**Article**

# Analyzing Sustainable Design in Post-Pandemic Business Space Planning from Consumer Perspective

## Chun-Pin Huang [1], Chia-Hui Huang [1,*], and Chun-Chih Chen [2]

[1]  Institute of Cultural and Creative Design, Tung-Fang Design University, Kaohsiung 829003, Taiwan; jimmyjimmy98886@gmail.com
[2]  Department of Industrial Design, National Kaohsiung Normal University, Kaohsiung 824005, Taiwan; ccchen@nknu.edu.tw
*  Correspondence: judy.tf.edu.tw@gmail.com

**Abstract:** The pandemic brought transformations in daily life and societal structures. It has impacted the design and planning of commercial spaces. Commercial spaces, serving as the direct interface with consumers, have played a more pivotal role recently. Consumer viewpoints and demands have been changed beyond comfort and convenience to mitigate concerns related to sustainable development and health. From the consumer perspective, we explored the key factors for the sustainable design of commercial spaces in the post-pandemic era. Kansei engineering, factor analysis, and the Kano model were used to identify dimensions, namely safety and comfort, community engagement and sustainability, environmental conservation and resource efficiency, as well as technological integration and waste management. Consumers expect commercial spaces to provide safety measures, adequate ventilation, hygiene and cleanliness, green landscapes, personalized services, and social distancing arrangements to create a pleasant and secure environment. Additionally, they are concerned about whether commercial spaces actively engage with the community, promote sustainable development, and prioritize energy efficiency. The result contributes to the optimization and sustainable development of commercial spaces. By comprehending consumer perspectives, companies can overcome the challenges of the post-pandemic era, innovate in the design of commercial spaces, and create business environments that are more appealing and aligned with consumer expectations.

**Keywords:** Post-pandemic era, Commercial space design, Kansei engineering, Kano model, Factor analysis

## 1. Introduction

The unexpected global pandemic has profoundly transformed human lifestyles, values, and societal structures. The COVID-19 pandemic has presented significant challenges to public health and affected the business landscape. The pandemic has changed remote working, a proliferation of online shopping, business disruptions, and fundamental shifts in consumer preferences and behavior. Since the post-pandemic era, the design and planning of commercial spaces have been important for the evolving needs of consumers. Consequently, we investigated the factors for the sustainable design of commercial spaces in the post-pandemic era, scrutinizing these factors from a consumer-oriented perspective. Throughout the pandemic, people prioritized their surroundings, including commercial establishments, thereby accentuating the significance of sustainable design within commercial spaces. Accordingly, in the post-pandemic era, commercial spaces provide more comprehensive offerings to satisfy consumers' new requisites for safety, health, sustainability, and community engagement. Commercial spaces, as a critical interface with consumers, play a pivotal role. Consumer viewpoints and demands have undergone substantial transformations since the onset of the pandemic. Consumers no longer anticipate commercial spaces for comfort and convenience but for sustainable development and health safety. To gain insights into the ramifications of the post-pandemic era on the planning and design of commercial spaces, we considered the consumer perspective. By comprehending consumer viewpoints, companies more effectively overcome the challenges of the post-pandemic era, innovate space design, and forge environments for consumer expectations. Additionally, the result of this study allows companies to devise sustainable and operational strategies.

## 2. Literature Review

### 2.1. Post-Pandemic Era and Commercial Space Design Directions

In the post-pandemic era, industries confront unprecedented challenges. These challenges encompass the swift integration of advanced technology, fundamental shifts in personal hygiene practices, and the imperative to adapt well-established business models

(Wu, Su and Chen, 2023; S Smith & Shi, 2023; Chang, Yeh and Lee, 2023; Cheung, 2022; Lai, 2022). We paid attention to the planning and design of commercial spaces. The associated containment measures have significantly disrupted the paradigms of commercial space planning and design, compelling the industry to reconsider its strategic development. Consequently, the design of commercial spaces must exhibit adaptability to the new reality, meeting consumers' needs and expectations for safety, comfort, and multifunctional environments. With a heightened emphasis on health and safety, particularly in the post-pandemic era, when concerns about viruses persist, this becomes particularly important. Lin (2022) applied the Analytic Hierarchy Process (AHP) to examine changes in home space planning in the post-pandemic era. Noticeable shifts were found in the demands of home users with semi-outdoor spaces gaining particular significance, followed by indoor spaces. Hence, interior designers need to reevaluate the significance of spatial elements and reconsider the interconnection of semi-outdoor spaces with indoor areas. Furthermore, Chang (2022) emphasized that living during a pandemic requires considerations for safety, security, and psychological well-being. Through therapeutic space design, the quality of life can be enhanced, promoting a pandemic-ready home life. The research findings underscored design principles for pandemic-ready home spaces, encompassing zoning, equipment arrangement, and therapeutic styles. Based on such results, we assume the planning and design of commercial spaces must consider these emerging demands and provide corresponding pandemic-preventive measures. For instance, malls and retail stores need to augment hygiene facilities such as restrooms, disinfection stations, and touchscreen cleaning procedures. Additionally, prudent spatial arrangements and crowd management become important to ensure the implementation of social distancing and crowd density control. These measures assist commercial spaces in offering a safer, more comfortable, and multifunctional environment in the post-pandemic era, meeting the evolving needs and expectations of consumers.

