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OUTDOOR FURNITURE DESIGN WITH AN ECOLOGICAL APPROACH TO IMPROVE AIR QUALITY

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Abstract

As the significance of environmental sustainability continues to grow, outdoor furniture designs are now focusing not only on aesthetics, functionality, and ergonomics but also on ecological compatibility. The primary objective of this study is to evaluate the impact of plant-integrated furniture designs on CO_2, CO, $PM_{2.5}$, and PM_{10} emissions while also assessing the particulate matter (PM) retention capacity of the materials used. Additionally, the effects of furniture shape and material selection on environmental sustainability are scientifically analyzed. By comparing the findings of different furniture samples, the most environmentally sustainable design combinations for outdoor furniture have been proposed. This study aims to provide a scientific foundation for sustainable furniture design and the reduction of environmental impacts, offering valuable insights for designs that achieve both aesthetic and environmental benefits. The findings reveal the potential of plants in absorbing PM_{10}, $PM_{2.5}$, CO, and CO_2 while improving air quality. Plant-integrated furniture designs have demonstrated significantly greater absorption of harmful emissions compared to non-plant designs, thereby contributing positively to air quality. Furthermore, the use of natural stone and wood materials in furniture has shown notable differences in particulate matter retention capacity.

Keywords: Outdoor furniture desing, eco-furniture design, air quality & furniture

HAVA KALİTESİNİ İYİLEŞTİRMEK İÇİN EKOLOJİK YAKLAŞIMLA DIŞ MEKAN MOBİLYA TASARIMI

Özet

Çevresel sürdürülebilirliğin önemi arttıkça, dış mekan mobilya tasarımları estetik, fonksiyonellik ve ergonominin yanı sıra ekolojik uyumluluğa da odaklanmaktadır. Çalışmanın temel hedefi, bitki entegreli mobilya tasarımlarının CO_2, CO, $PM_{2.5}$, PM_{10} emisyon salınımını ve aynı zamanda kullanılan malzemelerin partikül madde (PM) tutma kapasitesini değerlendirmektir. Ayrıca, mobilya biçimi ve kullanılan malzeme seçiminin çevresel sürdürülebilirlik üzerindeki etkileri bilimsel verilerle analiz edilmiştir. Mobilyalardan elde edilen sonuçlar karşılaştırılmış, açık alan mobilyaları için çevresel sürdürülebilirlik açısından en uygun tasarım kombinasyonları önerilmiştir. Bu çalışma, sürdürülebilir mobilya tasarımı ve çevresel etkilerin azaltılması konusunda bilimsel bir temel oluşturarak, hem estetik hem de çevresel fayda sağlayan tasarımlar için önemli bir kaynak sunmayı hedeflemektedir. Çalışma bulguları, bitkilerin PM_{10}, $PM_{2.5}$, CO ve *CO_2 emilimi ve hava kalitesini iyileştirme potansiyelini ortaya koymaktadır. Bitkili mobilya tasarımları, bitkisiz tasarımlara göre belirgin bir şekilde daha fazla zararlı emisyonları absorbe etmiş ve bu sayede hava kalitesine olumlu katkıda bulunmuştur. Ayrıca, mobilyalarda kullanılan doğal taş ve ahşap malzemeler partikül madde tutulumu açısından önemli farklılıklar göstermiştir.*

***Anahtar kelimeler**: Dışmekan mobilya tasarımı, eko-mobilya tasarımı, hava kalitesi ve mobilya*

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1. Introduction

Designers continue to make new discoveries in furniture design every day. In this process, environmentally friendly materials play a crucial role (Saad, 2016; Yang and Vezzoli, 2024). Today, designers are increasingly interested in new concepts and creative applications. Furniture developed with sustainable design approaches has become an integral part of this process (Elessawy et al., 2024). These approaches not only provide aesthetic benefits but also prioritize ecological factors, adding value to contemporary living spaces. Typical examples of such applications include reducing material usage, preferring recyclable or renewable materials, implementing energy-efficient production processes, and using recycled alternatives instead of raw materials. Additionally, replacing hazardous or toxic materials with environmentally friendly and safe alternatives is a key aspect of this process (Yang and Vezzoli, 2024). Minimizing environmental impact is one of the fundamental objectives of furniture design. Maximizing material efficiency and maintaining both functionality and visual appeal at every stage of a product's life cycle—design, production, use, waste management, and recycling—is an essential part of the sustainability concept (Zhu et al., 2023). Sustainable furniture design is gaining increasing importance and has become the subject of numerous academic studies (Li, Xiong and Qu, 2023). One key concept that emerges in this process is eco-design. Eco-design is an approach that aims to minimize the environmental impact of products throughout their entire life cycle. This approach involves a product development process that focuses on reducing environmental effects at every stage of a product's life cycle (Lindahl and Ekermann, 2013). The eco-design philosophy requires evaluating products not only in terms of aesthetics and functionality but also in terms of environmental sustainability (Bianco et al., 2021).

