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Office space design based on Kano model, AHP, QFD methods

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As a large part of modern life, approaches to the design of office spaces have always been of great concern. This prompts this paper's proposal of a user-driven approach to office space design that can address the need for more distinction between different careers and avoid the phenomenon of homogeneous office spaces. This research integrates the Kano model, the analytic hierarchy process (AHP), and the quality function deployment (QFD) methods to consider the design needs of employees in design roles. First, to target users, fourteen requirements were classified into attributes using the Kano model. Second, the AHP method was introduced to assign weightings to the different attributes. Third, the QFD method was used to determine the design elements to be emphasised in the design process. The resulting theory has been applied to design practice to test the approach and provide new ideas for office space design.

Keywords: office space design; kano model; AHP; QFD

1 Introduction

Full-time employees spend approximately 33% of their waking life in the workplace (Veitch, 2011). In the long term, the work environment can profoundly impact the physical and mental health of these employees. This is reflected in studies showing that people who are satisfied with their workspace more positively perceive their professional future than those who are dissatisfied (Lusa et al., 2019), demonstrating that an appropriate and user-friendly work environment is necessary for employees and employers.

Since the information revolution, service-based industries have flourished, making offices the most common workplace in developed countries. Although many studies on office space design have been published in recent decades, this research has generally categorised 'employees working in offices' as a group, ignoring the differences in working methods and user requirements between industries and roles, making office spaces frequently homogeneous and corresponding to a typical pattern approach. Furthermore, there are many gaps in the research into the design of office spaces specific to each profession, especially a lack of user-centred qualitative and quantitative research built around user requirements.

Therefore, this paper combines the Kano model, the Analytic Hierarchy Process (AHP), and the Quality Function Deployment (QFD) methods to study the qualitative and quantitative requirements and experiences of office spaces for users who work as designers. This encourages the design of the office space based on the user experience of designers, establishing an approach that can provide new ideas for the design of office spaces for other professions too.

2 Research methodology

In modern design research, qualitative and quantitative methods for constructing design models according to user needs include the Kano model, the analytic hierarchy process (AHP), the quality function deployment (QFD), the theory of inventive problem solving (TRIZ), and the technique for order of preference by similarity to ideal solution (TOPSIS) and so on. Qualitative research collects data comprising the words and actions of individuals to analyse and interpret patterns in it (Denzin & Lincoln, 2005). This produces results that are meaning-oriented yet somewhat subjective. Quantitative research is the collection of numerical data to explain a phenomenon, enabling analysis using mathematical methods (Muijs, 2010). It is objective but does not necessarily enable conclusive inferences about causality within the findings. Although qualitative and quantitative research demonstrate distinct approaches to data collection and analysis, they do not have to be mutually exclusive (Pathak, 2011). Combining qualitative and quantitative assessment methods can offset the limitations of each method (Whiston & Rahardja, 2005). Accordingly, recent years have seen many scholars construct complementary models and apply them in the development of design projects.

As Figure 1 shows, this paper combines the Kano model, the AHP and the QFD methods to obtain the best design solution for office spaces in the context of the design field. The Kano model is a valuable tool for investigating the importance of user requirements, categorising and ranking those requirements according to user feedback, thereby capturing the non-linear relationship between product performance and user satisfaction (Xu et al., 2009). However, the Kano model is based on qualitative inputs and does not accurately reflect the extent of user requirements (Berger, 1993). It also does not account for how a given design will meet user requirements. One solution to this is combining the Kano model with quantitative research methods to develop a suitable design strategy.

The AHP method is a powerful and flexible method for helping researchers prioritise and make the best decisions by scoring the decision-making process to obtain a weighted index of each input, in this case, user requirements (Ariff et al., 2008). In this study context, the AHP method is applied to determine the weight of the user requirements after they have been classified by the Kano model. This enables accurate weighting that reflects the importance of each requirement. The Kano model is integrated into the AHP method to make the hierarchical structure more scientific and rational. However, the Kano model and the AHP method still do not provide a straightforward solution to the problem of how to relate design proposals to user requirements, and further incorporation of other methods is needed to complete the final model.

The QFD method describes a user-oriented product development tool that aims to achieve higher levels of user satisfaction by translating customer requirements into design elements or production plans (Li et al., 2021). Kano's user satisfaction model can be optimised and combined with the QFD method to acquire design parameters. A prerequisite for combining the Kano model and the QFD method is the predetermination of the hierarchy of user requirements (Griffin & Hauser, 1993). Ultimately, the best solution for user-driven office space design can be achieved by analysing suitably weighted design elements.

