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Graphic Design of Architectural Environment Art Based on Kano Model

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Abstract

The process of improving a space's visual quality by the integration of components from other design disciplines, such as industrial, landscape, graphic, and interior design, is known as environmental design. When implemented correctly, ecological design can improve a place's utility, impact, and effect on visitors. The application of the Kano model (KM) to the design of graphics in architectural environmental art is the main topic of this work. Five groups are categorized using the Kano model, a satisfaction model, according to quality factors: Effectiveness in a single dimension, performance that must be met, indifferent quality, enticing quality, and reversing quality. In order to determine the most important graphic design elements that designers and architects should take into account when creating architectural environment art, this inquiry uses the Kano model. The study offers a thorough examination of KM and application in graphic design, and then it analyzes the model's applicability in the creation of architecture environment art. In order to improve satisfaction and produce outstanding architectural environment graphic design, architects and designers should concentrate on the following critical graphic design features, according to the study's conclusion.

Keywords: Designs of graphics, architecture environment design, industrial style, interactive graphic style, Kano model (KM), Green construction

1. Introduction

Architectural environment art is created in large part through graphic design. In order to develop aesthetically pleasing and useful materials for communication for architectural projects, it entails utilizing visual components like typography, color, photographs, and other design features. Graphic design aids in communicating the architect's or designer's vision and intention to the intended audience when it comes to architectural environment art [1, 2]. Architectural environment art graphic designs use a range of methods and resources to provide visually stimulating depictions of architecture concepts and ideas. These could include 3D modeling applications, digital rendering tools, and conventional painting and drawing methods. Usually, a blend of these methods yields a unified and strikingly beautiful depiction of the building undertaking [3].

In architectural environment art, graphic design has a practical use in addition to its aesthetic appeal. It facilitates the dissemination of crucial project details, including plans for floors, elevations, and site plans, to customers, stakeholders, and the general public [4]. It is also essential to the project's marketing and promotion, drawing in possible customers and investors. All things considered, graphic design of architecture environment art is an essential step in the process of designing buildings since it aids in visually stimulating and effectively realizing the architect's or designer's concept [5, 6]. In order to analyze the crucial element of the graphic architectural design, we present KM in this study. The Kano model is a framework that helps businesses and organizations understand and prioritize customer needs and expectations. In the context of graphic design for architectural environment art, the Kano model can be used to identify the features and design elements that are most important to stakeholders.

The KM has been combined with a number of Multi-criterion Decision Making (MCDM) methodologies, the Taguchi method, Kansei engineering, and more ways to determine the relative weights of the criterion [7]. Authors of [8] suggested design concepts based on three user skill levels, investigate the sensory level visual depiction of cultural aspects, look for suitable emotion mapping techniques, and enhance user experience. Users provided the suggested [9]virtual reality (VR) system a generally good in regards to realism, sense of scale, and brightness, which is congruent using the outcomes of research using the immersive virtual environment (IVE) for subjective assessments of daylight. An innovative interactive method to gather and display subjective user daylighting choices in a virtual museum setting at two different times of the day. In comparison to the more conventional method of environment recognition [10], virtual reality (VR) offers a significantly better level of environmental validity by applying a high level of realism (presence) through 360-degree movies or panoramas (e.g., drawings, maps, renderings, and videos). In accordance with distant education methods [11], the chosen technology tools, digital sites, arrangements used in architectural representation approaches, and technological devices are gradually replacing conventional modes of representation and communication. Use the Scenic Beauty Estimation Technique [12] to analyse the scenic beauty of an urban setting, paying special attention to how various variable sets may be used to forecast preferences as well as how these preferences might converge across various user and interest groups. The fact that both studies looked at rating dependability is also interesting. It presents a psychophysical method for gauging public preferences in order to create statistical models for forecasting and tracking the visual quality of forests and other environments.

