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Testing the moderating effect of top management support on the sustainability practices of quality costing and life cycle costing

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Abstract: Sustainability practices in private universities are a series of policies, programs, and activities carried out to ensure environmental, social, economic, and governance sustainability in campus operations. The goal is to create an efficient, responsible, and long-term-oriented educational institution. The use of a strategic costing approach is a cost management approach that focuses on determining and managing costs to support the long-term strategy of higher education institutions. Top management support at private universities is the level of commitment and involvement of top leaders in providing the strategic direction, resources, and encouragement necessary to ensure the successful implementation of institutional programs, including sustainability programs. This study investigates, using strategic costing dimensions that focus on Quality Costing and Life Cycle Costing, the influence on sustainability practices, with Top Management Support (TMS) as a moderating variable. Data were collected from 120 observation questionnaires of private universities in South Sulawesi and processed using Smart-PLS 4. The study shows that TMS strengthens strategic costing in achieving sustainability in private universities. These findings highlight the important role of strategic costing in achieving sustainability and suggest the comprehensive moderating influence of TMS.

Keywords: *Life cycle costing, Quality costing, Strategic costing, Sustainability practices, Top management support.*

1. Introduction

Historically, the theory of sustainability was first proposed by Meadows et al. [1], which explains that society's efforts prioritize social responses to environmental and economic issues. [2] proves that organizations that focus on TBL can increase the competitive advantage of companies. This theory forms the basis for various approaches to natural resource management, development policy, and long-term business practices. Sustainability in the context of private higher education institutions encompasses the application of sustainability principles in three main pillars: environmental, social, and economic, to create institutions that are long-lasting, relevant, and have a positive long-term impact. Studies related to sustainability in higher education have developed significantly. A study at the Polytechnic University of Madrid shows that sustainability reports help align the institution's vision with sustainability principles, improve communication, and build trust with stakeholders [3]. A case study at the University of Minho shows that a combination of bottom-up and top-down approaches is essential for integrating sustainability into all aspects of the institution, including curriculum, research, and operations [4].

In recent years, management accounting literature has recognized the influence of strategic costing as a strategic management accounting technique due to its competitive advantage and improvement in organizational performance [5]. Strategic costing has attracted the attention of practitioners and academics because of its significant influence on competitive advantage and organizational performance. Strategic costing is defined as the use of market-oriented strategies, costs, and data to prioritize and develop strategies that can provide sustainable competitive advantage [6]. The relationship between

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strategic costing and sustainability is very close, as this approach helps organizations achieve sustainability goals efficiently and strategically [7]. The relationship between strategic costs and sustainability in private universities lies in how universities manage costs to support their sustainability goals. One dimension of strategic costing that can help achieve sustainability is Quality Costing, which is a method that focuses on managing costs related to quality. Quality Costing is a cost management method that identifies and measures costs related to prevention, assessment, and failure in maintaining quality. In the context of private universities, Quality Costing can be applied to various activities, ranging from curriculum management and teaching processes to student services [8]. In addition, strategic costing can also be attributed to Life Cycle Costing (LCC). Life Cycle Costing in higher education is closely related to sustainability because this method allows institutions to consider all costs associated with an asset or project during its lifetime [9]. By understanding the relationship between LCC and sustainability performance, private universities can make better decisions in managing resources, reducing environmental impact, and improving economic efficiency.

However, the implementation of strategic costing will be easier to achieve sustainability if there is top management support. TMS is a key factor that influences the success of implementing sustainability initiatives in a private university. TMS refers to the involvement, commitment, and active support of top leaders in the organization towards certain initiatives or projects. Support from top management has a significant influence on the successful implementation and performance of sustainability initiatives in private universities. Disterheft et al. [10] emphasize the importance of management involvement in integrating sustainability into higher education strategies to achieve effective transformation. Lozano et al. [11] show that top management involvement in resource allocation is key to the success of sustainability in higher education institutions. Private universities are required to make improvements to achieve sustainability. The idea behind this research is to create awareness among stakeholders about the importance of sustainable performance in private universities. Currently, there is a growing awareness among the public and the business community about the need to create sustainable performance in higher education institutions [12]. However, most of these organizations find it challenging to prioritize sustainability issues and develop strategies and policies. Critical sustainability practices play an important role in determining an organization's sustainable performance. This study will examine the dimensions of strategic costing on sustainability practices by including Top Management Support as a moderating variable at private universities in South Sulawesi. This research is not only academically relevant but also practically important in the development of private universities and awareness of sustainability issues that continue to evolve.