Today, designers are developing environmentally conscious furniture through sustainable material choices and production processes, offering innovative solutions in terms of both aesthetics and functionality. In this context, eco-design has gone beyond being a temporary trend and has become a fundamental principle shaping the living spaces of the future.

One of the most pressing environmental threats today is air pollution. Furniture design is among the key factors influencing air pollution. A study conducted by Tarín-Carrasco et al. (2019) highlighted that pollution-related deaths in Europe cost approximately 158 billion euros annually, making it one of the most significant environmental challenges. The relationship between consumption and air pollution has become a global issue, prompting various policy proposals worldwide to address the problem. To combat this issue, furniture designers and manufacturers are actively engaged in research and development efforts (Bianco et al., 2021). Indoor air quality is influenced by multiple factors, including the airflow created by furniture arrangement (Tikul et al., 2022). According to the World Health Organization's "Turkey's Future Project Final Report," the annual average temperature in Turkey is projected to rise by 2.5°C to 4°C in the coming years, with an accelerated increase after 2030, leading to a hotter and drier climate (WWF, 2011). Due to these changing environmental conditions, sustainability and ecological compatibility have become critical design requirements in modern furniture design. In previous years, aesthetics, functionality, and ergonomics were the primary considerations, but today, the rapid depletion of natural resources, global efforts to reduce carbon footprints, and increased environmental awareness have made eco-friendly approaches essential in the furniture industry. As a result, sustainable design practices are becoming increasingly widespread, including: The use of recyclable materials in design processes, The adoption of low-energy manufacturing methods,

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The development of durable and long-lasting furniture solutions. These sustainable strategies are shaping the future of furniture design, contributing to both environmental protection and enhanced indoor air quality.

This study aims to examine the impact of specially designed outdoor furniture on air quality. The research will evaluate the role of plant-integrated furniture designs in absorbing CO_2, CO, $PM_{2.5}$, and PM_{10} and regulating airflow. The influence of furniture form and material selection will be assessed based on scientific data to analyze the environmental sustainability effects of design decisions. By doing so, the study seeks to establish a scientific foundation for furniture designs that can be utilized in urban open spaces, offering both aesthetic and environmental benefits. The ultimate goal is to demonstrate the potential of such designs in improving urban air quality. Additionally, the PM retention capacities of different materials used in furniture design will be measured to identify which materials are more effective in reducing air pollution. The study's findings will contribute to the development of sustainable urban furniture solutions, promoting healthier and more eco-friendly outdoor spaces.

• Assessing the Impact of Furniture Form: The study will identify how the shape and structure of furniture influence air quality and pollutant dispersion.

• Determining the Absorption Capacity of Plants: The CO, CO_2, $PM_{2.5}$, and PM_{10} absorption capacities of plants will be measured, quantifying the contribution of green-integrated outdoor furniture to air quality improvement.

• Proposing Environmentally Sustainable Design Combinations: By comparing the results, the study will recommend the most effective furniture design configurations for enhancing environmental sustainability in open spaces.

2. Material and Methods

2.1. Study area

Expo 2020 Dubai has been developed within the framework of sustainable design principles and has been selected as the primary study material for this research. Located in the southern part of the Emirate of Dubai, near the Jebel Ali region (25.95° N, 55.14° E), this area provides a collaborative environment based on innovation, cooperation, and sustainable development principles. One of the main reasons for choosing Expo 2020 Dubai is its environmentally friendly buildings, energy-efficient systems, and the use of sustainable materials (Figure 1). The site offers an ecosystem that encourages professionals from various sectors to come together, share knowledge, develop projects, and collaborate on a global scale. In this context, the site's alignment with sustainable design approaches has made it an ideal testing ground for examining the relationship between air quality and furniture design.

Figure 1. Study area (Google Map Pro)

2.2. Methods

In this study, the methodology has been examined in three stages (Figure 3). In the first stage, the selection of furniture in the study area was carried out. During the selection process, attention was paid to ensuring that the furniture differed in terms of design, materials, form, and shape (Figure 2).

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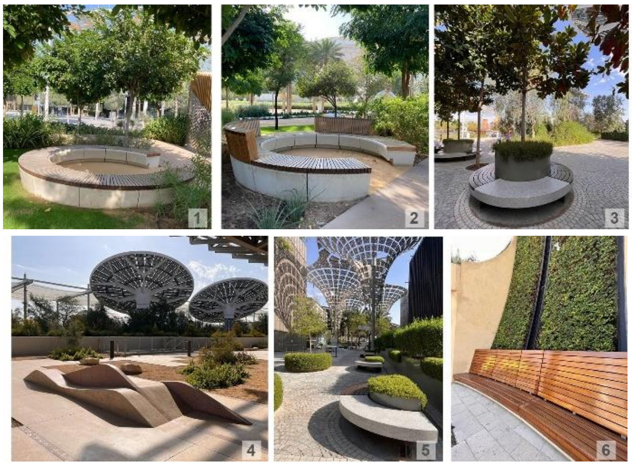

Figure 2. 6 furniture designs selected within the scope of the study

In the second phase of the study, emission measurements were conducted for all furniture over a six-month period. The emissions were measured using a device capable of infrared micro-scale measurements. The device is a handheld manual device capable of detecting emissions on a micro scale. Technically, it can measure and detect all emissions simultaneously.

