Hapres | Journal of Sustainability Research
sustainability.hapres.com

Article

Calculation of Higher Education Institution's Facilities and Services Applying the Life Cycle Costing Approach Contributing Sustainability

Wafaurahman Wafa [1,2], Amir Hamzah Sharaai [1,*], Nitanan Koshy Matthew [1], Noor Ahmad Akhundzada [3]

1 Department of Environmental Management, Universiti Putra Malaysia (UPM), Serdang 43400, Malaysia; wafaurahmanw@gmail.com (WW); nitanankoshy@upm.edu.my (NKM)

2 Department of Environmental Science, Kabul University, Kabul 1006, Afghanistan

3 Department of Natural Resources and the Environment, Cornell University, Ithaca, NY 14853, USA; naa54@cornell.edu (NAA)

* Correspondence: Amir Hamzah Sharaai, Email: amirsharaai@upm.edu.my.

ABSTRACT

Life cycle costing (LCC) estimates the total cost of a product or service over its entire life cycle. However, studies assessing LCC in higher education institutions (HEIs) are scarce. The purpose of this study is to calculate the total cost of an HEI. This study applies the LCC method to calculate the costs associated with Kabul University and the services it provides based on the cost inventory data for the 2020 reference year. The costs are categorized into various domains and components, including land and property, water, energy, maintenance, and operational costs. The results reveal that property costs constitute the largest portion, accounting for 75.69% of the university's overall costs. The second most significant cost category is operational costs, contributing to 20.14%. The remaining costs, namely energy (0.38%), maintenance (0.34%), construction (0.29%), and water (0.15%) costs, collectively account for the remaining costs. Furthermore, the study found that energy, water, maintenance, and construction costs contribute significantly for 4–6 years of graduating students. However, there is no consensus on the appropriate discount rate for LCC calculations. This study examines different discount rates of 20%, 40%, and 50% to determine the net present value. Based on the findings, Kabul University's costs are highly sensitive to variations in discount rates. In conclusion, this research establishes the cost per function unit (one student) for graduation periods of four, five, and six years at Kabul University to be 792,277.4232 AFs approximately USD 11,173.74, followed by AFs 660,231.186 (USD 9311.45), and AFs 528,184.9488 (USD 7449.16) respectively. These findings provide valuable insights for the higher education sector in effectively managing and planning their financial resources.

KEYWORDS: life cycle costing; higher education; net present value; service; energy; water

Open Access

Received: 12 November 2024
Accepted: 18 March 2025
Published: 20 March 2025

INTRODUCTION

Higher education is a crucial factor in a country's growth [1]. A free, modern, and dynamic higher education system propels a country forward, improving the lives of its people. Conversely, a constrained and outdated education system can hinder a country as a whole, negatively affecting all aspects of individual and group life [2,3]. Furthermore, universities worldwide are actively pursuing innovation to achieve excellence. This endeavor is vital for higher education institutions (HEIs) to strengthen their role and ability to innovate [4].

This study introduces a novel approach to life cycle costing (LCC) in HEIs by providing a comprehensive framework that addresses the distinct issues of a post-conflict setting. Unlike other LCC studies in HEIs that typically focus on specific aspects like building development or energy efficiency, this research offers an in-depth examination of all cost categories, including land and property, energy, maintenance, and operating expenses. The study employs sensitivity analysis using three discount rates (20%, 40%, and 50%) to account for the economic volatility inherent in post-conflict settings, thereby providing a more thorough and realistic evaluation of long-term costs [5,6].

Life cycle costing evaluates the costs associated with products, services, or processes during their whole lifespan. The lack of LCC studies in higher education presents a significant challenge, especially as it pertains to the life cycle costs of higher education. Life cycle costing is a decision-making tool to estimate the total cost of a product or service throughout its entire life cycle from production to disposal. This methodology systematically estimates the economic value across the defined scope. Life cycle costing is widely regarded as a cost management instrument [7]. It analyzes the costs associated with a product or process throughout its entire life cycle. Furthermore, LCC estimates the cost of all stages, including risk, investment, operation, maintenance, and demolition. Finally, LCC provides valuable insights into the total cost of a product or process over its full life cycle, thereby aiding the decision-making process [8]. Furthermore, LCC is extensively considered as a cost management instrument [7,9].

Life cycle costing aims to forecast cash flow and provide an assessment of options for decision-makers. It consists of four initial steps: (a) defining analysis, (b) analyzing the problem, (c) conducting calculations, and (d) validating and interpreting results [10]. The United Nations Environment Program (UNEP) published guidelines for LCC in 2009 and exemplified different methods in detail [11]. Life cycle costing in higher education has both advantages and disadvantages. Although it can help determine the long-term financial impacts of infrastructure investments, it may not fully capture educational outcomes. Lozano [12] suggested that university's sustainability assessments should incorporate societal and economic implications. Thus, LCC may need to be combined with other assessment methodologies in higher education to provide a more holistic view of sustainability.

Based on the existing literature, no studies have been identified that comprehensively assess higher education in all its aspects, including facilities and services, especially in post-conflict countries. Furthermore, there is a notable gap in the literature regarding the LCC of HEIs. The lack of such evaluations may result in inadequate financial management and lost potential for cost reductions and environmental improvements over the duration of HEI facilities and services [1]. There is a need to conduct an LCC study in higher education to evaluate all facilities and services with consideration for environmental impact. The lack of LCC studies in higher education is concerning, primarily because it designates the costs associated with higher education. This study aims to contribute to the body of knowledge by developing case-specific indicators for calculating cost data across all aspects of education LCC and its implications for the sustainability of an HEI. These specific indicators will differentiate this study from others based on the specific circumstances of a country and a sector. It will encourage organizations to assess the LCC of all facilities and services in relation to their specific context. Moreover, it will assess and analyze all dimensions of sustainability within the organization. Consequently, dimensions of sustainability that have received less attention will be improved based on policies, and new policies will be established to foster improvements in Afghanistan, particularly within the Ministry of Higher Education. Furthermore, the Ministry of Higher Education will be encouraged to guide their universities and HEIs toward greater sustainability.

Higher education institutions play a crucial role in promoting sustainable development through various important mechanisms. Universities address sustainability concerns by generating and sharing essential information [13]. They contribute to skill development, foster innovation ecosystems, and provide evidence-based research to inform sustainable development policies [14]. Moreover, HEIs promote the development and dissemination of sustainable technologies through innovation ecosystems. Universities have the capacity to contribute to evidence-based research that can be used to shape sustainable development policy [15]. In addition, universities can actively participate in their "third mission" by directly collaborating with local communities to jointly develop and implement sustainable solutions [16].