## 2.2. Kansei Engineering

Kansei Engineering, initially developed by Japanese scholar Masato Ujigawa and others in 1991, was later incorporated into sensory engineering. Kansei Engineering was developed by Junichiro Sanui and Masao Inui based on Kelly's (1955) research framework. The approach was proposed to capture individual cognitive concepts and organize them into lists (Zeng, 2007). The Elementary Geometric Method (EGM) is a research method in sensory engineering based on psychology. EGM is used to acquire individuals' cognitive concepts and subsequently organize these concepts into a list. This approach is based on interviews and the comparison of the perceptions of different respondents on a specific object by discussing the similarities and differences in their evaluations. Its purpose is to elucidate the individual characteristics of the evaluated object (Kelly, 1955). Based on this methodology, the object is evaluated by asking respondents about their preferences or dislikes. The second step uses additional questions to clarify the meaning or conditions behind the respondents' answers, thereby analyzing specific attractive factors and structuring relevant networks. This research approach is referred to as Kansei Engineering (Sanui, 1996). EGM is used to identify the factors of objects and theoretical analyses. To understand respondents' perceptions of the attractiveness of a product, in-depth interviews based on thematic categories are conducted to provide thematic stimuli to trigger respondents' perceptions. Through the experiences and perceptions of different respondents, the original thematic stimuli can be revealed. Subsequently, respondents provide clearer explanations of their concepts and derive specific and abstract reasons. In recent years, design applications based on Kansei Engineering theory were studied related to graphic visuals, product styling, and spatial planning. Through Kansei Engineering, consumer sensations and images are transformed into designed products to meet emotional needs. In Kansei Engineering, "kansei" is understood as an individual's feelings or images of things, representing expectations and sentiments towards objects. Through engineering techniques, these sensations are quantified, and design solutions are explored to meet specific sensory needs (Wang, 2008). Kansei Engineering allows for a deeper understanding of consumers' perceptions and emotional needs concerning commercial spaces. This provides more appropriate and thoughtful design solutions to meet consumer expectations, ultimately creating a more appealing and sustainable commercial environment.

## 2.3. Kano Model

When consumers assess the quality of products or services, they consider physical and psychological factors. The physical aspect is used to find the tangible characteristics of products or services such as durability, functionality, appearance while the psychological aspect pertains to consumers' subjective perceptions and satisfaction. Conventional notions of quality are related to a monolithic quality perspective, wherein higher quality leads to greater consumer satisfaction, and vice versa. However, the Kano Model introduces a distinct viewpoint, assuming that quality attributes elicit additional satisfaction when provided adequately but do not result in dissatisfaction when lacking. This model categorizes quality attributes into attractive quality and must-be quality, reflecting the nonlinear relationship between the degree of quality sufficiency and satisfaction. The Kano Model furnishes a comprehensive framework for evaluating quality, encompassing material and psychological facets of quality attributes. By

evaluating the influence of different quality attributes on consumer satisfaction, quality elements are determined to augment the appeal of post-pandemic era business space planning for consumer expectations (Kano, Seraku, Takahashi, and Tsuji, 1984).