2. Literature Review

2.1. Agency Theory

According to Jensen and Meckling [13], Agency theory is a framework that explains the contextual relationship between principals and agents, namely between two or more people, a group, or an organization. The principal is the party that has the right to make decisions for the future of the company and assigns responsibilities to other parties (agents). The difference in interests between management (agents) and principals can lead to agency conflicts. Principals and agents both want large profits. Principals and agents also both avoid risks [14]. In the context of private universities, this theory is relevant because the management structure often involves foundations, capital owners, or investors as principals, and the rectorate or campus management as agents. Agency theory helps explain management challenges in private universities, especially in managing the relationship between capital owners and campus management.

2.2. Sustainability Theory

Sustainability theory was first proposed by Meadows et al. [1], who explained that society's efforts prioritize social responses to environmental and economic issues. The concept of sustainability is currently growing and being applied in the context of corporate sustainability [2]. Corporate

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sustainability is commonly measured through the Triple Bottom Line (TBL), a concept developed by [15]. There are three dimensions of TBL, namely economic, social, and environmental. Purnama [2] stated that companies can move toward sustainable development by integrating TBL into their management strategies. Sustainability in private universities involves applying principles across three pillars: environmental, social, and economic, to create long-lasting institutions, relevant, and have a positive long-term impact.

2.3. Strategic Costing (SC)

Strategic Costing is a cost management approach that focuses on determining and managing costs to support a company's long-term strategy. Strategic costs are defined as the use of market-oriented strategies, costs, and data to prioritize and develop strategies that can provide a sustainable competitive advantage [6]. The relationship between strategic costing and sustainability in private universities lies in how universities manage costs to support their sustainability goals. Strategic costs in private universities not only help operational efficiency but also support sustainability initiatives that strengthen the reputation, attractiveness, and social contribution of universities. This approach enables universities to achieve sustainability goals while ensuring their financial sustainability.

2.4. Quality Costing (QC)

Quality Costing is a method that focuses on managing costs related to quality. It is a cost management method that identifies and measures costs related to prevention, assessment, and failure in maintaining quality. In the context of a private university, Quality Costing can be applied to various activities, ranging from curriculum management and teaching processes to student services [8]. Quality Costing enables universities to allocate resources more appropriately, directing investment to areas that will have the greatest impact on quality improvement and sustainability. Quality Costing in universities is closely related to sustainability because it helps institutions manage and reduce costs related to quality, both from an academic and operational perspective [16].

2.5. Life Cycle Costing (LCC)

Life Cycle Costing (LCC) is a method that evaluates the total costs associated with a product or system throughout its life cycle. Life cycle costing in higher education is closely related to sustainability because this method allows institutions to consider all costs associated with an asset or project during its useful life [9]. Life Cycle Costing is an important tool for private higher education institutions to improve their sustainability performance. By considering the total costs from the beginning to the end of the life cycle of an asset or project, HEIs can make wiser decisions, reduce environmental impact, and achieve greater economic efficiency. This ultimately helps universities fulfill their social and environmental responsibilities and maintain financial sustainability [17].

2.6. Top Management Support (TMS)

Top Management Support (TMS) refers to the involvement, commitment, and active support of the highest leadership in an organization toward a particular initiative or project. Support from top management has a significant influence on the successful implementation and performance of sustainability initiatives at HEIs. Disterheft et al. [10] emphasize the importance of management involvement in integrating sustainability into higher education strategies to achieve effective transformation. Lozano et al. [11] show that top management involvement in resource allocation is key to the success of sustainability initiatives in higher education institutions. Support from top management is a crucial factor influencing the successful implementation of sustainability initiatives in private higher education institutions.