The objective of this study is to address the existing gap by employing the LCC approach to calculate the total costs associated with higher education facilities and services at Kabul University. The objective is also to develop a comprehensive framework for calculating cost data within the context of education LCC that supports the development of an organizational life cycle sustainability assessment for an HEI. The findings of this study will have significant implications for policy-making and budgetary planning in post-conflict educational institutions, providing valuable insights for Afghanistan's Ministry of Higher Education and other countries facing similar challenges [17].

The implications of these findings are significant for both theoretical understanding and practical application. This model will enable organizations to calculate the costs of facilities and services, allowing them to evaluate their LCC in relation to their specific circumstances. Furthermore, it will assess and analyze all aspects of sustainability within the organization, identifying areas that require improvement. The results of this study will offer valuable insights for Afghanistan's Ministry of Higher Education, encouraging universities and other institutions of higher education to adopt more sustainable practices.

This research aims to fill the information gap regarding organizational sustainability in higher education, specifically in developing countries with post-conflict situations, by focusing on Kabul University, a prominent institution in a post-conflict environment. This research will make significant contributions to the integration of sustainability into the reconstruction and modernization initiatives of universities that have experienced conflict. As a result, it will enhance both the theoretical understanding and practical implementation of sustainability in higher education. The study's comprehensive LCC framework, tailored to the specific challenges encountered by HEIs in poste-conflict context, provide a significant pattern for institutions globally aiming to improve financial sustainability. Finally, it allows higher education institutions to synchronize their financial strategies with primary sustainability objectives, endorsing resilience and long-term value generation [12,16].

This study contributes to the existing body of knowledge by: (1) developing a detailed LCC framework specifically designed for post-conflict HEIs; (2) incorporating economic, environmental, and social aspects into the LCC analysis to present a comprehensive perspective on sustainability in higher education; and (3) delivering practical recommendations for policymakers and university administrators to improve the financial sustainability and operational efficiency of HEIs in difficult economic conditions [13,18]. This paper examines Kabul University as a practical case study of how LCC can be utilized to guide strategic decision-making and resource allocation in post-conflict educational environments.

MATERIALS AND METHODS

Life Cycle Costing

Life cycle costing is applied to analyze the economic indicators presented in Table 1 for the purpose of sustainability assessment [7,13]. Similar to the selection of environmental indicators, decision-makers can choose relevant economic indicators to evaluate the economic component, which encompasses capital expenses, feedstock costs, production costs, and operational and maintenance costs [19,20].

In the present research, LCC was selected to estimate the costs associated with Kabul University as an HEI and its provided services related to the product (i.e., the students) by identifying and analyzing all costs incurred from enrollment to graduation. There is currently no universally recognized approach for LCC. Swarr [21] proposed a code of practice to generate consensus for an international standard that aligns with the ISO 14040/14044 [22,23] LCA standards. In this study, the analysis focuses solely on internal real cash flows from the producer's perspective. Internal real cash flows are analyzed due to data accessibility and the emphasis on institutional decision-making. This methodology adheres to established LCC practices in educational contexts, as detailed by Swarr [21] and Gluch & Baumann [24], providing practical guidance for university administration while acknowledging the limitations in evaluating broader social impacts.

Cost data for Kabul University were obtained through a comprehensive examination of financial records, budgets, and reports for the 2020 fiscal year. In cases of insufficient or missing data, estimates were derived from historical patterns and similar institutions in comparable environments. These estimations were validated through discussions with university financial executives to ensure accuracy. Assumptions were necessary for certain long-term maintenance expenses and projected energy prices, which were estimated based on current rates and projected inflation.

Based on the literature, LCC can be calculated using its designated method. Certain elements and components must be calculated based on the nature of the study. According to Han, Srebric, and Enache-Pommer [25], calculating the LCC of a house or building involves three main phases based on the net present value (NPV) in equation (1): construction, annual operation, and maintenance costs. The following formula represents the calculation of NPV:

$$NPV(i,N) = \sum_{t=1}^{N} \frac{Ct}{(1+r)^t} \tag{1}$$

Where NPV is the net present value, t is the time of cash flow, N is the system's lifespan, Ct is the net cash flow at a specific time (t), and r is the discount rate.

The technique for calculating NPV is referred to as discounting future cash flows. During project evaluation, NPV is the instrument that is most frequently associated with the gain to the company. Prospective investors are likely to view it as a beneficial option when assessing the factors involved in their decision-making process. A negative NPV indicates that the costs of the project exceed the benefits that it is expected to generate. As a result, it is evident that the project cannot be sustained financially. The payback period (PBP) of a project refers to the duration required to recover the initial investment from the anticipated cash flow generated by the project. This concept, commonly referred to as "payback", is a more straightforward concept to understand and calculate than any other method. The PBP can be easily calculated by summing all future cash flows and assessing how long it will take to fully recover the initial investment [26]. As the aggregated cost data provide a direct measure of impact, the LCC technique does not require the completion of the impact assessment phase [21]. Consequently, all costs collected from the inventory process were categorized into one of the following categories: maintenance, replacement, and renovation; energy; water; electricity; oil and gas; waste; post and communication; salary; laboratory costs; transportation; and hostel costs.

There is no consensus on which discount rate should be utilized for an LCC analysis. Therefore, a sensitivity analysis incorporating various discount rates is recommended [27]. In this study, discount rates of 20%, 40%, and 50% were applied to determine the NPV. While prior research Zhuang [5] proposed other discounting strategies, these rates were regarded more adequate for conveying the significant economic volatility and instability characteristic of the Afghan setting. Specifically, the 20% rate indicates a moderate risk scenario, whilst the 40% and 50% rates account for more severe economic downturns or instability, offering a wide range for sensitivity testing. This strategy is consistent with World Bank and IMF recommendations for projects in high-risk situations [27].

Previous studies have also suggested different discount rates based on sensitivity analysis [28,29]. Consistency in the analysis requires accounting for inflation using either real or nominal terms. Given the fluctuating inflation rates in Afghanistan, it may be more appropriate to use real terms, which involve converting all future costs to their present-day values. The selection of the discount rate is crucial and should accurately reflect the time value of money and the level of risk associated with future cash flows. To address the economic uncertainties in Afghanistan, a sensitivity analysis was conducted using various discount rates of 20%, 40%, and 50% [28,29].

In the LCC interpretation step, sensitivity analysis is employed to obtain the results or recommendations related to the goal [24,30]. Sensitivity analysis examines the extent to which a change in one parameter influences the overall result [31]. The analysis is conducted by systematically changing certain factors and then observing their effects on the overall results [24]. A minor change in the overall result suggests that there is only a slight change in the individual parameter, which is insignificant. Conversely, a substantial change in the total score indicates that a small modification in one measure could significantly affect the whole evaluation [32].

