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Towards Sustainable Urban Transformation: The Role of LEED Certification in Istanbul's Future and Economy

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Abstract: Istanbul, a city with a rich history and vibrant culture, faces the imminent threat of a catastrophic earthquake due to its proximity to the North Anatolian Earthquake Fault. In response, the Turkish government has initiated a sweeping urban transformation led by the Ministry of Environment and Urbanization. This initiative aims to not only rebuild the city but also to enhance its resilience to earthquakes and environmental challenges. Central to this transformation is the adoption of green building principles, particularly LEED (Leadership in Energy and Environmental Design) certification. LEED provides a comprehensive framework for sustainable building design, construction, and operation, encompassing categories such as Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality, Innovation, and Regional Priority. This paper examines the economic and future considerations of enforcing green certification during Istanbul's urban transformation. Through a detailed analysis of the costs and benefits of LEED certification across different categories, as well as alternative approaches to sustainability, this paper aims to provide a holistic view of the implications for Istanbul's economic landscape and long-term prospects. By integrating environmental sustainability into its urban renewal efforts, Istanbul has the opportunity to not only mitigate the risks of earthquakes but also to emerge as a model for sustainable, environmentally conscious urban development. This paper seeks to highlight the importance of green certification in shaping Istanbul's urban landscape for generations to come, with a focus on economic considerations, environmental impacts, and broader implications for the city's future.

Keywords: Urban transformation, LEED certification, sustainability, economic considerations

Öz: İstanbul, zengin bir tarihe ve canlı bir kültüre sahip bir şehir olup, Kuzey Anadolu Fay Hattı'na yakınlığı nedeniyle yakın bir gelecekte büyük bir deprem tehdidi ile karşı karşıyadır. Türk hükümeti, bu tehdide yanıt olarak Çevre ve Şehircilik Bakanlığı öncülüğünde kapsamlı bir kentsel dönüşüm başlatmıştır. Bu girişim, sadece şehri yeniden inşa etmeyi değil, aynı zamanda depremlere ve çevresel zorluklara karşı direncini artırmayı amaçlamaktadır. Bu dönüşümün merkezinde, özellikle LEED (Energy and Environmental Design'da Liderlik) sertifikasyonu olmak üzere yeşil bina prensiplerinin benimsenmesi yer almaktadır. LEED, sürdürülebilir bina tasarımı, inşaatı ve işletmesi için kapsamlı bir çerçeve sunmakta olup, Sürdürülebilir Siteler, Su Verimliliği, Enerji ve Atmosfer, Malzeme ve Kaynaklar, İç Ortam Kalitesi, İnovasyon ve Bölgesel Öncelik gibi kategorileri içermektedir. Bu makale, İstanbul'un kentsel dönüşümü sırasında yeşil sertifikasyonun ekonomik ve geleceğe dönük boyutlarını ele almaktadır. LEED sertifikasyonunun farklı kategorilerdeki maliyetlerinin ve faydalarının detaylı bir analizi ile birlikte, sürdürülebilirliğe alternatif yaklaşımlar da incelenerek, bu makale İstanbul'un ekonomik manzarası ve uzun vadeli perspektifleri için bütüncül bir bakış sunmayı amaçlamaktadır. Çevresel sürdürülebilirliği kentsel yenileme çabalarına entegre ederek, İstanbul, deprem risklerini azaltmanın yanı sıra sürdürülebilir, çevre dostu kentsel gelişim için bir model olarak da ortaya çıkma fırsatına sahiptir. Bu makale, İstanbul'un kentsel peyzajını gelecek nesiller için şekillendirmede yeşil sertifikasyonun önemini vurgulamayı amaçlamaktadır, bunu yaparken ekonomik değerlendirmeler, çevresel etkiler ve şehrin geleceği için daha geniş çıkarımlara odaklanmaktadır.

Anahtar Kelimeler: Kentsel dönüşüm, LEED sertifikasyonu, sürdürülebilirlik, ekonomik değerlendirmeler

1. Introduction

Istanbul, a city full of life and history, rests uneasily near a North Anatolian Earthquake Fault (Figure 1). A powerful earthquake bigger than 7.2 could potentially hit the city. Responding to this risk, the Turkish government has initiated an ambitious urban transformation led by the Ministry of Environment and Urbanization.

