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Identifying Key Sustainability Factors in Co-Working Space Design: A Best Worst Method Perspective

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ABSTRACT

This study investigates and prioritizes the key determinants of sustainable co-working space (CWS) design using the Best Worst Method (BWM). It responds to the growing demand for flexible, health-conscious, and environmentally responsible workplaces. Based on an in-depth literature review and expert consultation, nine sustainability-related criteria were identified. A panel of five experts with backgrounds in sustainable architecture, urban planning, environmental engineering, and workplace design assessed the relative importance of these criteria. The results show that Indoor Air Quality and Low Volatile Organic Compound Materials, Daylight and Lighting Quality, and Thermal Comfort and User Control are the most influential factors. This highlights the importance of occupant well-being, comfort, and usability in sustainable co-working environments. In contrast, Water Efficiency and Reuse, Material Circularity and Waste Management, and Biophilic and Restorative Design were assigned lower priority. Overall, the findings indicate that user-oriented and comfort-driven design considerations outweigh purely technical or aesthetic elements in achieving sustainability. The proposed decision framework offers practical guidance for architects, planners, and policymakers seeking to design resilient, inclusive, and environmentally responsible CWSs aligned with sustainable development goals.

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1. Introduction

Co-working spaces (CWSs) have emerged as a defining feature of today's urban environment, offering a middle ground between remote work and conventional offices while enabling collaboration, innovation, and a sense of community. Initially associated with the sharing economy and smart-city initiatives, CWSs are increasingly discussed in terms of sustainability and regional resilience (Dell'Aversana & Miglioretti, 2025; Rex & Westlund, 2024). Yet, despite their rapid growth and

frequently cited environmental and social advantages, there is still no clear consensus on what a "sustainable" CWS actually entails. Prior research frames sustainability from different angles, including environmental, community-focused, and entrepreneurial perspectives (Oswald & Zhao, 2020), but also highlights the need for an integrated approach that jointly accounts for environmental efficiency, sustainable mobility, social inclusion, and economic feasibility within a coherent design framework.

Recent studies emphasize that CWSs can make a meaningful contribution to regional development by supporting the "six capitals" (physical, human, social, intangible, financial, and institutional) that underpin sustainable growth and local resilience (Lee & Haan, 2024). By reactivating underutilized urban and rural assets, improving access to digital infrastructure, and supporting local innovation ecosystems, CWSs go beyond their role as shared workplaces. In this way, they function as drivers of socio-economic regeneration (Moustafa et al., 2025). From a spatial and environmental perspective, CWSs also promote decentralized working arrangements. These arrangements help reduce commuting demand, lower emissions, and improve overall quality of life, outcomes that align closely with climate action and smart mobility goals (Schnieder, 2025). However, realizing these benefits depends on design and operational strategies that successfully integrate physical comfort, energy efficiency, accessibility, and user well-being.

Building on this context, the present study seeks to prioritize the key factors influencing sustainable CWS design using the Best Worst Method (BWM). Nine sustainability-related criteria were identified through a combined literature review and expert consultation. These criteria cover environmental, social, economic, and spatial dimensions. The BWM provides a structured and transparent approach for deriving consistent criteria weights from expert judgments, while reducing subjectivity and maintaining analytical rigor (Şahin et al., 2026; Yildiz et al., 2026). The resulting prioritization offers practical guidance for architects, planners, and policymakers aiming to design CWSs that improve environmental and operational performance and support resilient, inclusive, and adaptive urban communities.

2. Literature Review

In the post-pandemic shift toward hybrid and flexible work, evidence from office and co working studies consistently shows that indoor environmental quality (IEQ) such as daylight access, natural ventilation, thermal/acoustic comfort and dependable power/data strongly shapes user satisfaction and productivity in shared work-places. A people-centric perspective on hybrid office design highlights the salience of environmental features and socket/IT availability in everyday seat choice and space use, underscoring the need for adaptable, user-responsive interiors (Pan et al., 2024). Complementing this, a machine-learning behavioral study of CWSs finds that users gravitate toward window-adjacent and visually connected areas for collaboration, while semi-enclosed, low-visibility zones serve focused work, that evidence that spatial diversity is critical to support different work modes in shared environments (Pan et al., 2023).

