

# Exploratory Factor Analysis of Lighting As Preferable Physical Environment Attribute

Siti Aisyah Muhammad

**Abstract:** *A great design is something that satisfied both client need and desire, whilst it is a challenge of innovation is to go beyond aesthetics. Literature reviews have developed several survey regarded to interpret the ideal images of the attraction factor from the prospective customer where the prospective and retrospectives approaches happened. A coffee shop is a cultural trend where the function is not only a drinking place. The issue of short sustain in coffee shop service while the current mushrooming of the coffee shop business everywhere lead to understanding the factor of customers preference in selecting a coffee shop. This paper aims to determine component of lighting as preferable physical environment using exploratory factor analysis in SPSS. The constructs of lighting comprised of comfortable lighting, enough lighting, bright lighting, natural lighting, energy saving lighting, candle lighting and colorful lighting. The components of the attributes were identifies after the Exploratory Factor Analysis (EFA) using Principle Component Analysis (PCA) and Hierarchical Cluster analysis from 188 prospective customers consisted of 38.3% male respondents and 61.7% female respondents, resulted two main components extracted namely natural lighting and artificial lighting. The distinct factors determine the preferable lighting attributes by the prospective customers towards the natural lighting compared to artificial lighting. The opening therefore must put as design priority for a coffee shop to allow natural penetration of lighting to the interior. The selection of material and building components also can be part of the consideration in allowing the access of natural lighting with minimal artificial lighting used. The result potentially applied in architecture, service design and innovation industry to produce preferable lighting condition by the client.*

**Keywords :** lighting, physical environment, prospective customers, sustainability

## I. INTRODUCTION

Design thinking is a discipline that utilizes a designer's sensibility and methods to match people's needs with a technologically feasible and viable business strategy that can be converted into customer value and market opportunity [1]. It has not to be a designer to produce the design, yet anyone can explode the idea and more ideas can create better understanding what consumer need and desire, as people themselves are the target users or the prospective customers. It happened by the experiences; more experiences show more perceived quality of the product. It called as human-centred design methodology [1]. It is agreed that emotion has connection to a product and feature is what engage as first impression. Designers and innovators claim to have something new in

their invention. Innovation in design is linked to experiential services where customers play the central role in innovation and design as opposed to technology [2]. The design field rely much of human preferences i.e; color, material, cost, function, and more. Human consideration may vary but in a public space, human will experience an identical atmosphere. This atmosphere although been shared, human perceived different value.

Selecting commercial physical surrounding as the subject of research is part of the contribution in the world of creative industry. The commercial place is where public are utilized and become the centre of socialized and doing businesses. Understanding the important of the impact of physical surrounding could enhance the usability of the commercial area provided. Commercial area consists of the activities such as buying and selling, services in retailing, financing and wide variety services considered as business. Coffee shop is not only as a place for business but also provide a space for socialize and work according to the services perceived. Coffee shop currently a most rapid developed business in the world and become a famous trend in foodservices. There are many kind of coffee shops competing such as franchise, themed, and also independent entrepreneur where it provide choices for public in selecting the coffee shop. The prospective customer will judge the business offered from the physical surrounding considering their first impression and expectation. This study aims to determine the physical component analysis regarded to lighting using factor analysis. The findings of this research will enhance the importance of understanding the comfort factors in a service business such as a coffee shop. Previous studies on physical elements have been done at retail stores and restaurants; however, studies specifically conducted on coffee shops are scarce. The opportunity to conduct a study on the physical comfort factors of a coffee shop will contribute to the design field as well as the innovation field as it analyses the prospective customers' point of views. The methodology employed will provide information on consumers' perceptions and give suggestions to produce the best practice design in many parts of the design components i.e. universal design, ergonomics, building services, interior design et cetera. In fact, this research will also contribute to the theoretical understanding of specific factors and their relationship in creating what consumers expect in a design. It also provides understanding on the impact of the physical surrounding in enhancing the usability of a coffee shop.

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## II. MATERIALS AND METHODS

Literature reviews have developed several survey regarded to interpret the ideal images of the attraction factor from the prospective customer where the prospective and retrospectives approaches happened. In service business such as restaurant, cafe and fast food, there are limited research employed. hedonic and utilitarian motives [3] and impact of product quality, service quality and contextual experience. The important aspect or marketing research is understanding demographic characteristics of those who will purchase the product [4]. The prospective have their own imagination and intention upon specific need and satisfaction. Although there are vast marketing campaigns, the factor that lead to purchase preference is the goal. Thus, this research will contribute to understanding grounded factors of prospective customers in selecting a coffee shop based on lighting factor. The demographic survey and components preferences are developed referring to the precedents study of previous researcher. There are three types of environmental cues or architectural features: fixed feature elements (such as walls and floors), semi-fixed feature elements (such as furniture type and arrangement, window displays) and non-fixed feature elements (such as s ambiance and people in the environment) [5]. This was followed by Baker [6] who provided taxonomy of environment cues which consisted of design factors, social factors and ambient factors.