In [13], they should present a unique multi-modal approach that makes use of both textual and visual analysis methods to calculate a location's imageability rating. A deep learning model for picture sentiment analysis has also been built to offer more details on the emotions that urban environments generate in occupants. Architectural designers with a desire to comprehend the behaviour of the ultimate end user should apply evidence-based design (EBD) methods [14]. Human well-being is significantly influenced by the place, time, and level of exposure to a certain environment. The purpose of the study [15] was to build and evaluate a machine learning technique that incorporates using three distinct algorithms for machine learning, the urban visible environment can be automatically and widely analyzed. Research [16] carried out more thorough and systematic simulations of the procedures, aptitudes, and molecular components of "building" techniques of various numerous traps. The simulation findings were then systematically analysed.

2. Graphic design of environmental art

In the study [17], they examined LEED-certified GB IEQ residences and concluded that the sunlight and sound qualities might use enhancement. The most important factors were the heating, AQ, moisture, hygiene, and sight.The findings [18] revealed that while a significant portion of occupants believed the air in their workstations was excessively chilly, the inhabitants showed overall satisfaction with the interior environment. The carbon dioxide level was mostly greater as well. In a warm climatic zone in China, 20 green office architecture fared better in thermal conditions, user heat gain, and indoor air. A survey study was carried out by Media [19] for an Indonesian green office building. Just 51% of the building's inhabitants believed it matched the criteria for green architecture, and 21% of them thought the office building was "non-green," showing that the GB's efficiency needed to be improved. It was discovered [20] that discrepancies between LEED-certified architecture and non-certified architecture were considerably influenced by non-biological characteristics including office kinds, spatial layouts, age and gender. It was revealed [21] that residents of green architecture perceive the interior environment more favorably and have fewer "sub-health" symptoms than residents of conventional structures.

One potential research problem in graphic design for architectural environment art understands the preferences of different stakeholders, such as architects, clients, and end-users, and how to balance their competing needs and expectations. The Kano model can help address this problem by categorizing design features into five categories, and it can help designers to better understand customer requirements and prioritize their design decisions accordingly in the context of graphic design of architectural environment art.

3. Materials and Methods

This section describes an empirical study utilizing KM to establish the relationship between satisfaction and quality of graphical design in buildings and how people experience it. This article evaluates the quality standards for graphical

design in architecture to support future graphical design and development by using a questionnaire based on the KM. Below is a description of the experimental research design.

3.1 Data sample

At Taiwan's Midland University of Technology, the Kano questionnaire survey was carried out. Twenty-seven males and 38 females between the age of 18 to 39 developed the 62 people in the research. They were chosen because of the following factors: The subjects showed a high level of enthusiasm to engage in activities, and (a) every subject was selected from the university's design department.

3.2 Kano model

The KM is pioneering a new two-dimensional approach to defining quality. Understanding how consumers evaluate and perceive quality qualities is facilitated by this approach, which acknowledges that originally invisible concepts about quality may be made apparent. Figure 1 depicts the representation of the KM model. The KM has five benefits when used in building construction.

i. The model determines the parameters that have the most impact on satisfaction in order to describe architectural requirements.
ii. Enables significant assistance in sacrifice scenarios during the architectural development phase.
iii. Given that "must-be, one-dimensional" and aesthetic criteria differ in utility requirements among various consumer segments, the model allows customer-tailored approaches to unique challenges to be noticed, ensuring optimal satisfaction.
iv. A wide variety of chances for difference are widened by finding and achieving aesthetic requirements.

It is used to demonstrate the value of specific product aspects to satisfaction, and as a result, it produces the best precondition for activities that are process-oriented in their product development. Because of these factors, in order to attract people, a building has to consistently create a unique and new design in its architecture.

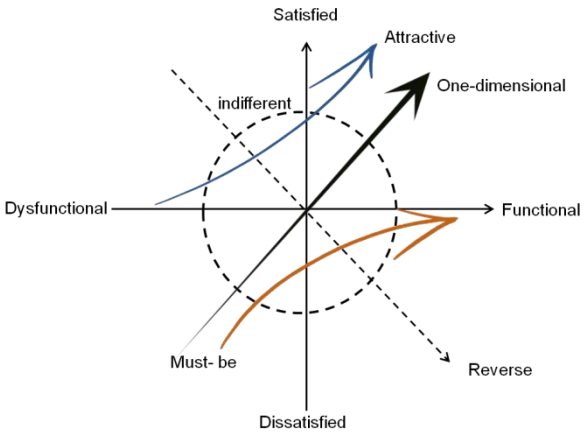

Figure 1: Representation of KM model

The theory of appealing quality is an explanation for the connection between the level of sufficiency and the level of user satisfaction. This relationship is explained by referring to a quality characteristic, which may be placed into one of five different categories that define perceived quality.

