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An Index for Measuring Aesthetic Perception of Shopping Building Frontages

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Abstract: Architects treat building frontages with careful attention to aesthetic detail. The ability of a building's frontage to draw attention is directly proportional to its aesthetic perception resulting from the composition of its constituent physical features. While deciding on the building's aesthetics is the architect's prerogative, a question arises as to on what basis can an architect compare various conceptual designs and decide on the best option, considering the building users' "likeability" factor. Aesthetic perception ratings and rankings from 206 regular shoppers were elicited. Further, 52 architects were asked to evaluate the aesthetics of these ranked shopping buildings. Combining Architects' Gestalt indices with Birkhoff's aesthetic measures as well as ranking weightages given by the public, a frontage aesthetic perception index of likeability—FAPIL, is proposed as an indexical aid for design decision making by architects. The findings were elicited by giving due consideration to building users' as well as architect's judgement so that they can be embodied into the design under conceptualization. Given site and cost constraints faced by the architect, the architect needs to ensure that the aesthetic features contributing to visual order be at least 2.3 times those that contribute to visual complexity for positive aesthetic perception of a shopping building.

Key words: Shopping building frontage, aesthetics, perception, likeability index.

1. Introduction

The frontage of a building is responsible for creating a good impression via perception formation in the people who use or intend to use it. The frontage is also a differentiator for the building's unique identity in a dense urban visual scape, full of buildings.

Urban designer Lynch [1] emphasized the role of visual elements in cognation of urban space way back in 1960s. In Lynch's definition of image as perception—"a picture especially in the mind", is a result of sentimental combination between objective city image and subjective human thoughts. Perceptions are formed by visual impressions made by the building's façade consisting of its visible elements such as entrance, display windows, signage and surroundings.

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The ability of a building's frontage to draw attention is directly proportional to its aesthetic properties resulting from the composition of its constituent physical features. While deciding on the building's aesthetics is the architect's prerogative, there are other determining factors such as sentiments it evokes on the onlookers, its ability to blend with the socio cultural landscape, its novelty and its notional real estate value for purposes of renting space, amongst others.

A series of designed elements in the frontage, come into perceptual play in creating the expectations and apprehensions in the mind even before the building is entered. If the first visual view of a shopping building is unsatisfactory, it is likely to have a negative connotation on the sum total experience that follows. This has been reported widely in shopping mall store research by Hirschman [2] and Bearden [3]. Some building features, over the passage of time, go on to create a positive attitude in the user while some others

leave a negative impact, which may lurk as a dislike sentiment in memory leading to gradually lowering the footfalls of visitors to the building. This ultimately may have a bearing on the commercial viability of the building's function as a shopping destination in a competitive marketing zone in a city. What could be the design strategy for a building's frontage that is functional, relevant and successfully creates the desired perception, is a question often confronted by an architect.

The term "Frontage" in this paper includes not only façade skins but also other elements such as openings, porches, entrance areas and all visible architectural elements that constitute the street level view from the front of the building.

A decision-aiding tool or metric that considers both, public's aesthetic preferences as well as the architects' judgement, if made available to the architects, would be immensely useful. It can become an index to lower the risk of unwittingly creating a perceptual barrier in the users' mental model due to mismatched aesthetics and prevent triggering of emotions leading to dislike of the building at the subconscious level. This paper discusses the aesthetic properties, features and their perception formation by proposing a framework for metrics.

The research questions that prompted this study are as follows:

(a) Can the shopping building's visage play a proactive role in formation of positive perception?

(b) Which visual characteristics of the building's frontage contribute to formation of positive, neutral, and negative perceptions resulting in some buildings being more liked than others?

(c) Is it possible to formulate perception-based metrics for indexing the "likeability" of a building's design? Such a metric if developed can aid architects in developing designs that are in consonance with user's perceptions of likeability.

To explore these questions from an architecture designer's point of view, a series of studies were conducted to collect and analyze users' perceptions along with architects' evaluations of shopping building frontages in India.

Based on data collected and its analysis, this paper proposes and develops a frontage aesthetic perception index of likeability (FAPIL). The proposed aesthetic perception index is intended as a metric for decision making by an architect. While there are aesthetic measures available in research literature, unlike them the proposed metrics in this paper take into consideration the aesthetic perception of the public in addition to the professional architect's aesthetic judgement.