To achieve the objectives of the research, a survey to determine prospective customers' preferences was constructed based on the common physical environment of the coffee shops. The components of the attributes of the coffee shops' physical comfort factors were identified after the Exploratory Factor Analysis (EFA) using Principle Component Analysis (PCA) and Hierarchical Cluster analysis. The components derived from previous researchers and precedent studies on the retails, upscale restaurants, hotels and other service businesses as well as several visual constructs were structured in a Likert scale survey and distributed to prospective customers of the selected coffee shops.

Prospective customers were asked about the stimuli and their experiences visiting the coffee shops and similar cafes, and the stimuli that fit their expectation of what a good coffee shop should be according to their preferences. The collective response of the prospective customers' preferences was then analysed to determine the physical comfort factors that highly influenced them. The constructs developed in the questionnaire were measured and clustered using the SPSS, especially using the Principle Component Analysis. The components that derived from the previous researchers and precedent studies about the retails, upscale restaurant, hotel and other service businesses, will be constructed in a Likert scale survey and distribute to the prospective customers of a coffee shop. The reason of using the existing components and construct suitable variables regards to coffee shop, is the prospective customers are persons who are not in decision maker stage yet. Prospective customer involves in

stimuli the experiences of visiting coffee shops and similar cafe, and stimuli the expectation of the best coffee shop should become according to his preference. The collective responds of the preferences by the prospective customers will be analysed to find the highest factors of physical environment influence them.

Lighting or the luminance value of the light will be taken as subject of component attribute in the coffee shop for this study. The level of comfort was growth at relatively low levels of light, while comfort reduced with high levels of light. Although mentioned researchers did not specifically encountered lighting as the component of the physical environment and became the attribute only, the study at a coffee shop is argued that lighting an indicator of comfortable level of the customers. Results showed that general communication was probably occur in bright environments, while intimate conversation occurred in softer light [7] A coffee shop may serve up to 24 hours a day and the consideration of lighting is very important. The attributes of lighting consisted of the brightness, natural lighting, artificial lighting, colourful lighting and energy saving lighting.

## III. RESULTS AND DISCUSSION

A survey has been distributed resulted 188 respondents from 72 male and 116 female (118 persons are single, 70 persons are married; 120 persons are age between 18-29, 58 person are age between 30-39, 10 persons age between 40-49; 112 persons are students, 10 persons are self-employed, 10 persons are part time working, 56 persons are full time working). The demographic study resulted the prospective customers at Figure 1 and Figure 2 as follow:

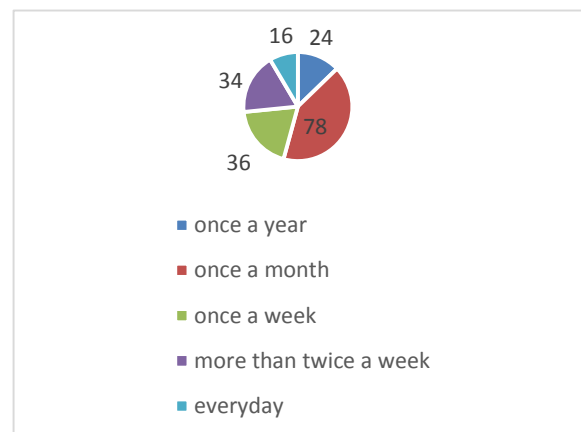
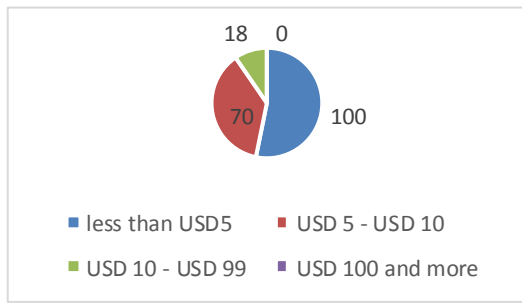


Fig. 1 Number of respondents regards to frequency of spending time in a coffee shop



**Fig. 2 Number of respondents regards to spending money in a coffee shop**

A likert scale 1- 10 (not at all likely – extremely likely) was used as the findings reveal that 10 points of Likert scale is more efficient than 5 points of Likert scale in operating of measurement model (Awang, 2015). The result constructs for Lighting were shown as follow:

The Exploratory Factor Analysis (EFA) procedure using the Principal Component Analysis (PCA) extraction method with Varimax Rotation examined on 7 items measuring Lighting. Table 1 shows the value for Bartlett’s Test which is significant (P-Value < 0.05) and also the measure of sampling adequacy by Kaiser-Meyer-Olkin (KMO) is 0.676 which is higher than the minimum requirement of 0.6 [8]. Both values (Bartlett Test which is significant and KMO > 0.6) reflect the current data is adequate to proceed into next step namely the Exploratory Factor Analysis (EFA) [8].