- **Attractive quality:** When properly achieved, attractive qualities contribute to astonishment and pleasure, but when unsatisfied, they do not lead to dissatisfaction. In other words, when correctly achieved, they offer satisfaction.

- **One-dimensional quality:** Satisfaction results from one-dimensional quality traits when they are satisfied, while dissatisfaction results when they are not satisfied.
- **Must-be quality:** When they meet the criteria, must-be quality characteristics aren't even noticed, but when they aren't, they lead to feelings of dissatisfaction; these characteristics might be reflected in the composition of the substance itself.
- **Indifferent quality:** The term "indifferent quality" refers to features of a graphical service that users do not find to have the possible or impossible impact on their interactions with graphics.
- **Reverse quality:** The term "reverse quality" denotes a scenario in which the quality of the design requires expectations, but the ultimate result is lower levels of consumer satisfaction. The increased levels of consumer satisfaction occur when the graphic design quality falls below requirements.

The assessment table of the KMmay be seen in Table 1, and the variable description used for the KM model is indicated in Table 2. The Kano assessment table enables one to compute the quality characteristics in 6 various categories; the highest value is denoted by the aggregate amount of quality attributes. In addition, the individual's satisfaction coefficient that was determined via the use of the questionnaire may be examined in such a way as to determine whether or not adequate or insufficient quality has an impact on level of satisfaction experienced by people. Findings of the questionnaire also reflect "the degree of dissatisfaction of satisfaction" and "the degree of dissatisfaction" of each characteristic using an equation (1) and (2), respectively.

$$(B + P)/(B + P + N + J) \quad (1)$$

$$-1(P + N)/(B + P + N + J) \quad (2)$$

Table 1: Kano evaluation table

Requirements	Dysfunctional					
Functional		Dislike	live	Neutral	Must	Like
	Dislike	R	S	S	S	S
	live	N	J	J	J	S
	Neutral	N	J	J	J	S
	Must be	N	J	J	J	S
	Like	P	B	B	B	R

Table 2: Variable description

Variable	Description
B	Attractive
N	must be
P	one dimensional
J	indifferent
S	reverse
R	questionable

3.3 Qualitative research

The analysis of graphical quality focused on both positive and negative quality. Consider that 13 quality criteria were categorized according to the notion of attractive quality. According to the findings of the Kano survey, which are presented in Table 1, one outcome indicates the sum of how many measures reduce into a particular condition according to the assessment table, with the state being classified as either “attractive one-dimensional, must-be, indifferent, or reverse."

The analysis was narrowed down at this stage. Using the Kano analysis, the quality result might be broken down into positive and negative categories for each questionnaire element. Next, the five quality characteristics of each aspect of graphic design in architecture were determined by quantifying the amount of frequency with which each attribute was mentioned. Attribute quality is largely dependent on element quality. Figure 2 depicts the Identifying attributes of the questionnaire.

The factors of satisfaction and dissatisfaction were calculated for each aspect of graphic design in architecture based on four characteristics "(attractive quality, must-be quality, one-dimensional quality, and indifferent quality)" using the equation (1) and (2) formulas. Finally, a conclusion was offered based on the analysis's findings.

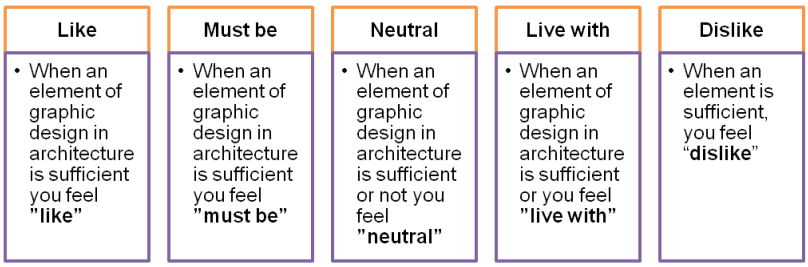

Figure 2: Identifying attributes of the questionnaire

Statistical Analysis

The Student's t-test is a statistical technique used to determine if the means of two groups significantly differ, often used in data with regular distribution. It includes various types such as independent samples and paired samples t-tests. The distance between a mean value taken from the sample and the distribution mean, represented by unit of the standard error, μ is an indication of t-statistics for a single-sample test ($\mathrm{S.E} = \frac{\mathrm{S.D}}{\sqrt{\mathrm{m}}}$).