The measured emissions included CO, CO_2, $PM_{2.5}$, and PM_{10}. Due to the micro-scale nature of the measurements, readings were taken at 1-meter intervals around the furniture. As a result of the measurement analyses, average values were determined.

In the final phase of the study, measurements of the materials used in the furniture were conducted, and the quantity of each material was determined. The numerical data of the materials were compared with the emission measurement results (CO, CO_2, $PM_{2.5}$, PM_{10}). This comparison will allow for a more comprehensive evaluation of the environmental impact of the design and clearly reveal its contribution to air quality.

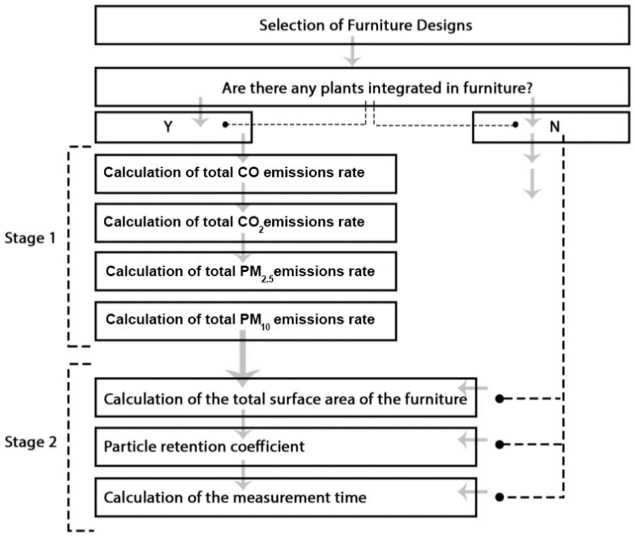

Figure 3. Research diagram

3. Findings

3.1. Making Emission Measurements

For each area where the furniture designs were located, measurement grids of 1 meter by 1 meter were created to ensure the highest level of accuracy and precision. These measurement areas were specifically designated and positioned to collect emission data in the most reliable manner. Each measurement was conducted at these carefully selected points to analyze the emission release effects of the chosen furniture designs in the finest detail, thereby maximizing the accuracy and scientific validity of the obtained data. After conducting measurements from the grid network surrounding the furniture, additional measurements were taken separately from the section where the plant was located. Measurements were conducted separately from all four corners of the plant (Figure 4).

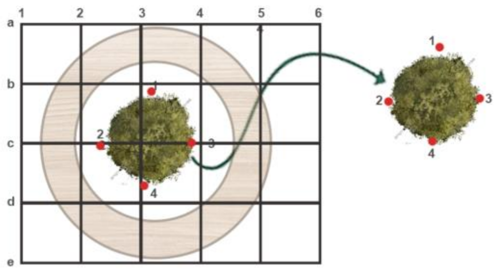

Figure 4. Measurement points created for measurements

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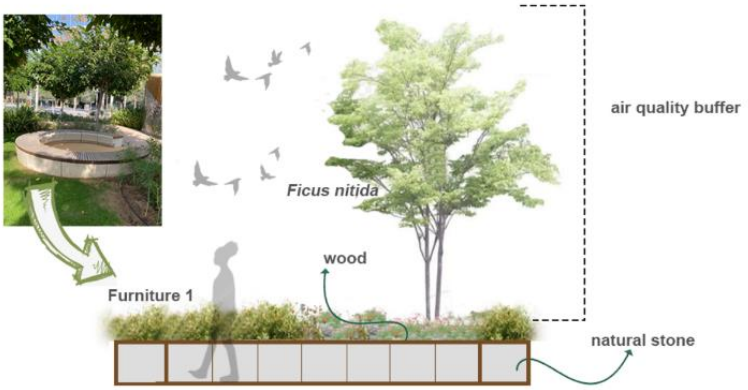
Upon analyzing the obtained measurement data, the average $PM_{2.5}$ level was found to be 97 µg/m³, while the PM_{10} level was measured at 91 µg/m³. Although these levels have the potential to negatively impact environmental health, they can be controlled through measures aimed at improving air quality in the area. Strategies implemented to optimize $PM_{2.5}$ and PM_{10} levels could be a significant step toward enhancing air quality. The levels of CO and CO_2 were measured at 1 mg/m³ and 278.52 ppm, respectively, indicating that the air quality in the area does not pose a major risk to respiratory health. The CO level is quite low, reflecting healthy air conditions, while the CO_2 level can be attributed to environmental factors. Balancing these values suggests that necessary measures can be taken to ensure sustainable air quality. The average Air Quality Index (AQI) value was recorded at 94 µg/m³, indicating that the air quality is within a healthy range and can be further improved through specific regulations. Monitoring AQI levels and optimizing them through environmental regulations presents a valuable opportunity to enhance air quality in the region. These findings provide valuable insights for environmental policies and sustainable urban planning, highlighting the potential for significant steps toward creating healthier living environments (Table 1).

