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Analyzing Key Quality Attributes in Commercial Space Design Planning Using Impact Range Performance Analysis by Computer Software for Sustainable Development Goals †

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Abstract: For intensified global environmental and societal challenges, the Sustainable Development Goals (SDGs) have come to the forefront as a pivotal framework for corresponding action. For SDGs, the role of commercial spatial design and planning gains unique prominence. Using importance–performance analysis (IPA) with importance–performance–scope analysis (IPSA), we explore the SDGs' deployment and ramifications in commercial spatial planning in this study. By spotlighting pivotal SDG indicators, the study results underscore commercial spaces' performance in the environmental, social, and economic sectors. The combined analytical approaches were used to elucidate the present-day salience and efficacy of these attributes and highlight prospective trajectories for future evolution. The results offer a blueprint to empower designers and planners in the commercial realm to assimilate the SDGs effectively and design with environmental stewardship, social responsibility, and economic viability. The industry can have pragmatic strategic guidance aligned with global sustainable development imperatives.

Keywords: SDG indicators; commercial spatial planning and design; importance–performance analysis; importance–performance–scope analysis

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1. Introduction

The global pandemic of COVID-19 profoundly impacted the perspectives of human life and reconfigured the structure of commerce. COVID-19 was not only a mere health crisis but revealed the inherent vulnerabilities and fluidity of the commercial milieu. From the rise of telecommuting to fundamental alterations in consumer behavior, the pandemic recalibrated the expectations of commercial environments. In this context, the design and planning of commercial activities for contemporary demands transcend design considerations. They directly implicate a business's sustainability and trajectory. In this overarching paradigm, consumer needs and expectations have been more multifaceted and nuanced, seeking a new method for shopping or consumption with an emphasis on health, safety, and environmental resilience. For businesses and consumers, the commerce industry necessitates prescient adjustments and innovations in both design and functionality.

Thus, this study, anchored in a consumer-centric paradigm, was conducted to explore the needs and anticipations of consumers in the post-pandemic epoch. Through analysis, orientations and strategies for commercial space design were proposed to guide companies to cultivate adaptable and enduring business frameworks.

2. Literature Review

2.1. Sustainable Development Goals (SDGs) and Commercial Design

In the aftermath of the pandemic, various sectors grapple with unparalleled challenges, ranging from the assimilation of cutting-edge technologies to radical transformations and reevaluating entrenched business models [1–5]. Thus, we researched business directions with an emphasis on the planning and design of commercial spaces. Architectural and strategic commercial spaces must be constructed according to the demands and epidemic prevention protocols. For example, shopping centers and retail stores need to amplify their sanitary provisions by adding more restrooms and disinfection points and establishing cleaning routines for touchscreens. Concurrently, astute spatial design and effective crowd regulation become indispensable to ensure social distancing measures. These measures help commercial spaces in the post-pandemic era to secure safety, comfort, and multifunctionality and aptly respond to the dynamic needs and anticipations of consumers.

2.2. Importance–Performance Analysis (IPA)

IPA is widely adopted in evaluating the operational efficiency of enterprises [6,7]. In IPA, questionnaires are formulated based on the attributes of products or services. Consumers are invited to appraise these attributes in terms of their 'importance' and 'performance'. These evaluations are plotted on a two-dimensional space with 'importance' on the *Y*-axis and 'performance' on the *X*-axis. Utilizing the mean values of both axes as a basis, the space is divided into four quadrants, each bearing its managerial implications. While IPA has been extensively used for various analytical purposes, it allows for decisions related to satisfaction and brand loyalty. However, it has limitations resulting in failing to effectively tackle the underlying issues. To address these shortcomings, the Impact Range Performance Analysis (IRPA) and impact-asymmetry analysis (IAA) theoretical frameworks, as well as the Penalty Reward Contrast Analysis (PRCA), were introduced to IPA [7]. In this approach, each attribute is represented by two distinct virtual variables: the Penalty Index (PI) and the Reward Index (RI). These indices are used to measure the influence of each attribute on overall customer satisfaction. PI assigns a value of 1 to the lowest scoring attribute with all other scores being 0. In contrast, the RI gives a score of 1 to the highest scoring attribute with other scores set to 0. The sum of the absolute values of the coefficients for the reward and penalty indices illustrates the magnitude of an attribute's influence on overall customer satisfaction as the Range of Impact on Overall Customer Satisfaction (RIOCS). The PRCA has two distinct functions. The first evaluates the RIOCS of each attribute, while the second determines the asymmetry of impact on customer satisfaction (Impact Asymmetry, IA). The computations are as follows.