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2.7. Research Framework

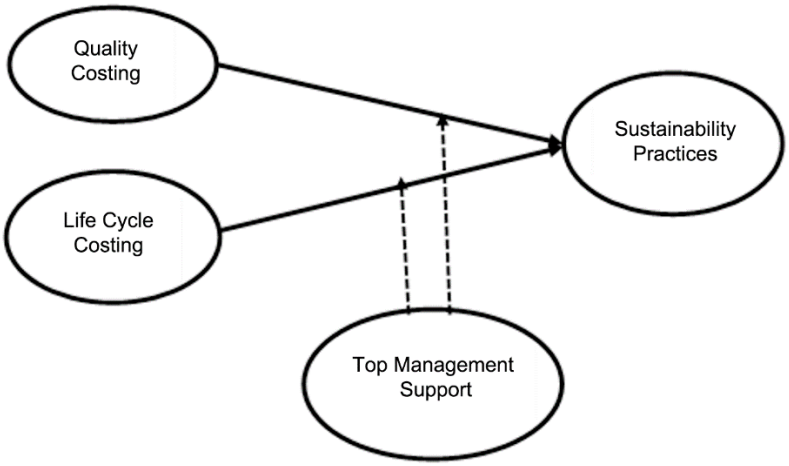

Figure 1.
Research Framework.

From the research framework that has been built, there are research achievements expected to be well explored through the following hypothesis approach.

Quality costing in higher education is closely related to sustainability because it helps institutions manage and reduce costs related to quality, both from an academic and operational perspective [16]. Private universities face demands to provide quality education and run sustainable operations. In private universities, quality costing can be applied to various activities, ranging from curriculum management and teaching processes to student services [8]. By identifying and reducing failure costs, private universities can improve operational efficiency and reduce resource waste. Quality costing enables universities to allocate resources more appropriately, directing investment to areas that will have the greatest impact on improving quality and sustainability. By reducing external failure costs, HEIs can increase student satisfaction and institutional reputation. This impacts the attractiveness of HEIs to prospective students and other stakeholders and strengthens the institution's social commitment, which is an integral part of social sustainability performance [18].

H_{1a} Quality Costing has a positive effect on sustainability practices.

Life cycle costing (LCC) in higher education is closely related to sustainability because this method allows institutions to consider all costs associated with an asset or project over its lifetime [9]. Private universities play an important role in shaping the future through education and research, but they must also consider sustainability in their operations. LCC helps private universities identify and select products, technologies, and infrastructure that have a lower environmental impact over their life cycle. LCC provides comprehensive data for decision-making, enabling private universities to choose solutions that are not only more economical but also more socially and environmentally sustainable. For example, when selecting laboratory equipment, a private university can consider not only the purchase cost but also the maintenance costs and potential environmental impact of disposing of the equipment. Life cycle costing is an important tool for private universities to improve their sustainability performance. By considering the total cost from the beginning to the end of an asset or project's life cycle, a private university can make wiser decisions, reduce environmental impact, and achieve greater economic efficiency. This ultimately helps universities fulfill their social and environmental responsibilities and maintain financial sustainability [17]. LCC can improve sustainability practices in HEIs by strengthening resource management efficiency, increasing financial transparency, and embedding sustainability values into institutional management and learning.

H_{1b} Life Cycle Costing has a positive effect on sustainability practices

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Top management support refers to the involvement, commitment, and active support of the highest leadership in an organization toward a particular initiative or project. Support from top management has a significant influence on the successful implementation and performance of sustainability initiatives in a private university. Disterheft et al. [10] emphasize the importance of management involvement in integrating sustainability into higher education strategies to achieve effective transformation. Lozano et al. [11] show that top management involvement in resource allocation is key to the success of sustainability initiatives in higher education institutions. Quality costing systems support sustainability management across all aspects of the product life cycle, including design, production, and waste management. This demonstrates the relevance of quality costing systems in supporting university sustainability policies with top management guidance [19]. Quality costing has great potential to improve sustainability performance in private higher education institutions, especially when supported by top management. This support ensures that quality costing is implemented effectively and becomes an integral part of the organization's strategy, ultimately supporting long-term sustainability. Studies show that pressure from stakeholders and economic benefits are the main drivers of sustainability, reinforced by strategic support from top management [20].

H_{2a} Top Management Support Moderates Quality Costing to Sustainability Practices

Life Cycle Costing is a cost calculation method that considers the total costs incurred throughout the entire life cycle of a product, service, or project, from development to discontinuation [21]. In the context of private universities or other organizations, the effective implementation of LCC, supported by top management, can play an important role in improving sustainability. In a private university, LCC can be applied to various aspects, such as infrastructure development, curriculum development, and information technology management. Support from top management is essential for the successful implementation of LCC. Top management can ensure that LCC is used as a strategic tool to support sustainability and long-term growth, not just as a cost-control tool. LCC has been applied to evaluate the economic impact of various educational infrastructure alternatives. Top management support is essential to balance economic and environmental factors, especially in environmentally friendly designs for educational facilities [22]. By involving top management, the application of LCC can support better decision-making with a focus on operational costs, maintenance, and a broader life cycle. This has been applied in the education sector to support operational sustainability and improve overall institutional performance [23].