**Table. 1: KMO and Bartlett's Test**

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.676
Bartlett's Test of Sphericity	Approx. Chi-Square	819.108
	df	21
	Sig.	.000

Another measures namely Total Variance Explained is very important as an indicator to reflect how much the items used in the study manage to estimate the respective latent construct. Table 2 show the Total Variance Explained to measure the latent construct namely the Lighting as the preferences by the respondents. The value in Table 4 show that, the measuring items fall into two components with the Total Variance Explained from these two components is 71.791%. The component score explain the contribution of the particular component in measuring the construct. The output show component 1 contribute 47.759% and component 2 contribute 24.032%. The Total Variance Explained for the construct is acceptable since it above the requirement of minimum 60%. The value lower than 60% indicate the existing items are not adequate to measure the construct, thus the researcher needs to create and add few more items for the respective construct.

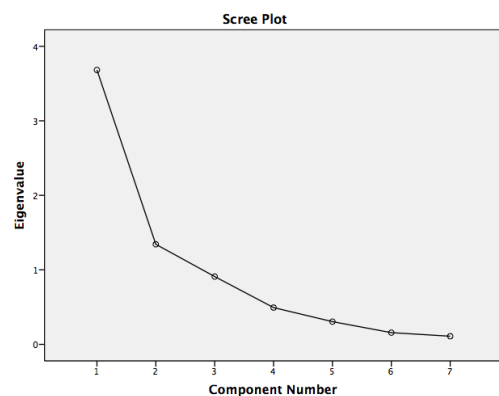
**Table. 2: Total Variance Explained contributed by every component**

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.683	52.608	52.608	3.343	47.759	47.759
2	1.343	19.183	71.791	1.682	24.032	71.791
3	.910	12.999	84.790			
4	.493	7.049	91.839			
5	.305	4.357	96.196			
6	.157	2.246	98.442			
7	.109	1.558	100.000			

The factor loading for each item indicates the importance of the respective item in measuring its construct. The minimum acceptable value of factor loading is 0.6, and the item with factor loading less than 0.6 should be removed and not used in the field study [8,9,10]. Table 3 and Fig. 3 show the factor loading for every items as well as their respective component. The study deleted the items with factor loading less than 0.6 as proposed by the literature. Fortunately, all items were above 0.6 and reliable to use for Lighting.

**Table. 3: Rotated Component Matrix**

	Component	
	1	2
Comfortable lighting	.821	.114
Enough lighting	.767	.257
Bright lighting	.638	.418
Natural lighting	.909	.129
Energy save lighting	.892	-.057
Candle lighting	.010	.835
Colorful lighting	.226	.843



**Fig. 3 Scree Plot of Lighting**

Cronbach Alpha which indicate the internal reliability of the selected items in measuring the construct. The Cronbach Alpha value for Lighting was .822 greater than 0.7 is acceptable as having good internal reliability. Thus the instruments for measuring the Lighting construct would consists of two characteristics.



There is significant between two clustered; the first group comprised of natural lighting criteria and another group consisted of artificial lighting. The analysis found that there were two components attributes from Lighting constructs with two distinct characteristics in a physical environment of a coffee shop. The prospective customers have decided that the natural lighting was most preferred in selecting good physical environment of a coffee shop. As stated, understanding the important of the impact of physical surrounding could enhance the usability of the commercial area provided. It can be seen by the selection of curtain wall or glazed window, open dining area and courtyard were higher seating choices than gloomy and dim atmosphere. The use of natural lighting also support the sustainable building in reducing depended to electricity. As agreed, mood and emotion influenced by the amount of light in a space.

#### IV. CONCLUSION

Lighting is one of the important element in considering the design and technology of the building. Using the natural lighting was proven the best solution not only to save the energy of electricity but also provide the most preferable physical environment in a space, namely a coffee shop. The findings have indicated two types of attributes in lighting preferences namely natural lighting and artificial lighting. Prospective customers play an important role in design and service business. The impact of their preferences upon a product results in the high market value and quality of the services provided.

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