiation. Moreover, out of 432 respondents, the maximum number of respondents responding to the identified soft skills is only 71.

In open-ended questions regarding soft skills, most of the respondents from all three universities mentioned irrelevant terminology. This highlights the need for comprehensive education and awareness initiatives to ensure that graduates are equipped with the necessary soft skills to succeed in the 4IR era. The results of soft skills underscore the importance of soft skills in the context of the 4IR era and highlight the need for ongoing education and awareness initiatives to foster the development of these competencies among THM graduates. By emphasizing problem-solving, leadership, adaptability, critical thinking, creativity, and other essential soft skills, educational institutions can better prepare graduates to thrive in the rapidly evolving landscape of the 4IR and contribute meaningfully to future advancements and innovations.
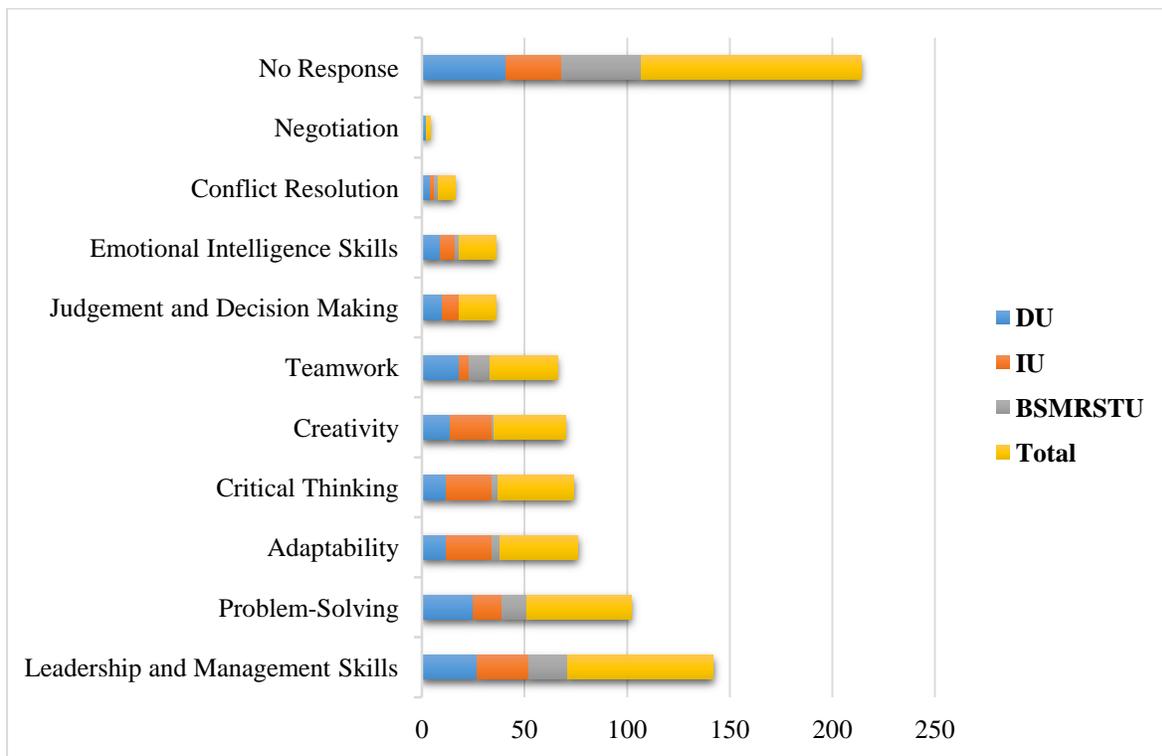
Figure 02: Present knowledge of THM about the Required Soft Skills in the 4IR Era. Data Source: Questionnaire Survey

Objective 2. Determinants of raising awareness about 4IR.

Assessment of Measurement Model

This study identified five determinants through field study and literature review that influence raising awareness about 4IR. In Table 1 the identified determinants are- Organizational Factors (OF), Government Policy and Regulation (GPR), Personal Factors (PF), and Supportive Facilities (SPF). The determinants are further confirmed through confirmatory factors analysis. All constructs demonstrated good reliability and validity. Cronbach's Alpha values ranged from 0.711 to 0.822, while Composite Reliability scores were between 0.792 and 0.875. Convergent validity was established with Average Variance Extracted values above 0.5 for all constructs. Factor loadings for individual items were generally high, ranging from 0.606 to 0.798, indicating effective measurement of respective constructs. Notably, AW showed the highest reliability (CA = 0.822, CR = 0.875) and convergent validity (AVE = 0.585), while SF demonstrated strong reliability (CA = 0.805, CR = 0.853) and good convergent validity (AVE = 0.578). The results suggest a robust measurement model, effectively capturing various factors influencing 4IR awareness, adoption, and implementation.

Table 01: Assessment of Item Reliability

Constructs/ Determinants	Description	Factor Loading	CA	CR	AVE
Awareness About 4IR (AW)	Recognize the 4IR Among Many Other Tech-Concepts	0.689	0.822	0.875	0.585
	Follow the News and Developments About 4IR	0.791			
	Discuss the 4IR with Friends and People	0.793			
	Some Characteristics of 4IR Come to Mind Quickly	0.798			
	Effortlessly Imagine What the 4IR Technologies	0.747			
Govt. Policy & Regulation (GPR)	Government Initiatives	0.680	0.778	0.846	0.524
	Government Special Order/Circular	0.753			
	Government Financial Incentives	0.691			
	Subsidies on 4iR-Related Products	0.733			
	Initiatives of Local Governments	0.759			
Organizational Factor (OF)	4IR-Focused Courses in the Curriculum	0.721	0.731	0.821	0.502
	Positiveness of the University Faculties	0.713			
	Positiveness of the University Administration	0.755			
	Vision of the University	0.641			

Constructs/ Determinants	Description	Factor Loading	CA	CR	AVE
	Relationships among Faculties and University Admin	0.624			
Personal Factor (PF)	Desire to Entrepreneurial Skills	0.701	0.711	0.802	0.510
	Learnings Enjoyment	0.669			
	Desire to New Knowledge	0.615			
	Desire To Get Top Positions	0.679			
	Enjoyment in Learning New Things	0.678			
Social Factor (SF)	Mass Media	0.606	0.805	0.853	0.578
	Interaction with Industry Experts	0.727			
	Webinar About 4IR	0.704			
	Information on social media	0.681			
	Using social media	0.655			
	Sharing Lectures on social media	0.709			
	Role of Social Media By Itself	0.630			
Supportive Facilities (SPF)	Facilitating conditions to use new technology	0.636	0.753	0.792	0.543
	Cooperation and Skill of Course Instructors	0.724			
	The Good Internet Connection	0.687			
	Digital Tools	0.744			

Note: No item was deleted as found acceptable loading composite reliability (> 0.792).

Table 2: Results of the Heterotrait-Monotrait (HTMT.85) Criterion

	AW	GPR	OF	PF	SF	SPF
AW						
GPR	0.436					
OF		0.631				
PF		0.535	0.497			
SF		0.668	0.489	0.596		
SPF		0.768	0.641	0.690	0.715	

Note: AW (Awareness), GPR (Govt. Policy & Regulation), OF (Organizational Factor), PF (Personal Factor), SF (Social Factor), and SPF (Supportive Facilities).

The Heterotrait-Monotrait (HTMT) ratio is used to assess discriminant validity between constructs in the measurement model. Table 2 presents the HTMT ratios for the six constructs: Awareness (AW), Government Policy & Regulation (GPR), Organizational Factor (OF), Personal Factor (PF), Social Factor (SF), and Supportive

Facilities (SPF). All HTMT ratios are below the 0.85 threshold, indicating good discriminant validity between all pairs of constructs. This suggests that each construct is distinct and captures unique aspects of the Fourth Industrial Revolution (4IR) adoption and implementation. The lowest HTMT ratio is observed between Awareness (AW) and Government Policy & Regulation (GPR) at 0.436, indicating these constructs are highly distinct from each other. This suggests that awareness of 4IR and government policies related to it are perceived as separate aspects by the respondents. The highest HTMT ratio is found between Supportive Facilities (SPF) and Government Policy & Regulation (GPR) at 0.768. While still below the threshold, this higher value suggests a stronger relationship between these constructs. This could indicate that respondents perceive a connection between government policies and the availability of supportive facilities for 4IR implementation. Organizational Factor (OF) shows moderate HTMT ratios with other constructs, ranging from 0.489 to 0.641. This suggests that organizational aspects are distinct from, yet related to, other factors influencing 4IR adoption. Personal Factor (PF) demonstrates HTMT ratios between 0.497 and 0.690 with other constructs, indicating it is sufficiently distinct while still showing some relationship with other factors, particularly with Supportive Facilities (SPF). Social Factor (SF) shows HTMT ratios ranging from 0.489 to 0.715, with the highest ratio being Supportive Facilities (SPF). This suggests that social aspects and supportive facilities may have some overlapping influences on 4IR adoption. Overall, the HTMT ratios demonstrate good discriminant validity among all constructs in the model. This supports the notion that each construct measures a unique aspect of 4IR adoption and implementation, providing a solid foundation for further analysis of their relationships and impacts.