H_{2b} Top Management Support moderates Life Cycle Costing to Sustainability Practices

3. Research Methodology

This study uses a quantitative research method. The research variables consist of 120 questionnaires from private universities in South Sulawesi. The researchers collected data through a Google Form distributed online. The data analysis technique was Structural Equation Modeling (SEM). Testing was carried out using Smart-PLS 4. Partial Least Squares (PLS) is a variance-based SEM statistical method designed to solve multiple regression when specific problems occur in the data, such as small research sample sizes, missing values, and multicollinearity. The questionnaire data were then processed to find answers and support the proposed hypotheses. After obtaining the processed results, they were adjusted to the hypotheses, and conclusions were drawn based on the processed results.

4. Research Result

This research approach can be discussed further with the empirical results obtained.

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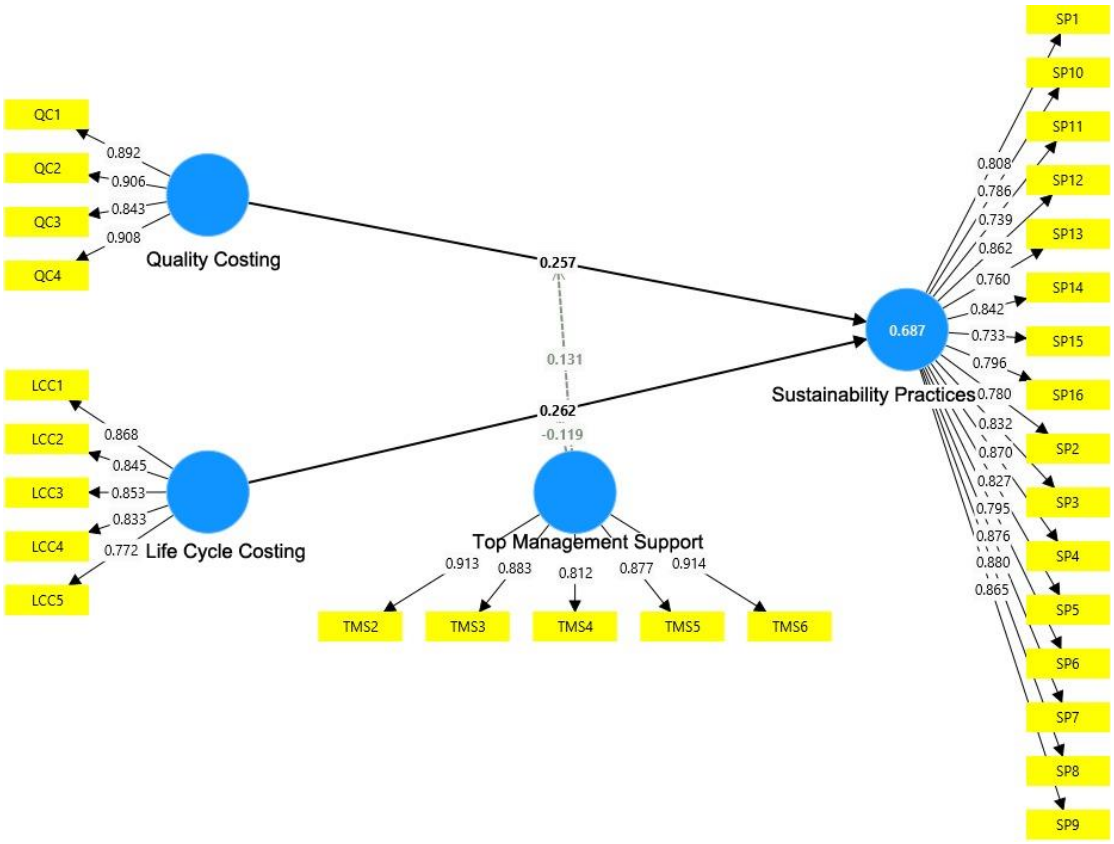

Figure 2.
Outer Model.

Figure 1 shows that all indicators used in this study are valid and reliable for measuring their respective latent variables. All outer loading values shown in the figure are above 0.70, indicating excellent results. Therefore, the measurement model (outer model) in this study is declared strong and eligible for further analysis.

