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Exploring Research Trends in Life Cycle Costing: A Bibliometric Analysis from 2010 to 2025

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ABSTRACT

This study aims to explore the evolution and research trends of life cycle costing (LCC) through a comprehensive bibliometric analysis of global publications from 2010 to 2025. Using data sourced from the Scopus database and analyzed with VOSviewer, this study examines publication trends, keyword co-occurrence, thematic clusters, and temporal developments in the LCC literature. The results indicate that LCC remains strongly rooted in cost analysis and economic evaluation, particularly within construction, infrastructure, and energy-related sectors. However, the findings also reveal a significant shift toward sustainability-oriented research, as reflected in the growing integration of concepts such as life cycle analysis (LCA), circular economy, environmental assessment, and waste management. Overlay visualization further demonstrates that recent studies increasingly emphasize environmental and interdisciplinary dimensions, while density analysis highlights the dominance of cost-related themes alongside emerging sustainability topics. Despite these advancements, the integration of advanced analytical tools and digital technologies in LCC research remains limited, suggesting opportunities for future development.

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1. INTRODUCTION

Life Cycle Costing (LCC) has become an increasingly important analytical approach for evaluating the total economic performance of products, systems, and projects throughout their entire life cycle [1], [2]. Unlike conventional cost accounting methods that primarily focus on short-term financial performance, LCC considers all costs incurred during the lifespan of an asset—from initial planning and acquisition to operation, maintenance, and eventual disposal [3]. This comprehensive perspective allows decision-makers to evaluate long-term economic efficiency and sustainability when selecting technologies, infrastructure, or business strategies [4], [5]. By integrating multiple stages of a product or system's life, LCC supports more informed decision-making in engineering, management, and policy contexts [6], [7].

Historically, the concept of life cycle costing emerged in the mid-twentieth century, particularly in sectors that required large capital investments such as defense,

infrastructure, and construction. Early applications were used to estimate the long-term operational and maintenance costs of complex systems, revealing that the majority of expenses often occur after the initial acquisition phase. This realization led organizations to adopt LCC as a strategic tool for evaluating total ownership costs rather than focusing solely on upfront investment [8], [9]. Over time, the concept expanded beyond engineering and defense industries and became widely applied in fields such as manufacturing, transportation, energy systems, and environmental management.

In recent decades, the growing emphasis on sustainability and resource efficiency has further increased the relevance of life cycle costing. Modern production systems and infrastructure projects are expected not only to be economically viable but also environmentally and socially responsible. LCC enables organizations to assess the economic implications of sustainable practices, such as energy-efficient technologies, renewable energy systems, and circular economy strategies [10], [11]. By examining costs across the entire life cycle, researchers and practitioners can identify opportunities to reduce resource consumption, minimize waste, and optimize long-term operational performance. Consequently, LCC has become closely associated with broader sustainability assessment frameworks, including life cycle assessment and life cycle management.

The increasing academic interest in life cycle costing has led to a rapid growth of scientific publications over the past two decades. Researchers from diverse disciplines have investigated methodological developments, sector-specific applications, and the integration of LCC with environmental and social assessment tools. As the body of literature expands, it becomes increasingly challenging for scholars to identify dominant research themes, influential publications, and emerging directions in the field. Understanding these trends is crucial for guiding future research, improving methodological frameworks, and supporting evidence-based decision-making in industry and policy contexts.

To address this challenge, bibliometric analysis has emerged as a valuable quantitative method for evaluating scientific literature. Bibliometric techniques analyze patterns within academic publications, including citation relationships, collaboration networks, and keyword trends, to reveal the intellectual structure and evolution of a research field. By systematically examining publication data, bibliometric studies can identify influential authors, institutions, and research clusters, as well as highlight emerging topics and research gaps. Such analyses are increasingly used across scientific disciplines to map research developments and inform strategic planning for future studies.

Despite the growing number of studies related to life cycle costing, comprehensive bibliometric investigations focusing specifically on this topic remain relatively limited. Existing literature often examines particular applications of LCC—such as construction, energy systems, or product-service systems—rather than providing a broad overview of the entire research landscape [9], [12]. As a result, there is a need for a systematic analysis that explores how life cycle costing research has evolved over time, particularly during the last decade and a half when sustainability concerns and technological advancements have significantly influenced cost analysis approaches. Conducting a bibliometric study covering publications from 2010 to 2025 can therefore provide valuable insights into research productivity, collaboration patterns, influential publications, and emerging thematic areas in the field of life cycle costing.