Table 1. Average index findings for furniture design 1

Particulate Matter	
Furniture 1	
$PM_{2.5}$	97.16 µg/m³
PM_{10}	91.74 µg/m³
CO	1 mg/m³
CO_2	278.52 ppm
AQIndex	94.37 µg/m³

Plan



The obtained measurement data indicate that the air quality in the area where this furniture design is located is at a highly favorable level and that the environmental conditions are suitable for healthy living. The $PM_{2.5}$ level was recorded at 84 µg/m³, generally indicating that the air quality is within a healthy range. $PM_{2.5}$ is a critical parameter in air pollution, and at this level, it does not pose any significant risk to respiratory health. The PM_{10} level was measured at 73 µg/m³, further confirming that air quality remains healthy and that the concentration of particulate matter is within acceptable limits. This value suggests that the presence of large airborne particles is low, which positively impacts overall air quality. The CO level was found to be 1 µg/m³, indicating that air pollutants are at minimal levels and that the air quality is excellent. The CO_2 level was measured at 135.21 ppm, which is within normal levels but should be monitored in cases where indoor air renewal is necessary. However, overall, the air quality can be considered to be within a healthy range. Finally, the average AQI was determined to be 75.1 µg/m³, signifying good air quality that does not pose any health risks. This value suggests that the air quality can be continuously maintained and improved through ongoing environmental management measures (Table 2).

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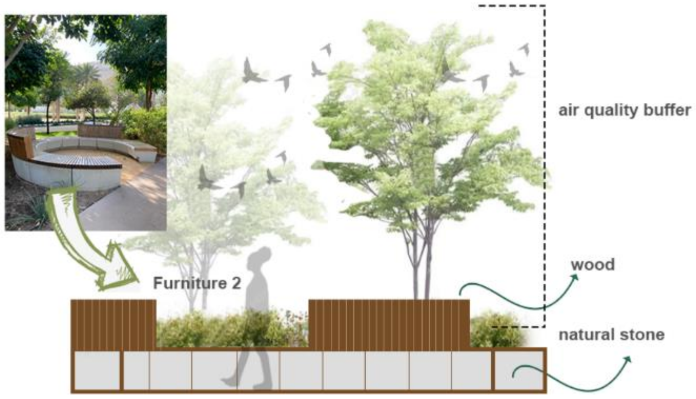
Table 2. Average index findings for furniture design 2

Particulate Matter	
Furniture 2	
$PM_{2.5}$	84.27 µg/m³
PM_{10}	73.37 µg/m³
CO	1 mg/m³
CO_2	135.21 ppm
AQIndex	75.11 µg/m³

Plan

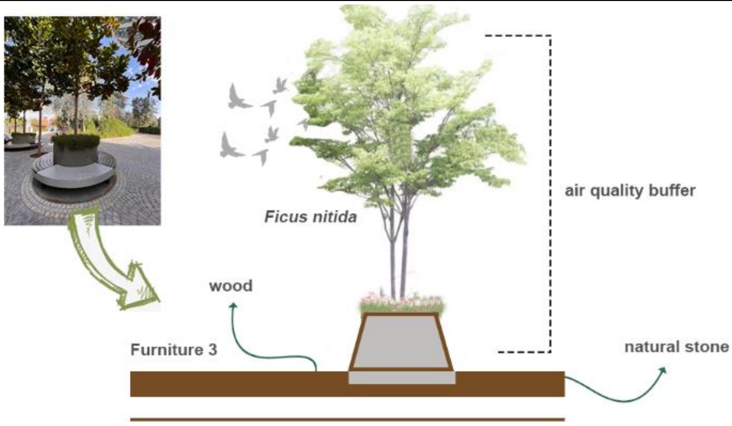


According to the measurement results for the third piece of furniture, the $PM_{2.5}$ level was recorded at 101.14 µg/m³, the PM_{10} level at 96.17 µg/m³, the CO level at 1 µg/m³, and the CO_2 level at 102.14 µg/m³. The $PM_{2.5}$ level of 101.14 µg/m³ indicates a certain concentration of fine particulate matter in the environment. The PM_{10} level was measured at 96.17 µg/m³. In outdoor environments, PM_{10} levels are typically influenced by road dust, construction activities, or natural sources such as pollen and soil particles. The elevated level suggests the presence of such particulate sources in the vicinity. However, in an open workspace, PM_{10} remains suspended in the air for a shorter duration, making the overall result more favorable. The CO level was recorded at 1 µg/m³, which is quite low for an outdoor environment, indicating no significant risk in terms of regional air pollution. The CO_2 level was measured at 102.14 µg/m³, which is relatively low in outdoor conditions and does not pose any negative impact on air quality. Finally, the average AQI was calculated as 99.11 µg/m³ (Table 3).