Table 1.
Construct Reliability and Validity.

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
LCC	0.891	0.897	0.920	0.697
QC	0.911	0.933	0.937	0.788
SP	0.967	0.968	0.970	0.668
TMS	0.928	0.943	0.945	0.775

Table 1 Overall, it presents excellent reliability and validity test results for the four latent variables studied. All metric values, namely Cronbach's Alpha (above > 0.7), rho_a (above > 0.7), rho_c (above > 0.7), and AVE (above > 0.5), meet the thresholds recommended in the PLS-SEM literature. This indicates that the research instruments used to measure these variables are consistent and valid.

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Table 2.
Discriminant Validity – HTMT.

Variable	Heterotrait-monotrait ratio (HTMT)
Quality Costing <-> Life Cycle Costing	0.677
Sustainability Practices <-> Life Cycle Costing	0.734
Sustainability Practices <-> Quality Costing	0.573
TMS <-> Life Cycle Costing	0.581
TMS <-> Quality Costing	0.380
TMS <-> Sustainability Practices	0.740

Table 2 shows that all HTMT values are below the recommended thresholds of 0.90 and 0.85, indicating that discriminant validity has been achieved for all latent variable pairs in this research model.

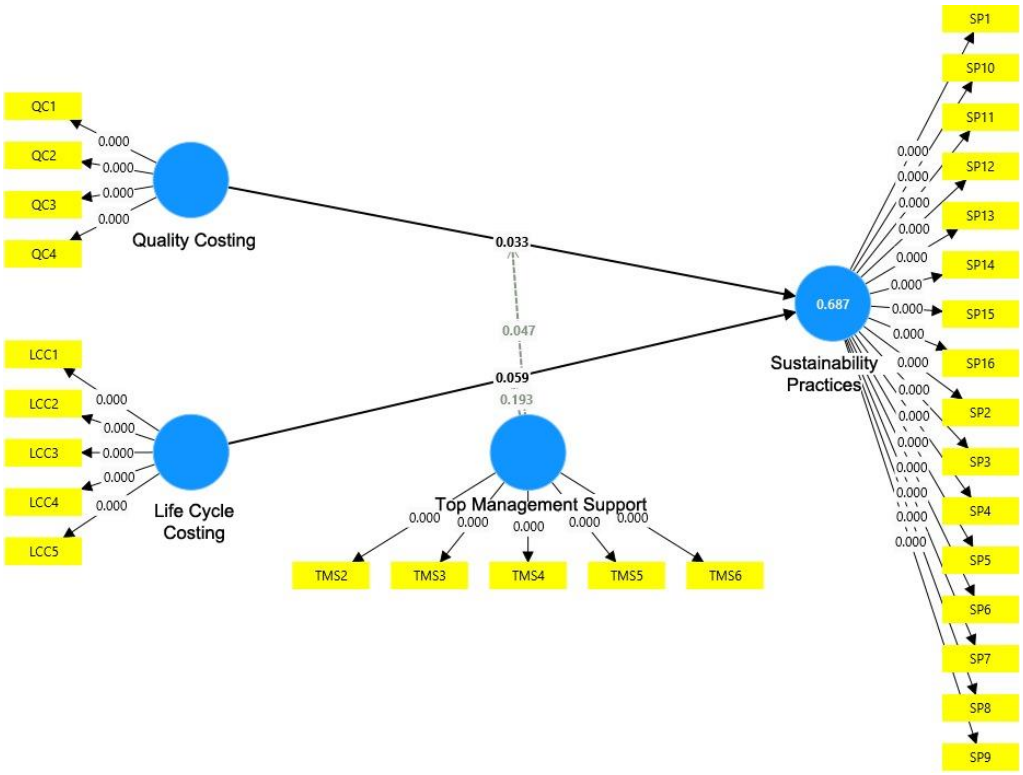

Figure 3.
Inner Model.

Table 3.
R-Square.

Variable	R-square	Adjusted R-square
Sustainability Practices	0.687	0.673

The results in Table 3 show that the research model has moderate to strong predictive power in explaining both dependent variables. The independent variables in the model are able to explain most of the changes that occur in the "Sustainability Practices" variable.

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Table 4.
Hypothesis Testing.