Ergonomic shortcomings and noise remain recurrent pain points in co-working. A survey of German CWSs reported limited compliance with ergonomic criteria and substantial shares of users perceiving noise as high; both noise and ergonomics were significantly associated with satisfaction and self-reported health, pointing to the importance of furniture adjustability, posture support and acoustic control in sustainable design (Robelski et al., 2022). Biophilic strategies are frequently linked to stress reduction, well-being and perceived productivity in co-working settings, reinforcing their value as low-regret measures in sustainable interiors *(Li et al., 2020; Zamri & Ahmad, 2025)*. In particular, circadian (dynamically tunable) lighting that mimics the spectrum and intensity profile of daylight has been experimentally shown in a co-working site (ABAB reversal, n=33) to improve early-morning alertness, sleep quality and self-rated productivity, supporting its inclusion as a controllable IEQ lever in co-working design (Elokdah et al., 2025).

User-satisfaction studies propose a multidimensional framework that unites (i) design attributes and layout, (ii) IEQ (light, acoustics, thermal comfort, air quality), (iii) supporting facilities (whiteboards, printers, displays) and (iv) support services (cleaning, security, booking, reliable high-speed internet) as co-determinants of perceived quality, practical categories that map directly to operator and design actions (Riratanaphong, 2021). Beyond satisfaction, design decisions have business consequences: co-working environments that emphasize ergonomics, lighting and noise control tend to increase user interest and rental potential, linking sustainable comfort measures to occupancy and revenue outcomes *(Fuzi, 2015; Soegoto & Hafandi, 2018)*.

At the urban scale, location factors powerfully condition sustainable co-working. A metropolitan analysis of "new working spaces" shows systematic clustering in compact, multifunctional districts and pedestrian zones, with implications that have yet to be fully absorbed in statutory planning despite clear connections to sustainable urban form and access equity (Marino et al., 2023). A city-scale, data-driven study of co-working site selection in Hangzhou constructs a five-pillar indicator system and quantifies their relative importance with entropy weights: innovation environment dominates, followed by convenience of life; this empirically links co-working success to innovation-ecosystem embedding and everyday amenities over nominal cost (Wang et al., 2022). Similarly, recent evidence from Türkiye emphasizes the importance of digital infrastructure, accessibility, and safety-related factors in co-working space location decisions, while highlighting the value of fuzzy multi-criteria decision-making (MCDM) approaches for evaluating alternative sites under uncertainty *(Cari & Ayyildiz, 2026)*.

Inside the building, classic workplace research catalogs design-controllable enablers of flexibility into four actionable groups: building planning physical layout, IT networking and building service systems which is a durable scaffold for low-carbon adaptability and reduced stranded assets as needs evolve (Hassanain, 2006). Finally, strategy literature at the co-living/co-working interface argues that operators can align competitive advantage with environmental and social outcomes by differentiating on amenity,

community facilitation and service layers that nudge low-carbon behaviors and social belonging, an increasingly important complement to physical design choices (Roy et al., 2024). Moreover, participatory co-design approaches from restorative landscape projects offer transferable insights: using Attention Restoration Theory (compatibility, being-away, extent, fascination) as a unifying taxonomy, co-design processes can integrate user experience with comfort and environmental protection goals that is useful for biophilic and restorative features in co-working environments (Fumagalli et al., 2020).

Taken together, the literature converges on three themes for sustainable co-working design and prioritization: (1) macro-location and access (multi-functionality, walkability and transit) enabling low-carbon, high-amenity operation (Marino et al., 2023; Wang et al., 2022); (2) IEQ and restorative strategies (biophilia, circadian lighting, acoustic/thermal comfort, ergonomic support) as direct levers for health and productivity *(Elokdah et al., 2025; Li et al., 2020; Riratanaphong, 2021; Zamri & Ahmad, 2025)*; and (3) flex-ible, service-rich systems (modular layouts, robust IT/services, community facilita-tion) that maintain performance with minimal embodied and operational penalties while strengthening business outcomes (Fuzi, 2015; Hassanain, 2006; Riratanaphong, 2021; Roy et al., 2024).