Table 3. Average index findings for furniture design 3

Particulate Matter	
Furniture 3	
$PM_{2.5}$	101.14 µg/m³
PM_{10}	96.17 µg/m³
CO	1 mg/m³
CO_2	102.14 ppm
AQIndex	99.11 µg/m³

Plan



For the fourth furniture design, the $PM_{2.5}$ level was recorded at 109.74 µg/m³, while the PM_{10} level was measured at 105.74 µg/m³. The CO level was found to be 1 mg/m³, which is within an acceptable range for outdoor conditions and well below the World Health Organization's (WHO) recommended short-term limit of 30 mg/m³. This indicates that combustion-

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related air pollutants in the environment are not significantly high. The CO_2 level was measured at 125.17 ppm, which is a normal level for outdoor air. The typical background concentration of CO_2 in the atmosphere is around 400 ppm, meaning this lower reading could be attributed to factors such as air circulation during the measurement, the effects of plant photosynthesis, or local emission sources. Finally, the average AQI was determined to be 109.54 µg/m³ (Table 4).

Table 4. Average index findings for furniture design 4

Particulate Matter	
Furniture 4	
$PM_{2.5}$	109.74 µg/m³
PM_{10}	105.74µg/m³
CO	1 mg/m³
CO_2	125.17 ppm
AQIndex	109.54 µg/m³

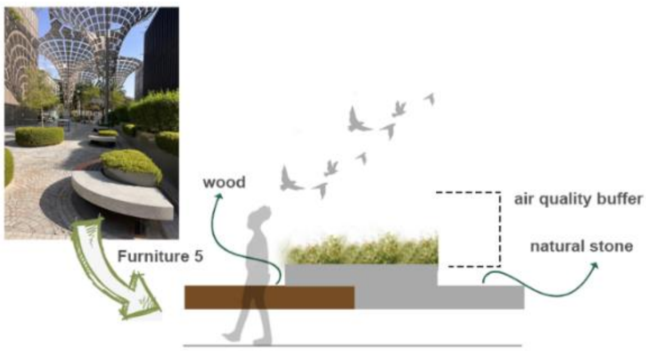
Plan

Upon analyzing the obtained measurement data, the $PM_{2.5}$ level was recorded at 84 µg/m³, while the PM_{10} level was measured at 82 µg/m³. Implementing measures to reduce $PM_{2.5}$ and PM_{10} particle levels plays a crucial role in improving air quality. The CO level was measured at 1 mg/m³, indicating that outdoor air quality remains at a healthy level. Low CO levels suggest that airborne pollutants do not pose a significant threat and that environmental risks are minimal. Additionally, the CO_2 level was recorded at 105.45 ppm, which aligns with the environmental conditions of the area and can be associated with normal air exchange processes. The AQI was measured at 84.11 µg/m³. This value indicates a moderate air quality level that does not pose a significant risk to healthy individuals (Table 5).

Table 5. Average index findings for furniture design 5

Particulate Matter	
Furniture 5	
$PM_{2.5}$	84 µg/m³
PM_{10}	82 µg/m³
CO	1 mg/m³
CO_2	105.45ppm
AQIndex	84.11µg/m³

Plan



According to the obtained measurement data, the $PM_{2.5}$ level was recorded at 76.45 µg/m³, while the PM_{10} level was measured at 78.11 µg/m³. The CO level was found to be 1 mg/m³, indicating a safe and healthy level for outdoor environments. The low CO concentration suggests that air pollution is not a concern and that the overall ambient air quality remains stable. The CO_2 level was recorded at 106.74 ppm, which is a common and normal level for outdoor air conditions. Finally, the AQI was measured at 80.47 µg/m³. According to the World Health Organization's (WHO) measurement classification; this value indicates a "moderate" air quality level that does not pose a significant risk, particularly for healthy individuals (Table 6).

Table 6. Average index findings for furniture design 6

Particulate Matter	
Furniture 6	
$PM_{2.5}$	76.45µg/m³
PM_{10}	78.11µg/m³
CO	1 mg/m³
CO_2	106.74ppm
AQIndex	80.47µg/m³
Plan	

3.2. Particulate Matter (PM) Holding Capacity of the Material

The materials used in furniture can influence air quality by either trapping or emitting fine particulate pollutants. The choice of materials in furniture production directly and indirectly affects air quality (Uhde and Salthammer 2007, Wang et al., 2021). Material selection is a crucial factor in terms of environmental emissions, both during the manufacturing process and throughout the product's lifespan. Different urban furniture materials, such as wood, metal, concrete, recycled plastic, and composite materials, have varying impacts on air pollutants. While wood is a natural and sustainable option, its processing can lead to increased emissions. The impact of urban furniture on air quality is also influenced by factors such as surface temperature and airflow. For instance, urban furniture incorporating plant-based materials has the potential to improve air quality. Therefore, material selection plays a significant role in sustainable urban furniture design by contributing to the reduction of air pollution.