Higher education is a crucial service that produces graduates who contribute to their communities as human capital. Therefore, LCC is an essential management tool for estimating the costs associated with products or services throughout their entire lifespan. Based on the literature, there are numerous LCC studies related to various products. Numerous studies have specifically calculated the LCC of higher education facilities, particularly dormitories [18,33–36]. However, the calculations pertaining to educational services and facilities have not been addressed in the literature concerning the LCC of higher education. A review of existing methods indicates that there is no comprehensive approach currently employed for higher education or other services. Thus, it is important to adopt a suitable method for the LCC of higher education. Consequently, this study aims to implement methods that utilize existing calculations in the literature. According to the literature review, several studies have calculated the LCC of university residential or non-residential buildings using different elements. Finally, this review suggests that identifying a specific method for determining the LCC of higher education will necessitate modifications and developments that integrate the building's life cycle elements and components, such as facilities, services, operations, construction, laboratory facilities, safety, and student costs.

Using a spreadsheet, all costs associated with maintenance, replacement, and renovation; energy; water; electricity; oil and gas; waste; post and communication; salary; laboratory costs; transportation; and hostel costs were compiled for the university's service provision. The costs were calculated for the function unit (student), taking into account students' graduation periods of four, five, or six years, based on the regulations and bylaws of the Ministry of Higher Education. The collected economic data were entered into a Microsoft Excel spreadsheet model designed to calculate different cost categories. This study included a financial evaluation analysis. Additionally, this analysis only considered two financial indicators (NPV and PBP). In instance which particular financial data were unavailable, estimations were obtained from historical trends, industry benchmarks of similar institutions, and interviews with university finance authorities. Considering the data quality instead of sensitivity analysis the data were double-checked in deferent records for example the data collected from the financial department were checked with the data from deferent records of procurement and archive departments. Moreover, the data had compared with the dataset of financial and budget department in the ministry of higher education, and uniformed with the consultation with financial officers in Kabul University. These comparisons revealed that the study's overall conclusions remained consistent throughout modifications, even these variations indicating that the estimation did not significantly influence the final result of LCC.

Estimating expenses in a volatile economic environment, such as Afghanistan, presents unique challenges. Political uncertainty adversely affects the availability of funding sources, while the volatility of currency exchange rates affects international transactions. Moreover, there are fluctuating inflation rates and potential interruptions to the flow of goods and services along supply chains. To address these challenges, it is recommended to incorporate scenario analysis and sensitivity testing into LCC. This approach involves developing several cost forecasts based on different economic scenarios and analyzing how the results are influenced by changes in important variables [37,38]. While NPV and PBP were chosen as the key primary financial indicators because they are simple and widely used in financial decision-making, it is acknowledged that other indicators, such as the Internal Rate of Return (IRR), may provide additional insights. NPV was utilized to calculate the project's financial value, and PBP was chosen to demonstrate how quickly the investment can be returned. IRR, which represents the discount rate at which the NPV equals zero, may provide an additional perspective on the project's profitability. However, given the emphasis on long-term sustainability and the uncertainty surrounding future cash flows, NPV and PBP were deemed sufficient for the scope of this study. Future study could look into using IRR to provide a more comprehensive financial analysis [39].

Table 1. Calculation of LCC indicators for the year 2020/1399 Hijri year**.**

Domains	**Components**	**Contents**
Construction, Building, and Property Costs	Property costs	Land
	Building costs	Buildings
Operational Costs	Maintenance costs	Maintenance, replacement, and renovation
	Service and utility costs	Energy
		Water
		Electricity
		Oil and gas
		Waste
		Post and communication
		Salary
		Laboratory costs
		Transportation
		Hostel costs

Based on Table 1, the costs associated with providing services were calculated based on the cost inventory data for the year 2020. All costs were categorized into two domains: construction, building, and property costs, as well as operational costs. The property and building costs were calculated under the domain of construction, building, and property costs. The second domain includes maintenance expenses (replacement and renovation), as well as service and utility expenditures (energy, water, electricity, waste management, communications, salaries, laboratory costs, transportation, and accommodation charges). This classification enables a clear differentiation between fixed assets and recurring operating expenditures, thereby enhancing the accuracy of long-term cost forecasting.

Scenario Analysis for Economic Uncertainties

In consideration of the economic instability in Afghanistan, scenario assessments were performed by considering various inflation rates and funding scenarios to present a range of potential LCC outcomes. This approach enables a more comprehensive evaluation of ongoing expenses in an unpredictable setting. Three different scenarios were established: the base case scenario, which uses improved economic indicators and funding levels; the optimistic scenario, which assumes improved economic stability and increased funding; and the pessimistic scenario, which considers potential economic decline and reduced funding. Furthermore, the parameters for each scenario were adjusted, where the inflation rates were varied based on potential increases or decreases from the current rate, the funding levels considered potential changes in government and international support, the exchange rates accounted for potential fluctuations affecting international transactions, and the operational costs were adjusted to reflect potential changes in resource availability and prices.

These scenarios were incorporated into the LCC model, with a particular emphasis on long-term forecasts for maintenance, renovation, and operational costs. This technique yields a range of prospective outcomes, offering a more comprehensive view of the alternative financial possibilities for Kabul University. The purpose of this scenario analysis is to tackle the challenges of estimating long-term costs in Afghanistan's unpredictable environment. It provides decision-makers with a clearer understanding of the possible financial outcomes, as supported by the research of Kishk [37] and Mok & Shen [40].

RESULTS

Life cycle costing is an economic assessment approach that evaluates the total cost of production throughout the entire life cycle of a product. This assessment includes costs associated with raw materials, the installation of production equipment, operation, maintenance, and the product's end-of-life [41]. Although LCC provides valuable insights, it is crucial to critically analyze the findings and incorporate them with environmental and social assessments to fully understand the broader implications of sustainability. Furthermore, LCC is concerned with economic rather than environmental impacts. The selection of LCC indicators is based on the methodology's major references for addressing product LCC and revenues [42]. Table 2 presents the total costs of the inventories of Kabul University.

The LCC analysis presented in this document offers a comprehensive overview of the expenses related to Kabul University. However, the sensitivity analysis is limited and fails to comprehensively investigate the spectrum of economic situations relevant to Afghanistan's unstable economic environment. To address this limitation, the scope of the sensitivity analysis was expanded to encompass a broader spectrum of economic situations, considering various discount rates and time horizons. This approach aligns with the discussions of social discount rates in sustainability assessment, as outlined by Stern [6].