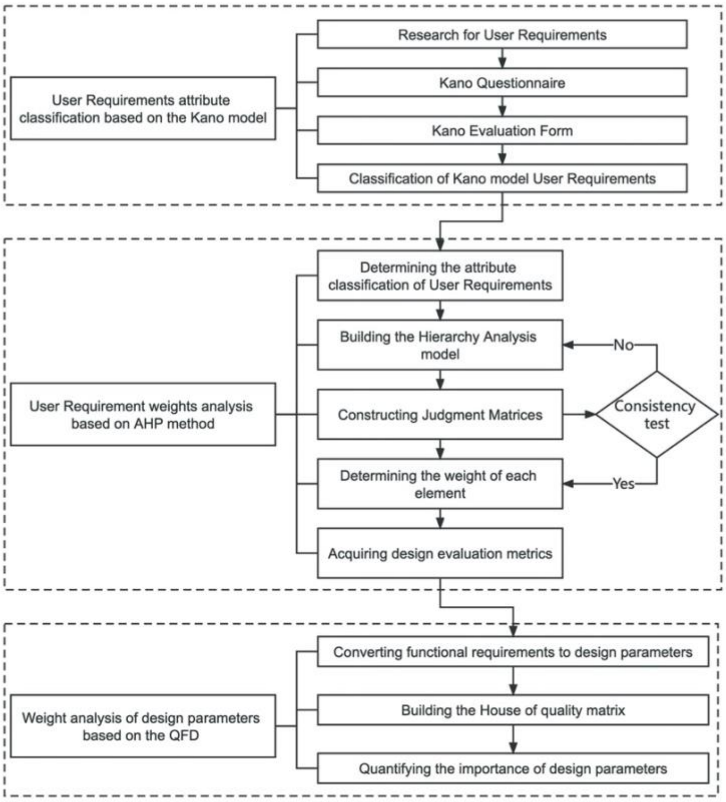

Figure 1. Research Methodology.

3 Office space design process incorporating the Kano model, the AHP and the QFD methods

3.1 Extracting user requirements

According to Vilnai-Yavetz et al. (2005), office space design depends on the three dimensions of instrumentality, aesthetics, and symbolism.

Instrumentality includes the tools used in the office process, such as computers, chairs, and devices. Aesthetics describes the decorative elements of the office space, such as colours and materials. Symbolism indicates the association that users have with a space and captures whether their profession is represented in the office space (Vilnai-Yavetz et al., 2005).

Based on that study, user requirements for office spaces are classified into the three main categories of instrumentality (office infrastructure), aesthetics (interior decorations) and symbolism (space characteristics). Furthermore, to make the user requirements more occupation-specific, after using the situational interview method and the observation method to survey seventeen designers who mainly work in offices, the requirement category space function was added to the original set of classifications. Table 1 presents the requirements and the classification they have been assigned to.

Table 1. User requirements for an office space

Classifications	Requirements	Number
Office Infrastructure	Comfort of Use	I1
	Efficiency of Use	I2
	Brand	I3
	Attractive Appearance	I4
Interior Decorations	Appropriate Colours	D1
	Suitable Decoration Style	D2
	Texture and Tactility of Decorative Materials	D3
	Safety of Decorative Materials	D4
Space Characteristics	Openness	C1
	Brightness	C2
	User Status Symbol	C3
Space Function	Work Function	F1
	Rest Function	F2
	Social Function	F3

3.2 Classifying user requirements

This paper focuses on meeting the requirements and enhancing the user experiences of designers working in office spaces. This requires investigating this professional group. The Kano model enables the identification of the importance of individual requirements to the user, and it can provide intuitive reference conditions for the design stage (Sauerwein et al., 1996). Using the Kano model, the user requirements (classified into attributes) were analysed to identify the importance of each condition in the office space from the perspective of designers. The Kano model indicates the extent to which a requirement is important to users using five evaluation categories:

- Must-have Quality (M): This is an attribute that users take for granted and must be included. Although users will be indifferent to its execution, if the requirement is not realised, it will cause great dissatisfaction. Hence, in general, such requirements must be satisfied.
- One-dimensional Quality (O): Such attributes heavily impact user satisfaction, with higher levels associated with greater user satisfaction and vice versa. Having this attribute can give products in the same category a competitive advantage over products without this attribute, and it should be satisfied to the extent possible after M attributes have been incorporated.
- Attractive Quality (A): This attribute’s presence will satisfy the user. However, if it does not exist, the user will not be dissatisfied. When M and O requirements have been achieved, this attribute can be implemented if conditions allow.
- Indifferent Quality (I): This attribute does not impact user satisfaction. Therefore, requirements with this attribute can usually be ignored during the design process.