Building on the above, our study advances the field in four ways. First, we synthesize urban siting evidence (multi-functionality, modal access, innovation density) with interior sustainability factors (air quality and low volatile organic compound materials; thermal/acoustic comfort; daylight/lighting quality including circadian strategies; biophilic/restorative design; water efficiency and reuse; material circularity/low embodied carbon; flexible space planning/modularity), yielding a co-working specific, sustainability-anchored factor set that bridges scales. Second, we employ the BWM to elicit expert and user judgments and derive consistency-checked weights across this integrated criterion set to interior design prioritization for co-working. Third, we conduct scenario sensitivity to show how weights shift under different operator strategies (community-intensive “third place” vs. focus-work premium) and urban contexts (innovation cores vs. emergent sub-centers), connecting sustainability with competitive positioning.

3. Methodology

This study employs BWM, a structured MCDM approach developed by Rezaei (2015). BWM is recognized for its ability to produce consistent and reliable weighting results while minimizing the cognitive effort required from experts (Şahin et al., 2026). In contrast to traditional methods such as the Analytic Hierarchy Process (AHP), which often face consistency issues due to numerous pairwise comparisons, BWM adopts a more compact and systematic structure. Decision-makers begin by identifying two reference criteria from the set of evaluation factors: the best and the worst. Comparisons are then made between these reference criteria and the remaining ones, significantly reducing redundancy and improving coherence in expert judgments.

In this study, BWM is applied to determine the relative importance of nine sustainability-related criteria for CWS design. By effectively capturing expert opinions and reducing subjectivity, BWM provides a transparent and analytically sound framework for prioritizing design factors that contribute to the sustainability, functionality, and resilience of co-working environments. The methodological framework is presented in Figure 1.

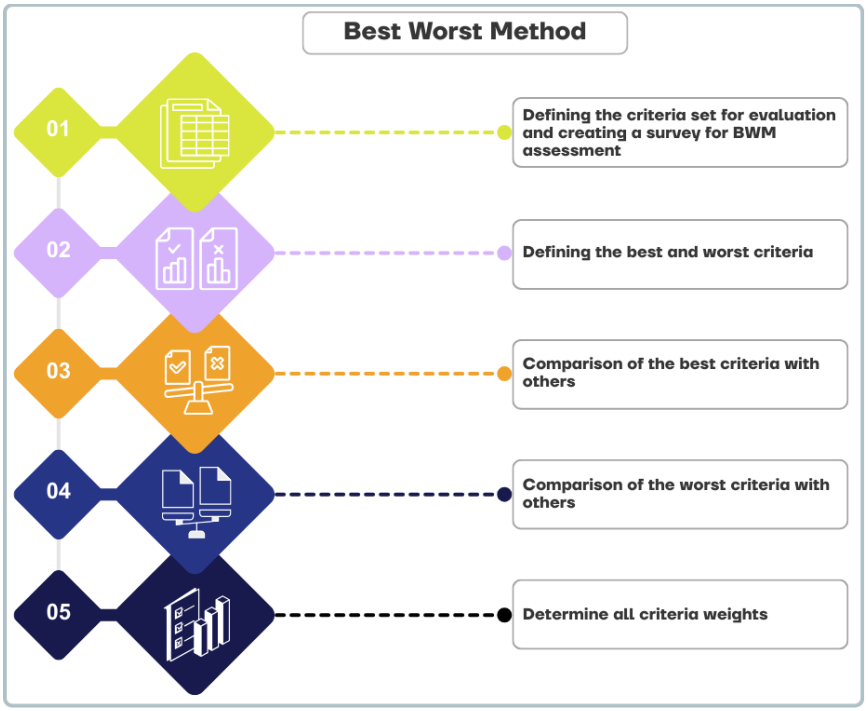


Fig. 1. Flowchart of the study

Step 1. A panel of experts determines a set of n evaluation criteria, represented as $\{C_1, C_2, \dots, C_N\}$, that are relevant to the context and objectives of the study.

Step 2. From the established set of criteria, the decision-makers determine the best criterion (C_b) and the worst criterion (C_w) within the evaluation context.