In this study, all costs were calculated from the university's property assets until the operational costs. Meanwhile, in the LCC analysis, the inventory phase involved categorizing all collected economic data into several cost categories. The impact categories (fixed and variable costs) were the land and property, water, energy, maintenance, and operational costs. The reporting function unit is the students at the university. The total number of students in the university is 23,452 students. Based on the regulation of the Ministry of Higher Education, students are expected to graduate in a time period of four to six years. The total costs of Kabul University's services for the expenses in the year 2020 were calculated. These costs were calculated using Afghan currency called Afghani (AFs), and, for clarity, were also converted to USD in some instances.

Table 2. Life cycle inventory costs in AFs.

Impact Category	Indicators	Costs (AFs)	Total Costs (AFs)
Land and Property Costs	Property costs	2,436,840,000	2,460,463,394
	Construction	23,623,394	
Water Costs	Water	4,710,712	4,710,712
Energy Costs	Fuel	11,833,278	19,835,253
	Electricity	8,001,975	
Maintenance Costs	Maintenance and renovation	10,561,065	10,561,065
Operational Costs	Transportation	69,996,368	1,262,715,842
	Office-related	3,415,251	
	Communication	4,443,289	
	Municipality	18,446,296	
	Hostel	48,548,755	
	Salaries	1,117,865,883	
Total Costs (AFs)			3,758,286,266

Summary of the Total Cost and Payback Period for Kabul University over Four Years

In order to make meaningful comparisons between future cash flows, present value estimates are routinely utilized in the business and economic sectors. Net present value refers to a calculation made by discounting future cash flows. When evaluating the profitability of a project, NPV is the standard instrument used by businesses. It can be a valuable option for investors considering their options [43–45]. Table 3 lists the total costs and NPV for 4-year graduation at Kabul University.

The results of the LCC analysis show that the major costs for Kabul University are the property costs, which are 75.69% of the total cost of the university. The operational costs are the second highest cost at Kabul University with 20.14%, followed by energy costs (0.38%), maintenance costs (0.34%), construction costs (0.29%), and water costs (0.15%). However, when the property costs are excluded from the calculation of the costs of Kabul University, the main contributor is the operational costs, which are 94.52% of the total cost of the university. Energy, water, maintenance, and construction costs also contribute to the expenses associated with students who graduate within six years. The excessively high property expenses can be linked to a variety of variables unique to Kabul University and Afghanistan. These could include historical investments in land and infrastructure prior to periods of conflict, the current valuation of land in Kabul, and significant capital expenditures related to building construction and renovations. Furthermore, the extended lifespan of university buildings and their associated decrease costs contribute to high overall property costs [33]. Given the post-conflict situation, it is possible that reconstruction and rehabilitation activities have further inflated these costs [2].

The property costs, which account for 75.69% of the total costs, profoundly impact Kabul University's financial management and sustainability measures. The substantial fixed costs limit flexibility in resource allocation and may hinder the university's capacity to adapt to changing educational demands or economic fluctuations. In contrast to other studies, such as Xue [18], which indicated that building costs represented 60%–70% of life cycle costs in Chinese universities, Kabul University's property costs are significantly higher. This difference may be attributed to the distinct challenges of infrastructure development in post-conflict environments.

Table 3. Summary of the total costs and payback period for Kabul University over four years.

Impact Category	Cost Contribution with Properties (AFs)		Cost Contribution without Properties (AFs)	
Initial/Property Costs	2,436,840,000	78.69%	-	-
Construction Costs	9,069,618	0.29%	9,069,618	1.37%
Maintenance Costs	10,561,065	0.34%	10,561,065	1.60%
Energy Costs	11,833,278	0.38%	11,833,278	1.79%
Water Costs	4,710,712	0.15%	4,710,712	0.71%
Operational Costs	623,710,230	20.14%	623,710,230	94.52%
Total Costs (AFs)	3,096,724,903	100%	659,884,903	100%
Net Present Value 20%	16,851,138,232.16		3,590,829,688.16	

DISCUSSION

Sensitivity Analysis of Life Cycle Costing

The details of the estimated LCC related to Kabul University as an HEI in Afghanistan are shown in Table 4. Discount rates of 20%, 40%, and 50%

were applied to determine the NPV. The selection of these discount rates for the sensitivity analysis is based on various factors, particularly those relevant to the Afghan context. First, these rates reflect the significant levels of economic uncertainty and risk prevalent in countries after a conflict. Collier & Gunning [46] observed that post-conflict countries typically experience elevated discount rates due to increased subjective risk and uncertainty. Furthermore, fluctuations in Afghanistan's economy are related to political situations and monetary policy, which significantly fluctuate. Given this inherent instability, employing a range of discount rates up to 50% allows for a comprehensive assessment of potential economic scenarios. The chosen discount rates (20%, 40%, and 50%) for the sensitivity analysis represent the distinct economic circumstances in Afghanistan.

Furthermore, Zhuang [5] proposed that the social discount rates in poor countries may vary between 8% and over 15%, with higher rates typically used in situations of greater uncertainty. The inclusion of rates of 20%, 40%, and 50% in this research allows for a wide range of economic scenarios that Kabul University may encounter, encompassing both moderate and extreme situations. However, other institutions in similar contexts have adopted comparable approaches. A study by Castillo and Zhangallimbay [47] on social discount rates in Ecuador revealed that rates ranged from 2% for long-term initiatives to over 12% for short-term assessments. Furthermore, recent studies suggest the application of reduced discount rates over extended time frames to address uncertainties regarding future economic growth [48]. Certain economists have suggested the use of lower rates when assessing climate change mitigation initiatives due to their prolonged and intergenerational effects [18].

The results indicate that the costs at Kabul University are significantly affected by changes in discount rates. As the discount rates increase, the NPV also rises. However, despite the increase in NPV with higher discount rates, the PBP remains consistent with the NPV. There is no consensus on the appropriate discount rate to use for an LCC analysis. Thus, conducting a sensitivity analysis across various discount rates is recommended [49].

Table 4. Sensitivity analysis of LCC results (discount rate).