Although life cycle costing has gained widespread attention across multiple disciplines, the rapid growth of publications has created challenges in understanding the overall development and structure of the research field. Many existing studies focus on specific applications or case studies, while comprehensive analyses that map global research trends, key contributors, and thematic evolution remain scarce. Without a

systematic bibliometric assessment, it becomes difficult for researchers and practitioners to identify dominant research directions, emerging topics, and potential knowledge gaps within the life cycle costing literature. Therefore, there is a need for a structured bibliometric analysis that examines the development of life cycle costing research from 2010 to 2025 to provide a clearer understanding of its intellectual landscape and future research opportunities. The objective of this study is to explore and analyze research trends in life cycle costing between 2010 and 2025 using a bibliometric approach. Specifically, the study aims to identify the growth of scientific publications, the most influential authors and journals, patterns of collaboration among researchers and institutions, and the major thematic areas that have shaped the development of life cycle costing research. By mapping these trends, the study seeks to provide a comprehensive overview of the evolution of life cycle costing literature and highlight potential directions for future research in this field.

2. METHOD

This study employs a bibliometric research method to systematically analyze the development and trends of Life Cycle Costing (LCC) research from 2010 to 2025. Bibliometric analysis is a quantitative technique used to evaluate patterns within scientific literature, including publication output, citation structures, collaboration networks, and thematic evolution. This approach enables researchers to identify influential publications, major research contributors, and emerging topics within a specific academic field. By applying bibliometric techniques, the study aims to map the intellectual structure and research dynamics of life cycle costing studies over the selected period. The methodological framework of this research consists of data collection, data screening, and bibliometric analysis to ensure that the results accurately represent the development of the research field.

3. RESULTS AND DISCUSSION

3.1 Result

a. Keyword Co-Occurrence Analysis

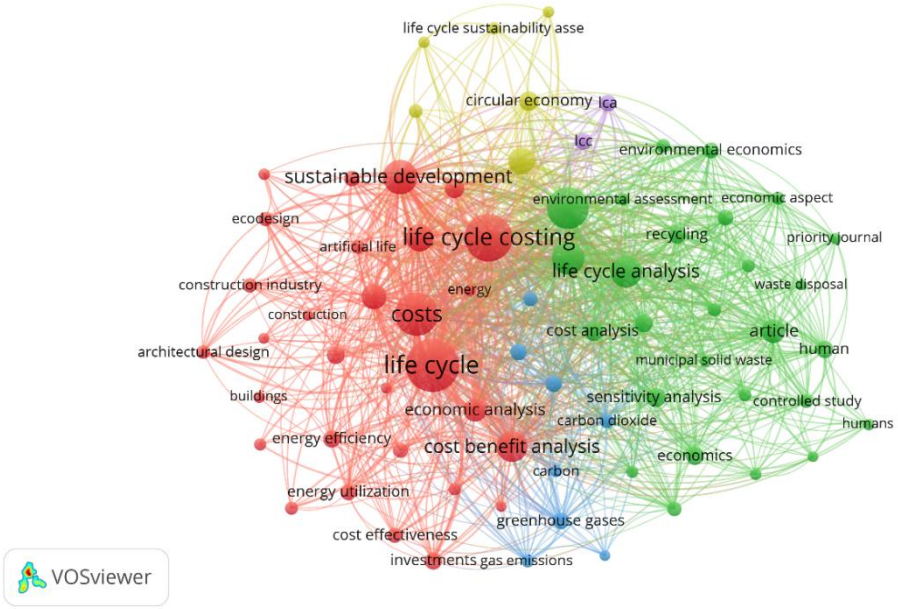

Figure 1. Network Visualization
Source: Data Analysis

Figure 1 reveals a highly interconnected research landscape centered on life cycle costing (LCC), which appears as the dominant and most influential keyword. Its central position indicates that LCC serves as

the core concept linking multiple research domains. The density and size of this node suggest that it has been widely studied and frequently co-occurs with other key terms, reinforcing its role as a foundational framework in cost evaluation and sustainability-oriented research. The red cluster primarily reflects the economic and construction-oriented perspective of LCC research. Keywords such as costs, cost benefit analysis, economic analysis, construction, and energy efficiency highlight the traditional focus of LCC as a financial and decision-making tool in infrastructure and building projects. This cluster suggests that early and dominant research streams emphasize cost optimization, investment evaluation, and performance efficiency, particularly within the construction and engineering sectors.