The above findings of this study provide valuable insights into the determinants of raising awareness about the Fourth Industrial Revolution (4IR) among tourism and hospitality management graduates. The results reveal a complex interplay of factors that influence 4IR awareness, with government policy and regulation, personal factors, and social factors emerging as significant determinants. Conversely, organizational factors and supportive facilities did not show a significant direct influence on 4IR awareness. The results are discussed below as per the role of each determinant.

Government Policy and Regulation

The study found that government policy and regulation have a significant positive influence on raising awareness about 4IR. This aligns with previous research highlighting the crucial role of government initiatives in promoting technological adoption and awareness (Schwab, 2017). The strong impact of government policy underscores the need for a comprehensive and coordinated approach to 4IR awareness and implementation. The high factor loadings for government initiatives (0.680), special orders/circulars (0.753), financial incentives (0.691), subsidies on 4IR-

related products (0.733), and initiatives of local governments (0.759) demonstrate the multifaceted nature of government influence. This suggests that a holistic approach to policymaking, encompassing both national and institutional levels, is crucial for effectively promoting 4IR awareness. These findings are consistent with the work of L. D. Xu et al. (2018), who emphasized the importance of government support in driving 4IR adoption across various sectors. In the context of tourism and hospitality, government policies can play a pivotal role in shaping the industry's technological landscape and preparing the workforce for future challenges (Ivanov & Webster, 2019).

Personal Factors

The significant impact of personal factors on 4IR awareness highlights the importance of individual characteristics and motivations in the learning process. The high factor loadings for the desire for entrepreneurial skills (0.701), learning enjoyment (0.669), desire for new knowledge (0.615), desire to get top positions (0.679), and enjoyment in learning new things (0.678) indicate that intrinsic motivation plays a crucial role in driving 4IR awareness. These findings align with the self-determination theory proposed by Ryan and Deci (2000), which emphasizes the importance of intrinsic motivation in driving learning and personal growth. In the context of 4IR, individuals who are naturally curious and eager to learn are more likely to seek out information and engage with new technologies. The strong influence of personal factors also resonates with the concept of digital natives proposed by (Prensky 2001). As many current students in tourism and hospitality management programs are digital natives, they may have a natural inclination toward technology adoption and learning. However, this also highlights the need to address potential disparities in technological familiarity among students from different backgrounds.

Social Factors

The study revealed that social factors, including mass media (0.606), interaction with industry experts (0.727), webinars about 4IR (0.704), information on social media (0.681), and sharing lectures on social media (0.709), play a crucial role in raising 4IR awareness. This finding underscores the importance of diverse information sources and social interactions in shaping awareness and understanding of complex technological phenomena. The significant impact of social factors aligns with social learning theory (Bandura, 1977), which posits that individuals learn through observation, imitation, and modeling. In the context of 4IR awareness, exposure to diverse perspectives and real-world applications through various social channels can significantly enhance understanding and engagement. The high factor loading for interaction with industry experts (0.727) is particularly noteworthy. This suggests that bridging the gap between academia and industry is crucial for enhancing 4IR awareness among students. This finding is consistent with research

by Nguyen and Nguyen (2020), who emphasized the importance of industry-academia collaboration in hospitality education.

Organizational Factors and Supportive Facilities

Interestingly, the study found that organizational factors and supportive facilities did not have a significant direct influence on 4IR awareness. This unexpected result contrasts with some previous research that has emphasized the importance of organizational support and infrastructure in technology adoption and awareness (Rogers et al., 2014). Several factors could explain this finding. First, the impact of organizational factors and supportive facilities may be mediated by other variables, such as personal or social factors. Second, students may perceive these factors as hygiene factors (Alshmemri et al., 2017) - necessary but not sufficient to drive awareness and engagement with 4IR concepts. The lack of significant direct influence from organizational factors and supportive facilities also raises questions about the current state of 4IR integration in tourism and hospitality management education. It may indicate that despite the presence of 4IR-focused courses (factor loading 0.721) and digital tools (factor loading 0.744), these resources are not being effectively leveraged to raise awareness about 4IR.

Assessment of Structural Model

The results of presented in Table 3 provide a detailed analysis of the structural model, examining the direct influences on Awareness, presumably about the Fourth Industrial Revolution (4IR). Government Policy and Regulation showed a significant positive influence on Awareness ($\beta = 0.190$, t = 3.238, p < 0.001), supporting hypothesis H5. The Social Factor emerged as the strongest predictor ($\beta = 0.194$, t = 3.525, p < 0.001), strongly supporting hypothesis H4. Personal Factor also demonstrated a significant positive influence ($\beta = 0.171$, t = 3.187, p < 0.001), supporting its hypothesized role. However, Organizational Factors ($\beta = 0.004$, t = 0.076, p = 0.940) and Supportive Facility ($\beta = 0.001$, t = 0.020, p = 0.984) showed negligible influences on Awareness, failing to support hypotheses H1 and H2, respectively. These results suggest that government policies, social interactions, and personal characteristics significantly impact 4IR awareness, while organizational factors and supportive facilities may not have direct effects as initially theorized.

Table 3: Results of the Structural Model

Direct Influence	Original Sample (O)	Sample Mean (M)	Stand. Dev. (STD)	T Statistics	P Values	Decision
Government Policy and Regulation -> Awareness	0.190	0.186	0.059	3.238	0.001	Supported
Organizational Factors -> Awareness	0.004	0.014	0.046	0.076	0.940	Not Supported
Personal Factor -> Awareness	0.171	0.175	0.054	3.187	0.001	Supported
Social Factor -> Awareness	0.194	0.197	0.055	3.525	0.000	Supported
Supportive Facility -> Awareness	0.001	0.006	0.057	0.020	0.984	Not Supported

**p < 0.01, *p < 0.05.
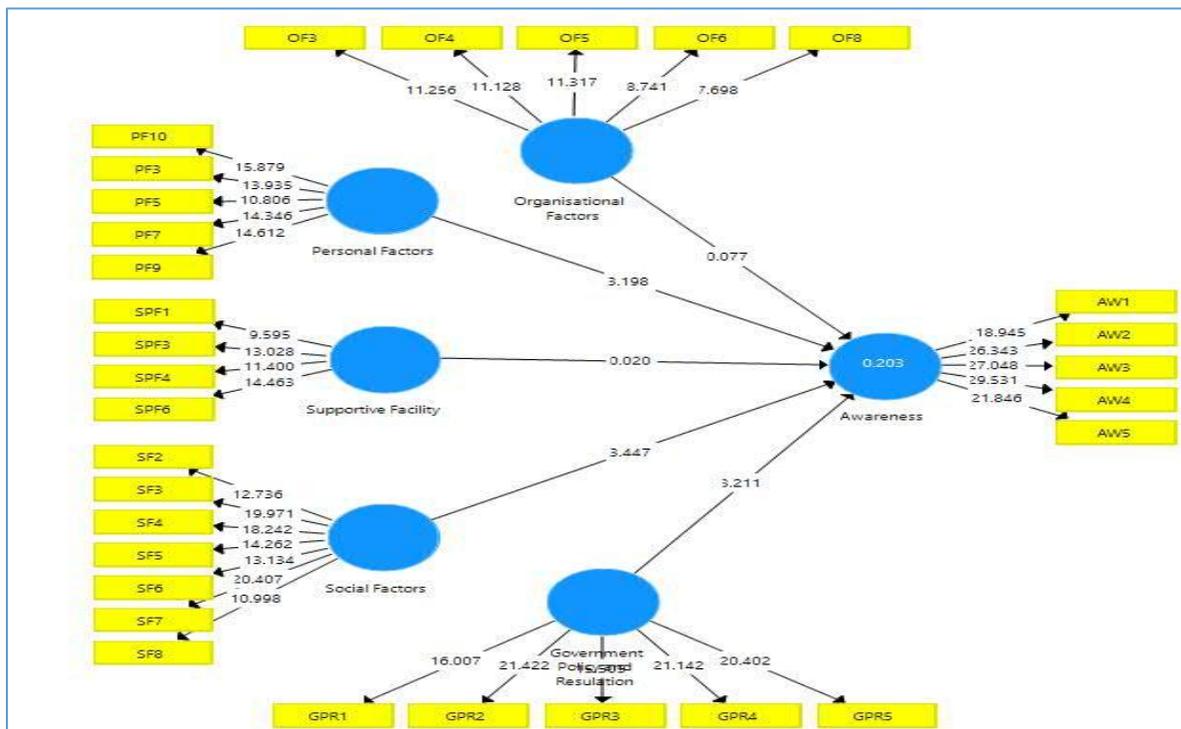
Figure 03: Assessment of Structural Model

The study reveals Social Factors as the most significant influence on 4IR Awareness (path coefficient = 3.447), emphasizing the importance of social interactions and community engagement. Government Policy and Regulation emerged as the second most influential factor (path coefficient = 3.211), highlighting the crucial role of governmental initiatives. Personal Factors also showed a significant impact (path

coefficient = 3.198), underscoring the importance of individual characteristics and motivations. Surprisingly, Organizational Factors (path coefficient = 0.077) and Supportive Facilities (path coefficient = 0.020) demonstrated minimal direct impact on Awareness, contrary to initial hypotheses. The model's explanatory power is moderate, with an R^2 value of 0.203 for Awareness, indicating that 20.3% of the variance is explained by the factors. Factor loadings for individual items, particularly for Social Factors (ranging from 10.998 to 30.407), suggest strong relationships between the items and constructs. These findings highlight the complex interplay of social, governmental, and personal factors in shaping 4IR awareness.