$$\text{RIOCSi} = |\text{Ri}| + |\text{Pi}| \quad (1)$$

$$\text{SGPi} = \text{Ri}/\text{RIOCSi} \quad (2)$$

$$\text{DGPi} = |\text{Pi}|/\text{RIOCSi} \quad (3)$$

$$\text{IAi index} = |\text{SGPi}| - |\text{DGPi}| \quad (4)$$

$$|\text{SGPi}| + |\text{DGPi}| = 1 \quad (5)$$

where Ri represents the reward coefficient of attribute i, while Pi symbolizes its penalty coefficient, and RIOCS denotes the "Relative Importance of Customer Satisfaction". The RIOCS matrix delineates the influence of various quality attributes on overarching customer satisfaction. Satisfaction-Generation Potential (SGP) indicates the potential for a quality attribute to positively influence customer satisfaction. Conversely, Dissatisfaction-Generation Potential (DGP) describes the potential of a quality attribute to adversely affect customer satisfaction. Lastly, Impact-Asymmetry (IA) quantifies the asymmetric influence on customer satisfaction when a particular quality attribute either improves or deteriorates.

3. Methodology

The Attractive Ergonomics Model (EGM) was used for in-depth interviews to discern factors of commercial space design and planning integrated with SDG indicators. For precise and targeted information during the in-depth interviews associated with attractive ergonomics, we bypassed traditional test samples. Instead, EGM interviews were conducted based on individual perceptions to avoid potential sample biases or undue influences and more accurately reflect the association of the SDG indicators and commercial space design. Twelve participants were selected for the interviews, including 6 interior designers, 3 commercial space operators, and 3 marketing planners with an average of over ten years of professional experience.

An IPA questionnaire survey was created based on the factors identified from the EGM interviews regarding the SDG indicators. An appropriate IPA questionnaire was curated after focus group discussions. This focus group consisted of 12 participants, including 6 interior designers, 3 commercial space operators, and 3 marketing planners, each with a professional tenure exceeding 10 years. We analyzed the attributes of SDGs in conjunction with commercial space design to understand participants' evaluations of each attribute and their satisfaction. We evaluated the attributes of commercial space designs integrated with the SDG indicators using metrics including RI, PI, RIOCS, SGP, DGP, and IA. These indicators were chosen to provide insights into various aspects of commercial space designs that incorporate the SDG indicators, ranging from satisfaction discrepancies to relative importance. The analysis results offer information with which concrete strategies and recommendations can be formulated in relevant fields.

4. Results and Discussion

4.1. EGM Interview

Utilizing the Attractive Ergonomics approach, 12 participants were interviewed in the Environment–Goal–Means (EGM) network diagram (Figure 1) to delve into the implications of the post-pandemic era on the planning and design of commercial spaces. Participant feedback was categorized into hygiene and safety, quality of life, spatial design, and sustainable development. The identified attractiveness factors were determined to exhibit substantial relevance from the consumer's vantage point as the primary attributes consumers value. These attributes impact satisfaction and purchasing intentions and reflect the evolving societal and economic trends and necessities.

A pronounced linkage was observed between waste management and green landscapes. After the pandemic, consumers tend to focus on environmental sustainability. Consequently, companies need to curtail waste and feature green spaces to enhance air quality and provide a relaxation zone. It is thus imperative to perform waste management and green landscaping to align with consumer expectations. Participation and sharing spaces encourage consumers to engage in and interact with commercial spaces. The shared space offers multifunctionality and choices resonating with consumers' inclination toward resource conservation. By integrating participation and shared spaces, diverse needs can be satisfied, leading to the creation of enticing environments.

In the post-pandemic era, the interrelation between hygiene, safety, and quality of life has been intensified. Consumers prioritize their health and safety in commercial spaces, seeking a potentially hazard-free environment. A clean, organized, and strictly hygienic space influences the consumer's quality of life. Such environments diminish stress by alleviating health concerns and enhance the overall experience. Moreover, a secure and hygienic space fortifies consumer trust. Such spaces reinforce the perception that companies prioritize the well-being of their customers and foster enduring trust and loyalty. They also generate positive word-of-mouth and social media endorsements, attracting potential patrons. Thus, hygiene, safety, and life quality are interwoven in commercial spaces.

The intricate interconnectedness of the attractive factors suggests that sustainable design in commercial space planning must be holistic, taking into account the diverse consumer preferences while balancing these elements. The efficacy of a commercial space relies

on its adeptness in harmonizing these elements and ensuring a secure, eco-conscious, and gratifying customer experience. Understanding these interconnections from a consumer perspective is crucial for the optimal design and management of commercial spaces to meet consumer anticipations and have a lasting competitive edge for a sustainable and appealing future of commercial spaces.