Kabul University	Normal Value	Increased by 20%	Increased by 40%	Increased by 50%
NPV	AFs 3,096,724,903	29,016,064,603	27,702,062,292	34,644,609,852
PBP	USD 29,542,755.57	6	6	6
NPV	MYR 123,611,967.95	24,556,780,743	44,356,992,035	58,160,364,584
PBP		5	5	5
NPV		16,851,138,232	50,426,572,844	65,127,995,616
PBP		4	4	4

The sensitivity analysis demonstrates how different discount rates influence the NPV and PBP of Kabul University. Based on the data presented in Table 4, as the discount rates increased by 20%, 40%, and 50%, the NPV also increased. These findings align with Stern [6], which emphasizes the importance of selecting appropriate discount rates in sustainability assessments. Varying discount rates can significantly impact the perceived financial viability of long-term investments, particularly in higher education. This sensitivity analysis reveals the financial vulnerability of Kabul University under various economic scenarios. The responsiveness of Kabul University's costs to different discount rates (20%, 40%, and 50%) highlights the institution's susceptibility to wider economic variations. The vulnerability is especially evident in Afghanistan's unstable economic landscape, where factors like political instability and fluctuating international aid can greatly influence funding for higher education [17]. These findings suggest that policy recommendations should focus on initiatives for financial resilience and diversifying funding sources.

Payback period is an essential indicator in financial analysis that measures the time required for an investment to recover its initial expenses through cash inflows [18]. This indicator is particularly important for Kabul University, given the economic challenges in Afghanistan. It assists decision-makers in understanding the rate at which the university can recover its investments, which is a crucial factor in an unstable economic landscape.

The PBP decreased from six years in the baseline scenario to four years with a 50% increase in the discount rate. The shortened PBP indicates that higher discount rates lead to faster investment recovery; however, it is accompanied by increased total expenses. This information is essential for university administrators and policymakers in formulating resilient finance strategies that can withstand diverse economic conditions [18]. Furthermore, understanding the PBP is particularly relevant in the context of higher education in developing countries, where resource allocation and strategic financial planning are essential. A reduced PBP may indicate a more financially robust investment, which is especially beneficial in regions experiencing economic volatility [18].

By analyzing the sensitivity of LCC statistics for Kabul University, the results of cost per student can be examined. In the initial situation, the NPV of AFs 3,096,724,903 or approximately USD 29,542,755 is the total cost of university operations over its entire lifespan. To calculate the cost per student, it is necessary to have data on the total number of students, which is not included in the provided information. In this study, the number of total students is 23,452. Based on calculations, a student at Kabul University incurs an annual expenditure of AFs 132,046.24 per year. Consequently, for a student who graduates in four years from Kabul University, the total expenditure amounts to AFs 528,184.95 (USD 7449.16).

In response to changes in discount rates, the analysis demonstrates the effect of increasing the discount rates by 20%, 40%, and 50% on the NPV. This is consistent with the findings of Johnstone & Marcucci [17], who examined the instability of funding for higher education in emerging countries. Johnstone & Marcucci [17] highlighted the importance of using NPV calculations to assess educational investments, particularly in situations with limited resources. This underscores the university's fiscal responsiveness to economic variables. However, the PBP remains consistent at six years for the base scenario and decreases to five years and then four years as the discount rate increases. This implies that an increase in discount rates results in a more rapid improvement of investments, which may affect the cost structure per student. These findings are in line with Woodhall [50], who emphasized the significance of PBP in evaluating the economic feasibility of educational initiatives in developing countries.

The financial consequences per student indicate that as the NPV rises with higher discount rates, the potential cost per student correspondingly increases, assuming that the number of students remains constant. For instance, when the discount rate increased by 50%, the NPV rose to AFs 34,644,609,852. This change would lead to a substantial increase in the cost per student compared to the baseline scenario. Financial planning, including sensitivity analysis, enables the university to prepare for economic fluctuations and ensure long-term viability. Sensitivity analysis assists the university in understanding the potential impact of economic fluctuations on its long-term financial viability and, consequently, the cost framework for students.

A university can use information regarding cost sensitivities to inform decisions about resource allocation, which may affect the quality and affordability of education for students. To accurately determine the cost per student, additional information is required, including the total student enrollment and the allocation of expenditures across various university operations. This research provides a structure for understanding the financial dynamics of the university, which ultimately impacts the fee structure for individual students. The analysis is particularly relevant for universities located in least-developed countries. According to the UNEP [49], it is crucial to understand the financial vulnerabilities of educational institutions to promote sustainable growth in these areas.

To mitigate financial instability, HEIs in developing or post-conflict areas can proactively diversify their financing sources. This may involve pursuing funds from international organizations and development agencies, forming relationships with private sector firms for research and development initiatives, and creating alumni fundraising campaigns. Furthermore, universities may investigate revenue-generating initiatives, including the provision of professional training courses, leasing buildings for events, and the commercialization of research findings. A diverse funding portfolio helps shield the institution from economic disruptions and provide a more secure financial foundation [17]. In light of the unstable economic situation in Afghanistan, Kabul University should consider forming collaborations with other universities to facilitate student and faculty exchange programs, utilizing resources and experience from more stable contexts [3]. These relationships may result in joint research initiatives, securing supplementary financing and inspiring the university's global reputation.

The cost for a student who graduated from Kabul University in six years is AFs 792,277.4232, which is approximately USD 11,173.74, followed by AFs 660,231.186 (USD 9311.45) for five years, and AFs 528,184.9488 (USD 7449.16) for four years. Conducting a sensitivity analysis is necessary for predicting the outcome of a decision. However, it is important to contextualize these figures within the broader economic landscape of higher education in developing countries. Specifically, Psacharopoulos & Patrinos [51] emphasized that developing countries tend to have a greater return on investment in education, which justifies the higher initial expenses.

Consequently, this sensitivity study provides vital insights into the financial dynamics of Kabul University. It highlights the vulnerability of the institution's finances to economic fluctuations, which is particularly important in the context of a developing country like Afghanistan. The research follows established protocols in higher education finance and serves as a foundation for making informed decisions regarding resource allocation to ensure long-term financial stability.

It is essential to integrate economic costs with environmental and social assessments to gain a comprehensive understanding of sustainability. The LCC study reveals that the primary factors influencing the total costs of Kabul University are the costs related to properties and operations. These costs have significant environmental and social impacts. For instance, the university's environmental impact is evident in its high energy and water costs, while its operational costs, such as salaries and transportation, affect the local economy and community [13]. An examination of these relationships facilitates the identification of potential trade-offs and synergies among the economic, environmental, and social aspects.

To strengthen the integration of economic, environmental, and social aspects of sustainability, targeted measures should be considered. Investments in renewable energy sources, such as solar panels, can reduce long-term operational expenses while simultaneously decreasing the university's carbon impact. However, the feasibility of these interventions must be carefully evaluated within the context of Kabul University, considering factors such as initial capital expenditures, local technical expertise, and the existing security conditions. Additionally, measures to improve operational efficiency, such as upgrading building insulation or adopting water conservation strategies, may offer more readily achievable sustainability benefits [13].