The Kano Model allows for the comprehension of quality attributes and consumer satisfaction and the identification of pivotal quality elements for enhancing the quality and allure of business design (Chen and Lee, 2008). This approach allows for achieving breakthroughs in product design and spatial planning to furnish superior products and experiences. Using the application of the Kano Model concept, it becomes feasible to assess and optimize the quality attributes of post-pandemic era business space planning and design more effectively, meeting consumer needs and expectations, and providing a more enticing business environment. Rooted in the dual-factor theory, wherein the degree of quality may not align with satisfaction, varying degrees of quality sufficiency impact customer satisfaction. By delineating these quality elements, it is possible to gain a comprehension of the relationship between different quality elements and consumer satisfaction and obtain the pivotal quality elements that substantially enhance consumer satisfaction. In Fig. 1, the X-axis represents the degree of sufficiency of a specific quality element, a higher level of sufficiency, and a lower level of sufficiency. The Y-axis represents consumer satisfaction, ascending signifying higher consumer satisfaction and descending denoting lower consumer satisfaction. By using the Kano Model, the design points of district signage were determined. From the point of consumers' view on traditional culture, customs, and religious beliefs, creative design applications directly or indirectly affect consumers. Consumers apprehend the inherent meaning and culture conveyed by the design through visual means, cultivating a quality perception and, in turn, establishing a favorable connection with the image of district signage and a positive impression (Chen and Lee, 2008).
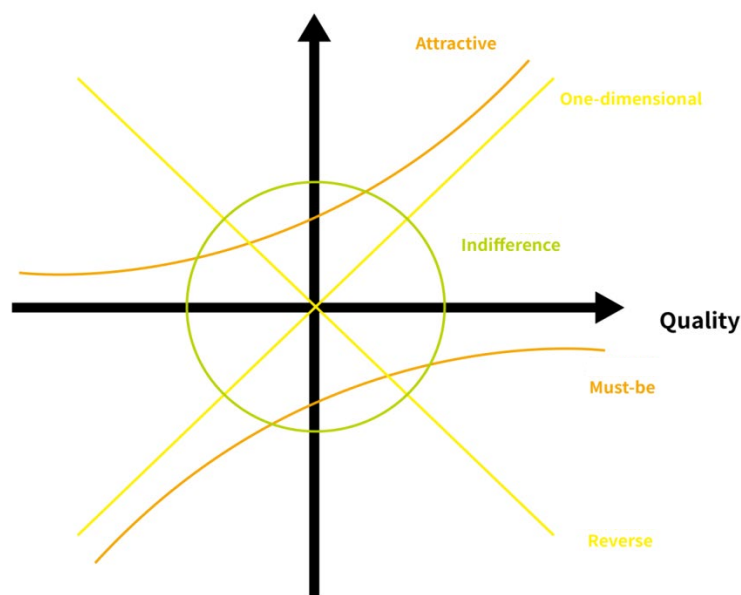


**Fig. 1.** Kano customer satisfaction model.

*2.4. Kano Regression Analysis*

The Kano quality attributes are used for the "bipartite survey" (Matzler and Hinterhuber, 1998). Concurrently, the utilization of "regression analysis" ascertains "quality attributes" related to the "Kano Quality Model" (Anderson and Sullivan, 1993; Mittal et al., 1998). Ting and Chen (2002) employed "consumer satisfaction within hypermarkets" to affirm the "asymmetrical" impact of "quality sufficiency" on "satisfaction" and its "non-linear" nature, as postulated by Anderson and Sullivan (1993) and Mittal et al. (1998). The "asymmetry" denotes the varying influence of "quality sufficiency" on "satisfaction" compared to the impact of "quality insufficiency" on "satisfaction" with different proportions. Specifically, when "quality is sufficient," "satisfaction" increases, whereas in cases of "quality insufficiency," "satisfaction" markedly decreases. "Non-linearity" implies that with varying "quality" levels, the rate of ascent or descent in "satisfaction" does not show a "linear" relationship. The regression model was applied in the related investigations (Chen and Lee, 2008). Following the Kano model, Ting and Chen proposed a regression model to gauge the influence of quality attributes on customer satisfaction. They conducted a regression analysis for each attribute with customer satisfaction as the dependent variable and positive/negative attribute performance as the independent variable. Positive performance indicated the presence or sufficiency of an attribute, while negative performance implied its absence or insufficiency. The ensuing linear regression model was employed to gauge the effect of positive and negative attribute performances on customer satisfaction.

$$US = C + \beta1 \times (-Kn) + \beta2 \times Kp$$

where US signifies the level of customer satisfaction, Kn and Kp denote negative and positive attribute performances, respectively, and β1 and β2 represent the corresponding regression coefficients.

When attribute performance is negative, the negative attribute performance value (−Kn) is found with Kp of 0. Conversely, when attribute performance is positive, the positive attribute performance value (Kp) is found with Kn of 0. By comparing the two regression coefficients (β1 and β2), the association between attributes and customer satisfaction is determined based on the coefficients. For attributes, β1 must be negative, while β2 must be positive. The magnitude of the coefficients reveals their impact on customer satisfaction. According to the Kano model, quality attributes are categorized according to the significance of the regression coefficients. The classification criteria are as follows.

(1) When β1 in the regression equation is not significant but β2 is markedly positive, it signifies Attractive Quality.
(2) When β1 in the regression equation is significantly negative and β2 is markedly positive, it signifies One-Dimensional Quality.
(3) When β1 in the regression equation is markedly negative but β2 is not significant, it signifies Must-Be Quality.
(4) When both β1 and β2 in the regression equation are not significant, it signifies Indifferent Quality.
(5) When β1 in the regression equation is significantly positive and β2 is markedly negative, it signifies Reverse Quality.