Implications

Practical Implications

The Fourth Industrial Revolution (4IR) affects tourism and hospitality. Curriculum redesign, faculty development, and industry engagement should be university priorities. Industry should invest in R&D and continuous learning, while policymakers should create 4IR plans and regulatory frameworks. Students should develop character and network with professionals. Workforce transformation, customer experience improvement, and sustainability are wider consequences. The integration of 4IR technologies may disrupt corporate paradigms and create new market participants, emphasising the relevance of data and technology capabilities as competitive advantages.

Theoretical Implications

The study explores 4IR awareness in higher education, combining qualitative and quantitative approaches for a validated framework. It identifies five key factors influencing 4IR awareness, particularly in tourism and hospitality management education. The research also contributes to contextual theory development by offering a novel framework for developing countries' educational systems. It strengthens stakeholder theory by incorporating multiple perspectives, validating measurement theory, social learning theory, policy implementation theory, and organisational change theory. The study validates the use of PLS-SEM for complex multi-factor technology adoption studies in Bangladeshi higher education.

Limitations

This study has limitations yet provides significant insights. First, its findings may be context-specific. Future studies should examine other cultures and places. Second, it emphasises 4IR awareness above skill development; future research should address this. The cross-sectional strategy only catches a snapshot; longer investigations are needed. Finally, the paper lists key determinants but not processes. To improve understanding, future studies should use qualitative or advanced quantitative methodologies. Filling these gaps will better equip tourism and hospitality graduates for 4IR opportunities and challenges.

Conclusions

This study examined 4IR awareness among Tourism and Hospitality Management (THM) graduates and its determinants. Few people comprehend 4IR, with only 10% knowing it well and many doubtful. Most grads realise 4IR will affect future jobs, but others don't. Communication and IT literacy are recognised by graduates, but digital literacy, big data analytics, and metacognition are not. Basic IT skills are strong, but complex software is lacking. Only 30% of people grasp soft skills like conflict resolution and negotiating. Standardised curriculum changes are needed due to university awareness gaps.

Government Policy & Regulation (GPR), organisational factors (OF), personal factors (PF), social factors (SF), and supportive facilities (SPF) were identified as major variables. Social factors were the largest predictor, highlighting the effect of peers and society on awareness. Government regulations and personal desire also encourage 4IR engagement. Organisational characteristics and enabling facilities had little direct impact, suggesting indirect effects.

The findings show that 4IR principles, technical and soft skills, and industry relationships must be included into curricular reform. To prepare graduates for the changing technological landscape, universities should offer tailored programs and lifetime learning.

Recommendations

The study recommends the following to enhance THM graduate quality. BAC may include criteria related to integration of 4IR technology for accreditation. BAC may also formulate discipline-specific quality assurance manual for THM discipline with the help of academic and tourism and hospitality industry experts to enhance quality of THM graduates. Universities/Entity offering THM programs may increase collaborations with tourism and hospitality industry and universities offering THM programs in home and abroad through signing MoU.

Acknowledgments

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Challenges of Integrating Education Technology for Quality Assurance of Higher Education in Bangladesh

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Abstract

Education technology (EduTech) has the potential to transform higher education by improving learning outcomes, accessibility, and quality assurance. In the era of the Fourth Industrial Revolution (4IR), marked by constant technological advancements, integrating EduTech is vital for streamlining the educational process, preparing students for future challenges, and enhancing teaching and learning quality. The global COVID-19 pandemic highlighted the importance of technology in ensuring education continuity during crises. However, despite its significance, Bangladesh's higher education system has yet to fully embrace educational technology, facing multiple barriers to its integration. This study investigates these challenges at four general public universities in Bangladesh, utilizing data from faculty and students through questionnaires. The research employs logistic and Probit regression to analyze the results. Findings reveal that positive perception of EduTech, access to EduTech, and strong internet connectivity significantly enhance the adoption, increasing the likelihood by approximately 48.9%, 29.2%, and 45.2% respectively. Training Constraint and infrastructure constraint decease the likelihood of EduTech adoption by 7.5% and 34.3% respectively. Besides, limited access to technology, lack of digital literacy, resistance to traditional teaching methods are also impeding the adoption. Model validation indicates strong predictive performance, with classification accuracies of 78.89% (logit) and 80.00% (probit). To overcome the barriers, the study recommends improving digital infrastructure, ensuring reliable internet connectivity, and providing extensive training and professional development for both faculty and students. Additionally, fostering collaborations with foreign universities, government agencies, and industry partners could help strengthen the integration of EduTech in Bangladesh's higher education system. Caution is advised when interpreting the findings due to the study's limited scope, which focused solely on four public universities. Future research should include data from private institutions and a larger sample of universities.

Keywords: Education Technology (EduTech); Higher Education; Bangladesh

Introduction

In 2015, the United Nations (UN) endorsed the Sustainable Development Goals (SDGs), with one of the key goals being the provision of quality education for all (UNDP, 2015). This goal emphasizes the need for inclusive and quality education that promotes lifelong learning, aiming to transcend the limitations of the Millennium Development Goals. Quality education is recognized as a vital driver of long-term socio-economic growth (Visvizi et al., 2018; Saunders and Gale, 2011; Churches, 2007) and has significant implications for both developed and emerging economies worldwide.

The rapid advancement of technology has transformed various aspects of life, including communication, occupation, income, and living standards, and education is no exception. According to Harman (1998), quality assurance in higher education institutions is crucial for producing competent graduates, while Ali et al. (2018) highlight technology as an intrinsic component of teaching and learning processes, especially in higher education. Technology is becoming increasingly essential in education, positively influencing learning by facilitating access to educational resources, enabling faster communication, and promoting academic collaboration (Alyoussef, 2021).

The era of the Fourth Industrial Revolution (4IR) presents even greater challenges and opportunities. The fusion of the digital, biological, and physical worlds, along with the increasing integration of technologies such as Artificial Intelligence (AI), cloud computing, robotics, 3D printing, and the Internet of Things, has created new demands for higher education. Graduates of the 4IR economy are expected not only to possess technological skills in fields like AI, robotics, and data analytics but also to develop essential soft skills to adapt to a rapidly changing and disruptive environment (Hassan, 2022).

The integration of EduTech in higher education is based on several theoretical models that guide how educational technologies can be used effectively. One of the most prominent frameworks is the Technological Pedagogical Content Knowledge (TPACK) model, which emphasizes the need for instructors to blend technology, pedagogy, and content knowledge in teaching (Mishra & Koehler, 2006). This model suggests that successful integration depends not only on the technology itself but also on the instructor's ability to use it in a pedagogically sound way. Similarly, the Unified Theory of Acceptance and Use of Technology (UTAUT), developed by Venkatesh et al. (2003), outlines factors such as performance expectancy, effort expectancy, social influence, and facilitating conditions that influence the adoption of technology in educational settings.

In Bangladesh, while there have been notable strides in expanding access to higher education, quality assurance remains a pressing issue. The integration of education technology (EduTech) could help address quality concerns by offering innovative teaching methods, fostering collaboration, enhancing student engagement, and

enabling continuous assessment and feedback. However, the full potential of EduTech has yet to be realized in the context of Bangladeshi higher education institutions, which continue to face significant challenges in adapting to the demands of the 4IR.

The use of technology in education is increasingly essential, especially given the growing complexity of knowledge and the increasing demand for skilled professionals in emerging economies. Technology-enhanced learning (TEL) has emerged as a viable solution for providing sustainable, quality higher education (Orozco-Messana et al., 2020; Alyoussef, 2021). As technology becomes more ingrained in everyday life, traditional methods of content delivery are being replaced by more dynamic and flexible approaches. The advent of technology has enabled the rapid availability of e-courses and learning resources, making education more accessible, particularly to those who may not have time or resources for traditional learning environments. TEL is not just a tool; it is an evolving methodology that enhances educational outcomes, providing opportunities for rapid capacity building among faculty members and fostering collaboration within academic communities (Mumford and Dikilita, 2020).

Globally, EduTech has been lauded for its role in enhancing teaching effectiveness and improving student learning outcomes. Many countries have successfully integrated technologies like Learning Management Systems (LMS), e-learning platforms, and digital assessments into their higher education systems. For instance, institutions in countries like the United States, the United Kingdom, and Australia have used digital tools to improve accessibility and engage students in more personalized learning experiences. These initiatives have been crucial for improving student engagement, streamlining administrative processes, and providing greater flexibility in learning, such as through blended learning models that combine online and face-to-face learning (Buasuwan, 2018).