- Reverse Quality (R): The user's satisfaction level is reduced when attributes with this rating are present. This may lead to differences in the user experience of different users.

3.2.1 Constructing the Two-Factor Likert questionnaire to complete the Kano model

A Likert questionnaire was created based on the user requirements extracted (see Table 1). It uses a two-factor format in which respondents are asked to answer positive and negative questions about their attitudes toward the presence of each attribute. The response options were based on the traditional Kano questionnaire setting, which categorises satisfaction using a five-point Likert scale, where 5 indicated 'like', 4 indicated 'necessary', 3 indicated 'irrelevant', 2 indicated 'tolerable', and 1 indicated 'dislike' (Kano, 1984). The questionnaire design appears in Table 2. Respondents selected the most appropriate option from the two questions, enabling each requirement to be evaluated according to the categories introduced.

Table 2. Kano two-factor Likert questionnaire

If available, what is your attitude?					**Office space requirements for designers**	**If not, what is your attitude?**				
1	**2**	**3**	**4**	**5**		**1**	**2**	**3**	**4**	**5**
					The comfort of office furniture					
					Efficiency in the use of office instruments					
					Office instruments are famous brand products					
					Aesthetically pleasing office instruments					
					A reasonable colour combination in the space					
					The interior style meets the needs					
					……					
					Social function areas exist in the office space					

3.2.2 Analysing the results of the Kano questionnaire

A total of 87 working designers responded to the Kano questionnaire (28 graphic designers, 24 interior designers, and 34 architects). The process of assigning the results to evaluation categories is shown in Table 3, with Table 4 providing detailed statistical information. The evaluations are based on the most common score given by respondents. For example, 76% of the participants gave 'safety of decorative materials' Must-have(M) leading to the classification in the category M. Based on this analysis method, the Kano attributes of the other thirteen user requirements have been identified (see Table 4).

Table 3. Kano evaluation

Positive	**Negative**				
	Like (5)	**Necessary (4)**	**Irrelevant (3)**	**Tolerable (2)**	**Dislike (1)**
Like (5)	Q	A	A	A	O
Necessary (4)	R	I	I	I	M
Irrelevant (3)	R	I	I	I	M
Tolerable (2)	R	I	I	I	M
Dislike (1)	R	R	R	R	Q

The fourteen requirements only pertained to four (not five) evaluation categories, namely, M, O, A, and I. Of these, I3, D2, and C1 have been classified as I, which means that these user needs will not need to be considered in the subsequent design process, D4 and F1 have been classified as M, meaning they must be considered when designing office spaces, C2, I1, F3, D1, and C3 have been classified as O, meaning that they should be addressed after fulfilling requirements classified M, and D3, I4, I2, and F2 have been classified as A, meaning they should be considered after M and O conditions have been met.

Table 4. Kano model statistical results

Number	**Percentage (%)**						**Kano orientation**
	A	O	M	I	R	Q	
D4	2	20	76	2	0	0	Must-have Quality (M)
F1	6	43	47	4	0	0	
C2	6	79	11	4	0	0	One-Dimensional Quality (O)
I1	9	75	8	6	0	2	
F3	17	68	6	9	0	0	
D1	13	65	7	15	0	0	
C3	19	55	4	22	0	0	
D3	70	21	4	5	0	0	Attractive Quality (A)
I4	55	23	7	15	0	0	
I2	53	30	6	11	0	0	
F2	51	22	7	20	0	0	
I3	15	6	0	79	0	0	Indifferent Quality (I)
D2	25	23	9	43	0	0	
CI	21	28	8	43	0	0	

3.3 Calculation and analysis of user requirement weights based on the AHP

The analytic hierarchy process generates a structured decision framework, enables hierarchical decomposition from different levels, constructs a hierarchy of relevant factors and judgement matrices, systematises user needs, and finally uses quantitative calculations to obtain weight values (Li et al., 2019). Having classified the user requirements for office space using the Kano model, the AHP can quantify weight values for each design requirement, providing essential data for prioritising design elements.

There are four core steps required to complete the AHP (Vargas, 1990):

- Step 1: Construct an ordered progressive hierarchical model that categorises complex conditions into several clusters, each comprising different sub-elements.
- Step 2: Separately construct a comparative two-by-two judgement matrix.
- Step 3: Calculate the total hierarchical ranking of indicator weights and (through normalisation) obtain the weight of influence of the upper-level indicators on the elements and the general targets.

- Step 4: Conduct a consistency test (using a stationary formula) to determine whether the matrix is valid.