Table 1 presents information regarding the significance of regression coefficients and their relationship with quality attributes. Quality attributes are classified by the significance of β1 and β2 with accompanying annotations in different attribute types.

**Table 1.** Relationship between "significance of regression coefficients" and "quality attributes".

| Quality Attributes | β1 (Backward) Sig. | β2 (Forward) Sig. | Table Remark |
|---|---|---|---|
| Attractive | n.s. | * | β1 = 0; β2 > 0 |
| One-Dimensional | * | * | β1 < 0; β2 > 0 |
| Must-Have | * | n.s. | β1 < 0; β2 = 0 |
| Indifferent | n.s. | n.s. | β1 = 0; β2 = 0 |
| Reverse | * | * | β1 > 0; β2 < 0 |

Sig. < 0.05 represents significance; n.s. represents non-significance; * represents significance. Data source: Chen and Lee (2008).

## 3. Research Methodology

We studied the sustainable design of business space planning in the post-pandemic era and explored its correlation with consumer attitudes. The objective of this study was to explore how business space planning in the post-pandemic era must incorporate sustainability design and determine the design elements related to consumer perceptions and attitudes. In the first phase of this study, the EGM in-depth interview from Kansei Engineering was conducted to collect qualitative data. The advantage of the EGM in-depth interview method is its ability to capture consumer needs and emotional responses. Previous research indicated that consumer purchase intent and satisfaction were influenced by emotional responses rather than rational ones. The importance of the EGM in-depth interview method is to obtain the subjective viewpoints of the respondents and their emotions and values regarding sustainability design. Through in-depth interviews with nine participants, how these attributes impacted their perceptions and feelings were gained was investigated. The results provided the consumer's emotional needs for sustainability design, aiding space planners in providing design directions for market expectations. Based on the findings of the earlier EGM interview analysis, the Kano Model was applied to investigate consumer perceptions of sustainability design attributes in the post-pandemic era. The Kano Model distinguished the impact of design attributes on consumers. In sustainability design, the Kano Model is used to assess consumer satisfaction with product or service attributes and identify attributes of basic needs with expected quality. In the third phase, factor analysis was employed to comprehend the complexity of sustainability design in business spaces. This method was used to identify factors for sustainability design and consumer attitudes. Prior research results demonstrated that the evaluation of consumers for a product or space usually involved multiple factors. In this stage, the research framework was simplified to focus on the most influential factors. Business space planners allocate resources for the effectiveness of sustainability design based on the result. In the fourth phase, the Kano regression analysis method was to correlate the quantitative results with the sustainability design in business spaces. The result provided an understanding of the impact of different attributes on consumer attitudes which had nonlinear relationships. This in-depth analysis results were used to optimize business space planning to ensure consumer needs, satisfaction, and the maximum value of sustainability design. Recommendations for business space planning and design in the post-pandemic era were made based on consumer perception, emotion, and attitude for the value and significance of sustainability design.

## 4. Research Findings

### 4.1. Extraction and Induction of Attractive Factors.

Kansei Engineering methodology was used to integrate the interview results from nine participants and construct an EGM network diagram (Fig. 2) to understand the impact of the post-pandemic era on business space planning and design. The interview results were categorized into four dimensions: hygiene and safety, quality of life, spatial design, and sustainability development. The factors exhibited consumer relations as key attributes in business spaces. These attributes influenced their satisfaction and purchase intent and reflected current societal and economic demands and trends. A close association between waste management and green landscapes was observed. In the post-pandemic era, consumers were concerned about environmental sustainability, hoping that business spaces reduce waste and provide green landscapes to improve air quality and offer recreational spaces. Therefore, in the sustainability design of business spaces, it is necessary to consider waste management and green landscapes.
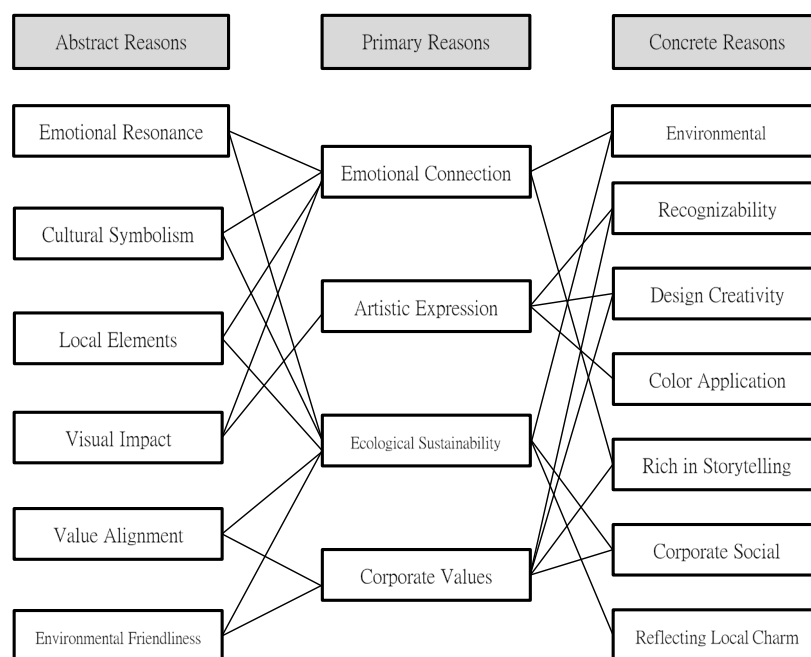