2. Literature Review

Architects Ghosh et al. [4] have studied the case of Kolkata city while evolving a methodology for application of visual perception of an urban place. According to them visual perception has a substantial bearing on cognation, and fixing the importance of an urban place both in terms of prestige as well as popularity. They argue for a holistic interrelationship between the visual communicating aspect and spatial place making aspect of an evolving urban place. Their analysis reported that apart from buildings other elements of urban design such as signage, advertising and street furniture play a key role in forming the visual perception of a place. They concluded that the visual perception of the surrounding environment affects actions, reactions and feelings of the populace in that environment. While the conclusions strengthen role of visual perception, how exactly these visual elements matter in designing buildings and how are they to be integrated with the conceptualisation process have not been dealt by the authors. Who decides on the aesthetics and on what basis remains unaddressed in their paper. In this paper, the architects' role as aesthetic decision maker as well as the building users' perceptions is considered.

Researchers like Houston and Nevin [5]; Sinha and Banerjee [6]; Baker and Haytko [7] have investigated

the image aspects of shopping malls. Shopping mall image plays an important role for customers while choosing between different competitive shopping malls. Doyel and Fenwick [8] have shown that store image plays an important role for customers while choosing between different competitive shopping destinations. If a visiting experience has left a positive salience towards being liked, chances of repeat visits increase and every revisit reinforces past positive perceptions. These positive perceptions add up to a positive salience in terms of "likeability", which result in brand loyalty of the shopping building in terms of quality, service, ambience and general feel good factor. All these are known variables in increasing footfalls in a retail space. Higher the footfalls, greater is the rent value of the commercial space.

Hirschman [2] has shown that store image influences loyalty of the customer towards rating satisfaction. Bearden [3] indicated price, quality of the merchandise, assortment, atmosphere, location, parking facilities and friendly personnel as the characteristics affecting the store image. Bloemer and Ruyter [9] have elaborated on the relationship between store image, store satisfaction and store loyalty. In all these papers, the subject of study is more on correlations of shopping mall image as a perceptual construct in the minds of the shoppers and its influence on increase in commerce. They have no mention of correlating architectural or aesthetic design features themselves to satisfaction levels.

There is a general lack of frame works using which these findings can be converted into measurable or comparable aids for designing the aesthetics of a building by an architect. Given the need to compare the perceptual impression formed by two building design concepts under consideration by an architect, there are not many indices available in architecture. Therefore, in this paper a perceptual index is being proposed and developed to fulfil the gap. There is a dearth of research on the role of visual elements on the facade of a building and their influence in perception formation, which this paper intends to address.

3. Proposing Perception as Basis of an Index for a Building's "Likeability"

The development of an FAPIL that is proposed in this paper draws upon theoretical foundations as laid by Koffka [10]—Gestalt psychology; Birkhoff [11]—aesthetic measure; Arnehem [12]—artistic perception and Gibson [13]—affordances.

Nasar [14] has indicated that aesthetic responses to the environment are derived from the cognition of aesthetic properties based on the different features of an environment, such as building style, colour, streetscape, house style, city image and urban environment. Perception and aesthetics are interlinked cognitive phenomena. Gestalt psychology that emerged in the 20th century explains aesthetic properties in the form of laws of perception governing the principles of visual organisation dealing with forms and patterns. Koffka's [10] Gestalt School of Psychology propagated theories that describe how we perceive whole shapes by grouping individual sensory elements. Architectural building features and elements incorporated in the building's frontage are signs and symbols communicating and evoking the sum total perception as well as meanings in the building users' mental model. Arnheim [12] explains how we derive meaning (cognate) from our sensory perceptions using Gestalt psychology to form constructs.

How can all these aesthetic perception and cognation contributing variables be utilized to come up with a summated weightage value which can become the index of aesthetic measurement is the central question being explored in this paper. The paper proposes the basis and development of a building FAPIL using the architectural features of the building's facade. It is to be noted that while the entire building and its architecture play a role in perception formation and experience, only the frontage of a shopping building is under consideration here. This is

because for a user approaching the building, its frontage is the first sight of view and impression as well as starting point of "attention" leading up to "perception" formation resulting in the sum total nature of anticipated experiences inside the building. Towards development of the new index in this paper, a building FAPIL is proposed and developed using a combination of Birkhoff's aesthetic measure, Gestalt value and public's ranked likeability ratings. When the perception of the public is given due consideration in determining the aesthetics, such a building has a higher probability of being perceived as "liked" shopping destination which in turn increases its repeat footfalls resulting in higher brand equity of its renting value.