The green cluster represents the environmental and sustainability dimension, strongly connected with life cycle analysis (LCA), environmental assessment, recycling, waste disposal, and carbon dioxide. This indicates a clear shift in the literature toward integrating LCC with environmental evaluation frameworks. The presence of terms like municipal solid waste and environmental economics further shows that LCC is increasingly applied in environmental management and policy contexts, highlighting its relevance in addressing ecological challenges. Meanwhile, the blue cluster captures the analytical and methodological integration within LCC research. Keywords such as cost analysis, sensitivity analysis, carbon, and greenhouse gases suggest a growing emphasis on quantitative modeling and data-driven approaches. This cluster reflects efforts to enhance the robustness of LCC through advanced analytical techniques, enabling more accurate predictions and better decision support in uncertain or complex systems.

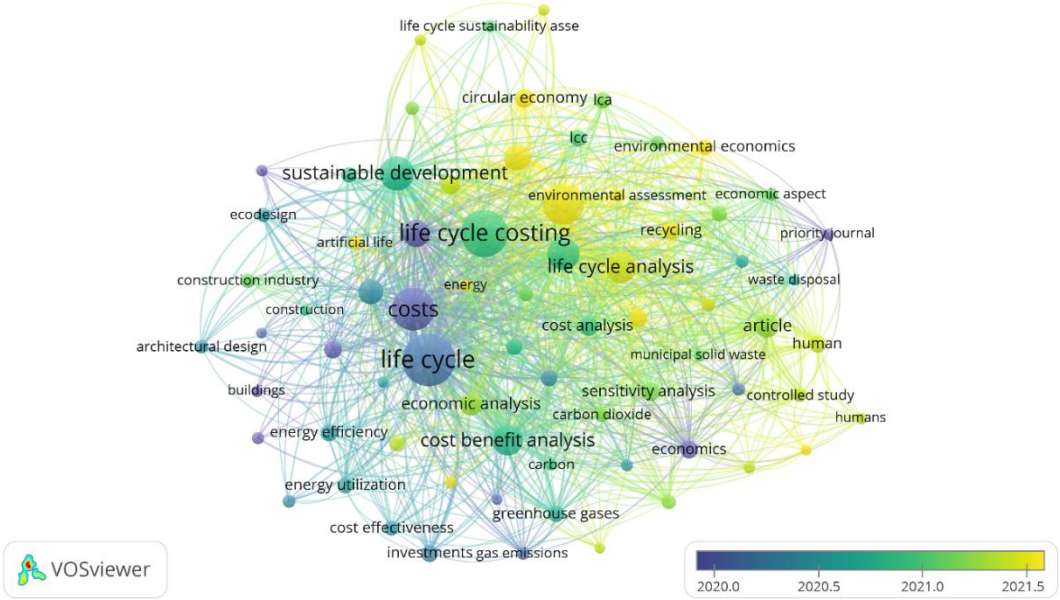

Figure 2. Overlay Visualization
Source: Data Analysis

Figure 2 highlights the temporal evolution of research on life cycle costing (LCC), where color gradients indicate the average publication year of keywords. Terms shown in darker blue represent

earlier research (around 2020), while yellow indicates more recent topics (closer to 2021–2022+). The central position of life cycle costing and life cycle with greenish tones suggests that these concepts have remained consistently relevant over time, acting as a stable foundation while new themes continue to emerge around them. Earlier research trends (blue–teal nodes) are strongly associated with traditional cost and construction-oriented themes, such as costs, construction industry, architectural design, energy efficiency, and buildings. This indicates that initial LCC studies were primarily focused on economic evaluation in engineering and infrastructure contexts. These works emphasized cost optimization, project feasibility, and energy-related efficiency, reflecting the original role of LCC as a financial decision-support tool within technical domains.