In the scope of the study, two different types of materials were used in all selected furniture designs: natural stone and wood. Neither of these materials contains toxic substances such as formaldehyde, lead, radon, PVC, particulates, dust, or fibers (Zorlu and Tıkansak Karadayı, 2020). To determine the impact of material differences and their interaction with plants, calculations were conducted for six different furniture designs. In the first furniture design, the total area of natural stone was 3.5 m², and the measurement duration was completed in 2 hours. Similarly, the total area of the wooden material was 3.5 m², with a total measurement duration of 2 hours (Figure 5).

In the second furniture design, the natural stone surface area is also 3.5 m². Similarly, the wooden part of the furniture has a surface area of 1.75 m². The total measurement duration for all furniture designs was conducted over 2 hours (Figure 6). In the third furniture design, a total of 4.75 m² of natural stone and 2.9 m² of wooden material were used. The measurement duration, as with all other furniture pieces, was recorded as 2 hours (Figure 7). In the fourth furniture design, only wooden materials were used. The wooden material was designed in a total of three sections. The first section consists of 4.55 m²,

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the second section 2.75 m², and the third section 1.95 m² of wood (Figure 8). The fourth furniture design has a circular form. The materials used in the design are natural stone and wood. Within this form, there are 5.48 m² of natural stone and 2.6 m² of wooden material (Figure 9). The final furniture design consists solely of wooden material. Behind it, there is a vertical garden made of plants. It was designed with a total of 6.5 m² of wood (Figure 10).

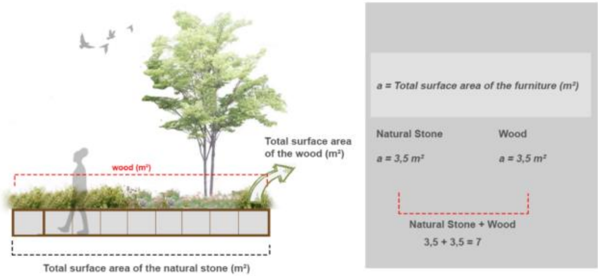

Figure 5. Furniture design 1

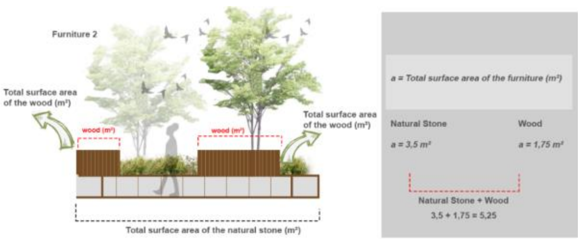

Figure 6. Furniture design 2

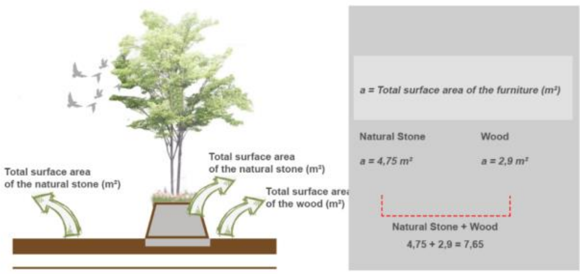

Figure 7. Furniture design 3

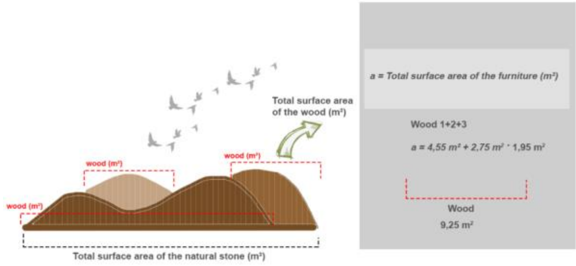

Figure 8. Furniture design 4

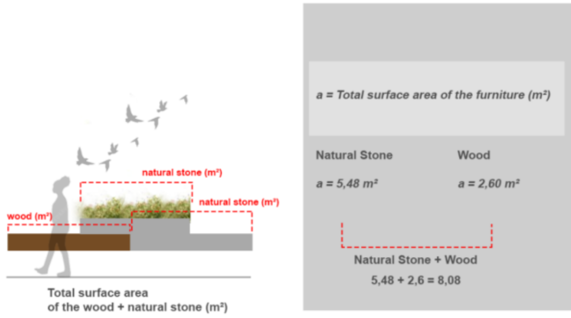

Figure 9. Furniture design 5

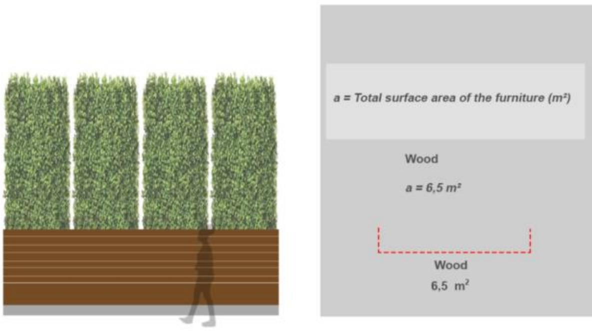

Figure 10. Furniture design 6

4. Conclusion and Discussion

This study investigated the effect of plant-integrated furniture designs on air quality by measuring harmful emissions such as CO, CO_2, $PM_{2.5}$, PM_{10} and by evaluating the relationship between these measurements and the materials used in the furniture. The findings indicate that the study's results provide important data supporting the positive effects of ecological furniture on sustainable urbanization and human health. According to these results;