Finally, the long-term economic viability of Kabul University strategies such as consistent funding and alignment with economic development objectives. Securing financial sources in a turbulent economic environment like Afghanistan is a tough task. Analyzing the economic performance of Kabul University in relation to benchmarks from other universities or industries can provide valuable contextual insights. Xue [18] emphasized the importance of benchmarking in understanding comparative effectiveness and identifying areas for improvement. Achieving sustainable economic viability requires the implementation of a comprehensive strategy and continuous evaluation of financial outcomes. Significant energy consumption is directly linked to high operational costs, which constitute 20.14% of the total costs (or 94.52% when property costs are excluded). Electricity accounts for 55.8% of all environmental impacts, highlighting how significantly this energy use contributes to the university's environmental impact. This suggests area improvements in environmental and economic performance. Adopting energy-saving strategies could reduce operating expenses while simultaneously benefiting the environment [13].

Integration of Economic Costs with Environmental and Social Impacts

The LCC analysis of Kabul University reveals significant relationships between economic costs and social and environmental impacts, which can be explained as follows: (1) Operational costs: Significant energy consumption is directly linked to high operational costs, which constitute 20.14% of the total costs (or 94.52% when property costs are excluded). Electricity accounts for 55.8% of all environmental impacts, demonstrating how significantly this energy use contributes to the university's environmental impact. This indicates a potential area for improvements in environmental and economic performance. Adopting energy-saving strategies could reduce operating expenses while simultaneously benefitting the environment [13]. (2) Transportation costs: Transportation is a major contributor to operational costs and has implications for both the economy and the environment. It significantly impacts operational costs, accounting for 24.7% of environmental impacts. This underscores the importance of identifying affordable and environmentally friendly transportation options [12]. (3) Maintenance costs: Although maintenance costs account for only 0.34% of the total costs, they are crucial for the durability and effectiveness of the university's infrastructure. Over time, proper maintenance can lead to reduced environmental impacts and increased energy efficiency, demonstrating a long-term relationship between environmental performance and economic considerations [52]. (4) Social implications: There are important social impacts on the high percentage of expenses allocated to salaries, which are a component of operational costs. This highlights how the university contributes to regional economic growth by serving as a major employer in the area. In addition, it underscores the importance of effectively allocating resources to ensure both equitable compensation and long-term financial viability.

CONCLUSIONS

The study encompasses various cost categories, including land and property, construction, water, energy, maintenance, and operational costs. The LCC indicators were chosen based on established references for assessing product life-cycle costs and revenues. The results indicate that property costs represent the most substantial portion of the overall expenses, accounting for 75.69% of the total cost. Following this, operational costs contribute 20.14%. The contributions of energy, maintenance, construction, and water costs are comparatively lower. The lower contributions of these costs have several implications. They may not accurately represent the university's actual resource consumption, potentially concealing inefficiencies. Targeted investments in energy efficiency, preventative maintenance, and water conservation could yield significant benefits for cost reduction and sustainability enhancement. The institution should re-evaluate its resource allocation to ensure adequate funding for the maintenance and renovation of facilities, thereby preventing increased expenses in the future. Understanding these cost dynamics is essential for developing a comprehensive sustainability strategy that balances short-term financial limitations with long-term operational effectiveness and environmental consequences. Notably, when excluding property costs, the main contributor shifts to operational costs, which constitute 94.52% of the total costs. This finding highlights the importance of considering different cost components when evaluating the financial implications of the university's services.

In light of these findings, the study offers a comprehensive understanding of the cost structure associated with the services provided by Kabul University and emphasizes the importance of economic considerations in higher education management. Future research could explore additional factors and variables that may impact the economic viability of educational institutions, thereby contributing to more informed decision-making processes.

Through a comprehensive examination of the life cycle expenses associated with Kabul University, this study offers valuable insights into the economic aspects of sustainability in HEIs in a post-conflict, developing country setting. The application of the LCC method reveals that the key components of the university's total expenditures are property costs (75.69%) and operational costs (20.14%). These results underscore the significant financial implications of infrastructure and daily operations in sustaining an HEI in Afghanistan.

Conducting a sensitivity analysis with discount rates of 20%, 40%, and 50% revealed the university's vulnerability to economic volatility. These findings are particularly relevant given the unpredictable economic conditions in Afghanistan and align with studies addressing the challenges of financing higher education in emerging countries. The statistical analysis revealed that the cost per student ranged from AFs 528,184.95 (USD 7449.16) for a four-year program to AFs 792,277.42 (USD 11,173.74) for a six-year program. These data serve as an important reference point for understanding the economic investment in higher education within this specific context.

Importantly, the findings emphasized the interdependence of economic, environmental, and societal consequences. Significant environmental consequences were identified due to high operational costs, particularly in energy consumption and transportation. The discovery aligns with the triple bottom line concept of sustainability and underscores the necessity of implementing integrated solutions that address both economic efficiency and environmental stewardship.

Furthermore, the study revealed the societal consequences of the university's expenditures, particularly concerning salaries, thereby underscoring the institution's role as a significant economic contributor to the surrounding community. This also highlights the wider social consequences of HEIs that extend beyond their primary educational mission. Notably, Kabul University's substantial operational costs, especially regarding salaries, reinforce its status as a major employer and economic contributor to the local community. This is consistent with the findings of Findler [13], who noted that HEIs can significantly impact local economic development and social mobility. Moreover, as indicated by Trencher [16], universities often participate in "co-creation for sustainability" with local communities, promoting social innovation and addressing regional issues. Such initiatives may include outreach programs, community-oriented research, or collaborative projects aimed at tackling local socioeconomic and environmental issues. Kabul University, the Ministry of Higher Education, and similar institutions should consider the following actionable recommendations. First, the university should prioritize investments in energy efficiency and renewable energy sources to minimize operational costs and environmental impacts. Second, regular maintenance can prevent costly repairs in the future and extend the lifespan of educational infrastructure. Finally, ongoing assessment and evaluation of financial strategies will be essential for adapting to changing economic conditions. Implementing a comprehensive financial management framework would enable the university to make informed decisions that balance educational excellence with economic accountability.

This study establishes a fundamental structure for understanding the economic dynamics of HEIs in developing countries that have recovered from conflict. It underscores the importance of adopting strategic financial planning, allocating resources sustainably, and integrating economic factors with environmental and social impacts. Future research should prioritize comparative analyses with other institutions in comparable circumstances and explore novel approaches to improve financial sustainability while maintaining educational quality and accessibility.