In contrast, more recent research trends (green–yellow nodes) show a clear shift toward sustainability and environmental integration, with keywords such as circular economy, recycling, environmental economics, waste disposal, and life cycle analysis. The emergence of these terms indicates that LCC is increasingly combined with environmental and sustainability frameworks, moving toward interdisciplinary applications. This evolution suggests that current research is no longer limited to cost efficiency alone, but is expanding to address broader issues such as environmental impact, resource management, and sustainable development, marking a transition toward more holistic and future-oriented analytical approaches.

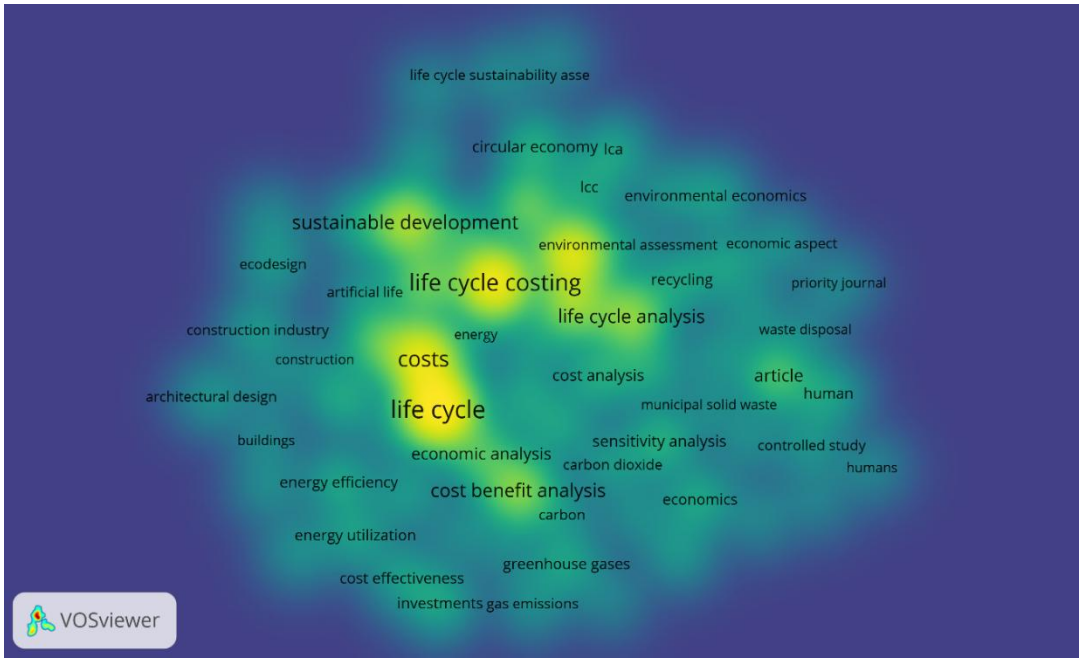

Figure 3. Density Visualization
Source: Data Analysis

Figure 3 highlights the most intensively researched and frequently co-occurring topics within the life cycle costing (LCC) literature. Areas shown in bright yellow indicate high-density regions, where keywords such as life cycle costing, life cycle, and costs dominate the intellectual

structure of the field. This confirms that the core of the research remains strongly anchored in economic evaluation and cost-related analysis. Supporting terms like cost benefit analysis, economic analysis, and energy further reinforce the centrality of financial and efficiency considerations in LCC studies. Beyond this core, the surrounding green and blue areas represent moderately and less explored themes, including life cycle analysis, sustainable development, circular economy, environmental economics, and recycling. Although these topics are not as dense as the core cost-related terms, their proximity indicates strong conceptual linkages and growing importance.

b. Citation Analysis

Table 1. Most Cited Article

Citations	Author and Year	Title
419	[13]	Cost of corrosion
417	[14]	Bio-based plastics - A review of environmental, social and economic impact assessments
340	[15]	Application of life cycle assessment in municipal solid waste management: A worldwide critical review
279	[16]	Downcycling versus recycling of construction and demolition waste: Combining LCA and LCC to support sustainable policy making
272	[17]	Integration of LCA and LCC analysis within a BIM-based environment
269	[18]	A cost roadmap for silicon heterojunction solar cells
247	[19]	Microalgae based biorefinery promoting circular bioeconomy-techno economic and life-cycle analysis
236	[20]	Review of green and sustainable public procurement: Towards circular public procurement
227	[21]	LCA in architectural design—a parametric approach
227	[22]	An integrated life cycle sustainability assessment of electricity generation in Turkey