In terms of quality assurance, EduTech offers significant advantages by providing real-time data on student performance, which can be used to improve teaching practices and ensure that learning objectives are met (Ally & Wark, 2020). The use of analytics and automated systems for monitoring student progress is an effective way to identify areas where improvements are needed, thus contributing to continuous quality enhancement in higher education (Orozco-Messana et al., 2020).

Another significant barrier is faculty readiness and training. In many developing countries, faculty members are not adequately trained to use digital tools in the classroom. This lack of professional development and ongoing training prevents instructors from fully utilizing the capabilities of EduTech platforms (Barrera-Osorio and Linden, 2009). The resistance to adopting new technologies due to a preference for traditional teaching methods further exacerbates this challenge (Hassan, 2022).

EduTech's role in quality assurance is multi-dimensional, impacting various aspects of the educational process. First, streamlined data collection through EduTech

systems provides valuable insights into teaching performance, student progress, and institutional effectiveness. This data-driven approach enables more effective monitoring and evaluation of academic programs (Alyoussef, 2021). Moreover, digital platforms enhance student engagement through interactive learning tools, promoting active participation and personalized learning pathways (Ally & Wark, 2020).

In Bangladesh, the integration of EduTech is still in its early stages, and the country faces a unique set of challenges in adopting these technologies within higher education. Despite significant investments in expanding the higher education sector, infrastructural constraints, such as inadequate internet connectivity and a lack of modern educational tools, remain a significant barrier (Forid et al., 2022). Furthermore, there is limited institutional support for the adoption of EduTech, and faculty members often lack the necessary training to incorporate technology effectively into their teaching methods.

Moreover, the perception of EduTech as a supplementary tool rather than an integral part of the curriculum continues to hinder its widespread acceptance (Hassan, 2022). However, recent shifts in policy, such as the government's emphasis on the need for education reform to align with the demands of the Fourth Industrial Revolution (4IR), show promise for future development. The integration of machine learning, artificial intelligence, and big data in education is expected to reshape the curriculum and teaching methods in Bangladesh, fostering the development of a more skilled workforce capable of thriving in the 4IR economy (Ally & Wark, 2019).

The COVID-19 pandemic highlighted the critical importance of EduTech in maintaining the continuity of education during times of crisis. When educational institutions were forced to close and transition to remote learning, technology became the cornerstone of teaching and learning. Digital access to educational resources, interactive apps, and online courses allowed students and educators to stay connected despite physical distance. Even prior to the pandemic, online learning platforms were growing in popularity, as they provided flexible, affordable educational options for those seeking academic or professional development. Thus, EduTech is no longer a mere contingency plan during crises but a central pillar in improving education quality, especially in the context of the 4IR.

The integration of EduTech in higher education is widely acknowledged as a crucial factor in enhancing the quality of teaching, learning, and assessment. However, in Bangladesh, despite rapid expansion in higher education, challenges remain in fully leveraging EduTech for quality assurance. With the increasing demand for higher education, universities in Bangladesh face considerable pressure to maintain and enhance academic standards. Quality assurance is vital to ensuring that graduates are equipped with the necessary skills to compete in a globalized job market.

The lack of systematic integration of EduTech hampers efforts to improve teaching quality, student engagement, and learning outcomes in Bangladesh's higher

education institutions. The importance of understanding the barriers to EduTech adoption is paramount in formulating strategies that meet the growing demand for quality education. Given the potential of EduTech to improve access, facilitate personalized learning, and provide effective monitoring, identifying and addressing the challenges to its integration is crucial for enhancing the quality of higher education. This study is therefore justified, as it aims to investigate these barriers and offer actionable solutions that can guide policymakers and academic institutions in overcoming these challenges.

The role of quality in higher education is fundamental to national economic and technological development (Soomro & Ahmad, 2012). In Bangladesh, the higher education sector includes both public and private universities, with a pressing need to maintain quality standards across all institutions (Forid et al., 2022). While numerous studies emphasize the importance of information and communication technologies (ICTs) in delivering high-quality higher education (Hoque & Alam, 2010), Bangladesh remains significantly behind in utilizing EduTech to improve its educational offerings.

Various studies have explored the impact of information technology on education (Machin et al., 2007; Barrera-Osorio and Linden, 2009; Malamud and Pop-Eleches, 2011), the effect of internet access (Goolsbee and Guryan, 2006; Belo et al., 2013), and computer-aided instruction (Angrist and Lavy, 2002; Barrow et al., 2009). However, to date, there has been a lack of research focused specifically on identifying the barriers to EduTech adoption in Bangladesh's higher education system. Furthermore, no studies have provided actionable solutions to address these challenges. This gap in the literature highlights the critical need for this research, which aims to investigate the obstacles and propose solutions for successfully integrating EduTech in Bangladesh's higher education institutions.

This study has two objectives:

- To assess the current status of education technology in different public universities of Bangladesh.

- To identify the constraints in adopting education technology in higher education sector of Bangladesh.

The study will focus on identifying the challenges that faculty members and students face in applying EduTech to enhance knowledge sharing and ensure the delivery of quality education. Additionally, the study will propose solutions to overcome these barriers and recommend strategies to improve the integration of EduTech in Bangladesh's higher education system, preparing it for the demands of the 4IR in an emerging economy.

This study will contribute to improving quality assurance in higher education by identifying the barriers to EduTech adoption in Bangladesh. Although previous studies have explored the significance of EduTech in improving education quality,

particularly during the COVID-19 pandemic, none have comprehensively examined the specific barriers to adoption in the context of Bangladesh. By evaluating both faculty and student perspectives, this study provides a holistic view of the challenges and offers practical recommendations to overcome them. These findings will be valuable not only for Bangladesh but also for other emerging economies facing similar challenges in integrating EduTech into their higher education systems.
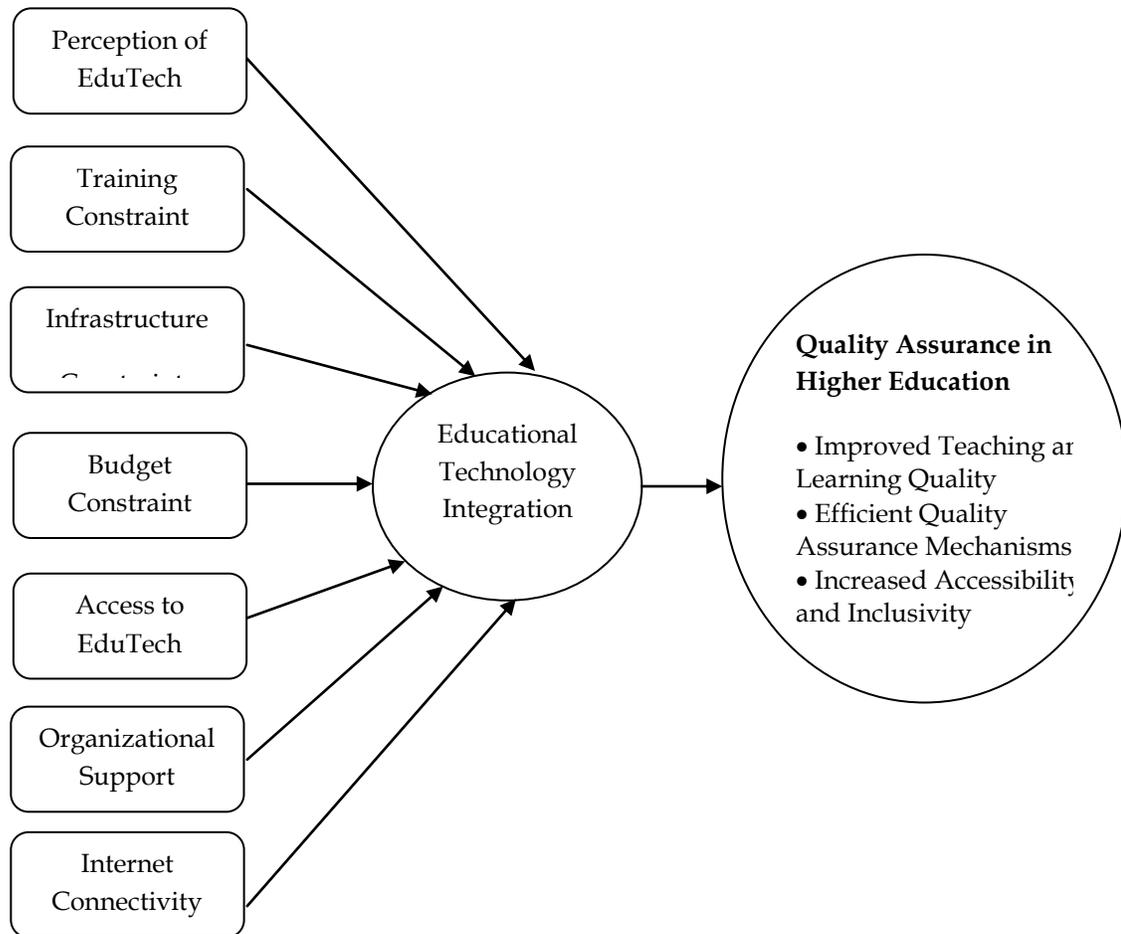

Figure 1: Conceptual Framework of Educational Technology Integration

Methodology

The research methodology used to examine the challenges of integrating educational technology for quality assurance in higher education in Bangladesh. It adopts a structured approach to identify barriers to effective technology integration. The methodology includes quantitative surveys among academics and students to assess institutional and individual factors influencing technology adoption.