$$\mathrm{s} = \frac{\text{sample mean} - \mu}{\mathrm{S.E.}} \tag{3}$$

The statistical significance of the measured value of s is determined by comparing it with the t distribution. The tabulated s values define the area of rejection, which is indicated by the ends of the s distribution. The mean of the single sample and the two-tailed test are then used to estimate an interval of confidence (CI) on the actual average in the population.

$$\mathrm{CI} = (\text{sample's mean}) \pm \mathrm{s(S.E.)} \tag{4}$$

$$\mathrm{CI} = (\text{sample's mean}) + \mathrm{s(S.E.)} \tag{5}$$

$$\mathrm{CI} = (\text{sample's mean}) - \mathrm{s(S.E.)} \tag{6}$$

The combined t-test may be applied in the statistical computations for a two-sample scenario. Given is the t-statistics value.

$$\mathrm{s} = \frac{\mathrm{mean1} - \mathrm{mean2}}{\mathrm{SP}\sqrt{\frac{1}{\mathrm{m}_1} + \frac{1}{\mathrm{m}_2}}} \tag{7}$$

Since the combined t-test assume an equal variance for the two population from which the two sets of samples were drawn, the symbol "SP" stands for the combined standard deviation, which is the combined estimation of each of the variances of the samples. The possibility of ignoring a null hypothesis that is not true can increase if the populations' variances are not homogeneous and a combined t-test is employed, which is undesirable. When there are differences in the variances, the Behrens-Fisher's test can be used instead of the combined t-test.

$$s' = \frac{\text{mean1} - \text{mean2}}{\sqrt{\frac{\text{variance1}}{m_1} + \frac{\text{variance2}}{m_2}}} \quad (8)$$

The variances found in equation (6) correspond to the samples. The numbers of observations in samples 1 and 2, denoted by the symbols m_1 andm_2, respectively. For both the combined t-test and a separate t-test, the two-tailed confidence intervals on the actual variation between the averages in the sample groups $(\mu_1 - \mu_2)$are,

$$\text{CI} = (\text{mean1} - \text{mean2}) \pm s(\text{SP}) \sqrt{\frac{1}{m_1} + \frac{1}{m_2}} \quad (9)$$

$$\text{SP} = \sqrt{\left\{\frac{[(m1-1)(\text{variance1}) + (m2-1)(\text{variance2})]}{(m1+m2-2)}\right\}} \quad (10)$$

$$\text{CI} = (\text{mean1} - \text{mean2}) \pm s \sqrt{\frac{\text{variance1}}{m1} + \frac{\text{variance2}}{m2}} \quad (11)$$

Change "±" to "+" or "-" for the lower or higher limit of a one-tailed test respectively

A paired t-test is the third variety of t-test. In contrast to the other two varieties, the paired t-test examines a single sample drawn from the population. A variable of interest is measured twice on the individuals in this sample: once prior to "treatment" and once following it. To put it another way, each acts as his control, which makes the data produced by this method more accurate. Similar twins are used in certain instances, where one is measured before receiving "treatment," and the other after. In the latter instance, the person may be required to take a psychological test as part of the "treatment."

The standard deviation and mean of the resulting differences (d_j) are found by computing the variances between the readings "before" and "after" using the paired t-test. The t-values are,

$$s = \frac{\text{mean of the differences}}{\text{SE}} \quad (12)$$

4. Experimental results

The results of the questionnaire used in the empirical investigation are reported below. The findings of the survey indicated that the quality characteristics were computed by taking into consideration the quantity of duration a certain quality attribute was mentioned. Following that, the attributes that were mentioned most frequently were selected to be included on the list of quality standards. The KM categorizes qualities into five distinct groups: "B," "N," "P," "J," and "S." The following characters stand for "attractive quality," "must-be quality," "one-dimensional quality," and "indifferent quality," respectively. "S" stands for "reverse quality." The findings of the present study place a priority on all quality characteristics, with the exception of reverse quality.