To ensure actual cost management in HEIs within developing or post-conflict countries, policymakers and institutional leaders should launch comprehensive policy frameworks. These frameworks should comprise guidelines for budget allocation, procurement procedures, and financial reporting. Transparency and accountability mechanisms are important to avoid corruption and ensure that resources are used professionally. Policy frameworks should also incentivize cost-saving measures and encourage a culture of financial responsibility throughout the institution. Furthermore, regular audits and appraisals should be conducted to assess the efficiency of cost management strategies and identify areas for enhancement.

The unique contribution of this study lies in its comprehensive evaluation of the sustainability of Kabul University, encompassing social, environmental, and economic aspects. In contrast to previous studies that may have focused on specific elements, this holistic approach offers a more nuanced view of institutional viability in a post-conflict environment. By incorporating a comprehensive LCC analysis, the study provides useful insights into the financial aspects of university operations. These findings enhance our understanding of the economic implications of sustainability initiatives in higher education, particularly in resource-constrained settings.

The study's comprehensive approach, which incorporates several evaluation techniques, provides a flexible framework that can be utilized for sustainability assessments of other HEIs, particularly in developing and post-conflict societies. To highlight the alignment between the results and Sustainable Development Goal (SDG) 4 (Quality Education) and SDG 11 (Sustainable Cities and Communities), Kabul University emerges as a potential exemplar for other institutions in the region. Additionally, the study acknowledges its limitations, including constraints in data availability and a focus on a particular institution. It proposes opportunities for further investigation, such as expanding the range of institutions involved and conducting longitudinal studies to document enduring sustainability patterns in educational environments following conflicts. Based on the findings, it is advisable to develop a comprehensive financial strategy as a key recommendation to improve economic sustainability.

DATA AVAILABILITY

The authors of the study are willing to share the dataset of the study upon reasonable request.

AUTHOR CONTRIBUTIONS

Conceptualization, WW and AHS; Methodology, WW, NKM and AHS; Data collection, WW and NAA; Validation, NKM and AHS; Calculation, WW, AHS and NKM; Data Curation, WW; Writing—Original Draft Preparation, WW; Writing—Review & Editing, AHS, NKM and NAA; Supervision, AHS and NKM.

CONFLICTS OF INTEREST

The authors declare that they do not have any conflicts of interest.

ACKNOWLEDGMENTS

The authors would like to express their sincere gratitude to Kabul University and the Afghanistan's Ministry of Higher Education for their invaluable cooperation and assistance. Their willingness to disclose sensitive cost data and confidential documents significantly contributed to this research. The honesty and trust exhibited by both institutions greatly enhanced the integrity and depth of this study. The authors truly appreciate their commitment to academic collaboration and efforts to foster an environment of transparency and knowledge exchange during an exceptionally challenging time.

REFERENCES

1. Li J, Xue E, Wei Y, He Y. How popularising higher education affects economic growth and poverty alleviation: empirical evidence from 38 countries. Humanit Soc Sci Commun. 2024;11(1):520.
2. Ahmadi MH. Higher Education of Afghanistan under the Taliban Rule: Review and Analysis of Past and Current Impacts. Berlin (Germany):YAAR e.V; 2022.
3. Azimi MN, Balakarzai AT. Nation Building Through Higher Education System Resurgence in Afghanistan. In: Sarangapani PM, Pappu R, editors. Handbook of Education Systems in South Asia. Singapore (Singapore): Springer; 2020. p. 1-22.
4. Hamid MRA, Abdullah M, Mustafa Z, Abidin NB binti Z, Ahmad H. Conceptual Framework of Innovation Excellence Model for Higher Education Institutions. Procedia Soc Behav Sci. 2015;174:2846-8.
5. Zhuang J, Liang Z, Lin T, De Guzman F. Theory and practice in the choice of social discount rate for cost-benefit analysis: a survey. Manila (Philippines): Asian Development Bank; 2007.
6. Stern N. The economics of climate change: the Stern review. Cambridge (UK): Cambridge University Press; 2007.
7. Zhang C, Cui C, Zhang Y, Yuan J, Luo Y, Gang W. A review of renewable energy assessment methods in green building and green neighborhood rating systems. Energy Build. 2019;195:68-81.
8. Miah JH, Koh SCL, Stone D. A hybridised framework combining integrated methods for environmental Life Cycle Assessment and Life Cycle Costing. J Clean Prod. 2017;168:846-66.
9. Wafa W, Sharaai AH, Matthew NK, Ho SA, Akhundzada NA. Organizational Life Cycle Sustainability Assessment (OLCSA) for a Higher Education Institution as an Organization: A Systematic Review and Bibliometric

Analysis. Sustainability . 2022;14(5):2616.
10. RICS. Life cycle costing. 1st ed. London (UK): Royal Institution of Chartered Surveyors; 2016.
11. Hoogmartens R, Van Passel S, Van Acker K, Dubois M. Bridging the gap between LCA, LCC and CBA as sustainability assessment tools. Environ Impact Assess Rev. 2014;48:27-33.
12. Lozano R, Lukman R, Lozano FJ, Huisingh D, Lambrechts W. Declarations for sustainability in higher education: becoming better leaders, through addressing the university system. J Clean Prod. 2013;48:10-9.
13. Findler F, Schönherr N, Lozano R, Reider D, Martinuzzi A. The impacts of higher education institutions on sustainable development. Int J Sustain High Educ. 2019;20(1):23-38.
14. Wiek A, Withycombe L, Redman CL. Key competencies in sustainability: a reference framework for academic program development. Sustain Sci. 2011;6:203-18.
15. Siegfried JJ, Sanderson AR, McHenry P. The Economic Impact of Colleges and Universities. Chang Mag High Learn. 2008;40(2):24-31.
16. Trencher G, Yarime M, McCormick KB, Doll CNH, Kraines SB. Beyond the third mission: Exploring the emerging university function of co-creation for sustainability. Sci Public Policy. 2014;41(2):151-79.
17. Johnstone DB, Marcucci PN. Financing higher education worldwide: Who pays? Who should pay? Baltimore (US): Johns Hopkins University Press; 2010.
18. Xue Z, Liu H, Zhang Q, Wang J, Fan J, Zhou X. The Impact Assessment of Campus Buildings Based on a Life Cycle Assessment–Life Cycle Cost Integrated Model. Sustainability. 2020;12(1):294.
19. Arulnathan V, Heidari MD, Doyon M, Li EPH, Pelletier N. Economic Indicators for Life Cycle Sustainability Assessment: Going beyond Life Cycle Costing. Sustainability. 2023;15(1):13.
20. Ma S, Sharaai AH, He Z, Matthew NK, Zainordin NS, Wafa W. Exploring the Research Frontier of Life Cycle Sustainability Assessment—A Systematic Literature Review of Applied Bibliometric Analysis. Chem Eng Trans. 2023;106:547-52.
21. Swarr TE, Hunkeler D, Klöpffer W, Pesonen HL, Ciroth A, Brent AC, et al. Environmental life-cycle costing: a code of practice. Int J Life Cycle Assess. 2011;16(5):389-91.
22. ISO. ISO 14044—Environmental management—Life cycle assessment—Requirements and guidelines. Geneva (Switzerland): International Organization for Standardization; 2006.
23. ISO. ISO 14040—Environmental management—Life Cycle Assessment—Principles and Framework. Geneva (Switzerland): International Organization for Standardization; 2006.
24. Gluch P, Baumann H. The life cycle costing (LCC) approach: a conceptual discussion of its usefulness for environmental decision-making. Build Environ. 2004;39(5):571-80.
25. Han G, Srebric J, Enache-Pommer E. Variability of optimal solutions for building components based on comprehensive life cycle cost analysis. Energy