Source: Scopus, 2026

3.2 Discussion

The findings of this bibliometric analysis reveal that research on life cycle costing (LCC) remains strongly anchored in its traditional role as a cost evaluation and decision-support tool. The network and density visualizations consistently position keywords such as life cycle costing, life cycle, and costs at the core of the research landscape, indicating their dominant and sustained relevance. This suggests that despite the evolution of the field, the primary function of LCC as a financial assessment framework—particularly in construction, infrastructure, and energy-related projects—continues to shape the majority of scholarly contributions. The strong linkage with terms such as cost benefit analysis and economic analysis further reinforces the importance of efficiency, feasibility, and long-term financial planning within LCC research.

However, the overlay visualization highlights a significant temporal shift in research focus, demonstrating that LCC is increasingly integrated with sustainability-oriented concepts. Emerging keywords such as circular economy, recycling, environmental economics, and waste disposal indicate that recent studies are expanding beyond purely economic considerations toward environmental and resource management perspectives. This transition reflects a broader paradigm shift in which LCC is no longer viewed as an isolated financial tool but as

part of a more comprehensive sustainability assessment framework. The growing co-occurrence between LCC and life cycle analysis (LCA) further supports this integration, suggesting that researchers are increasingly combining economic and environmental evaluations to support more informed and responsible decision-making.

In addition, the results reveal the growing importance of analytical and methodological sophistication in LCC research. The presence of keywords such as sensitivity analysis, cost analysis, carbon dioxide, and greenhouse gases indicate a trend toward more data-driven and quantitative approaches. This development suggests that scholars are attempting to enhance the robustness and predictive capability of LCC models, particularly in addressing uncertainty and environmental impact assessment. Nevertheless, the relatively lower density of advanced analytical and digital-related terms implies that the integration of technologies such as artificial intelligence, big data, and decision support systems remains underdeveloped, representing an important avenue for future research.

The study demonstrates that LCC research is undergoing a gradual but clear transformation from a cost-centric discipline to a more interdisciplinary and sustainability-driven field. While economic evaluation remains the dominant foundation, the increasing incorporation of environmental and analytical dimensions signals a shift toward holistic life cycle thinking. These findings imply that future research should focus on strengthening the integration between LCC, sustainability frameworks, and advanced analytical tools, particularly in diverse sectors and developing country contexts. By addressing these gaps, LCC can evolve into a more comprehensive framework capable of supporting sustainable development goals and long-term strategic decision-making.

4. CONCLUSION

This study concludes that research on life cycle costing (LCC) has evolved significantly over the period 2010–2025, transitioning from a predominantly cost-oriented framework toward a more integrated and sustainability-driven approach. While core themes such as cost analysis, economic evaluation, and infrastructure applications remain dominant, there is a clear and growing convergence with environmental and sustainability concepts, including life cycle analysis, circular economy, and environmental assessment. The findings also highlight an increasing emphasis on analytical methods, although the integration of advanced digital technologies remains relatively limited. The study underscores that LCC is no longer confined to financial decision-making but is progressively becoming a holistic tool for supporting sustainable development, thereby offering substantial opportunities for future interdisciplinary research and innovation.

REFERENCES

[1] W. T. França, M. V. Barros, R. Salvador, A. C. de Francisco, M. T. Moreira, and C. M. Piekarski, "Integrating life cycle assessment and life cycle cost: A review of environmental-economic studies," *Int. J. Life Cycle Assess.*, vol. 26, no. 2, pp. 244–274, 2021.

[2] M. Altaf, W. S. Alaloul, M. A. Musarat, and A. H. Qureshi, "Life cycle cost analysis (LCCA) of construction projects: sustainability perspective," *Environ. Dev. Sustain.*, vol. 25, no. 11, pp. 12071–12118, 2023.

[3] N. A. Nuhu, K. Baird, and L. Jiao, "The effect of traditional and contemporary management accounting practices on organisational outcomes and the moderating role of strategy," *Am. Bus. Rev.*, vol. 26, no. 1, p. 6, 2023.

[4] P. Digkoglou and J. Papathanasiou, "Application of multiple criteria decision aiding in environmental policy-making processes," *Int. J. Environ. Sci. Technol.*, vol. 22, no. 8, pp. 6967–6982, 2025.