Description	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values	Results
LCC -> SP	0.262	0.260	0.139	1.891	0.059	Not significant
QC -> SP	0.257	0.250	0.121	2.128	0.033	Sig.
TMS -> SP	0.464	0.462	0.123	3.775	0.000	Sig.
TMS x LCC -> SP	-0.119	-0.109	0.091	1.302	0.193	Not significant
TMS x QC -> SP	0.131	0.127	0.066	1.988	0.047	Sig.

5. Findings and Discussion

Agency Theory [13] explains that the contextual relationship between principals and agents, namely between two or more individuals, a group, or an organization, is significant. In the context of private universities, agency theory explains the relationship between principals (owners/foundations) and agents (management/university leaders). The foundation or owner of the campus wants long-term sustainability for the institution, while the campus management is responsible for running operations to achieve this goal. This difference in interests makes sustainability a control mechanism to reduce conflicts of interest between the principal and the agent. Strategic costing can be used as a cost management approach that focuses on determining and managing costs to support long-term strategies. The relationship between strategic costing and sustainability in this study is attributed to quality costing and life cycle costing, which relate to how universities manage costs to support their sustainability goals. Strategic costs at private universities not only help operational efficiency but also support sustainability initiatives that strengthen the reputation, attractiveness, and social contribution of universities. This approach enables universities to achieve sustainability goals while ensuring their financial sustainability. The implementation of strategic costing will be easier to achieve in terms of sustainability if there is top management support. Top management support is a key factor that influences the successful implementation of sustainability initiatives in private universities.

The results of the analysis show that quality costing has a significant and positive effect on sustainability practices at private universities. The positive regression coefficient and p-value < 0.05 indicate that better implementation of quality costing increases commitment and sustainability performance in economic, social, and environmental aspects. This finding confirms that investment in quality costs, including the costs of prevention, assessment, and control of internal and external failures, contributes directly to the effectiveness of sustainability practices. In the context of private universities, quality costing encourages more responsible use of resources, improves the quality of academic services, and reduces waste in administrative and operational processes. This aligns with the literature, which states that systematically managed quality not only affects financial performance but also encourages the achievement of sustainability goals. These findings are consistent with previous studies showing that organizations with structured quality systems have better sustainability performance [24]. In higher education, quality and sustainability have been shown to reinforce each other, with good quality management encouraging more responsible organizational behavior. The implementation of quality costing helps private universities reduce costs due to academic or service errors, increase stakeholder satisfaction (students, lecturers, community), and create more transparent governance. Thus, the findings of this study reinforce that quality costing practices are an important foundation in strengthening the sustainability of higher education institutions, especially in the face of competitive pressures and accreditation requirements that emphasize sustainability aspects.

The results of the study show that Life Cycle Costing does not have a significant effect on the sustainability of private universities, with a coefficient value of 0.059. This finding indicates that the application of LCC in universities has not been implemented as a comprehensive cost control system, so it has not been able to encourage sustainability practices. Empirically, this lack of significance indicates that cost calculations in higher education institutions focus more on initial costs rather than covering

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the costs throughout the life cycle of assets. Incomplete data on operating, maintenance, and disposal costs means that LCC is not yet used as a basis for strategic decision-making, especially in procurement, facility maintenance, and operations policies that impact sustainability. Furthermore, a short-term orientation in financial management causes universities to emphasize current cost efficiency over long-term savings. As a result, LCC fails to become an instrument capable of improving environmental performance, energy efficiency, or sustainable asset management practices. The findings of this study are not in line with studies showing that LCC improves resource and fund efficiency. By analyzing the total costs over the lifetime of assets (such as buildings, laboratories, or equipment), universities can avoid waste and choose more sustainable investment options. However, this study is consistent with studies showing a lack of comprehensive understanding and application of LCC. Many private educational institutions do not yet have the capacity or resources to conduct a comprehensive life cycle cost analysis. LCC requires detailed data from the planning, operational, and maintenance stages of assets, which are often not well documented in universities [25]. Private universities generally assess financial performance per academic year, rather than based on the total costs over the life cycle of an asset or project, so the benefits of LCC are not immediately apparent. Thus, these differences in results may be due to organizational context characteristics: universities have different cost structures, work cultures, and decision-making patterns than the industrial sector, so LCC does not have a significant impact on sustainability.