3.3.1 Constructing the AHP model

The first step in the AHP is constructing a recursive hierarchy model of evaluation indicators. Based on the analysis of the needs of office space users (see Table 4), the scope and objectives of the evaluation are determined, and a recursive hierarchy is constructed that comprises the target level, the baseline level, and the sub-baseline level (see Figure 2). The target level of the hierarchical analysis model is 'Best Office Space Design Solution for Designers'; the baseline level captures the three Kano qualities of interest; the sub-baseline level includes the 11 design requirements corresponding to the three Kano qualities of interest.

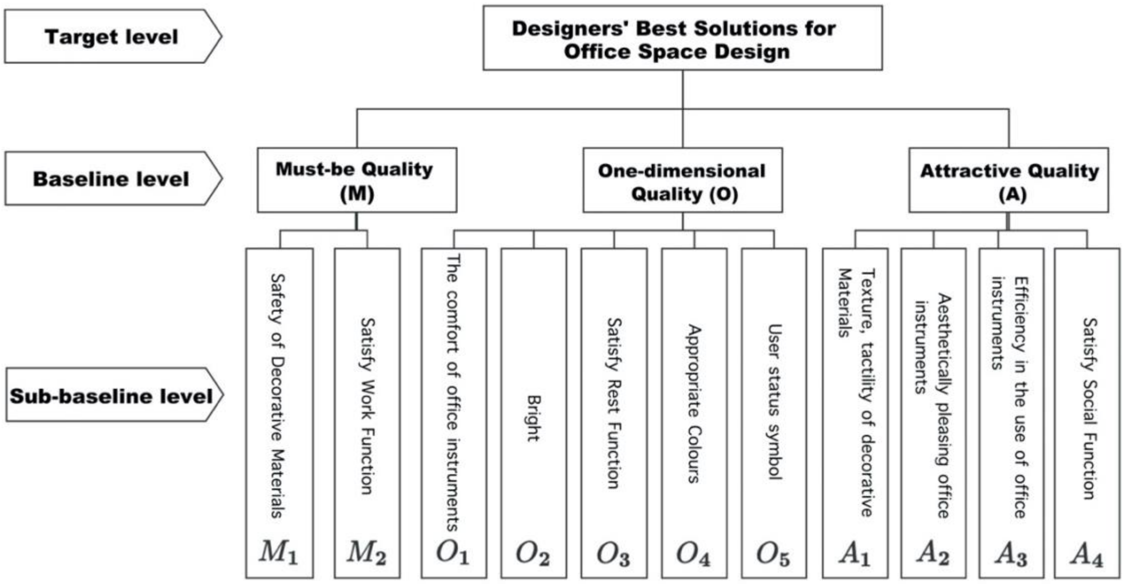

Figure 2. Hierarchy expansion of designer demands for office space. Source: Author's own work

3.3.2 Calculating user requirement weights

To ensure the usability of the weighting results, fifteen experts in office space design were invited to complete an evaluation matrix (two professors of interior and space design research, five office space designers, three office furniture research scholars and five postgraduate students of interior and space design). This led to the following step-by-step procedure:

- Step 1: The fifteen experts scored each tier of indicators $\boldsymbol{a_i}$ and $\boldsymbol{a_j}$ on a two-by-two basis using a nine-point scale, enabling the construction of a judgement matrix R, with the arithmetic mean algorithm used to find user demand weight X according to Equation (1), $\boldsymbol{a_{ij}} \cdot \boldsymbol{a_{ji}} = 1$, j ≠ l = 1, 2, ..., n (see Table 5):

$$R = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1j} \\ a_{21} & a_{22} & \cdots & a_{2j} \\ \vdots & \vdots & \ddots & \vdots \\ a_{i1} & a_{i2} & \cdots & a_{ij} \end{bmatrix} \quad (1)$$

- Step 2: The weight values of each sub-baseline requirement (Table 7) were multiplied by the weight value of its corresponding baseline-level attribute (Table 6) to calculate the composite weight of each requirement.
- Step 3: The largest characteristic root of the matrix λ_{max} was determined and tested for consistency according to Equation (2), where *CI* denotes the consistency indicator and *CR* indicates the consistency ratio:

$$I_{CI} = \frac{\lambda_{max} - n}{n-1}$$
$$I_{CR} = \frac{I_{CI}}{RI} \quad (2)$$

Normally, if $I_{CR} \leq 0.1$, it is considered to pass the consistency test. If it does not pass the consistency test, the judgment matrix must be reconstructed. Based on the above steps, the weights of the baseline and sub-baseline items in the office space requirements hierarchy were calculated separately and tested for consistency (see Tables 5–7). Table 5 indicates that all the judgement matrix consistency tests were passed.