Data and Methods

This research identifies the primary constraints faced by university faculty and students in implementing educational technology. Data was collected through a multi-dimensional survey targeting teachers and students in higher education institutions in Bangladesh. The questionnaire includes sections on demographics, exposure to and usage of EduTech, access to technology, internet connectivity, IT support, infrastructure, and organizational support. To collect the data the questionnaire was provided.

Pre-Test

After developing the initial questionnaire, a pre-test is conducted to validate the content similar to Babbie, 2011. To participate in that pre-test a specialist group consist of two researchers and five respondents were formed following the research of Xia et al., 2018.

Population and Sample

The survey is conducted using both face-to-face and online platforms for a four-month window. Convenience sampling method is used for the data collection using research networks of universities. The criterion of selecting the participants is that only those, who are either teaching or studying in any public universities of Bangladesh, will be considered.

There are 55 public (Government) universities in Bangladesh (UGC, 2023). For sampling, four general universities from eight administrative division of Bangladesh are considered. For having a large number of populations following the sample selection technique (equation 1) for 95 % confidence level, a Z values of 1.96 and at least 5 percent—plus or minus—precision a sample of 386 is considered. Sampling details are presented in Table 1.

$$n = \frac{Z^2 pq}{e^2} \tag{1}$$

To compose the set of respondents, equal weight to both teachers and students is given. The structured online questionnaire is conveniently distributed through emails, WhatsApp, Face book messenger, and other social media throughout this network in Bangladesh. A questionnaire is designed using dichotomous questions and to support the responses, respondents was requested to answer Likert scale and open questions.

Table 1: Demographic data

Characteristics	Categories	Percentage
University	Jagannath University	18.15
	Jatiya Kabi Kazi Nazrul Islam University	28.5
	University of Barishal	29
	University of Comilla	24.35
Gender	Male	69.1
	Female	30.9
Education	Ph.D.	14.9
	M.phill	Less than 1
	Master's	29.5
	Graduation	38.9
	H.S.C	15.9
Designation	Professor	11.5
	Associate Professor	9.7
	Assistant Professor	10.8
	Lecturer	13.2
	Student	54.8
Discipline	Pure Sciences	17.4
	Law	3.8
	Social Science	22.3
	Engineering and Technology	2.6
	Agricultural Sciences	2.3
	Business and management	32
	Life Sciences	12
	Arts and Humanities	8
Age	≤ 30 years	74.3
	31- 40 years	18.6
	41-50 years	7.1
	51-60 years	nil
	≥ 61 years	nil

Measuring Variables

Measuring Education Technology (EduTech)

Since EduTech refers to the use of technology in education, including open source and digital tools, to facilitate and enhance teaching and learning processes. To measure EduTech, we have listed several academically popular and well used Education tool, for example, Padlet, miro, kahoot, google classroom, Moodle, Jamboard, Nearpod, Canva, Grammarly, Google Drive, Google Meet, Zoom, YouTube, and Others in our questionnaire and asked the respondent to specify the frequency of usage of the respective education tools. Additionally, we also asked the respondent to rate their familiarity with open resources, frequency of using open resources and perception about using open resources.

For constructing a composite EduTech index, first, the researchers have created a composite index using five indicators, number of education tool used and frequency of using those tools, familiarity with open resources, frequency of using open resources and perception about using open resources, using Principal Component Analysis (PCA). Before using PCA the researchers normalize the indicators using min-max normalization as equation (2):

$$nmx = \frac{X_i - X_{min}}{X_{max} - X_{min}} \tag{2}$$

where X_{min} = minimum data point and X_{max} = maximum data point.

Figure 2 shows the eigenvalues of the five EduTech indicators, which are 2.05, 1.21, 0.76. 0.52 and 0.44, indicating that the first two component cumulatively explains more than 65% of the variations, and thus the researchers use the first two components to develop EduTech as the equation (3).
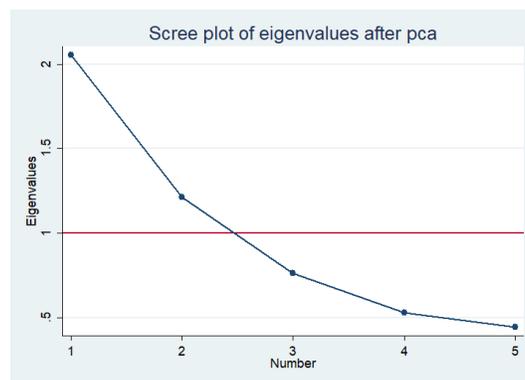

Figure 2: Eigenvalues of the EduTech indicators

Education Technology Index (EduTech index) = $\sum_{i=1}^{n} \gamma_{ij} x_i$ (3)

γ_{ij} are the weights (loadings of components) obtained from PCA, and x_i are the original variables. A higher index value indicates better usage of Education technology of a student or teacher. After developing the index, the researchers again use min-max normalization to normalize it. The KMO measure of sampling adequacy is 0.63, which justify the use of PCA for developing the index. Second, the researchers calculate the mean of EduTech index for the observations which is 44.89. Finally, to make EduTech a dummy variable, the researchers assign value one "1" if the respective index value is higher than the mean value otherwise assign Zero "0". The frequency and percentage of adoption EduTech is presented in Table 2 below.

Table 2: Tabulation of Adoption and non-Adoption of EduTech

Dummy	Frequency	Percentage (%)
0	194	50.26
1	192	49.74
Total	386	100

Measuring the constraints

Since the researchers collected the data using questionnaires, to identify the constraints the researchers categorized the questions in different groups, namely, Access to education technology, Internet Connectivity, Effective online Education, lack of knowledge of EduTech, lack of Infrastructure, lack of supporting IT staff, perception of EduTech and Organizational support, and aggregated the answers, if there are more than one questions in a group/category, using PCA method. The detail processes of aggregation of different indicators (the answers of different question of each group/category) are discussed below.

Access to Education Index

To aggregate the answer of questions regarding Access to EduTech, first the researchers normalize the value of each indicator (answer), which are- premium subscription to google, zoom, different journals, and plagiarism detection tools, using min-max normalization. Second, the researchers construct a composite index of Access to EduTech (Access EduTech) index by applying PCA to those normalized indicators. The eigenvalues of the four EduTech access indicators are 2.47, 0.74, 0.49 and 0.29 indicating that the first component explains more than 62% of the variations, and thus the researchers use the first components to develop the Access EduTech.
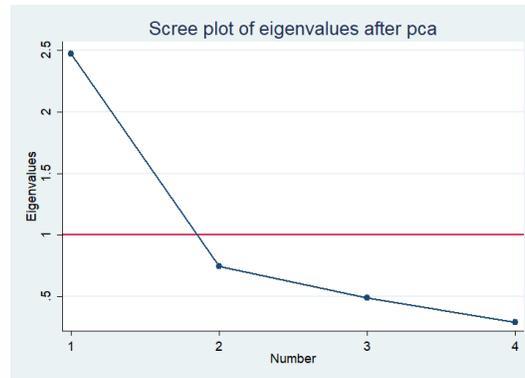
Figure 3: Eigenvalues of the Access to EduTech indicators

A higher index value indicates better access to Education technology by a student or teacher. After developing the index, the researchers again use min-max normalization to normalize it. The KMO measure of sampling adequacy is 0.67, which justify the use of PCA for developing the index.

Index of Internet Connectivity

To aggregate the answer of questions related to internet connectivity, first the researchers normalize the value (answer) of three questions, which are, availability of uninterrupted internet, availability of unlimited internet and availability of alternative internet, using min-max normalization. Secondly, construct a composite index of Internet connectivity (Internet Connect) by applying PCA to those normalized indicators. The eigenvalues of the three internet connectivity indicators are 2.17, 0.54, and 0.28 indicating that the first component explains more than 72% of the variations, and thus the researchers uses the first components to develop the Internet Connect.
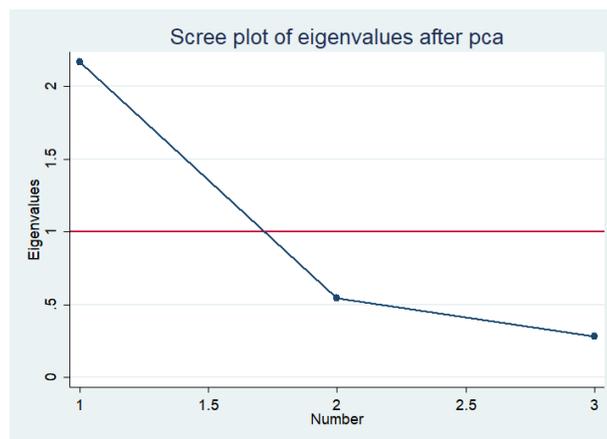

Figure 4: Eigenvalues of the internet connectivity indicators

A higher index value indicates better internet connectivity available to a student or teacher. After developing the index, the researchers again use min-max normalization to normalize it. The KMO measure of sampling adequacy is 0.66, which justify the use of PCA for developing the index.