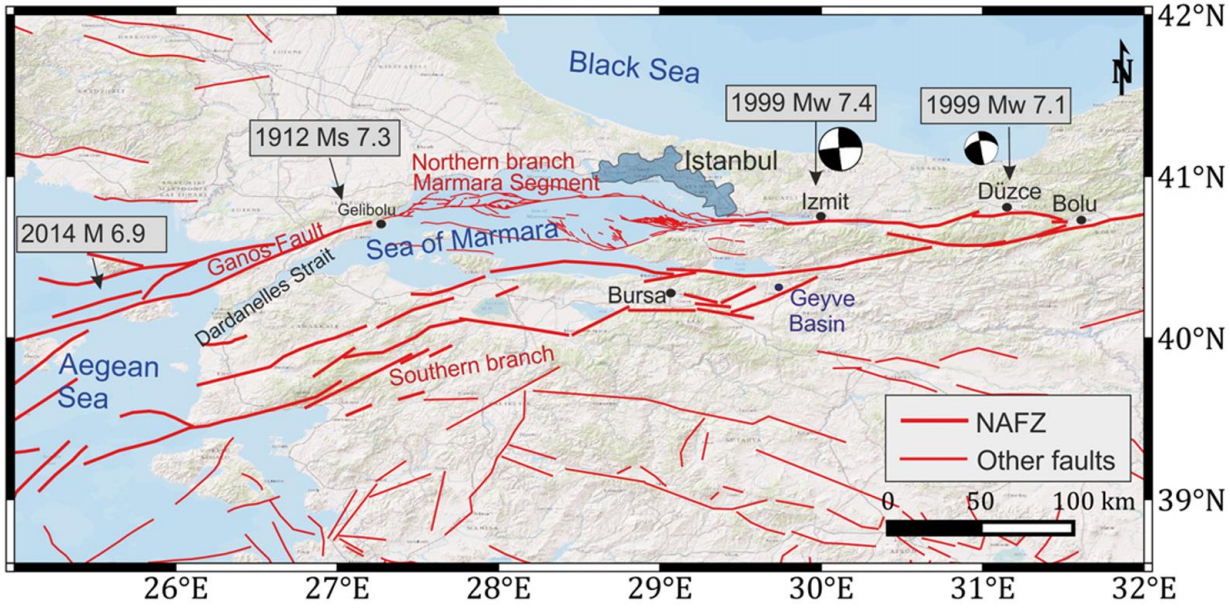

Figure 1. North Anatolian Fault Zone Istanbul and Marmara Sea Area, adapted from Bohnhoff et al [1]

This initiative goes beyond mere physical reconstruction, aspiring to safeguard lives and enhance earthquake resilience. The scale is significant: over 232,000 buildings across Istanbul urgently need reconstruction and risk collapsing during the expected earthquake [2].

However, the imperative for change extends beyond physical reconstruction. Erecting new structures on shaky foundations falls short of genuinely fortifying Istanbul. A comprehensive approach is necessary, involving comprehensive city planning, robust infrastructure development, and careful disaster preparedness. This vision is not just about reinforcing buildings; it's about empowering communities to endure earthquakes and emerge more resilient.

The ongoing urban transformation also provides an opportunity to integrate environmental sustainability into Istanbul's renewal. By incorporating green building principles such as energy efficiency, water conservation, renewable energy use, and pollution reduction, Istanbul can become a city resilient to earthquakes and environmentally conscious.

In this context, the discussion in this paper revolves around the concept of forcing green certification during urban transportation. The paper delves into the positives and negatives of this approach concerning Istanbul's economy and future. The notion of imposing green certification, explored against the backdrop of the city's seismic concerns and ongoing urban transformation, is crucial for understanding the potential impacts on Istanbul's economic landscape and long-term prospects.

The concept of green buildings, which began in Turkey in the early 2000s, has already made progress. Growing awareness in both the public and private sectors, particularly in recent years, is driving this advancement. Embracing green building practices is key to achieving Turkey's sustainable development goals, and Istanbul's transformation is fertile ground for their implementation.

In essence, Istanbul's urban transformation is more than just rebuilding structures. It can be a catalyst for creating a future that is earthquake-resistant, climate-resilient, and environmentally responsible. By combining community empowerment, green building principles, and sustainable development, Istanbul has the opportunity to stand tall not only during earthquakes but also as a sustainable and environmentally friendly city, with the discussion on forcing green certification adding an additional layer to the city's economic and future considerations.