The analysis results show that Top Management Support significantly moderates the relationship between quality costing and sustainability practices at private universities. These findings indicate that strong support from top management can strengthen the relationship between quality costing and the implementation of sustainability practices. The significance of the TMS-moderated relationship shows that top management plays a strategic role in making quality costing a tool for sustainability decision-making. Dekker and Smidt [26] emphasize that top management support can improve the effectiveness of cost accounting systems through the integration of strategic objectives, budget provision, and alignment between cost performance and sustainability performance. The significance of TMS moderation also shows that the success of quality costing in improving sustainability practices is highly dependent on the extent to which top management provides strategic direction and implementation commitment. Proactive top management support ensures that quality costs are treated as a long-term investment for sustainability, not merely a cost-efficiency tool. Lozano [27] states that integrating sustainability in higher education requires consistent strategic leadership, which includes providing resources, training, and an organizational culture that supports sustainable practices. Thus, quality costing supported by TMS not only improves the quality of educational services but also encourages the creation of environmentally friendly and sustainable operational systems. Overall, the results of the study confirm that the relationship between quality costing and sustainability practices will be even stronger when TMS is present as a reinforcing factor. This support ensures that quality costing is implemented strategically, thoroughly, and consistently throughout the entire institutional process, thereby producing a significant sustainability impact for private universities.

The results of the analysis show that the interaction between Life Cycle Costing and Top Management Support does not have a significant effect on sustainability practices in private universities. These findings indicate that top management support has not been able to strengthen the relationship between the use of a life cycle cost approach and the implementation of institutional sustainability practices. One factor explaining this insignificance is that many private universities do not yet have an adequate long-term cost information system. Life Cycle Costing requires comprehensive data on the long-term operational and maintenance costs of assets, but higher education institutions often have not developed the necessary integrated recording mechanisms [28]. In addition, the effectiveness of Top Management Support moderation greatly depends on the extent to which top management prioritizes sustainability as a strategic priority. Lozano [27] asserts that many universities implement sustainability partially and more symbolically than as a core institutional strategy. If Top Management Support does not ensure that Life Cycle Costing information is used in strategic planning, budget

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allocation, and asset maintenance policies, then Life Cycle Costing only functions as a technical approach without having a significant impact on institutional sustainability. Thus, the findings of this study confirm that Life Cycle Costing can only contribute to sustainability practices if Top Management Support plays a proactive role in integrating the asset life cycle perspective into institutional policies and strategies. The lack of strategic involvement from top management means that Life Cycle Costing information is not being utilized optimally, thereby failing to have a significant impact on the implementation of sustainability practices. Therefore, private universities need to strengthen the role of Top Management Support in developing a long-term cost recording system, integrating Life Cycle Costing into investment decision-making, and ensuring that this approach becomes part of the institution's sustainability strategy.

6. Conclusion

The conclusion of this study shows that quality costing has a significant effect on sustainability practices, as does Top Management Support when it acts as a moderator. Meanwhile, Life Cycle Costing does not have a significant effect on sustainability practices. Similarly, when LCC on sustainability practices is moderated by TMS, it still has no significant effect. This is because TMS has not been able to strengthen the relationship between the use of a life cycle cost approach to assets and the implementation of institutional sustainability practices.

Quality costing is a managerial instrument that strengthens sustainability practices through cost efficiency, continuous quality improvement, and the reduction of service failure risks. By implementing quality costing, universities can identify the cost of conformance (prevention and assessment costs) and the cost of non-conformance (internal and external failure costs). In the context of private higher education institutions facing competitive pressures, quality regulations, and resource constraints, the application of quality costing requires institutions to operate more efficiently, meet accreditation standards, and optimize the use of funds. When TMS provides strong support through a clear picture of the direction to be taken, quality costing activities such as error prevention, quality audits, process improvement, and waste reduction can be carried out consistently.

The application of Life Cycle Costing in private universities has not been implemented as a comprehensive cost control system, so it has not been able to encourage sustainable practices. The impact of Life Cycle Costing on sustainability at the private university is insignificant because universities have not taken into account the costs of operational activities during the accreditation period, the limitations of long-term costing systems for building branding, and the limitations in taking into account disposal costs and asset replacement costs that are covered by the operational costs used. Although there is support from top management, this support tends to be administrative in nature and is not translated into the provision of adequate data, accounting systems, or funding for LCC implementation. Under these conditions, top management support is unable to strengthen the relationship between LCC and sustainability because the two variables are not strongly integrated into operational policies or long-term strategies.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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