Birkhoff [11] was first to define an aesthetic measure using the concepts of beauty such as order and complexity. Several architects, psychologists and scientists such as Eysenck [15], Boselie [16], Marine and Leder [17], Das and Chithra [18] and many others interested in the phenomena of beauty and aesthetics have often cited and extended Birkhoff's measures in their published works.

Birkhoff denoted the aesthetic measure with the relationship M = f (O, C). Birkhoff's aesthetic measure was a numerical means of measuring beauty in structured geometric form such as in geometric patterns. It is the relationship between the order (O) and the complexity (C) of any form, denoted by the letter M. In his book *Aesthetic Measure*, Birkhoff defined the measure in relation to the effort (complexity C) with which the object demands of the perceiver and the pleasing features (order O) which can be recognised in the object. It also needs to be noted that Birkhoff did not define "f" except that the measure is a relationship of the two quantities namely order and complexity in a general setting. Several researchers like Douchov [19] have attempted to apply or prove Birkhoff's measure using variety of geometric figures such as polygon. Some have applied it to architecture building's 2D shape [18]. In all these cases, the researchers have defined their own O & C and the approach is purely structural with intention to quantify exact values. Birkhoff on the other hand intended it as an index of beauty and not as an absolute quantitative measure. In this paper, an index is being proposed and Birkhoff's measure has been adopted as the basic foundation to develop it.

In this paper, O in Birkhoff's f = (O, C) is characterised by ten order giving properties such as symmetry, harmony etc. summated by applying Gestalt principles. The resulting Gestalt Value, for each building is derived from summation of semantic ratings given by 52 professional architects on a semantic differential scale. It intends to metricize the relationship between the "likeability" of the frontage and the degree of adherence of its constituent design elements to Gestalt laws. Gestalt Law, also known as laws of good configuration, is utilized to determine sum total order "O" and complexity "C". Complexity C here in this paper is taken as those characteristics contributing towards disharmony and disorder as judged by architects, on a bipolar semantic differential scale that has complexity properties at one end and order contributing properties at the other end. The differential scale is based on the premises that the more visual complexity beyond a threshold, the lesser is the aesthetic attention holding capability.

In this paper, we define:

FAPIL = Birkhoff's M * Public Ranked weightage/10.

Where Birkhoff's Measure M = (GV - C)/C and Gestalt Value GV = (O + C).

6-point semantic differential scale > 3 degrees of Gestalt adherence as rated by architects.

C = Sum of all Gestalt parameter ratings on the 6-point scale < 3 on the semantic differential scale.

Public ranked weightage is rankings of buildings from 1 to 10 with weightage ranging from ten points to one point, normalized to base 10. The public who frequented shopping buildings ranked them. The detailed method and process adopted is outlined in Fig. 1.

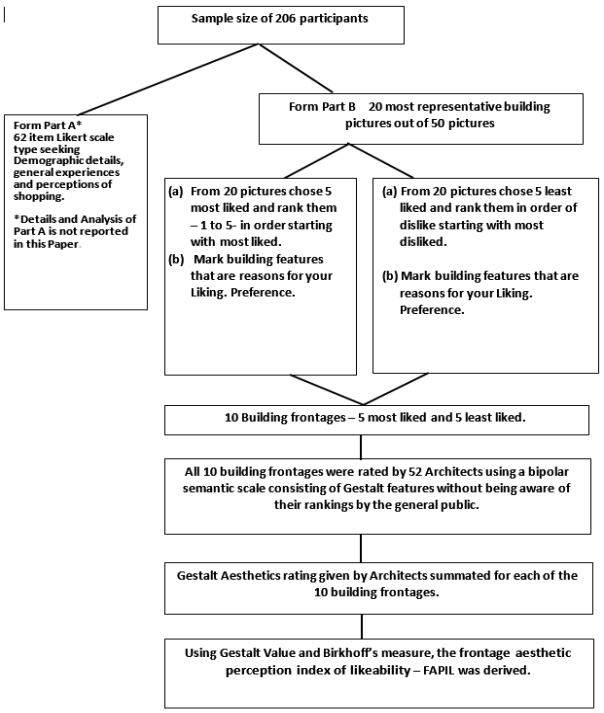

Fig. 1 Methodology flow diagram.