2. Methodology and Research Design

In this paper, the economic and future considerations for the urban transformation considering the green building certification are examined. For this purpose, the building stock of the city of Istanbul is examined and checked for each category on the LEED® certification. For categories, not all the subsections are examined but the main category is observed in order to understand the economic effects of it particularly.

LEED® Categories for new construction and renovation on Istanbul Urban Transformation

Sustainable Sites

According to the U.S Green Building Council LEED® documentation, this section is giving one point each if the below considerations are addressed:

•Site Development – Protect or Restore Habitat

In alignment with the vision of the Turkish Ministry of Environment and Urbanization, prioritizing reconstruction on existing building sites minimizes habitat disturbance and promotes resource efficiency. This approach aligns with the Ministry's goals and reduces environmental impact without incurring additional economic burdens. However, a thorough environmental impact assessment remains crucial to identify and mitigate any potential negative impacts on sensitive habitats, even within existing footprint areas.

•Site Development – Maximize Open Space

The urban transformation plan encourages the consolidation of smaller building plots into larger sites. This strategy presents a cost-neutral approach to maximizing open space within the transformed urban landscape. By consolidating plots, opportunities arise for the creation of more extensive, interconnected green areas, parks, plazas, or other community spaces, potentially enhancing quality of life and environmental benefits without incurring additional development costs. However, careful consideration should be given to potential challenges, such as ensuring equitable access to open space for all residents, balancing individual property rights with community needs, and mitigating potential social disruptions associated with land consolidation.

•Stormwater Design – Quantity Control and Stormwater Management – Quality Control

This study considers both stormwater quantity and quality control measures within the existing urban infrastructure. This approach leverages the current system, potentially allowing for points to be earned without incurring additional capital expenditure. However, further investigation is required to assess the adequacy of the existing infrastructure to meet all regulatory requirements and desired performance standards.

•Heat Island Effect – Nonroof and Roof

Recent research highlights by to Baykara [3], Istanbul's intensifying heat island effect, posing significant challenges for urban inhabitants. However, emerging evidence suggests that this issue can be addressed through urban transformation projects without incurring additional costs. By strategically integrating heat mitigation strategies into these initiatives, a significant cooling effect can be achieved.

Water Efficiency

•Water Efficient Landscaping

Integrating water-efficient landscaping strategies into urban transformation initiatives presents unique challenges. Retrofitting existing infrastructure often proves more complex and costly compared to incorporating sustainability features in new builds. While initial investments in technology and installation might be higher, the potential for long-term water savings, especially considering the often-large scale of urban transformation projects, necessitates a closer examination of the cost-benefit analysis.

•Innovative Wastewater Technologies

Effective water management strategies are crucial for successful urban transformation, demanding attention at both individual buildings and city-wide levels. At the individual level, implementing rainwater harvesting systems for irrigation and separating greywater (excluding kitchen wastewater) from blackwater offers numerous benefits. These include reduced reliance on potable water, minimized strain on centralized treatment facilities, and potential resource recovery like nutrient recycling from greywater.

On a city-wide scale, large-scale implementation of filtration systems for treated sewage and rainwater holds significant promise. This contributes to improved water quality discharged into receiving bodies, mitigating potential environmental and public health impacts associated with untreated wastewater. While upfront costs are associated with installing these systems, their long-term economic benefits through reduced water consumption and avoided environmental damage warrant thorough evaluation. Additionally, social factors like public acceptance and equitable access to resources must be carefully addressed. Overall, prioritizing sustainable wastewater management through rainwater harvesting, greywater separation, and large-scale filtration presents a powerful opportunity to enhance the environmental and social outcomes of urban transformation projects.

Energy and Atmosphere

The Leadership in Energy and Environmental Design (LEED) certification system emphasizes sustainable building practices, with the Energy and Atmosphere (EA) category playing a crucial role in promoting energy efficiency and reducing environmental impact. This section accounts for up to 40 points within the overall LEED score, signifying its substantial influence on achieving certification. The EA category focuses on reducing a building's energy consumption and its associated environmental consequences. By implementing strategies outlined within the EA credits, buildings can achieve significant improvements in energy performance, leading to reduced operational costs, decreased greenhouse gas emissions, and enhanced occupant comfort and health.