Step 3. Each expert evaluates how strongly the best criterion is preferred over every other criterion in the set, commonly through the use of a Likert-type scale. Let a_{bJ} denote the degree of preference of the best criterion compared to criterion C_j, where $j \neq b$. These preference values constitute the vector $A_b = (a_{1w}, \dots, a_{jw}, \dots, a_{nw})^T$, representing the comparative assessments of the best criterion against the others, with the self-comparison defined as $a_{bb} = 1$.

Step 4. Each expert determines how much each criterion (except the best one) is preferred compared to the worst criterion. These assessments constitute the others-to-worst vector $A_b = (a_{1w}, \dots, a_{jw}, \dots, a_{nw})^T$, where a_{jw} represents the preference degree of criterion C_j over the worst criterion, under the conditions $j \neq b$ and $j \neq w$.

Step 5. The weights of the decision criteria are determined in accordance with the preference ratios, where the relationship between the best and each remaining criterion is expressed as $w_b/w_j^1 = a_{bj}$ and the relationship between each criterion and the worst is given by $w_j^1/w_w = a_{jw}$. Consequently, the objective is to obtain the set of weights $(w_1^1, w_2^1, \ldots, w_n^1)$ that minimizes the discrepancies between $\left|\frac{w_b}{w_j^1} - a_{bj}\right|$ and $\left|\frac{w_j^1}{w_w} - a_{jw}\right|$. This objective is represented through the minimization model illustrated in Eq. (1).

$$\min \xi \tag{1}$$

subject to:

$$\left|\frac{w_b}{w_j^1} - a_{bj}\right| \leq \xi, \qquad \forall_j$$

$$\left|\frac{w_j^1}{w_w} - a_{jw}\right| \leq \xi, \qquad \forall_j$$

$$\sum_j w_j^1 = 1$$

$$w_j \geq 0, \qquad \forall_j$$

In this study, nine key factors identified through a comprehensive literature review and expert consultation were prioritized using BWM, as presented in Table 1. To enhance the reliability of the decision-making process, an expert panel consisting of five specialists with professional experience in sustainable architecture, urban planning, environmental engineering, energy-efficient building design, and workplace management was established. This interdisciplinary expert group enabled a comprehensive evaluation of sustainability factors by integrating technical, economic, social, and environmental perspectives.

Table 1. Definitions of the criteria

Criteria	Defination	References
C1. Indoor Air Quality and Low Volatile Organic Compound Materials	Adequate outdoor air supply, effective ventilation strategies, air filtration, and the use of finishes, adhesives, coatings, and flooring with a low content of volatile organic compounds.	(Felgueiras et al., 2023; Tsang et al., 2023)
C2. Thermal Comfort and User Control	Provision of thermal comfort supported by personal adjustability and adaptive strategies such as local controls, shading, and the option for natural ventilation.	(Oswald & Zhao, 2020; Tsang et al., 2023)
C3. Daylight and Lighting Quality	Access to daylight, control of glare, visual comfort, and lighting design that supports the circadian rhythm.	(Heidari et al., 2025; Schnieder, 2025)
C4. Acoustic Comfort and Privacy	Control of speech privacy, reverberation, and background noise in open plan areas through sound absorbing surfaces and, where appropriate, the use of sound masking.	(Lee & Haan, 2024; Rachman et al., 2024)
C5. Flexible Space Planning and Modularity	A variety of activity based areas, modular partitions and furniture, and the ability to quickly reconfigure the workspace, contributing to efficient use of space and energy.	(Fai et al., 2025; Forooraghi et al., 2023; Lee & Haan, 2024)

C6. Biophilic and Restorative Design	Integration of plants, natural materials, views of nature, and nature inspired patterns to reduce stress and support well-being and performance.	(Messina et al., 2023)
C7. Location, Access to Public Transport, and Active Mobility	Proximity to public transport, provision for bicycles and walking, and short distance accessibility to reduce travel related emissions and encourage low carbon commuting.	(Schnieder, 2025)
C8. Water Efficiency and Reuse	Use of low flow fixtures, leak management, sub metering and monitoring, and, where feasible, the use of greywater to reduce indoor water consumption.	(Craft et al., 2024)
C9. Material Circularity, Low Embodied Carbon, and Waste Management	Interior solutions that prioritize reuse, refurbishment, and recycling, selection of materials with low embodied carbon, and on site infrastructure for source separation and resource recovery.	(Craft et al., 2024; Moustafa et al., 2025)