The lowest $PM_{2.5}$ value was observed in the 6th furniture (76.45 µg/m³), while the highest

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value was recorded in the 4th furniture (109.74 µg/m³). The lowest PM_{10} value was found in the 2nd furniture (73.37 µg/m³), and the highest in the 4th furniture (105.74 µg/m³). The 4th furniture exhibits the worst air quality in terms of both $PM_{2.5}$ and PM_{10}. Regarding CO_2, the lowest level was detected in the 3rd furniture (102.14 ppm), and the highest in the 1st furniture (278.52 ppm). The lowest air pollution index was recorded in the 2nd furniture (75.11 µg/m³), while the highest was in the 4th furniture (109.54 µg/m³). Notably, the 4th furniture does not include any plants, and its air quality is the worst, which may indicate the potential of plants to improve air quality. Although no natural materials were used in the 3rd and 4th furniture, the 3rd furniture still exhibits a relatively lower CO_2 level. Plant usage might improve air quality because the 4th furniture—lacking any plants—shows the poorest air quality. This result is supported by the effect of material differences on air quality as stated in the study of Jung et al. (2024). The use of natural materials might also affect CO_2 emissions. For instance, even though the 3rd furniture does not contain natural materials, it has the lowest CO_2 level, whereas the highest CO_2 emissions occur in the 1st furniture, which incorporates both natural and wooden materials. The 3rd furniture, which has a high proportion of wood, shows the lowest CO_2 level. However, as the amount of wood increases, particulate matter levels ($PM_{2.5}$ and PM_{10}) tend to rise. Particularly, in the 3rd furniture, where 9.25 m² of wood is used, the PM levels are high (Table 7).

Table 7. Emission results and materials used

Variables	**Furnitures**					
	1.	**2.**	**3.**	**4.**	**5.**	**6.**
$PM_{2.5}$	97.16 µg/m³	84.27 µg/m³	101.14 µg/m³	109.74 µg/m³	84 µg/m³	76.45µg/m³
PM_{10}	91.74 µg/m³	73.37 µg/m³	96.17 µg/m³	105.74µg/m³	82 µg/m³	78.11µg/m³
CO	1 mg/m³	1 mg/m³	1 mg/m³	1 mg/m³	1 mg/m³	1 mg/m³
CO_2	278.52 ppm	135.21 ppm	102.14 ppm	125.17 ppm	105.45ppm	106.74ppm
AQIndex	94.37 µg/m³	75,11 µg/m³	99.11 µg/m³	109.54 µg/m³	84.11µg/m³	80.47µg/m³
Plant	●	●	●	-	●	●
Wood	3.5 m²		4.75 m²	9.25	2.6 m²	6.5 m²
Natural	3.5 m²		2.9 m²	-	5.48 m²	-

Ecological furniture not only offers aesthetic and ergonomic benefits, but also contributes to environmental sustainability. Integrated with natural materials and plants, this furniture harmonises with the urban texture and makes an aesthetic contribution to modern design (Bianco et al., 2021; Fekry Gamal, 2022).

Such furniture improves the quality of life of individuals by improving the air quality in the city (Tikul et al., 2022). Planted furniture increases oxygen production by absorbing carbon dioxide in the air, while at the same time filtering harmful particles, making the air cleaner. Furthermore, the use of certain plants that absorb toxic gases can contribute to the reduction of air pollution in cities. Furthermore, ecological furniture has a strong link with urban identity. The integration of green design approach into urban furniture contributes to the development of an aesthetic in harmony with nature and the development of urban culture. This situation both increases the sensitivity of city dwellers to the environment and supports sustainable urban policies. This study highlights the positive effects of plant furniture designs on air quality and emphasises the need to increase the use of ecological designs in urban areas. Future research can offer more comprehensive solutions for sustainable urban furniture by examining the long-term effects of different plant species and materials on air quality. In addition, these studies can also address the psychological

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and social effects of ecological furniture and strengthen individuals' perception of green spaces in the city.