The specific requirements of the EA category delve into various aspects of building design and operation that influence energy consumption. These include building envelope performance, high-performance windows and doors, energy-efficient HVAC systems, and lighting systems. While the EA category encompasses various aspects of building energy use, it excludes the specific minimum efficiencies required for home appliances, as these are typically left to the discretion of individual owners. By prioritizing energy performance throughout the design, construction, and operation phases, buildings can contribute to a more sustainable and resilient future for cities like Istanbul undergoing significant urban transformation. The considerations highlighted within the EA category offer a valuable framework for guiding the development of energy-efficient buildings within this context.

Considering Istanbul's ongoing urban transformation, the cost associated with implementing the EA measures in this section is estimated to range from $1,000 to $1,500 per unit, according to Schifman [4]. With an estimated 292,000 buildings requiring this transformation, each containing an average of 10 individual units, the total number of units requiring intervention reaches 2,922,000. Assuming the most cost-effective option of $1,000 per unit, the total estimated cost for implementing these measures across Istanbul's buildings would be approximately $2,922,000,000.

However, it is crucial to acknowledge that this initial investment is expected to be offset over time through reduced energy consumption and associated cost savings. Additionally, the positive impact on public health due to improved indoor air quality and occupant comfort should be factored into the overall economic evaluation.

Materials and Resources

The Materials and Resources section of LEED certification focuses on three key sustainability aspects:

-Environmentally Friendly Materials: This credit encourages the use of materials with reduced environmental impact throughout the construction process.

-Reducing Construction and Demolition Waste: This credit emphasizes strategies to minimize waste generation during construction and demolition activities.

-Building Durability and Resilience: This credit promotes the design and construction of buildings with enhanced durability and resilience to withstand natural disasters and extreme weather events.

Given Istanbul's location within the seismically active North Anatolian Fault zone (Figure 1), durability becomes a paramount concern during urban transformation. Implementing measures to enhance building resilience against earthquakes is crucial to prevent catastrophic consequences similar to those witnessed in the 1999 Düzce earthquake and the 2023 Hatay and Kahramanmaraş earthquakes. However, achieving this objective without incurring significant additional costs requires careful consideration.

The selection of construction materials inevitably impacts the environment. While minimizing environmental impact is desirable, it is essential to acknowledge the current limitations and infrastructure realities within Istanbul. The widespread use of reinforced concrete in recent Turkish construction projects presents challenges in transitioning to alternative materials like steel or timber structures. This shift might be hindered by the potential lack of a readily available skilled workforce accustomed to working with these alternative materials. Consequently, a detailed cost analysis considering both environmental and economic factors is necessary before implementing significant changes in material selection.

While opportunities for minimizing waste from existing buildings might be limited, strategies can be employed to reduce waste generation during the demolition and reconstruction phases. Reusing existing reinforcement materials from demolished structures after appropriate processing offers a viable solution that can contribute to both cost savings and environmental benefits.

The Materials and Resources section presents significant opportunities to promote sustainability within Istanbul's urban transformation. However, a balanced approach that prioritizes earthquake resilience, economic feasibility, and environmental considerations is crucial for successful implementation.

Indoor Environmental Quality

Over the past two decades, Istanbul has experienced a notable enhancement in its air quality, largely credited to the increased adoption of natural gas for residential heating purposes. The improvement is evident in Table 1, which outlines the air quality index and other relevant parameters for 2023 for the districts of the city of Istanbul. Throughout the year, the air quality index consistently registers below 50 across most districts, indicating that the air quality concern in residential areas primarily stems from internal sources, which consequently impacts the overall air quality negatively. To combat this issue, integrating in-house air filters and purifiers with existing air conditioning systems emerges as the most viable solution. However, during winter, the city's air quality index sees a significant rise, necessitating the use of air purifiers and filtration systems for entire buildings. The cost of an air purifier per unit is approximately $300, and with an estimated 2,992,000 units required, the total cost for implementing this solution would amount to around 900 million dollars.