[5] H. Alastal, A. Sharaf, S. Mahmoud, O. Alsaidi, and Z. Bahroun, "Integrating multiple criteria decision-making techniques in sustainable supplier selection: A comprehensive review," *Decis. Mak. Appl. Manag. Eng.*, vol. 8, no. 1,

pp. 380–400, 2025.
[6] I. Trofimenko, Y. Chen, A.-K. Müller, U. Liebau, and A. Flore, "Real-Time LCA/LCC Integration: A Framework of Agile Sustainability and Cost Management," *Sustainability*, vol. 17, no. 21, p. 9433, 2025.
[7] C. Shaw, F. de Andrade Pereira, K. Farghaly, C. Hoare, T. Hartmann, and J. O'Donnell, "Life cycle cost analysis at scale: a reference architecture-based approach," *Built Environ. Proj. Asset Manag.*, vol. 14, no. 5, pp. 713–733, 2024.
[8] M. S. Medina-Salgado, F. E. García-Muiña, M. Cucchi, and D. Settembre-Blundo, "Adaptive life cycle costing (LCC) modeling and applying to Italy ceramic tile manufacturing sector: Its implication of open innovation," *J. Open Innov. Technol. Mark. Complex.*, vol. 7, no. 1, p. 101, 2021.
[9] A. Nicita, G. Squadrito, and G. Maggio, "Life-cycle cost (LCC) applied to hydrogen technologies: a review," *Int. J. Life Cycle Assess.*, vol. 29, no. 1, pp. 46–79, 2024.
[10] U. K. Pata and S. Karlilar Pata, "Assessing the power of biofuels and green technology innovation on the environment: The LCC perspective," *Energy Environ.*, p. 0958305X241279905, 2024.
[11] E. C. Onukwulu, M. O. Agho, and N. L. Eyo-Udo, "Circular economy models for sustainable resource management in energy supply chains," *World J. Adv. Sci. Technol.*, vol. 2, no. 2, pp. 34–57, 2022.
[12] F. Zahedi, H. Alavi, J. Majrouhi Sardroud, and H. Dang, "Digital twins in the sustainable construction industry," *Buildings*, vol. 14, no. 11, p. 3613, 2024.
[13] G. Koch, "Cost of corrosion," *Trends oil gas Corros. Res. Technol.*, pp. 3–30, 2017.
[14] S. Spierling *et al.*, "Bio-based plastics-A review of environmental, social and economic impact assessments," *J. Clean. Prod.*, vol. 185, pp. 476–491, 2018.
[15] H. Khandelwal, H. Dhar, A. K. Thalla, and S. Kumar, "Application of life cycle assessment in municipal solid waste management: A worldwide critical review," *J. Clean. Prod.*, vol. 209, pp. 630–654, 2019.
[16] A. Di Maria, J. Eyckmans, and K. Van Acker, "Downcycling versus recycling of construction and demolition waste: Combining LCA and LCC to support sustainable policy making," *Waste Manag.*, vol. 75, pp. 3–21, 2018.
[17] R. Santos, A. A. Costa, J. D. Silvestre, and L. Pyl, "Integration of LCA and LCC analysis within a BIM-based environment," *Autom. Constr.*, vol. 103, pp. 127–149, 2019.
[18] A. Louwen, W. Van Sark, R. Schropp, and A. Faaij, "A cost roadmap for silicon heterojunction solar cells," *Sol. Energy Mater. Sol. Cells*, vol. 147, pp. 295–314, 2016.
[19] J. R. Banu, S. Kavitha, M. Gunasekaran, and G. Kumar, "Microalgae based biorefinery promoting circular bioeconomy-techno economic and life-cycle analysis," *Bioresour. Technol.*, vol. 302, p. 122822, 2020.
[20] S. D. Sönnichsen and J. Clement, "Review of green and sustainable public procurement: Towards circular public procurement," *J. Clean. Prod.*, vol. 245, p. 118901, 2020.
[21] A. Hollberg and J. Ruth, "LCA in architectural design—a parametric approach," *Int. J. Life Cycle Assess.*, vol. 21, no. 7, pp. 943–960, 2016.
[22] B. Atilgan and A. Azapagic, "An integrated life cycle sustainability assessment of electricity generation in Turkey," *Energy Policy*, vol. 93, pp. 168–186, 2016.