Table 5. Characteristic roots and consistency testing results

Project	Primary indicator	Secondary indicator		
		M	O	A
λ_{max}	3.009	2.000	5.082	4.031
I_{CI}	0.0046	0	0.0204	0.0103
I_{RI}	0.520	0	1.120	0.890
I_{CR}	0.0088	0	0.0182	0.0116

Table 6. Primary indicator weights

Primary Indicators	M	O	A	Weight Value
M	1	2	3	0.5390
O	1/2	1	2	0.2973
A	1/3	1/2	1	0.1638

Table 7. Secondary indicator weights

Secondary Indicators	Judgement Matrix					Partial Weight	Composite Weight
M_1	1	2	x	x	x	0.6667	0.3594
M_2	1/2	1	x	x	x	0.3333	0.1796
O_1	1	2	3	3	4	0.4061	0.1207
O_2	1/2	1	1	2	2	0.1981	0.0589
O_3	1/3	1	1	2	2	0.1843	0.0548

O_4	1/3	1/2	1/2	1	2	0.1241	0.0369
O_5	1/4	1/2	1/2	1/2	1	0.0873	0.0260
A_1	1	2	1/3	1/2	x	0.1611	0.0264
A_2	1/2	1	1/4	1/3	x	0.0960	0.0157
A_3	3	4	1	2	x	0.4658	0.0763
A_4	2	3	1/2	1	x	0.2771	0.0454

3.4 Design element analysis using the QFD method

3.4.1 Transformation of user requirements and design parameters

The QFD method is a user-requirements–oriented tool that provides ideas for transposing the requirements of users into design bases (Avikal et al., 2018). Design parameters are a central component in the construction of the house of quality (HOQ) within the context of the QFD method. After the AHP method has identified the weighting of each user requirement in the office space, the user requirements of the office space need to be transformed into design parameters to ensure that the research provides a directive for the subsequent design practices. The steps for obtaining design parameters were as follows:

- Step 1: Preliminary understanding and acquisition of the design parameters of office space via literature review.
- Step 2: Matching (or refining) the acquired design parameters to (or in accordance with) the eleven user requirements.
- Step 3: Inviting relevant designers to propose modifications to the inferred design parameters.
- Step 4: Classifying the design parameters of the office space in terms of office infrastructure, interior decorations, interior function, and space characteristics (see Table 8).

Table 8. Comparison of user requirements with design parameters

Category	Number	User Requirement	Design Parameter
Office Infrastructure	O_1	Comfort of Use	Ergonomic specifications for shape and size DP_1
	A_3	Efficiency of Use	Office tools to boost productivity DP_2
	A_2	Attractive Appearance	Styling parameters (aesthetic appearance, suitable colours, etc.) DP_3
Interior Decorations	O_4	Appropriate Colours	
	A_1	Texture and Tactility of Decorative Materials	Good tactile feel DP_4
	M_1	Safety of Decorative Materials	Non-toxic, high temperature resistant, electric shock resistant material DP_5
Space Characteristics	O_2	Bright	Interior illumination, daylight parameters DP_6
	O_5	User Status Symbol	Design elements that reveal the identity of users DP_7
Space Function	M_2	Work Function	Adding work function area DP_8
	O_3	Rest Function	Adding Rest function area DP_9
	A_4	Social Function	Adding Social function area DP_{10}

3.4.2 Building House of Quality

Building the HOQ is essential to the QFD process. The HOQ allows for a more intuitive and precise representation of the relationship between user requirements and design elements and thus for the prioritisation of design elements (Hauser & Clausing, 1988).

In Table 9, the degree of relevance of each of the eleven office space requirements of designers to each of the ten design elements is indicated by ● (Strong relevance), ◎ (Moderate relevance), △ (Weak relevance), and blank spaces (No relevance) in the HOQ matrix. After quantifying the degree of association, the default values for each item are ●=5, ◎=3, △=1 and Blank Space=0.