Table 1. Istanbul air quality data from 2023 (1.1.2023 – 31.12.2023), Data is obtained from the Istanbul Metropolitan Municipality Air Quality Department [5]

Station	Air Pollution Index	PM10 (µg/m³)	PM25 (µg/m³)	SO_2 (µg/m³)	CO (µg/m³)	NO (µg/m³)	NO2 (µg/m³)	NOX (µg/m³)	O_3 (µg/m³)
Şile	32	22.5	-	9.2	-	2.9	8.3	13.1	71
Kumköy	24	20.7	5.7	-	322	15.4	21.5	54.8	24.3
Büyükada	17	17.8	-	-	-	-	-	-	12.9
Kandilli 2	27	29.5	-	19.1	1516.2	36.9	33	91.7	-
Silivri	39	29.8	16	7.5	-	6.9	17	28.2	76.5
Esenler	32	33.1	20.3	3.4	558.5	41.3	42.8	106.9	33.3
Kağıthane 2	22	-	19.4	12.3	-	38	43.3	102.1	36.4
Esenyurt	44	54	-	20.5	-	36.2	40.1	96.1	45.8
Yenibosna	27	48.3	-	2.1	693.7	40.3	42.5	104	-
Sultanbeyli	32	30.5	-	22	-	22.7	34.2	69	60.2
Kadıköy	33	33.3	21.1	3.6	604.3	42.7	38.7	103.9	36.1
Alibeyköy	38	32	18.8	4.8	521.7	103.9	43.8	212.2	18.1
Kartal	39	53	28.9	3.7	556.2	38.9	42.2	102.1	34.7
Bağcılar	33	38.6	21.7	2.9	543	25.4	42.5	81.4	36.1
Sarıyer	37	21.8	-	3.9	-	24.1	29.6	66.4	42.4
Sancaktepe	39	47.7	-	4.5	597.1	22.1	30.9	64.3	42.1
Tuzla	39	47.8	20	5.4	366.7	39.6	44.4	105.4	20.5
Üsküdar 1	37	26.3	12.5	2.5	-	15.1	33.7	55.4	-
Kağıthane 1	42	57.9	21.3	5.8	536.8	41.4	34	102.9	12.6
Arnavutköy	32	32.6	18	3.5	393.3	9.7	21.6	36.4	44.5
Başakşehir	36	41.8	-	25.7	1671.1	15.1	29.6	52.6	53.3
Ümraniye 2	42	35.6	16	13.8	6014.8	52.5	49.3	130.5	-
Üsküdar 2	32	35.8	-	-	-	34.2	41.3	94.5	-
Aksaray	45	40.5	21.8	3.7	728.9	104.3	77.6	237.2	13.3
Şirinevler	38	36.8	-	3.8	1231.9	32.8	65.1	116.1	-
Beşiktaş	38	38.1	20	3.8	513.3	42.4	50.8	115.4	26
Mecidiyeköy	30	53.5	-	-	1928.5	80.5	26.2	150.3	-
Selimiye	37	45.8	26.6	-	479.3	30.5	22.7	68.6	40.4
Göztepe	59	90	-	-	1061.4	67.6	68.2	171.6	-
Çatladıkapı	28	31.3	17.9	-	603.6	27.3	40.3	82.7	36
Maslak	28	30.6	15.4	3	-	26.3	20.9	62.1	27.4
Ümraniye 1	52	44.9	28.5	3.8	-	14.3	31.8	56.8	36
Avcılar	26	26.4	17.6	3.1	-	8.3	27.6	41.9	33
Kandilli 1	13	14.9	-	-	-	-	-	-	14.8
Average	35	38.4	19.4	7.6	1021.1	35.6	37.4	93	36.5

Innovation and Regional Priority

Although this category of LEED certification requires mostly individual solutions for the buildings, forcing the contractors to follow LEED innovation catalog [6] can easily help the buildings receive the points that can be obtained from the Innovation section. Since this section is more subjective with respect to the contractor, the cost of the application for this part is not included in the overall system.

For regional priority, according to v4.1 of the LEED rating system, each individual location can be accessed and checked for extra points. Since this part is specific to buildings this part is also left out for the cost calculations.

Application and Other Costs

The LEED rating system entails more than just registration; it also involves payment for third-party testing and final verification. The total cost breakdown is detailed below in Table 2.