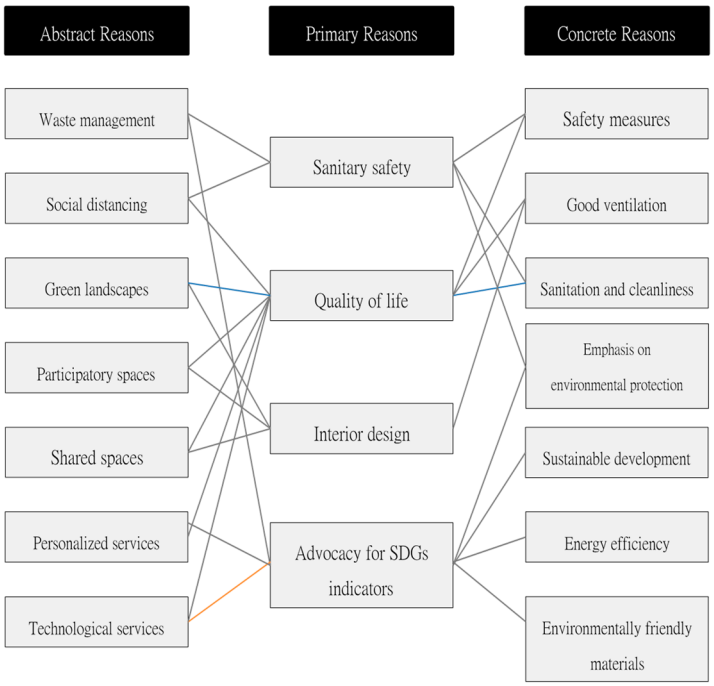


Figure 1. EGM interview.

4.2. IPA Results

In September 2023, we distributed a questionnaire for an online survey. The target participants included professionals such as commercial space operators, interior designers, and renovation specialists, as well as consumers acquainted with SDGs and those regularly using commercial spaces. Overall, 158 valid responses were obtained, and the reliability of the IPA questionnaire was assessed using Cronbach's α coefficient. The coefficient was 0.938, signifying the survey's reliability.

Table 1 shows safety protocols, efficient ventilation, and cleanliness in the "Maintain Strength" quadrant. These three quality attributes are regarded as supremely essential, reflecting exemplary standards, and highlighting their dominance and indispensability in commercial space design. Such results resonate with the contemporary societal emphasis on health and safety, especially in the ongoing context of pandemics and heightened environmental concerns. Thus, commercial space designers must prioritize these attributes to ensure their designs meet foundational necessities.

The "Priority for Improvement" quadrant identifies attributes such as environmental conservation, a focus on sustainability, energy efficiency, and efficient waste management. These elements are important, yet their performance is comparatively suboptimal. This indicates areas for improvement in commercial spaces, especially for sustainability. Within the SDGs framework, these attributes adhere to societal anticipations and mitigate negative environmental consequences. Hence, designers in the commercial space domain need to concentrate their efforts on developing and implementing more sustainable methodologies to enhance outcomes in these areas. Attributes such as eco-friendly material usage, social distancing design considerations, and personalized services were categorized under the "Secondary Improvement" quadrant. While these elements may not be as pivotal as other attributes, they need to be enhanced. Designers of commercial spaces must incorporate these aspects to enrich the holistic quality of their designs and ensure that they adapt

to the constantly shifting consumer requirements and market dynamics. The "Excessive Emphasis" quadrant presents the provision of shared spaces but a lack of performance. This indicates that several commercial spaces focus overly on shared space configurations and neglect other integral quality aspects. Thus, designers must realign their priorities to balance their designs for diverse needs.

Table 1. IPA analysis results.

	Questionnaire Title	Importance (M = 4.42)	Satisfaction (M = 3.32)	IPA
1.	Diverse vegetarian options	4.93	3.51	I.
2.	Reducing food waste and providing recycling measures	4.83	3.38	I.
3.	Supporting local agriculture and farmers	4.92	3.76	I.
4.	Regulating energy conservation and resource efficiency	4.58	3.29	II.
5.	Sustainable fisheries and marine conservation	4.51	3.25	II.
6.	Eco-friendly tableware and reducing single-use plastic products	4.34	3.18	III.
7.	Supporting development in impoverished areas and increasing farmers' income	4.51	3.23	II.
8.	Promoting healthy eating choices and advocating a healthy lifestyle	4.28	3.27	III.
9.	Organic agricultural products and additive-free ingredients	4.29	3.39	IV.
10.	Water resource protection and conservation	4.23	3.25	III.
11.	Cultural exchange of ingredients and culinary fusion	4.20	3.28	III.
12.	Sustainable economic development and employment opportunities	4.09	3.25	III.
13.	Sustainable banquet venues and environmental design	4.34	3.24	III.
14.	Active promotion of local ingredients and agricultural products at banquets	3.82	3.20	III.