**Fig. 2.** EGM interview results.

Participatory areas and shared spaces offer consumers opportunities for engagement and interaction in business spaces for the demand for participatory spaces. Simultaneously, shared space models provide versatility and options for consumers' resource-saving needs. Hence, business spaces need to satisfy diverse needs by providing participatory areas and shared spaces, creating appealing environments. There is a close connection between personalized services and technological services as modern consumers expect customized experiences with technological support. Business spaces need to employ technology to deliver personalized services and enhance customer satisfaction. For example, through the use of virtual guides or smart systems, business spaces can better accommodate customer needs, personalized recommendations, and services. The link between hygiene and safety and the quality of life becomes significant in the post-pandemic era. Consumers emphasize health and safety, especially in public places such as business spaces, and demand a secure environment. This relates not only to physical health but also to mental well-being. A safe, clean, and hygienic business space impacts customers' quality of life. When customers enter an environment that is clean, orderly, and strictly adheres to hygiene standards, they feel more relaxed and comfortable. They do not have to worry about potential health risks, which reduces their stress and enhances their quality of life. A safe and hygienic business space also increases customers' trust in the place. Customers perceive health and well-being and the establishment of long-term relationships with providers. They are more likely to become loyal customers and share their positive experiences on social media, further attracting potential customers. Therefore, hygiene, safety, and quality of life are closely related in the business spaces in the post-pandemic era. A safe, clean, and hygienic environment enhances customers' quality of life and increases their trust and satisfaction with the business space. Therefore, the design and operation of business spaces must include two factors to meet consumer expectations and provide a better customer experience. Environmental materials and sustainable development are two related factors. The use of environmentally friendly materials reduces waste and, at the same time, diminishes adverse environmental impacts, aligning with the sustainable development

goals (SDGs). Consumers are increasingly concerned about a company's environmental responsibility and are more inclined to employ environmentally friendly materials and implement sustainability measures. In summary, the interrelationships of factors reflect the need for sustainability design in business space planning to consider consumer needs and the factors. The success of a business space depends on how to integrate these factors to provide a safe, environmentally friendly, comfortable, and valuable customer experience. Therefore, gaining an in-depth understanding of these interrelationships from the consumer's perspective is crucial for the design and operation of business spaces.

### 4.2. Descriptive Statistics

Table 2 shows the descriptive statistics. The highest mean was found for the integration of green landscapes (mean = 4.869). The respondents demanded green landscapes in commercial spaces as natural elements and for a pleasant, relaxing, and healthful environment. Therefore, green landscapes are a significant attraction factor in commercial space planning. With good ventilation (mean = 4.713), concern for air quality and comfort within commercial spaces are important. Particularly, in the era of pandemics, good ventilation was important in reducing air pollutants and providing a healthier and more suitable environment. The implementation of technological services (mean = 4.689) ranked third, indicating respondents' interest in modern technology. In the post-pandemic era, consumers expect the integration of technologies such as touchless payments and smart home systems into commercial spaces to enhance convenience and efficiency. High standard deviations were observed for community participation spaces (standard deviation = 1.000), indicating greater variability in respondents' evaluations. The respondents had different opinions or requirements regarding community spaces with differentiated design approaches. The provision of shared space areas (standard deviation = 0.987) ranked second, demonstrating a variance in the evaluations of shared space areas, possibly reflecting variations in people's needs and expectations based on factors such as respondents' geographic locations and cultural backgrounds. The relatively higher standard deviation (standard deviation = 0.953) for SDGs suggested inconsistent evaluations of respondents regarding sustainability. This necessitates further education and promotion to enhance awareness and concern regarding sustainability issues. Good ventilation, hygiene, and cleanliness had smaller standard deviations, indicating consistent expectations of the respondents. The respondents emphasized ventilation and hygiene to be properly maintained in commercial spaces. This reflected the increased concern regarding air quality and hygiene conditions.