Availability of IT supporting staff

To aggregate the answer of questions related to availability of IT supporting staff, first the researchers normalize the value (answer) of four questions, which are, availability of IT department in the institution, promptness, helpfulness and expertise of the IT personnel, using min-max normalization. Secondly, develop a composite index of availability of IT support (IT support) by applying PCA to those normalized indicators. The eigenvalues of the three internet connectivity indicators are 2.76, 0.53, 0.41 and 0.28 indicating that the first component explains more than 69 % of the variations, and thus the researcher's uses the first components to develop the IT support.
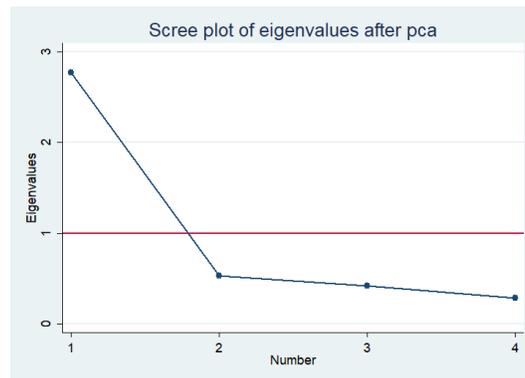

Figure 5: Eigenvalues of the availability of IT support indicators

A higher index value indicates better IT support available to a student or teacher. After developing the index, the researchers again use min-max normalization to normalize it. The KMO measure of sampling adequacy is 0.81, which justify the use of PCA for developing the index.

Effective Online Education Index

To aggregate the answer of questions regarding the online education system, first the researchers normalize the value (answer) of six questions, which are about the safety, flexibility, easy record keeping, convenience of drawing, convenience of examination evaluation and detection of malpractice in the examination, using min-max normalization. Secondly, construct a composite index of effective online education (effective online) by applying PCA to those normalized indicators. The eigenvalues of the six online education indicators are 2.76, 1.09, 0.72, 0.59, 0.54, and 0.27 indicating that the first two components cumulatively explain more than 64% of the variations, and thus the researchers use the first components to develop the effective online.
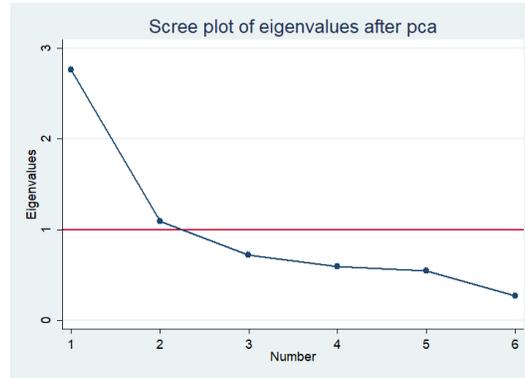
Figure 6: Eigenvalues of the online education indicators

A higher index value indicates more effective online education to a student or teacher. After developing the index, the researchers again use min-max normalization to normalize it. The KMO measure of sampling adequacy is 0.74, which justify the use of PCA for developing the index.

Measuring control variables

For this study used different categorical variables as control variable to address the heterogeneities of the observations, such as Age, Gender, and Designation. The Age has five categories in the dataset, which are below 30 years, 31- 40 years, 41-50 years, 51-60 years, and above 61 years, whereas gender has two category- male and female and designation also has five categories- Student, Lecturer, Assistant Professor, Associate Professor, and Professor.

Model

After collecting, the data is analyzed applying a logistic regression model (equation-4) to identify the factors responsible for not adopting education technology. Logistic regression is the process of estimating logistic parameters in regression analysis. An event's log-odds can be represented statistically as a linear combination of one or more independent variables using the logistic model.

$$ln\left(\frac{p_i}{(1-p_i)}\right) = \sum_{k=0}^{k=n} \beta_k x_{ik} \tag{4}$$

For this analysis, the dependent variable is adopting education technology, which is a dummy variable representing the adoption (1) or not adoption (0) of EduTech.

Besides, for robustness of our results, the researchers estimate the Probit model. The following equation (5) represents the probit model. Probit regression is a specialized regression model of binomial response variables and is also used to analyze the relationship between binary dependent and explanatory variables.

$$\Phi^{-1}(p_i) = \sum_{k=0}^{k=n} \beta_k x_{ik} \tag{5}$$

The difference between these two approaches, even though they are both symmetric binary choice models, is in this assumption about the error-term's distribution. While the probit model assumes a normal distribution of error terms, the logistic model assumes a conventional logistic distribution.

Results and Discussion

Data Summary and Insights

Table 3 displays the descriptive statistics for the data used in our investigation. All variables except unitary and dummy variables are winsorized at the 1st and 99th percentile levels. Winsorized data is used in analysis to reduce the influence of outliers or extreme values that could distort the results of statistical analyses. By replacing the extreme values at both ends of the data distribution with values closer to the center, Winsorization minimizes the impact of these outliers, making the analysis more robust and representative of the overall data trends. This approach helps improve the validity of statistical tests, such as mean and variance calculations, particularly when dealing with small or skewed datasets where outliers can disproportionately affect the results.

The *EduTech-Integration* is a dummy variable, having value of 0 and 1, where Zero (0) means no adoption of Education Technology and one (1) means adaptation of Education Technology.

Table 3: Data Summary and Insights

Variable	Obs	Mean	Std. Dev.	Min	Max
EduTech Integration	385	0.511	0.502	0	1
Time Constraint	385	3.078	1.12	1	5
Budget Constraint	385	3.411	1.17	1	5
Training Constraint	385	3.467	1.12	1	5
Digital literacy Constraint	385	3.578	1.09	1	5
Teaching Content Constraint	385	3.411	1.13	1	5
Infrastructure Constraint	385	3.556	1.14	1	5
Organizational Support Available	385	2.956	1.16	1	5
Positive Perception of EduTech	385	4.244	1.19	1	5
Access to EduTech	385	0.243	0.25	0	1
Internet Connectivity index	385	0.496	0.28	0	1
ITsupport availability	385	0.508	0.22	0	1
Effectiveness of online index	385	0.548	0.23	0	1

The mean of *EduTech Integration* is 0.511, which indicates that around 50 percent of our sample has adopted education technology and standard deviations shows significant variance among observations. *Time Constraint, Budget Constraint, Training Constraint, Digital literacy Constraint, Teaching Content Constraint, Infrastructure Constraint, Organizational Support Available* and *Positive Perception of EduTech* are five-point likert scale answer, ranges from 0 to 5, showing perceived magnitude of the constraints. The mean of all these constraints except *Positive Perception of EduTech* are around 3, which usually represent the indifferent or neutral view. *Access to EduTech, Internet Connectivity index, IT support availability* and *Effectiveness of online index* are indexes which are normalized after construction, therefore showing a range of 0 to 1. The *Positive Perception of EduTech* has the highest standard deviation among all variables, implying while some people think EduTech is important, others may not consider it as essential to assure quality education of higher education institutions. Other variables are showing moderate variability.

Identifying the Barriers and Challenges in Integrating EduTech

To identify the constraints and estimate the magnitudes of those constraints responsible for less or non-adoption of education technology in universities, we estimate equation 4 using logit regressions. The results are reported in Table 4, where model (1) shows the logit regression and model (2) shows the marginal effect of it.