In addition, it may be possible to monitor the air quality instantly and make appropriate arrangements accordingly thanks to ecological furniture to be integrated with smart sensor systems. For example, air purifying plant systems that are automatically activated by sensors when air quality falls below certain thresholds can be effective in reducing particulate matter, especially $PM_{2.5}$ and PM_{10}. However, such applications are mostly applicable in closed or controlled semi-open areas; their effectiveness may be limited due to environmental variables such as wind in outdoor conditions. Since gases such as CO and CO_2 cannot be removed from the atmosphere instantly and remain in the carbon cycle for a long time, these systems are not applicable for these gases. Thus, while protecting the respiratory health of individuals living in the city, it can also contribute to the reduction of air pollution. In conclusion, the use of plant-integrated furniture should be considered within the scope of sustainable urbanisation policies and should be expanded to improve urban air quality. Such designs not only provide environmental benefits but also add value to the visual identity of cities and create a modern, green urban aesthetic. With the right design and material choices, ecological furniture has the potential to make the urban environment healthier and more livable. Especially when used in dense traffic and industrial areas, such furniture has the effect of reducing air pollution and helps city dwellers to live in a cleaner environment. In this direction, designers and decision makers should take steps for a sustainable future by adopting environmentally friendly approaches. While ecological designs become an important element shaping the cities of the future, urban furniture in harmony with nature will contribute to both individual and social welfare.

References

Bianco, I., Thiébat, F., Carbonaro, C., Pagliolico, S., Blengini, G. A. and Comino, E. (2021). Life cycle assessment (LCA)-based tools for the eco-design of wooden furniture. *Journal of Cleaner Production*, 324, 129249. https://doi.org/10.1016/j.jclepro.2021.129249

Elessawy, N. A., El Shakhs, A., El-Saka, M. F., Youssef, M. E., Youssef, B. A. and Ali, M. A. M. (2024). Sustainable and eco-friendly 3D printing filament fabricated from different recycled solid wastes and evaluate its impact on interior and furniture design. *Results in Engineering*, 23, 102428. https://doi.org/10.1016/j.rineng.2024.102428

Fekry Gamal, D. (2022). Concept of circular dconomy in eco-friendly furniture design. *Journal of Design Sciences and Applied Arts*, 3(1), 80-89. doi: 10.21608/jdsaa.2021.101152.1140

Jung, C., Ismail, M. A., Arar, M. and AlQassimi, N. (2024). Mitigating indoor air pollution in UAE's high-rise apartment buildings: a study on eco-friendly materials and adsorbents. *Smart and Sustainable Built Environment*. doi: 10.1108/SASBE-09-2023-0269

Lindahl, M. and Ekermann, S. (2013). Structure for categorization of EcoDesign methods and tools. Re-engineering manufacturing for sustainability: Proceedings of the 20th CIRP International Conference on Life Cycle Engineering (pp. 117-122). Springer. https://doi.org/10.1007/978-981-4451-48-2_19

Li, Y., Xiong, X. and Qu, M. (2023). Research on the whole life cycle of a furniture design and development system based on sustainable design theory. *Sustainability*, 15(18), 13928. https://doi.org/10.3390/su151813928

Saad, R. (2016). The revolution of materials used in 3D printing applications in furniture and interior design. *International Design Journal*, 6(3), 143-163. https://doi.org/10.12816/0036501

Tikul, N., Hokpunna, A. and Chawana, P. (2022). Improving indoor air quality in primary school buildings through optimized apertures and classroom furniture layouts. *Journal of Building Engineering*, 62, 105324. https://doi.org/10.1016/j.jobe.2022.105324

Uhde, E. and Salthammer, T. (2007). Impact of reaction products from building materials and furnishings on indoor air quality—A review of recent advances in indoor chemistry. *Atmospheric Environment*, 41(15), 3111–3128. https://doi.org/10.1016/j.atmosenv.2006.09.015

URL-1, Physical Location Map of Abu Dhabi, http://www.maphill.com/united-arab-emirates/abu-dhabi/location-maps/physical-map/

URL-1, Dubai Exhibition Centre, UAE. https://www.latlong.net/place/dubai-exhibition-centre-uae-31629.html

Wang, Y., Wang, H., Tan, Y., Liu, J., Wang, K., Ji, W. and Xiong, J. (2021). Measurement of the key parameters of VOC emissions from wooden furniture, and

DOI: 10.56629/paud.1656672

the impact of temperature. *Atmospheric Environment*, 259, 118510. https://doi.org/10.1016/j.atmosenv.2021.118510

Yang, D. and Vezzoli, C. (2024). Designing environmentally sustainable furniture products: Furniture-specific life cycle design guidelines and a toolkit to promote environmental performance. *Sustainability*, 16(7), 2628. https://doi.org/10.3390/su16072628

Zhu, L., Yan, Y. and Lv, J. (2023). A bibliometric analysis of current knowledge structure and research progress related to sustainable furniture design systems. *Sustainability*, 15(11), 8622. https://doi.org/10.3390/su15118622

Zorlu, K. and Tıkansak Karadayı, T. (2020). İç mekan hava kalitesinde yapı malzemelerinin rolü. *Sinop Üniversitesi Fen Bilimleri Dergisi*, 5(2), 193–211.

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