4. Results and Discussion

The relative importance of the nine sustainability factors was evaluated using BWM. In this process, the expert panel identified the most significant (best) and least significant (worst) criteria, which served as the basis for weight determination. As shown in Table 2, Indoor Air Quality and Low Volatile Organic Compound Materials and Location, Access to Public Transport, and Active Mobility were most often selected as key factors, emphasizing the importance of health, comfort, and accessibility. In contrast, Biophilic and Restorative Design and Water Efficiency and Reuse were considered less critical. These evaluations were used to construct the Best-to-Others and Others-to-Worst comparison vectors for further analysis.

Table 2. Decision vectors for criteria

	Best	Worst
E1	Location, Access to Public Transport, and Active Mobility	Water Efficiency and Reuse
E2	Daylight and Lighting Quality	Biophilic and Restorative Design
E3	Thermal Comfort and User Control	Biophilic and Restorative Design
E4	Indoor Air Quality and Low Volatile Organic Compound Materials	Biophilic and Restorative Design
E5	Indoor Air Quality and Low Volatile Organic Compound Materials	Material Circularity, Low Embodied Carbon, and Waste Management

These comparison vectors, constructed from the experts' evaluations, were used to calculate the weights of the criteria as presented in Figure 2. Additionally, the consistency ratios were analyzed to verify the reliability of expert judgments, and all assessments were found to satisfy the acceptable consistency threshold.