The Gestalt parameters identified to summate the Gestalt values are: Proportions + Harmony + Symmetry + Composition + Massing + Rhythm + Simplicity + Pattern + Balance + Order - with their opposites on the other end of the scale signifying Complexity. The 6-point semantic differential scales had, for example Asymmetry - Symmetry at bipolar ends. Data was collected online from 52 architects located all over India by using survey forms hosted on a popular search engine. Cronbach's Alpha for the collected data measured 0.979, which is > 0.7 thereby ascertaining that the semantic scale was reliable and displayed internal consistency.

4. Methodology

The flow diagram of the research investigation is shown in Fig. 1.

4.1 Sampling Procedure for Selecting Stimuli

To begin with, fifty (50) numbers of shopping building pictures from metros and medium sized urban towns, classified as Tier 1, 2 & 3, were picked from all regions of India. The sources of these pictures were architectural magazines, real estate brochures and websites. From these fifty (50) randomly compiled images of shopping malls, twenty (20) of the most representative cases reflecting typical shopping frontages in India were segregated by the researchers using the following criteria: (a) independent standalone building meant and built only for shopping purpose, (b) unobstructed view of frontage from street, (c) wide verity of architectural styles that are representative of a typical shopping mall frontage in India, (d) distinct

Fig. 2 ranking of the 10 building frontages by 206 respondents from the public.

building forms were chosen by eliminating buildings with high similarity in looks from amongst the 20 pictures, (e) closeness of the design to an architype or typical shopping building found in Indian metros, tier-2 and tier-3 towns.

These twenty (20) shopping building pictures formed the perceptual stimuli database from which 206 respondents from the public finally picked and ranked 10 pictures. Out of these 10 pictures picked (see Fig. 2), five of them were for "the most liked' and five "the least liked", in the aesthetic judgement of the respondents.

4.2 Administrating Survey Instrument for Experimental Data Collection

A survey form with two parts (A) & (B) (see Fig. 1) was administered to 206 randomly approached participants who volunteered to take part with consent. These respondents were regular shopping mall visitors belonging to metros and tier 2, tier 3 towns in India. Part A of the survey containing 62 Likert scale items focused on rating past experience of shopping malls in general and collected demographic details. Part A is not reported and discussed in this paper as it is related to constructs where as in this paper only perception is being addressed.

Part B (Fig. 1) of the experiment involved choosing and ranking pictures of shopping mall frontages and identifying constituent features, which contributed to formation of percepts such as "like" or "dislike". Respondents were asked to choose five most liked and five least liked (total 10) building frontages from a set of twenty shopping building pictures. The building frontage samples were A4 sized good quality colour printed and laminated picture cards. Respondents were asked to rank them in order from 1st rank to 5th rank in terms of their liking of building's architecture designs from aesthetic point of view. Further using a transparent sheet over the 10-ranked building pictures, respondents were asked to mark on the transparent overlay using a marker, those features on the ranked building that they thought, contributed towards their liking or disliking of the buildings. However, the structural configuration analysis of these marked feature themselves is not part of this paper which confines to perception of those features.

Hence, we obtained 5 most liked buildings ranked 1 to 5 and five least liked buildings ranked 1 to 5 by the 206 public respondents. Fifty-two volunteering architects on a bipolar semantic differential scale having 17 parameters out of which ten were Gestalt properties, later rated these ten ranked buildings. The architects were not aware of these buildings having been ranked by the public nor were they presented in any ranking order. They were asked to rate the 10 randomly sequenced pictures of buildings on a six point semantic scale using online forms. Statistics were compiled and the inferences drawn after analyzing the data are presented in the next section.

5. Analysis

The results of the ranking of five most liked and five least liked shopping building frontages by 206 respondents are shown in Fig. 2.

The statistically summated Gestalt value given by 52 architects to the ten ranked buildings, the resulting Birkhoff's measure—M and subsequent FAPIL derivations are shown in Table 1.