**Table 2.** KANO questionnaire survey results.

| Item | Minimum Value | Maximum Value | Mean | Standard Deviation | Mean Ranking |
|---|---|---|---|---|---|
| Safety measures | 2.00 | 5.00 | 4.48 | 0.55 | 11 |
| Good ventilation | 3.00 | 5.00 | 4.71 | 0.47 | 2 |
| Hygiene and cleanliness | 2.00 | 5.00 | 4.63 | 0.53 | 4 |
| Emphasis on environmental protection and sustainability | 1.00 | 5.00 | 4.59 | 0.83 | 8 |
| Business focus on energy efficiency | 1.00 | 5.00 | 4.60 | 0.86 | 7 |
| Use of eco-friendly materials | 1.00 | 5.00 | 4.55 | 0.79 | 10 |
| Consideration of waste management | 1.00 | 5.00 | 4.56 | 0.80 | 9 |
| Social distancing planning | 3.00 | 5.00 | 4.61 | 0.67 | 5 |
| Incorporation of green landscapes | 1.00 | 5.00 | 4.87 | 0.54 | 1 |
| Provision of community engagement spaces | 1.00 | 5.00 | 4.39 | 1.00 | 13 |
| Offering shared spaces | 1.00 | 5.00 | 4.43 | 0.99 | 12 |
| Personalized services | 1.00 | 5.00 | 4.61 | 0.81 | 6 |
| Integration of technological services | 1.00 | 5.00 | 4.69 | 0.69 | 3 |
| Promotion of SDGs (SDGs) indicators | 1.00 | 5.00 | 4.30 | 0.95 | 14 |

### 4.3. Factor Analysis

We explored the respondents' evaluations of 14 aspects of commercial space planning and design quality using principal component analysis with orthogonal varimax rotation. Factors were extracted based on eigenvalues greater than or equal to 1, and the factors were screened. Afterward, the suitability of factor analysis was confirmed using the Kaiser-Meyer-Olkin (KMO) method. The factors with a KMO value of higher than 0.80 were selected (KMO values between 0.70 and 0.80 indicate sample adequacy). Bartlett's test of sphericity was significant at the significance level of 0.000. The result is presented in Table 3.

<div align="center"><b>Table 3.</b> KMO and Bartlett's test results.</div>

| | | |
|---|---|---|
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy: | | 0.800 |
| Bartlett's Test of Sphericity: | Approx. Chi-Square: | 477.617 |
| | Degrees of Freedom: | 91 |
| | Significance: | 0.000 |

Table 4 shows the factors selected. Factor 1 "Safety and Comfort" presented safety measures, good ventilation, hygiene and cleanliness, integration of green landscapes, personalized services, and social distancing planning. These collectively contribute to the safety and comfort of commercial spaces. In the post-pandemic era, people are increasingly concerned about the safety measures of the spaces. Therefore, these factors must be key in creating safe and comfortable commercial spaces. Factor 2 "Community Engagement and Sustainability" presented shared space areas, community participation spaces, advocacy of SDG indicators, and energy-efficient practices. These factors were related to community engagement and sustainability in commercial spaces. In the post-pandemic era, customers are more attentive to community interaction and sustainability values. Commercial space planning must provide community engagement and incorporate sustainability into its core values. Factor 3 "Environmental Preservation and Resource Efficiency" presented eco-friendly materials, environmental preservation, sustainable development, and good ventilation. It underscored the environmental characteristics and resource efficiency of commercial spaces. In today's society, sustainability and resource management are paramount. Commercial spaces must show eco-friendly measures, including the use of environmentally friendly materials and providing good ventilation to reduce environmental impact while enhancing resource efficiency. Factor 4 "Technology Integration and Waste Management" presented the integration of technological services and considerations for waste management. It emphasized the integration of technology in commercial spaces and effective waste management. Modern technology enhances convenience in commercial spaces and improves the customer experience. Additionally, waste management is critical to ensuring that commercial spaces effectively handle waste and reduce their environmental footprint.

Each factor described its role in commercial space planning. Simultaneously, the importance of each factor addressed the challenges in the post-pandemic era "Safety and Comfort," "Community Engagement and Sustainability," "Environmental Preservation and Resource Efficiency," and "Technology Integration and Waste Management" need to be included in sustainable commercial space design to meet consumers' demands for safety, greenery, community engagement, and technological integration and offer a sustainable environment. Designers must consider the factors to ensure the quality of space and its sustainability and customer satisfaction and construct a safer, more sustainable, and more attractive commercial environment.