According to the findings, there are five components that contribute to an appealing quality: "shape," "Uniqueness," and other components of quality that really must be present: A component of quality with only one dimension, "quality assurance": "Quality" across all levels for each of the 13 components of graphic design in architectural design.

It is more apparent that a sufficient amount of attractive quality is present, which results in people's satisfaction; this suggests that graphic design created by a graphical designer possesses the appealing quality attribute with a high degree of reliability. The term "quality" refers to ensuring that products of collaborative art have as many indications of quality as is achievable. The level of quality and the degree to which one is satisfied appear to be one and the same dimension: as the quality is increased, the extent to which one is satisfied also increases. Because the “must-be quality” includes "Commemorative value," "quality assurance," and "local elements and features," it follows that the level of discontent will grow if the quality is lacking. People, therefore, take into account graphic design that incorporates regional components and traits, which highlights the variety between conventional approaches and graphic design.

Other components are categorized as not significantly affecting customer satisfaction and exhibiting no difference in the quality of graphic design in architecture, either good or bad. This outcome demonstrates that there is no reversal quality in the classification quality. Table 3 indicates the KM model for Adornment, Commemorative value, and Quality assurance (ACQ).

Table 3: Result of KM for ACQ

Element of graphic design in architecture	KM analysis				
	B (%)	P (%)	N (%)	J (%)	R (%)
Adornment	11.4	4.9	11.5	71.2	0
Commemorative value	11.4	17.8	40.5	30.8	0
Quality assurance	6.6	29.3	40.7	24.3	0

The majority of the components in Figures 3 and 4 and Tables 4 and 5 have positive qualities. In other words, when people acquire specific items that reflect local culture, sustainable development will not be a factor. Improvements in visual design quality increase consumer satisfaction, determined by the categorization of components as appealing, required, and one-dimensional. Furthermore, multiple benefits arise from distinct quality categories, allowing for optimal quality priority. For satisfied individuals, must-have features must be prioritized; “the attractive, one-dimensional quality” is also a key consideration. The information for the quality "Shape," must-be, and one-dimensional attributes, on the other hand, are quite close. Positive and negative statistics showed correlations of greater than fifty percent. This indicates that the satisfaction level shifts in either the direction toward or away from “one-dimensional quality." It also shows that "Architectural Shape" is more important than the others.

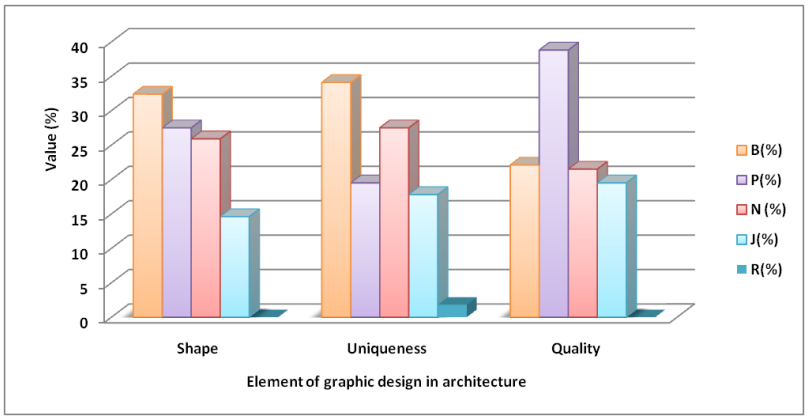

Figure 3:Result of KM for shape, uniqueness, quality

Table 4: KM value for shape, uniqueness, quality

Element of graphic design in architecture	KM analysis				
	B (%)	P (%)	N (%)	J (%)	R (%)
Shape	32.4	27.5	25.9	14.6	0
Uniqueness	34.1	19.5	27.5	17.8	1.8
Quality	22.1	38.8	21.5	19.5	0