Table 2. Registration fees break downs for residential areas. Data is obtained for certification for out of United States Section [7]

Building Design and Construction fees per building	**Silver, Gold and Platinum level members**	
Registration	$1,350	
Precertification		
Flat fee (per building)	$4,500	
Combined Certification Review: Design and Construction	Rate	Minimum
Project gross floor area (excluding parking): less than 24,000m^2	$0.695/m^2	$3,200
Project gross floor area (excluding parking): 24,000m^2 - 48,000 m^2	$0.674/m^2	$16,000
Project gross floor area excluding parking): 48,000m^2 - 72,000m^2 sq ft	$0.608/m^2	$31,000

Since the problematic buildings are mostly fit in the first bullet, which is "Project gross floor area (excluding parking): less than 24,000m^2" and the areas are less than 5,000 m^2, the average certification review cost is taken as $3,500. Adding Registration and Flat fee on top of the certification review cost makes the total of $9,350. Considering 292,000 buildings, the total cost for the project using LEED certification for all the urban transformation areas makes $2,730,200,000.

3. Conclusion

In conclusion, Istanbul's urban transformation represents a critical opportunity to not only rebuild the city but also to create a more resilient, sustainable, and environmentally conscious urban environment. The city's seismic risks, highlighted by its proximity to the North Anatolian Earthquake Fault, underscore the importance of holistic and forward-thinking approaches to urban development.

The LEED certification process, while presenting significant upfront costs, offers a framework for achieving these goals. By incorporating green building principles across categories such as Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality, Innovation, and Regional Priority, Istanbul can not only enhance its earthquake resilience but also improve its overall quality of life for residents.

While the total cost of LEED certification may seem prohibitive, the long-term benefits, including improved life quality, reduced health hazards, and a more sustainable future, far outweigh the initial investment. Moreover, the potential savings in energy costs and environmental impact mitigation contribute to the economic viability of the certification process.

4. Total Breakdown

When considering the total cost breakdown of LEED certification for Istanbul's urban transformation, including Certification and Review, Indoor Environmental Quality, Energy and Atmosphere, and other associated costs, the total amount reaches $5,653,100,000. While this cost is substantial, the benefits in terms of improved life quality, reduced health hazards, and a sustainable future justify the investment.

An alternative approach could involve not enforcing LEED certification but still implementing green building practices. This could reduce the total cost by approximately $2,730,200,000. However, without certification, the process would need to be overseen by authorities to ensure adherence to sustainability standards.

In conclusion, while the cost of LEED certification for Istanbul's urban transformation is significant, the potential benefits in terms of resilience, sustainability, and quality of life make it a worthwhile investment for the city's future.

Conflict of Interest

All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

Ethics Committee Approval

Ethics committee approval is not required.

Author Contribution

Conceptization, methodology, laboratory analyzes, writing draft, proof reading and editing: OT.

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5. References

[1] Bohnhoff, M., Martínez-Garzón, P., Bulut, F., Stierle, E., & Ben-Zion, Y. (2016). Maximum earthquake magnitudes along different sections of the North Anatolian fault zone. Tectonophysics, 674, 147-165.
[2] Municipality İ. M. (2019). İstanbul Deprem Çalıştayı, Istanbul Metropolitan Municipality, İstanbul.
[3] Baykara, M. (2023). An Assessment of Long-Term Urban Heat Island Impact on Istanbul's Climate. International Journal of Environment and Geoinformatics, 10(2), 40-47.
[4] Schifman, M. R. (2020). LEED v4.1 for Homes 101: Translating The Energy & Atmosphere Prerequisites, Rise, 17 December. [Online]. Available: https://www.buildwithrise.com/stories/leed-for-homes-101-energy-and-atmosphere-prerequisites. [Accessed 24 February 2024].
[5] Department, I. M. M. A. Q. (2023). Periodical Air Quality Report, Istanbul Metropolitan Municipality , 31 12 2023. [Online]. Available: 10. [Accessed 3 2024].
[6] Council, U. G. B. (2024). LEED Credit Library, U.S Green Building Council , March 2024. [Online]. Available: https://www.usgbc.org/innovationcatalog. [Accessed 2024].
[7] Council, U. S. G. B. (2024). LEED certification fees, United States Green Building Council , 2024. [Online]. Available: https://www.usgbc.org/tools/leed-certification/fees. [Accessed 2024].
[8] Bayat, F., & Küçükali, U. F. (2021). Sürdürülebilirlik bağlamında yeşil binaların ulusal ve uluslararası örnekler üzerinden incelenmesi. Anadolu Bil Meslek Yüksekokulu Dergisi, 16(64), 321-347.