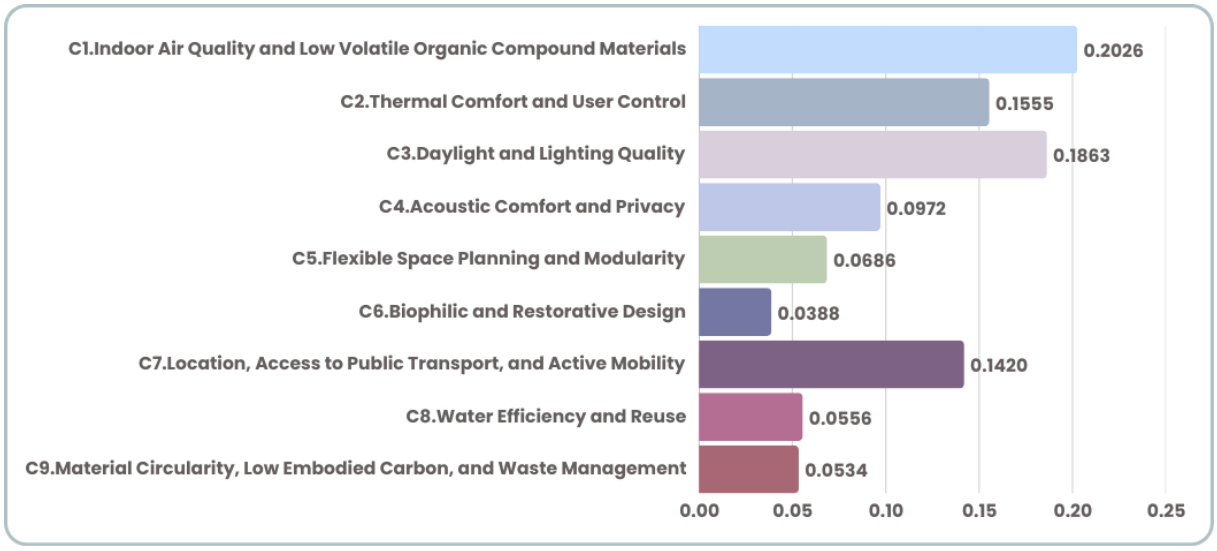


Fig. 2. Criteria Weights

The results show that user health and indoor environmental quality are the most influential aspects of sustainable CWS design. Indoor Air Quality and Low Volatile Organic Compound Materials (C1) received the highest weight, followed by Daylight and Lighting Quality (C3) and Thermal Comfort and User Control (C2), highlighting the importance of comfortable, healthy and controllable indoor conditions in shared work environments. Location, Access to Public Transport, and Active Mobility (C7) and Acoustic Comfort and Privacy (C4) were assigned moderate importance, indicating that accessibility and noise-related considerations remain relevant but secondary. In contrast, Flexible Space Planning and Modularity (C5), Water Efficiency and Reuse (C8), Material Circularity, Low Embodied Carbon and Waste Management (C9) and Biophilic and Restorative Design (C6) received lower weights, suggesting that sustainability measures less directly perceived by users play a more limited role in expert evaluations. Overall, the findings indicate that sustainable CWS design is primarily driven by user-centered comfort and health-related factors, while resource efficiency and aesthetic considerations have a supporting role.

The discussion of this study aligns with and extends recent findings in the literature on sustainable and human-centered CWS design. Previous research emphasizes that environmental comfort, accessibility and flexibility are central to user satisfaction and productivity. Riratanaphong (2021) identified indoor environmental quality and design attributes as key determinants of user satisfaction in Bangkok's CWSs, while Elokdah et al. (2025) demonstrated that lighting quality directly enhances productivity by supporting circadian rhythms. Similarly, Robelski et al. (2022) highlighted ergonomic workplace features and acoustic comfort as crucial factors for well-being and satisfaction in shared work environments. In line with these studies, the present results underscore the primacy of Indoor Air Quality and Low Volatile Organic Compound Materials, Daylight and Lighting Quality, and Thermal Comfort and User Control as dominant drivers of sustainable co-working design, revealing a consistent

global emphasis on indoor environmental performance as the foundation of healthy and productive workplaces.

Furthermore, while Marino et al. (2023) emphasized the spatial and functional integration of CWSs within urban structures and the importance of accessibility and multi-functionality in location planning, this study extends that perspective by demonstrating that Location, Access to Public Transport and Active Mobility remains a high-priority sustainability factor even at the design level. The lower weights assigned to Water Efficiency and Reuse and Material Circularity suggest that aesthetic and resource-oriented elements, though important for long-term sustainability, are often secondary to immediate human-centered needs. This finding is also consistent with (Pan et al., 2023), who noted that post-pandemic workspace design increasingly prioritizes flexibility, comfort and well-being over purely technical sustainability metrics. Overall, this research reinforces that future CWS strategies should adopt an integrative framework that balances environmental efficiency with health, comfort and accessibility to support resilient, user-focused urban work ecosystems.

5. Conclusion

This study presented a structured assessment of sustainability factors influencing the design of CWSs by applying BWM. The results demonstrated that human-centered factors, particularly Indoor Air Quality and Low Volatile Organic Compound Materials, Daylight and Lighting Quality, and Thermal Comfort and User Control, play a dominant role in shaping sustainable co-working environments. These findings highlight that the success of sustainable design extends beyond technical efficiency, depending largely on creating healthy, comfortable and accessible spaces that enhance user well-being and productivity. The higher significance of accessibility and indoor environmental quality indicates a growing awareness of the role of comfort-oriented design in fostering both environmental and social sustainability within shared workplaces.

Moreover, the relatively lower importance assigned to resource-based and aesthetic factors, such as Water Efficiency and Reuse and Biophilic and Restorative Design, suggests that practical design aspects that directly affect users' daily experience are currently prioritized over long-term ecological attributes. Nevertheless, integrating these lower-ranked dimensions in future frameworks can strengthen the holistic sustainability of CWSs. Overall, this study contributes to the growing body of knowledge on sustainable workspace design by providing a transparent prioritization model and empirically grounded insights for architects, planners and policymakers seeking to design resilient, inclusive and health-oriented co-working environments aligned with contemporary urban sustainability goals.

Future studies could expand upon the findings of this research by including a larger and more diverse group of experts from different geographical and cultural contexts to better capture variations in sustainability perceptions. Incorporating quantitative performance data such as energy consumption, indoor air quality or user satisfaction could further strengthen and validate the expert-based results. In

addition, using hybrid approaches that combine BWM with other MCDM techniques. Future research could also examine the integration of smart building technologies, post-occupancy evaluations, and behavioral analyses to design adaptive co-working environments that continuously respond to user needs while maintaining strong environmental performance.

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