<div align="center"><b>Table 4.</b> Factor analysis results.</div>

| Item | Factor 1 | Factor 2 | Factor 3 | Factor 4 |
|---|---|---|---|---|
| Hygiene and cleanliness | 0.842 | 0.034 | 0.067 | 0.022 |
| Safety measures | 0.743 | 0.092 | 0.269 | 0.031 |
| Incorporation of green landscapes | 0.640 | 0.322 | −0.124 | 0.080 |
| Personalized services | 0.493 | 0.410 | −0.052 | 0.456 |
| Social distancing planning | 0.464 | 0.232 | 0.249 | 0.168 |
| Offering shared spaces | 0.129 | 0.770 | 0.109 | −0.029 |
| Provision of community engagement spaces | 0.066 | 0.728 | 0.065 | 0.253 |
| Promotion of SDGs (SDGs) indicators | 0.276 | 0.602 | 0.272 | 0.403 |
| Business focus on energy efficiency | 0.158 | 0.497 | 0.463 | −0.036 |
| Use of eco-friendly materials | −0.126 | 0.215 | 0.729 | 0.332 |
| Emphasis on environmental protection and sustainability | 0.221 | 0.361 | 0.651 | −0.110 |
| Good ventilation | 0.478 | −0.233 | 0.539 | −0.054 |
| Integration of technological services | 0.025 | 0.123 | 0.020 | 0.812 |
| Consideration of waste management | 0.156 | −0.010 | 0.499 | 0.506 |
| Explained Variance (%) | 31.58 | 11.43 | 9.30 | 7.34 |
| Cumulative Explained Variance (%) | 31.58 | 43.01 | 52.31 | 59.65 |

## 4.4. Kano Regression Analysis

The Kano model survey was commenced in July 2023 through the distribution and collection of online survey results via Google Forms. The survey respondents consisted of individuals with a background in spatial design, users of commercial spaces, and individuals with relevant knowledge of SDGs. In the survey, a total of 122 valid questionnaires were collected. The reliability of the questionnaire was analyzed with SPSS 77. The result is shown in Table 5. Cronbach's α value for the two-way Kano model questionnaire survey was 0.892, indicating a high level of questionnaire reliability.

**Table 5.** Reliability of KANO questionnaire survey.

| Item | Reliability |
|---|---|
| Safety measures | 0.824 |
| Good ventilation | 0.818 |
| Hygiene and cleanliness | 0.811 |
| Emphasis on environmental protection and sustainability | 0.812 |
| Business focus on energy efficiency | 0.816 |
| Use of eco-friendly materials | 0.818 |
| Consideration of waste management | 0.814 |
| Social distancing planning | 0.818 |
| Incorporation of green landscapes | 0.812 |
| Provision of community engagement spaces | 0.814 |
| Offering shared spaces | 0.807 |
| Personalized services | 0.823 |
| Integration of technological services | 0.793 |
| Promotion of SDGs (SDGs) indicators | 0.824 |

9 necessary qualities, 4 one-dimensional qualities, and 1 indifferent quality were determined. Necessary qualities included safety measures, good ventilation, environmental sustainability, emphasis on energy efficiency, use of eco-friendly materials, integration of green landscapes, provision of community engagement areas, and advocacy of SDG indicators. These factors were related to consumers' needs and expectations as the core elements of commercial spaces. Safety measures and social distancing ensure the safety of customers and employees, while good ventilation and hygiene enhance environmental quality and hygiene standards. Environmental sustainability, energy conservation, and the use of eco-friendly materials reflect a sense of social responsibility of companies, which is increasingly emphasized in today's society. The necessary factors meet regulations and standards and reflect the commitment of commercial space planners to create a safe, healthy, and sustainable environment. Consumers hope to find these features in commercial spaces as key factors in their choices and loyalty to companies. Therefore, commercial space planners must build more attractive and competitive environments based on these necessary factors while showcasing their corporate values of social and environmental responsibility.