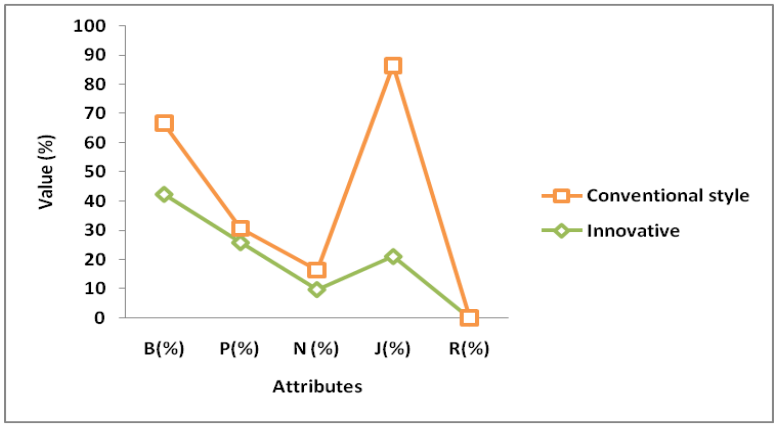

Figure 4: Result of KM for conventional style and innovative

Table 5: Result value of KM for conventional style and innovative

Element of graphic design in architecture	KM analysis				
	B(%)	P(%)	N (%)	J(%)	R(%)
Innovative	42.5	25.9	9.8	21.15	0
Conventional style	24.3	4.9	6.6	65.5	0

Figure 5 and Table6 depict the usage of Architectural graphic design. Graphical requirements and design are both undifferentiated in Figure 4. This indicates that whether or not architecture is given with a graphical design has little impact on customer satisfaction or standard of quality. This is due to the majority of graphic design being utilized in architecture.

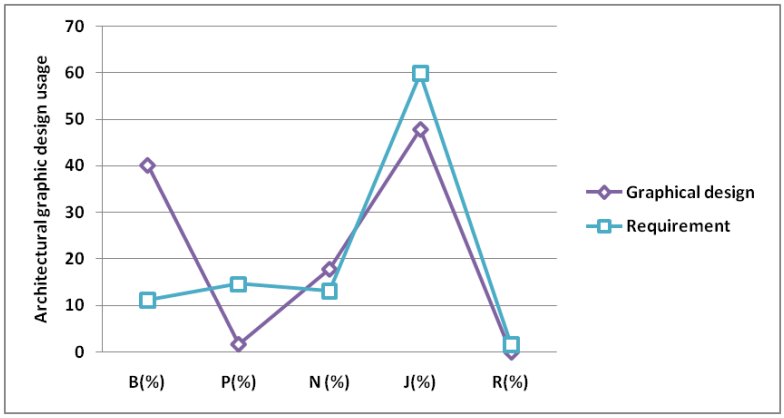

Figure 5: Usage of Architectural graphic design

Table 6: Value of Usage in Architectural graphic design

Element of graphic design in architecture	KM analysis				
	B (%)	P (%)	N (%)	J (%)	R (%)
Graphical design	40.1	1.7	17.8	47.8	0
Requirement	11.2	14.6	13.1	59.8	1.6

Figure 6 and Table 7 depict the completed usage. Local features and characteristics are necessary attributes in Figure 5, and the "traditional method" is a desirable trait. Conventional methods are used to create the highest quality graphic designs in construction. We created a variety of creative designs that correlate to the essential aspects of the growth of innovative architecture by utilizing local elements and features.