The user requirements from Table 7 – along with their respective combined weight values – are imported and presented on the left side of the HOQ matrix. The design elements corresponding to each user requirement (Table 8) are imported and presented at the top of the HOQ matrix. Five office space design professionals were then approached to determine the degree of correlation between user needs and design elements and fill in the symbols to score the correlation and build the HOQ correlation matrix. Finally, the weight scores of the design elements were calculated according to Equation (3), where $\boldsymbol{W_d}$ is the weight score of the design elements, $\boldsymbol{W_i}$ is the combined weight of user requirements, and $\boldsymbol{P_{ij}}$ is the relevance coefficient:

$$W_d = \sum_{i=1}^{q} W_i P_{ij} \quad (3)$$

3.4.3 Analysis of Design Parameter Weights

The total score shown at the bottom of the HOQ matrix (Table 9) allows for an analysis of the prioritisation of the design parameters in the office space design process. Adding work function area DP8 (3.4655), non-toxic, high temperature resistant, electric shock resistant material DP5 (2.8255), ergonomic specifications for shape and size DP1 (2.1877) and adding rest function area DP9 (2.0078) scored highest and were considered the main elements of interest during the design process. Office tools to boost productivity DP2 (1.6416), styling parameters (e.g., aesthetic appearance and suitable colours) DP3 (1.6319), interior illumination, daylight parameters DP6 (1.4942), and design elements that reveal the identity of users DP7 (1.3294) also scored high and needed to be considered during the design process.

The elements good tactile feel DP_4 (1.0032) and adding social function area DP_{10} (0.9544) received average scores, enabling their representation in the design process to be reduced when funding or space is unavailable.

Table 9. HOQ design parameters for office spaces

DP_x / **UR_x**	**Composite Weight**	**DP_1**	**DP_2**	**DP_3**	**DP_4**	**DP_5**	**DP_6**	**DP_7**	**DP_8**	**DP_9**	**DP_{10}**
M_1	0.3594				△	●			◎	◎	△
M_2	0.1796	●	●	◎	△	◎	●	●	●		
O_1	0.1207	●	◎		△	◎			●	◎	△
O_2	0.0589			◎			●		●	△	△
O_3	0.0548	◎		◎	◎	◎	△	△		●	

O_4	0.0369			●			◎	△	△	△	△
O_5	0.0260			●				●	◎	△	◎
A_1	0.0264	◎		●	●			△	◎	◎	△
A_2	0.0157	△		●	◎			◎	△	◎	◎
A_3	0.0763	●	●						●		
A_4	0.0454	△		●		△	◎	◎		△	●
SUM (Scores)		2.187 7	1.641 6	1.631 9	1.003 2	2.825 5	1.494 2	1.329 4	3.465 5	2.007 8	0.954 4

4 Office space design practice based on the Kano Model, the AHP and the QFD methods

This section considers office space design practices based on the procedures described in the previous section. The target user for this design project was an architect because architects represented the majority of the respondents to the Kano questionnaire.

4.1 Design statement

In designing office infrastructure, the size and shape of the furniture selected for the space were all informed by ergonomic requirements to meet user comfort requirements. In addition, some of the furniture was customised to fit the space, improving the use of the space and enabling the needs of more users to be met. In addition to improving the efficiency of the office by providing high-quality office tools, the efficiency of the architect's office can be improved by rationalising movement in the space and reducing the number of times that architects must handle materials. Movable lockers and shelving in office areas have been designed for this purpose.

In terms of interior decorations and space characteristics, this project is inspired by constructivism, which developed in the early twentieth century and had a significant impact on modern architecture design. Piet Mondrian's famous *Composition with Red, Blue, and Yellow* (1930) used elements of constructivism. Because the movement is a major design language in contemporary architecture, the painting is invoked in the plan and elevation of the space to represent the profession of architecture in an inspirational manner (see Figure 3).

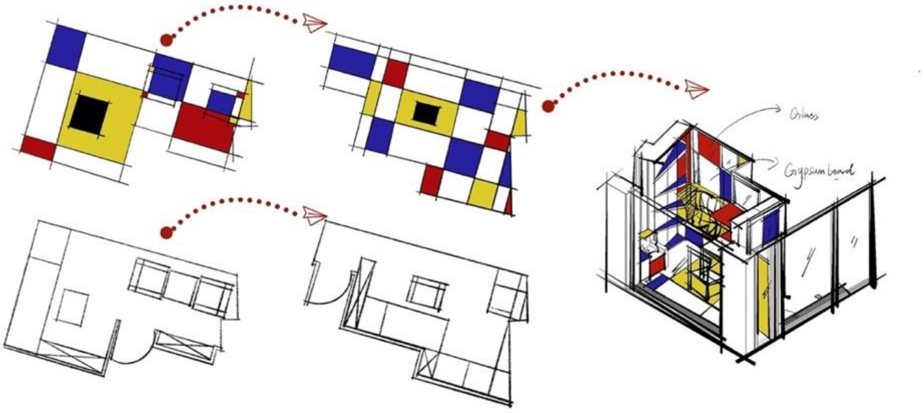

Figure 3. The design solution generation process.