The IPA analysis results provide a reference for commercial space design and planning for SDGs. The results can guide designers to satisfy fundamental requirements and tackle the challenges of sustainability and societal accountability. This underscores the collaboration between researchers and practitioners and the continuous refinement of commercial space designs for evolving demands and societal values.

4.3. IRPA Results

RI in Table 2 indicates the respondents' evaluation of the importance of each quality attribute. Notably, attributes such as safety measures, optimal ventilation, hygiene and cleanliness, commitment to environmental conservation and sustainable development, and an emphasis on energy efficiency scored higher in RI. This underscores the respondents' perception that these attributes are crucial to the success of commercial space design. These findings resonate with the current societal emphasis on health, environmental consciousness, and sustainability, revealing their tangible impact on considerations in commercial space design. PI reflects the actual performance of each quality attribute. All attributes scored below zero. This suggests a potential for enhancement of these attributes in commercial space designs. Specifically, personalized services, the integration of technological solutions, the incorporation of green landscapes, and the provision of community engagement spaces scored low for PI, indicating their deficiency for deployment.

Table 2. IRPA analysis results.

	Items	RI	PI	RIOCS	SGP	DGP	IA
1.	SMEs' participation in social welfare activities	0.523	−0.496	1.019	0.513	0.487	0.026
2.	Gender equality employment opportunities	0.491	−0.557	1.048	0.469	0.531	−0.063
3.	Resource recycling implementation	0.555	−0.446	1.001	0.554	0.446	0.109
4.	Assistance to charitable organizations	0.585	−0.507	1.092	0.536	0.464	0.071
5.	Availability of SDGs-compliant products	0.533	−0.532	1.065	0.500	0.500	0.001
6.	Active promotion of SDGs	0.590	−0.499	1.089	0.542	0.458	0.084
7.	Price increases due to SDGs without affecting choices	0.577	−0.506	1.083	0.533	0.467	0.066
8.	Economic benefits from SDGs products/services	0.529	−0.506	1.035	0.511	0.489	0.022
9.	Uniqueness of SDG indicators	0.531	−0.525	1.056	0.503	0.497	0.006
10.	Provision of SDGs-related information	0.528	−0.566	1.094	0.483	0.517	−0.035
11.	Sense of security using SDGs products	0.532	−0.585	1.117	0.476	0.524	−0.047
12.	Creativity and innovation of SDGs products	0.573	−0.550	1.123	0.510	0.490	0.020
13.	Increased consumer awareness of SDGs	0.489	−0.571	1.060	0.461	0.539	−0.077
14.	Enhanced environmental knowledge from SDGs	0.546	−0.621	1.167	0.468	0.532	−0.064
	Mean (M)	0.542	−0.533	1.075	0.504	0.496	0.008

RIOCS captures the disparity between RI and PI, showing the areas of improvement for each quality attribute. RIOCS scores indicate required improvement: a positive value implies a need to elevate performance, whereas a negative value suggests that performance has already exceeded its perceived importance. In this context, commercial space designs need to be designed to enhance attributes such as personalized services, technological integration, green landscapes, and community engagement. SGP and DGP are used to decide the direction of improvements. SGP is related to attributes such as social distancing planning, the provision of shared spaces, and safety measures for enhancement. Conversely, DGP underscores the personalized services, technological integration, and the inclusion of green landscapes. IA is used for the assessment of the gap between RI and PI in commercial space design and its refinement. Commercial space design needs to be improved for quality attributes to meet the respondent's expectations and needs.

IRPA results provide a basis for assessing the quality attributes of commercial space design and planning. The results can be used to create a roadmap for designers and decision-makers and guide strategies for the sustainability and client satisfaction of commercial spaces. Moreover, they highlight the imperative for a holistic strategy, ensuring a balanced and superior performance for the attributes in commercial space design.

5. Conclusions

In an ever-evolving society and globalization, commercial space design stands at a crossroads with both opportunities and challenges. Originating from a consumer-centric perspective, we delved into commercial spaces for SDGs and integrated design strategies to meet the demands of sustainable development. Through multifaceted analyses, attributes that decisively influence consumer satisfaction were determined to understand the disparity between consumer expectations and experiences for the attributes. The results highlight that the commercial space has a value for 'safety measures', 'optimal ventilation', and 'hygiene and cleanliness'. Yet, performance related to 'environmental conservation and sustainability' needs to be improved. As environmental sustainability is gaining paramount attention,

commercial spaces are more than just platforms for brand display and service. They manifest corporate culture and values. As such, innovation and sustainability emerge as the mission for commercial space design. The outcomes of this study offer strategic directions for commercial space design, prompting industry professionals to re-evaluate their designs and strategies from the consumer perspective. The present preliminary research needs to be expanded to investigate the expectations and needs of diverse consumer groups concerning commercial space design under the purview of the SDGs to offer comprehensive and actionable strategies.

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