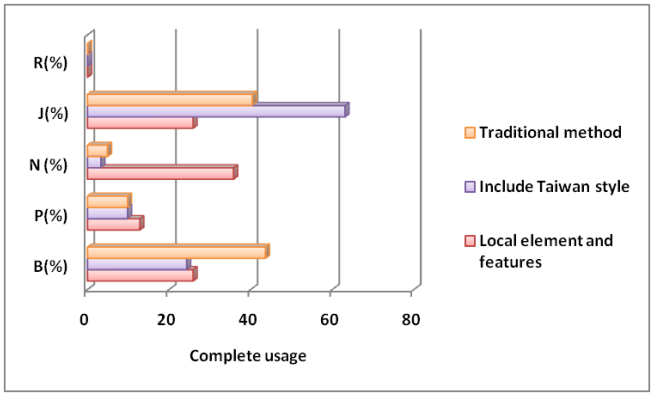

Figure 6: Outcome of complete usage in architectural graphic design

Table 7: Outcome value of complete usage in architectural graphic design

Element of graphic design in architecture	KM analysis				
	B(%)	P(%)	N (%)	J(%)	R(%)
Include Taiwan style	24.3	9.8	3.3	63.1	0
Traditional method	43.6	9.8	4.9	40.4	0
Local elements and features	11.4	4.9	11.5	71.2	0

Figure 7 depicts the satisfaction score for the element of graphic design in architecture. Figure 7 and KM analysis show the classification of elements used for graphic design in architecture. Elements such as shape, uniqueness, and traditional methods, innovative are classified as attractive. Graphical design requirements include Taiwan style; conventional style and adornment are classified as indifferent. Local elements and features, Commemorative value, and Quality assurance are classified as must be. Quality is classified as one-dimensional.

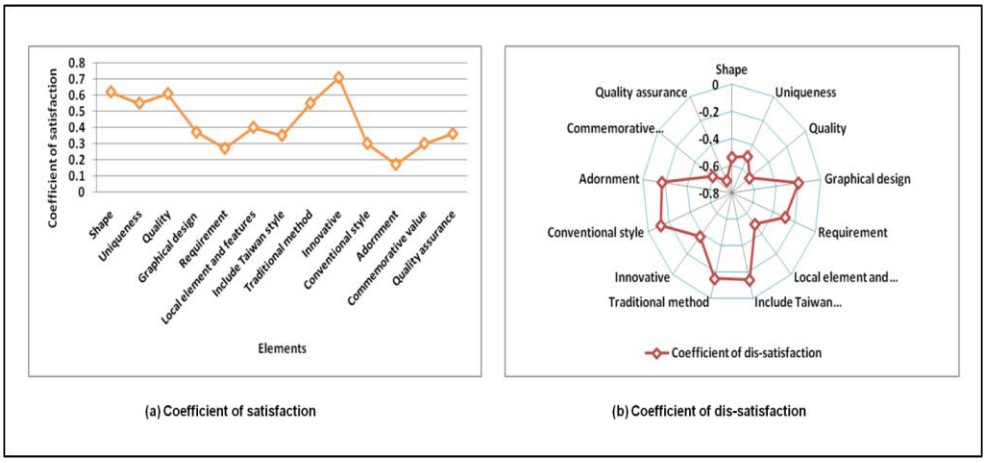

Figure 7: Coefficient of satisfaction and dissatisfaction

5. Conclusion

To sum up, the knowledge management system offers a valuable structure for comprehending contentment in the visual design of architecture environment art. Furthermore, the study offers insightful information about the essential graphic design qualities—clarity, simplicity, and visual appeal—that designers and architects ought to prioritize when producing architectural environment art. Architects and designers can meet the needs of their clients and produce superior architectural environment art by adding these qualities into their designs. This will increase customer satisfaction. All things considered, the KM may help designers and architects create designs that are centered on the needs of their clients and raise the standard of architecture environment art. Another drawback is that the study was conducted using a small sample size, which means it may not fully represent the total number of architects and designers. Larger-scale research could be done in the future to confirm the findings and provide more solid understanding of how KM is used to graphic arts in architectural environment art.

Ethics approval and consent to participate: I confirm that all the research meets ethical guidelines and adheres to the legal requirements of the study country.

There is **no human participate** /involved in this research. this article manuscript is created from collection of data set.

Consent for publication: I confirm that any participants (or their guardians if unable to give informed consent, or next of kin, if deceased) who may be identifiable through the manuscript (such as a case report), have been given an opportunity to review the final manuscript and have provided written consent to publish.

Availability of data and materials: The data used to support the findings of this study are available from the corresponding author upon request.

Competing interests: here are no have no conflicts of interest to declare.

All authors have seen and agree with the contents of the manuscript and there is no financial interest to report. We certify that the submission is original work and is not under review at any other publication.

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