Research indicates that colours impact the psychology of users in interior spaces (Haller, 2017), demanding attention to the colour composition in this context. Accordingly, light blue delivers mental calm to the user, helping to reduce stress and relieve tension. The light yellow colour conjures positive emotions of happiness, optimism, and self-confidence. Green represents balance and harmony, and it also has a refreshing effect. Finally, the simplicity of white can increase user efficiency (Karen, 2019).

The office space is decorated with non-toxic, temperature-resistant, and electric-shock–resistant materials to ensure user safety. The lighting parameters are also one of the critical design elements. This is because architects use their eyes intensely when working and therefore have stringent requirements for the brightness of the lighting in their office spaces. As a rule, the illumination level of an office space should not fall below 550lx. Meanwhile, users record the highest satisfaction when the illumination level is between 600lx and 650lx (Fakhari et al., 2021). Based on this information, combined with the actual room area, the luminaires in this space must deliver approximately 6600 lumens.

In terms of the design of the space functions, as shown in the exploded diagram in Figure 4, this office space is divided into a work function area, a rest function area, and a social function area. The work function area occupies the largest area of the overall office space, while the rest and social function areas are combined to occupy a smaller area. The functional areas are not separated by walls but by furniture with different functions.

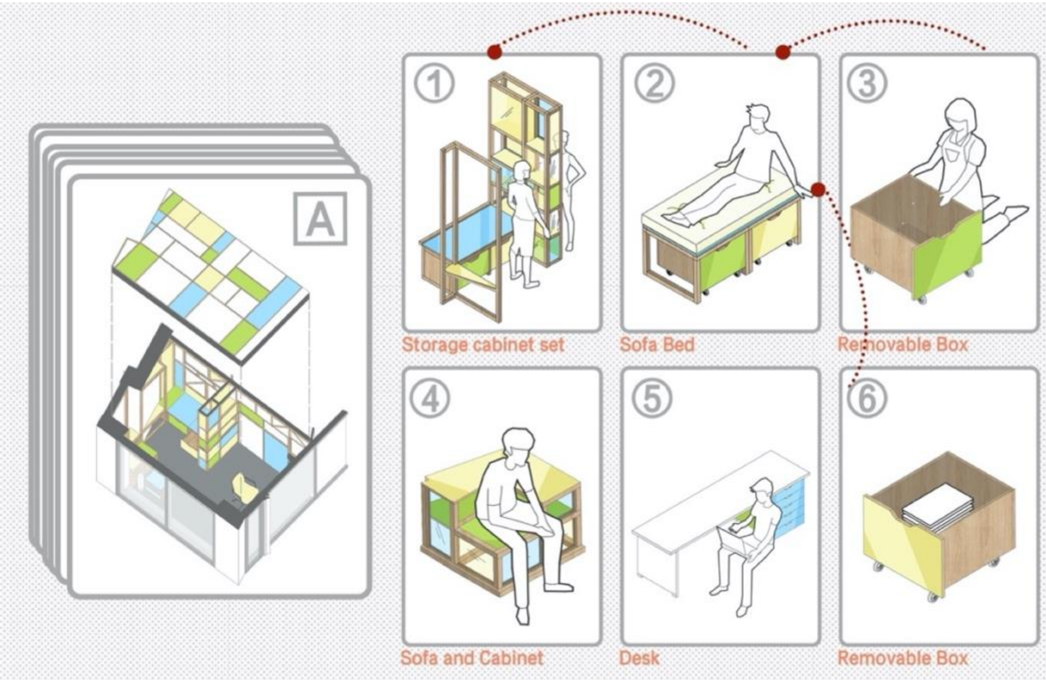

Figure 4. Exploded views and illustrations of furniture functions.

4.2 Office space design results

Figure 5 shows both daytime and night-time scenes to be presented as final renderings. The office space comprises a frame structure that can accommodate one person working and multiple people completing social and break activities. This office space is surrounded by three windows facing south. Given the northern hemisphere location, on sunny days, the natural lighting is excellent.

Figure 5. Renderings of the office space at night (left side) and during the day (right side).

5 Analysis of limitations

This paper has used qualitative and quantitative approaches to studying office space design. However, there are limitations to the study design that affect the quality of the findings. The accuracy of the qualitative approach depends on the impartiality of the observer at the time of recording, leading to potentially biased results, a function of subjectivity and other factors. Meanwhile, the reliability of the data obtained by quantitative methods is highly dependent on the quality of answers provided by users and experts and the design of the survey. Furthermore, quantitative methods do not provide conclusive evidence of causality or allow strong inferences to be made (Queirós et al., 2017). More investigations and experiments are needed to address these concerns and adjust the design processes accordingly.