Table 4: Baseline Estimation-logit model

Variables	(1)	(2)
	Logit	**Marginal Effect**
Time Constraint	1.755	0.317
	(1.178)	(0.203)
Budget Constraint	-1.574	-0.284
	(1.379)	(0.242)
Training Constraint	-0.418**	-0.075**
	(0.178)	(0.032)
Digital literacy Constraint	-0.693	-0.1250
	(1.804)	(0.325)
Teaching Content Constraint	-1.960	-0.354
	(1.625)	(0.285)
Infrastructure Constraint	-1.901**	-0.343**
	(0.812)	(0.146)
Organizational Support Available	-1.263	-0.228
	(1.050)	(0.185)

Variables	(1)	(2)
	Logit	Marginal Effect
Perception of EduTech	2.708***	0.489***
	(1.073)	(0.168)
Access to EduTech	1.617**	0.292**
	(0.691)	(0.124)
Internet Connectivity index	2.500**	0.452**
	(1.174)	(0.192)
ITsupport availability	-0.155	-0.028
	(1.494)	(0.269)
Effectiveness of online index	-0.840	-0.152
	(1.633)	(0.293)
1.Gender	-1.555**	-0.282***
	(0.651)	(0.104)
2.Age (≤ 30 years)	0.141	0.025
	(1.182)	(0.213)
3.Age (31- 40 years)	0.198	(0.0358)
	(1.339)	(0.242)
4.Age (41-50 years)	0.060	0.011
	(1.988)	(0.359)
Constant	-2.118	
	(1.617)	
Observations	385	385
Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1		

The coefficients of *Training Constraint* and *Infrastructure Constraint* are negatively significant, whereas the coefficients of *Perception of EduTech*, *Access to EduTech* and *Internet Connectivity index* are positively significant in model (1), suggesting that lack of training and poor infrastructure hinder the integration of education technology, and positive perception of EduTech, Access to EduTech, and uninterrupted internet connectivity foster the adoption of education technology in the higher educational institutes. Since the coefficients of logit regression cannot be interpreted as magnitude of impact due to difference of measuring unit of different variables, we estimate the marginal effect in model (2). Therefore, for magnitude of impact of each variable, we will focus and explain the coefficient of it in model (2). Specifically, *Training Constraint* and *Infrastructure Constraint* decease the likelihood of EduTech adoption by 7.5% and 34.3%, respectively, while, *Perception of EduTech, Access to*

EduTech and *Internet Connectivity index* increase the probability of EduTech adoption by 48.9%, 29.2% and 45.2% respectively. The results can be presented using the following equations (6), which is written from the results of the logit average marginal effect analyses.

$$
\begin{aligned}
EduTech\ Adoption = \\
-0.075\ Training\ Constraint_i - 0.343\ Infrastructure\ Constraint_i + \\
0.489\ Perception\ of\ EduTech_i + 0.292 Access\ to\ EduTech_i + \\
0.452\ Internet\ Connectivity\ index_i
\end{aligned}
\tag{6}
$$

The results are quite obvious, since without access to adequate training and infrastructure, faculties often lack the necessary skills and knowledge to effectively leverage technology in their teaching practices. Researchers have noted that teachers' reluctance to integrate technology is often rooted in their beliefs about teaching and learning, which can be resistant to change (Suleman & Hussain, 2011). Insufficient training can reinforce these conventional classroom practices, as teachers are unable to see the potential benefits of incorporating technology (Suleman & Hussain, 2011) whereas lack of infrastructural support hinders effective technology integration even if the teachers willing to (Shi, 2016).

Positive perception of EduTech among both students and faculty is a crucial determinant of its successful integration. Learners are increasingly accustomed to the use of personal computers, mobile devices, applications, and social media in their daily lives, and they expect to see similar technologies integrated into their academic activities. When students and faculty perceive the benefits of education technology, such as enhanced engagement, knowledge retention and sharing, and problem-solving skills, they are more likely to embrace its integration.

Access to education technology is another essential factor in fostering its integration within higher educational institutes. The lack of access to digital information and technologies is a significant barrier to the effective utilization of education technology. Ensuring equitable access to necessary hardware, software, and digital resources is crucial for enabling students and faculty to fully leverage the potential of education technology.

Furthermore, uninterrupted internet connectivity is a crucial enabler of education technology integration. Technology-enhanced instruction and learning often rely on seamless internet access to facilitate remote learning, online collaboration, and the use of digital resources. The coefficients of other explanatory variables, such as *Time Constraint, Budget Constraint, Digital literacy Constraint, Teaching Content Constraint,* and *IT support availability* are not significant in our dataset.

Interestingly the categorical variable *Gender* is significantly negative in our estimation, which indicate that female are 28.2% less willing to EduTech adoption compare to male. This gender gap in EduTech adoption can be attributed to a variety of factors, including the socialization of gender roles, the representation of

women in technology-related fields, and the diverse learning preferences and approaches of males and females (Seng et al., 2014, Gatan et al., 2021). The literature suggests that female students and teachers may face unique challenges in the adoption of educational technology (Seng et al., 2014). For instance, female teachers can be regarded as role models for female students, and their lack of exposure to ICT-related experiences and training programs can negatively impact the confidence levels and attitudes of female students towards EduTech. Additionally, studies have found that male students tend to consider learning technology more necessary and important than do female students (Jimenez & Fernández, 2016).

These gender differences in the perception and usage of educational technology can have far-reaching implications, as they can perpetuate the underrepresentation of women in technology-related fields and limit their ability to fully participate in the digital society. The impacts of another categorical variable Age is not significant indicating technology adoption in education does not essentially depends on the users (Faculties and students) age, rather on their perception, willingness and infrastructural support.

Classification results of logit

Table 5: Classification results of logit estimated models

Models	Correctly classified	Sensitivity	False negative rate for true positive	Specificity	False positive rate for true negative
Logit	78.89%	80.43%	19.57%	77.27%	22.73%

Table 5 shows the classification results of logit estimated models. The classification accuracy of logit functions is very high, 78.89% and therefore, the model's goodness of fit is quite high and acceptable. The sensitivity and specificity of our model are 80.43% and 77.27%, respectively The False negative rate for true positive is only 19.57% and false positive rate for true negative is only 22.73%. Thus, the model can be said as good fit to predict the adoption and non-adoption of education Technology in the higher educational institutes of Bangladesh.

Robustness Check of the previous findings using Probit model

In this section, using probit regressions, we estimate equation 5 in order to check the robustness of the results reported in the baseline estimation, Table 4. Table 6 presents the findings, with model (1) displaying the probit regression and model (2) displaying its marginal effect.

Similar to the findings of logit model, the results of probit model (1) indicates that the coefficients of *Perception of EduTech, Access to EduTech,* and *Internet Connectivity index* are positively significant and conversely the coefficients of *Training Constraint* and *Infrastructure Constraint* are negatively significant, implying the adoption of

education technology in higher education institutions is facilitated by positive perceptions of EduTech, access to EduTech, and uninterrupted internet connectivity, while budget, training and infrastructural constraint impede the integration of it. Because the differing measuring units of the variables make it impossible to interpret the probit regression coefficients as the degree of the influence, we estimate the marginal effect in model (2). Subsequently in order to determine the impact of each variable, we will concentrate on and discuss each variable's coefficient in model (2). Similar to the baseline estimations of table 2, the likelihood of EduTech adoption is decreased by *Training Constraint* and *Infrastructure Constraint* by 6.7% and 33.2%, respectively, whereas the likelihood is increased by *Perception of EduTech, Access to EduTech,* and *Internet Connectivity index* by 48.8%, 32.5%, and 45.1%, respectively. The coefficient of probit model is lesser than the coefficient of logit model except in case of Access to EduTech. Equation (7), which is derived from the findings of the probit average marginal impact studies, can be used to demonstrate the results.

$$EduTech\ Adoption =$$
$$-0.067\ Constraint\_Training_i - 0.332\ Constraint\_Infrastracture_i + \qquad (7)$$
$$0.488\ Perception\_EduTech_i + 0.325 AccessEduTech_i + 0.451\ InterConnect_i$$

The results are apparent because teachers frequently lack the skills and expertise needed to successfully integrate technology into their teaching practices when they lack access to proper training and infrastructure. Scholars have observed that educators' unwillingness to use technology is frequently associated with potentially change-resistant attitudes about education (Suleman & Hussain, 2011). Teachers who receive insufficient training may find it difficult to see the advantages of integrating technology into the classroom (Suleman & Hussain, 2011). Additionally, teachers who are willing to integrate technology may find it difficult to do so due to a lack of infrastructure support (Shi, 2016).

Table 6: Robustness Test-Probit Estimation

Variables	(1)	(2)
	Probit	**Marginal effect**
Time Constraint	1.009	0.310
	(0.695)	(0.207)
Budget Constraint	-0.927	-0.285
	(0.845)	(0.255)
Training Constraint	-0.219**	-0.0673**
	(0.094)	(0.028)
Digital literacy Constraint	-0.438	-0.135
	(1.114)	(0.342)
Teaching Content Constraint	-1.123	-0.345

Variables	(1)	(2)
	Probit	**Marginal effect**
	(0.981)	(0.296)
Infrastructure Constraint	-1.079**	-0.332**
	(0.462)	(0.141)
Organizational Support Available	-0.719	-0.221
	(0.611)	(0.184)
Perception of EduTech	1.586***	0.488***
	(0.607)	(0.166)
Access to EduTech	1.057**	0.325**
	(0.451)	(0.138)
Internet Connectivity index	1.466**	0.451**
	(0.671)	(0.191)
ITsupport availability	-0.111	-0.034
	(0.879)	(0.270)
Effectiveness of online index	-0.444	-0.136
	(0.925)	(0.284)
1.Gender	-0.868**	-0.267**
	(0.367)	(0.104)
2.Age (≤ 30 years)	0.129	0.039
	(0.658)	(0.202)
3.Age (31- 40 years)	0.112	0.035
	(0.748)	(0.230)
4.Age (41-50 years)	0.077	0.023
	(1.188)	(0.365)
Constant	-1.278	
	(0.949)	
Observations	385	385
Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1		

Another key factor in the successful integration of EduTech is the positive perception of EduTech that both students and educators possess. Students, since they are accustomed to using social media, mobile devices, applications, and personal computers in their daily lives, expect to see similar technology incorporated into their academic pursuits. Besides, students and teachers are more likely to support the inclusion of educational technology when they recognize its advantages, which include improved engagement, knowledge retention and sharing, and problem-solving abilities. Facilitating the integration of education technology in higher education institutions requires access to this technology. One of the biggest obstacles to the efficient use of technology in education is the lack of

access to digital information and tools. Educators and students must have equal access to the hardware, software, and digital resources needed to fully utilize educational technology.