There were four one-dimensional qualities with cleanliness being one of the minimum requirements in commercial space planning. While it does not enhance customer satisfaction, the absence of basic hygiene standards dissatisfy customers. Especially in the post-pandemic era, customers are sensitive to the cleanliness and hygiene of spaces, expecting the commercial spaces to be cleaned and disinfected for safety and health. Commercial spaces must have adequate waste disposal and recycling plans for cleanliness and sustainability. Neglected waste management leads to waste generation, affecting the customer experience and damaging brand reputation. In personalized service, commercial space planners need to be sensitive to customer needs and provide customized experiences. While this may not be a basic requirement, it increases customer satisfaction and loyalty. The Kano regression analysis results, as shown in Table 6, provide detailed insights into how various factors such as safety measures, good ventilation, and personalized services significantly impact consumer satisfaction in commercial spaces.Personalized service is provided by understanding customer preferences, providing customized options, and establishing personalized interactions. With the continuous development of technology, the integration of technological services has become important as a one-dimensional quality. This includes providing wireless networks, smart devices, mobile applications, and more. While it may not necessarily bring additional satisfaction, the lack of modern technological services makes commercial spaces appear outdated and lose competitiveness. The integration of technological services improves efficiency, convenience, and interactivity, which is important for consumers. These four one-dimensional qualities may not directly increase customer satisfaction but they are crucial for

maintaining basic standards and brand image. Therefore, commercial space planners should consider these factors to ensure that space design meets customer expectations in all aspects. In summary, sustainable design plays a significant role in commercial space planning, especially in the post-pandemic era. Consumers are more concerned about safety, environmental sustainability, community engagement, and sustainable development. These factors allow for enhancing the attractiveness of commercial spaces and increasing consumer satisfaction and loyalty. Therefore, commercial space planners mmust consider these factors to meet consumer needs and create more attractive and sustainable commercial spaces.

**Table 6.** Kano regression analysis results.

| Item | β1 | Sig. | β2 | Sig. | R2 | Quality Classification |
|---|---|---|---|---|---|---|
| Safety measures | −0.216 | 0.114 | 0.335 | 0.015 | 0.265 | Must-be |
| Good ventilation | −0.178 | 0.609 | 0.011 | 0.976 | 0.019 | Must-be |
| Hygiene and cleanliness | −0.291 | 0.112 | −0.015 | 0.150 | 0.935 | One-dimensional |
| Emphasis on environmental protection and sustainability | 0.001 | 0.994 | 0.219 | 0.169 | 0.032 | Must-be |
| Business focus on energy efficiency | −0.150 | 0.343 | 0.069 | 0.663 | 0.028 | Must-be |
| Use of eco-friendly materials | −0.064 | 0.684 | 0.201 | 0.204 | 0.050 | Must-be |
| Consideration of waste management | −0.315 | 0.016 | −0.066 | 0.609 | 0.058 | One-dimensional |
| Social distancing planning | −0.119 | 0.510 | 0.099 | 0.581 | 0.028 | Must-be |
| Incorporation of green landscapes | −0.172 | 0.294 | 0.080 | 0.625 | 0.043 | Must-be |
| Provision of community engagement spaces | −0.237 | 0.152 | 0.089 | 0.589 | 0.085 | Must-be |
| Offering shared spaces | 0.055 | 0.705 | 0.406 | 0.0065 | 0.117 | Indifferent |
| Personalized services | −0.293 | 0.161 | −0.001 | 0.998 | 0.070 | One-dimensional |
| Integration of technological services | 0.091 | 0.582 | 0.264 | 0.112 | 0.021 | One-dimensional |
| Promotion of SDGs (SDGs) indicators | −0.114 | 0.417 | 0.317 | 0.026 | 0.157 | Must-be |

## 5. Conclusion

Through the post-pandemic era, the design and planning of commercial spaces have become increasingly critical to meet evolving consumer demands. Consumer expectations for commercial spaces have changed beyond goods and services pursuing the overall quality and experience of the space. Consequently, the effective enhancement of the sustainability design of commercial spaces in the post-pandemic era is important to meet consumer needs and emotional experiences. For the sustainability design of commercial spaces in the post-pandemic era, we analyzed consumer needs and priorities from their perspective. The results allowed for a better understanding of consumer needs and emotional experiences and offered principles for the design of commercial spaces. Four key factors for commercial spaces impacting consumer experiences were identified. Consumers expected commercial spaces to provide superior safety measures, ventilation, cleanliness, green landscapes, personalized services, and social distancing planning in a pleasant and secure environment. Secondly, in terms of community engagement and sustainability, consumers were concerned about whether commercial spaces were engaged with the community, promoted sustainable development, and prioritized energy efficiency. This reflected consumers' concerns about the social and environmental impact of business practices. Commercial space design in the post-pandemic era requires continuous adjustment and innovation to meet consumers' evolving needs. Auch results provide the industry with recommendations in commercial space planning. Future research is required to investigate consumer behavior and decision-making in commercial spaces for a better understanding of their responses to different sustainability design strategies. Additionally, cross-cultural studies are required to compare consumer needs and preferences in different cultures and understand the influence of cultural factors on commercial space design.

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