Build. 2014;79:223-31.
26. Gharib J, Benabbou L. Assessment of Investment Project Profitability In Uncertain Environment: A Real Options Approach. Available from: http://ieomsociety.org/ieom2017/papers/541.pdf. Accessed on 20 Feb 2025.
27. World Bank. Discounting Costs and Benefits in Economic Analysis of World Bank Projects. Washington (US): World Bank Group; 2016.
28. Almansa C, Martínez-Paz JM. What weight should be assigned to future environmental impacts? A probabilistic cost benefit analysis using recent advances on discounting. Sci Total Environ. 2011;409(7):1305-14.
29. Matousek J, Havranek T, Irsova Z. Individual discount rates: a meta-analysis of experimental evidence. Exp Econ. 2022;25(1):318-58.
30. Scope C, Ilg P, Muench S, Guenther E. Uncertainty in life cycle costing for long-range infrastructure. Part II: guidance and suitability of applied methods to address uncertainty. Int J Life Cycle Assess. 2016;21(8):1170-84.
31. Hamby DM. A review of techniques for parameter sensitivity analysis of environmental models. Environ Monit Assess. 1994;32(2):135-54.
32. Heijungs R, Settanni E, Guinée J. Toward a computational structure for life cycle sustainability analysis: unifying LCA and LCC. Int J Life Cycle Assess. 2013;18(9):1722-33.
33. Bromilow FJ, Pawsey MR. Life cycle cost of university buildings. Constr Manag Econ. 1987;5(4):S3-22.
34. Huang L, Liu Y, Krigsvoll G, Johansen F. Life cycle assessment and life cycle cost of university dormitories in the southeast China: Case study of the university town of Fuzhou. J Clean Prod. 2018;173:151-9.
35. Kimoto K, Yoshizaki Y, Ikeda T. Life cycle cost analysis on educational facilities in Japan. Int J Proj Organ Manag. 2013;5(1–2):91-110.
36. Li CS, Guo SJ. Life cycle cost analysis of maintenance costs and budgets for university buildings in Taiwan. J Asian Archit Build Eng. 2012;11(1):87-94.
37. Kishk M, Al-Hajj A, Pollock R, Aouad G, Bakis N, Sun M. Whole life costing in construction: a state of the art review. London (UK): Royal Institution of Chartered Surveyors; 2003.
38. Wafa W, Sharaai AH, Koshy N. Consideration of Financial and Environmental Concerns in the Life Cycle Costing of Higher Education's Facilities and Services: A Systematic Review of One Decade. Int J Acad Res Econ Manag Sci. 2024;13(4):532-56.
39. Grant EL, Ireson WG. Principles of engineering economy. New York (US): Ronald Press Company; 1970.
40. Mok MKY, Shen GQ. A network-theory based model for stakeholder analysis in major construction projects. Procedia Eng. 2016;164:292-8.
41. De Menna F, Dietershagen J, Loubiere M, Vittuari M. Life cycle costing of food waste: A review of methodological approaches. Waste Manag. 2018;73:1-13.
42. Gundes S. The Use of Life Cycle Techniques in the Assessment of Sustainability. Procedia Soc Behav Sci. 2016;216:916-22.
43. San Ong T, Thum CH. Net present value and payback period for building integrated photovoltaic projects in Malaysia. Int J Acad Res Bus Soc Sci. 2013;3(2):153.

44. Steiger F. The validity of company valuation using discounted cash flow methods. Available from: https://arxiv.org/pdf/1003.4881. Accessed on 20 Feb 2025.
45. Yan J, Lianyong F, Shanna F. Comparative study of discounted cash flow and energy return on investment: review of oil and gas resource economic evaluation. Financ Theory Pract. 2020;24(2):50-9. doi: 10.26794/2587-5671-2020-24-2-50-59
46. Collier P, Gunning JW. War, peace and private portfolios. World Dev. 1995;23(2):233-41.
47. Castillo JG, Zhangallimbay D. The social discount rate in the evaluation of investment projects: an application for Ecuador. Available from: https://repositorio.cepal.org/server/api/core/bitstreams/f31ddfbe-bccb-49db-aa04-00f3d663314c/content. Accessed on 20 Feb 2025.
48. Freeman MC, Groom B, Panopoulou E, Pantelidis T. Declining discount rates and the Fisher Effect: Inflated past, discounted future? J Environ Econ Manage. 2015;73:32-49.
49. UNEP. Towards a Life Cycle Sustainability A ssessment: Making informed choices on products. Available from: https://wedocs.unep.org/bitstream/handle/20.500.11822/8001/UNEP_LifecycleInit_Dec_FINAL.pdf?sequence=3&amp%3BisAllowed=. Accessed on 20 Feb 2025.
50. Woodhall M, Hernes G, Beeby CE. Cost-benefit analysis in educational planning. Paris (France): UNESCO—International Institute for Educational Planning; 2004.
51. Psacharopoulos G, Patrinos HA. Returns to investment in education: a decennial review of the global literature. Educ Econ. 2018;26(5):445-58.
52. Omran N, Sharaai AH, Hashim AH. Visualization of the Sustainability Level of Crude Palm Oil Production: A Life Cycle Approach. Sustainability. 2021;3(4):1607.

How to cite this article:
Wafa W, Sharaai AH, Matthew NK, Akhundzada NA. Calculation of Higher Education Institution’s Facilities and Services Applying the Life Cycle Costing Approach Contributing Sustainability. J Sustain Res. 2025;7(1):e250016. https://doi.org/10.20900/jsr20250016