6 Conclusions

New professional demands are emerging regularly, and professionals are increasingly looking for an ideal office environment. Good office space enhances not only employee identification with the company but also their operational efficiency. However, the design of office spaces continues to be substantially homogenous, and office spaces are rarely designed based on user requirements. Therefore, this study has developed a model for a user-driven approach to office space design and obtained the best design solution for office space by classifying and weighting the attributes of user needs in the context of design professions. The findings enable the development of design practices that enhance user satisfaction with their office space, with positive outcomes for both companies and their employees. The office space design approach integrating the Kano model, the AHP, and the QFD method compensates to a certain extent for the shortcomings of single-method research and has the advantage of being systematic and scientifically sound, providing guidance on making accurate user-centred decisions on design elements in office spaces. The paper concludes with an example of office space design practice to further demonstrate the feasibility of the theory and provide ideas for user-demand–driven office space design.

References

Ariff, H., Salit, M. S., Ismail, N., & Nukman, Y. (2008). Use of analytical hierarchy process (AHP) for selecting the best design concept. *Jurnal Teknologi*. https://doi.org/10.11113/jt.v49.188

Berger, C. (1993). Kano's methods for understanding customer-defined quality. *Center for quality management journal*, *2*(4), 3-36.
Denzin, N., & Lincoln, Y. (2005). The SAGE handbook of qualitative research.
Fakhari, M., Fayaz, R., & Asadi, S. (2021). Lighting preferences in office spaces concerning the indoor thermal environment. *Frontiers of Architectural Research*, *10*(3), 639-651. https://doi.org/10.1016/j.foar.2021.03.003
Griffin, A., & Hauser, J. R. (1993). The voice of the customer. *Marketing science*, *12*(1), 1-27.
Haller, K. (2017). Colour in interior design. In *Colour Design* (pp. 317-348). https://doi.org/10.1016/b978-0-08-101270-3.00014-x
Hauser, J. R., & Clausing, D. (1988). The house of quality.
Kano, N. (1984). Attractive quality and must-be quality. *Journal of the Japanese society for quality control*, *31*(4), 147-156.
Karen, H. (2019). *The little book of colour : how to use the psychology of colour to transform your life*. Penguin Life, An Imprint Of Penguin Books.
Li, M., Zhang, J., & Pan, W. T. (2021). Integrating Kano Model, AHP, and QFD Methods for New Product Development Based on Text Mining, Intuitionistic Fuzzy Sets, and Customers Satisfaction. *Mathematical Problems in Engineering*, *2021*, 1-17. https://doi.org/10.1155/2021/2349716
Lusa, S., Kapykangas, S. M., Ansio, H., Houni, P., & Uitti, J. (2019). Employee Satisfaction With Working Space and Its Association With Well-Being-A Cross-Sectional Study in a Multi-Space Office. *Front Public Health*, *7*, 358. https://doi.org/10.3389/fpubh.2019.00358
Muijs, D. (2010). Doing quantitative research in education with SPSS. *Doing quantitative research in education with SPSS*, 1-264. https://doi.org/10.4135/9781446287989
Pathak, R. P. (2011). *Statistics in education and psychology*. Pearson Education India.
Queirós, A., Faria, D., & Almeida, F. (2017). Strengths and limitations of qualitative and quantitative research methods. *European journal of education studies*. https://doi.org/10.5281/zenodo.887089
Vargas, L. G. (1990). An overview of the analytic hierarchy process and its applications. *European journal of operational research*, *48*(1), 2-8.
Veitch, J. A. (2011). Workplace design contributions to mental health and well-being. *Healthc Pap*, *11 Spec No*, 38-46. https://doi.org/10.12927/hcpap.2011.22409
Vilnai-Yavetz, I., Rafaeli, A., & Yaacov, C. S. (2005). Instrumentality, Aesthetics, and Symbolism of Office Design. *Environment and Behavior*, *37*(4), 533-551. https://doi.org/10.1177/0013916504270695
Whiston, S. C., & Rahardja, D. (2005). Qualitative career assessment: An overview and analysis. *Journal of Career Assessment*, *13*(4), 371-380.
Xu, Q., Jiao, R. J., Yang, X., Helander, M., Khalid, H. M., & Opperud, A. (2009). An analytical Kano model for customer need analysis. *Design Studies*, *30*(1), 87-110. https://doi.org/10.1016/j.destud.2008.07.001

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