Moreover, constant internet access is a critical component that makes education technology integration possible. In order to enable remote learning, online collaboration, and the usage of digital materials, technology-enhanced education and learning frequently depend on uninterrupted internet access.

It's interesting to note that, according to our estimation, the categorical variable gender is strongly negative, meaning that women are 28.2% less likely than men to use EduTech. Many factors, including as the socialization of gender norms, the representation of women in technology-related sectors, and the differences in learning styles and techniques between males and females, can be the reason for this gender gap in the adoption of EduTech (Seng et al., 2014, Gatan et al., 2021). According to the literature, adopting educational technology may present particular difficulties for female teachers and pupils (Seng et al., 2014). For example, female educators serve as role models for female pupils, and their lack of exposure to ICT-related events and training might have a detrimental effect on the self-assurance and

Furthermore, research indicates that male students are more likely than female students to view learning technology as essential and significant (Jimenez & Fernández, 2016). These gender disparities in how educational technology is perceived and used can have significant effects since they can impede women's participation in the digital society and contribute to their continued underrepresentation in technology-related fields. The effects of an additional category variable Age is not important, suggesting that perception, willingness, and institutional support—rather than the age of users (faculty and students)—are the main determinants of technology adoption in education.

Classification results of probit

Table 7: Classification results of probit estimated models

Models	Correctly classified	Sensitivity	False negative rate for true positive	Specificity	False positive rate for true negative
Probit	80.00 %	82.61%	17.39%	77.27%	20.83%

Table 7 shows the classification results of Probit estimated models. The classification accuracy of probit functions is very high, 80.00%, which is even higher than the logit model and therefore, the model's goodness of fit is quite high and acceptable. The sensitivity and specificity of our model are 82.61% and 77.27%, respectively. The False negative rate for true positive is only 17.39% and false positive rate for true negative is only 20.83%. Thus, the model can be said as good fit to predict the adoption and non-adoption of education Technology in the higher educational institutes of Bangladesh.

Based on the above analysis we found the major constraints of integrating education technology in higher education of Bangladesh, which are- poor internet connectivity, limited access to technology, a lack of digital knowledge and literacy among students and faculty, and inadequate infrastructure to facilitate the use of technology, Perception regarding inclusion of higher education technology into higher education, and the lack of extensive training and professional development for educators and students.

Bangladesh faces persistent challenges in internet connectivity, particularly in rural and semi-urban areas. Many universities, particularly public ones, have limited bandwidth and unstable connections. According to the Bangladesh Telecommunication Regulatory Commission (BTRC), as of recent reports, internet penetration is still developing in many regions. Studies highlight that the country's average internet speed remains low, making online learning and digital platforms difficult to use in real-time education. Zia et al. (2021) also found that this lack of reliable internet connectivity severely disrupts efforts to deliver uninterrupted online classes, hampering the growth of online education platforms.

Besides, Access to technological devices like computers, tablets, and smartphones is also uneven in Bangladesh, especially for students from economically disadvantaged backgrounds. According to Hosen et al. (2022), only a small percentage of students in public universities have regular access to personal computers or laptops. This disparity makes it difficult for students to fully participate in online classes or benefit from digital resources. Moreover, limited access to electricity in rural areas exacerbates this problem, as students and faculty alike are unable to charge their devices consistently, further hindering digital learning.

Both students and faculty members often lack sufficient digital literacy and extensive training, and poses negative perception of EduTech, which makes the effective use of EdTech challenging. According to a study by Hossain et al. (2012), many faculty members have not received adequate training on how to incorporate digital tools into their teaching. This gap in digital literacy among educators leads to a reluctance to adopt new technologies, as they may not feel confident using online platforms or other digital tools. Students, especially those from rural areas, are similarly disadvantaged in terms of digital skills, having limited prior exposure to computers or online resources before university.

In addition, Infrastructural limitations are another major constraint. Many universities in Bangladesh, especially in rural areas, lack the basic infrastructure needed to support technology integration, such as equipped computer labs, stable electricity, and classroom environments conducive to blended learning. Hossain et al. (2012) emphasized that outdated technological infrastructure in many higher education institutions hinders their capacity to host advanced EduTech solutions. This infrastructural gap not only limits current integration efforts but also creates long-term barriers to scaling up digital learning.

The combined effect of poor internet connectivity, limited access to devices, low levels of digital literacy, and inadequate infrastructure forms a significant barrier to the successful integration of EdTech in higher education in Bangladesh. To overcome these challenges, it is crucial to implement large-scale initiatives aimed at improving internet access, investing in technology infrastructure, and offering comprehensive digital literacy programs for both students and faculty.

Implications

The integration of education technology (EduTech) into higher education holds transformative potential for improving academic quality, administrative efficiency, and equitable access—particularly in the context of the Fourth Industrial Revolution (4IR), which demands digital fluency and innovation. The study reaffirms global findings (e.g., Daniela et al., 2018; Orozco-Messana et al., 2020) that EduTech enhances learning outcomes and institutional effectiveness. Moreover, the COVID-19 pandemic starkly highlighted EduTech's critical role in maintaining educational continuity during crises. Despite this global consensus, Bangladesh remains significantly behind in realizing these benefits due to systemic constraints. The findings of this study—based on logistic regression analysis of faculty and student data from four public universities—demonstrate that challenges such as inadequate infrastructure, limited access to devices, digital illiteracy, poor internet connectivity, and entrenched resistance to pedagogical change are key barriers. Addressing these issues is not merely a technical adjustment but a strategic imperative for ensuring quality assurance and national progress in a digital era.

Limitations

While the study offers valuable empirical insights into the challenges of EduTech integration in Bangladesh's public universities, certain limitations should be acknowledged. Firstly, the research scope is confined to four general public universities, omitting private institutions and other specialized universities. This limited sample may not fully capture the heterogeneity of the higher education landscape. Secondly, the study relies exclusively on data from faculty and students, excluding crucial administrative and technical staff who are often directly involved in the implementation and maintenance of EduTech infrastructure. Their absence may have skewed perceptions or left out critical operational constraints. Lastly, the data represents a cross-sectional snapshot rather than a longitudinal view, which limits the ability to assess temporal changes or long-term trends in EduTech adoption. Future studies should expand the sample across more diverse institutions—including private and technical universities—and consider a broader set of stakeholders to enable comparative analysis and richer insights.

Conclusions

The adoption of EduTech in higher education has the potential to enhance learning outcomes, accessibility, and administrative efficiency, particularly in the 4IR era. Despite its recognized benefits, including its role during the COVID-19 pandemic, Bangladesh lags behind in utilizing EduTech in higher education. This study investigates the constraints to integrating EduTech in Bangladesh's higher education system using data from surveys conducted with students and faculty at four public universities.

The findings show that the main barriers include poor internet connectivity, limited access to technology, a lack of digital literacy, inadequate infrastructure and organizational support, resistance to traditional teaching methods, and the need for extensive educator training. Overcoming these obstacles requires improvements in infrastructure, faculty development, financial investment, and policy reforms.

The study acknowledges its limitations, including data from only four public universities and the absence of input from administrative and support departments. Future research could expand the scope to include private universities and additional stakeholders. Potential solutions to address these challenges include improving infrastructure, offering extensive training programs, and creating awareness about the benefits of EduTech through workshops and seminars. These efforts can help ensure the successful integration of EduTech, improving the quality and accessibility of higher education in Bangladesh.

Recommendations

To successfully integrate education technology in higher education and address the barriers identified, a coordinated and multi-layered strategy is essential. First, infrastructure upgrades and digital connectivity improvements must be prioritized, particularly in under-resourced areas. Simultaneously, extensive training programs are needed to enhance digital literacy and technological competence among both faculty and students. Such initiatives can also help reduce resistance to change by building confidence in the use of EduTech tools. Organizations like BAC can play a pivotal role by organizing awareness-building workshops, motivational seminars, and professional development sessions in collaboration with universities. Secondly, promoting a positive perception of EduTech—shown to be a critical enabler in this study—should be a targeted objective. BAC and other stakeholders can lead campaigns to highlight the long-term academic and professional benefits of digital education. These combined efforts will not only foster greater acceptance and adoption of EduTech but also help ensure that higher education in Bangladesh becomes more inclusive, efficient, and future-ready.

Acknowledgements

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