The prevalence of aesthetic properties as summated by the Gestalt Values of Order and Complexity rated by architects are shown in Fig. 3. As observed in the graph (Fig. 3) there is a decrease in properties that contribute to Order (red bars) and increase in properties that contribute to Complexity (blue bars) as the rank of the buildings descends from left to right.

As observed in Table 2, for the five most liked ranked buildings, both the public and the architects have overall congruency in the rank positions.

For the buildings ranked one to five by the public respondents (column 3 in Table 2) the architects too have rated them in the same descending ranks (column 4 of Table 2) as arranged by the Gestalt

Table 1 Results of the statistical summation of the ratings to yield Gestalt values, Birkhoff's measure and FAPIL that were defined under Section 3.

Rank order liked 1 to disliked 10 in descending order	1	2	3	4	5	6	7	8	9	10
	LPN10	LPN13	LPN18	LPN03	LPN17	DLPN09	DLPN16	DLPN01	DLPN04	DLPN06
Total complexity C	0.04	0.26	0.35	0.18	0.20	0.45	0.40	0.40	0.39	0.45
Total order O	0.73	0.41	0.32	0.49	0.47	0.16	0.26	0.25	0.27	0.20
Gestalt value GV = O + C	0.77	0.68	0.68	0.67	0.67	0.61	0.66	0.66	0.66	0.65
GV - C	0.73	0.41	0.32	0.49	0.47	0.16	0.26	0.25	0.27	0.20
Birkhoff's measure M = (GV - C)/C	17.16	1.57	0.92	2.71	2.33	0.36	0.64	0.63	0.68	0.46
FAPIL = M * ranked weight/10	17.16	1.41	0.74	1.90	1.40	0.18	0.26	0.19	0.14	0.046

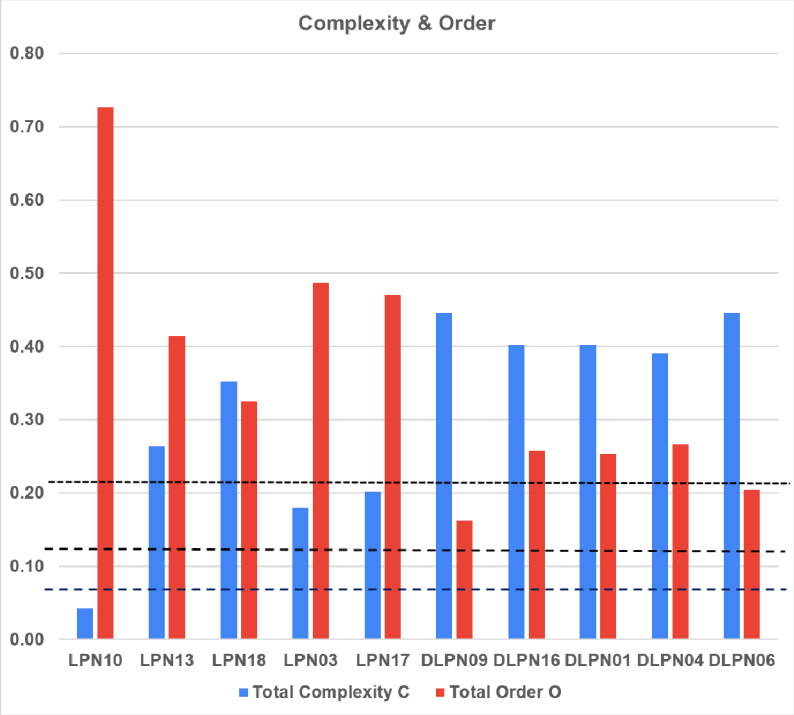

Fig. 3 Graph showing order and complexity properties as deduced from the Semantic differential scale ratings by architects.

Table 2 The ten building frontage ranks order given by the public in comparison to rankings attributed by calculating Gestalt value, Birkhoffs M and FAPIL.

Ranking table based on aesthetic indices					
Category	Picture No.	Ranking order as accorded by general public	Ranking order by architects based on Gestalt values CV = O + C	Ranking order by architects based on Birkhoff's measure M = (GV - C)/C	Ranking order based on FAPIL = M * ranked weight
	LPN10	1	1	1	1
	LPN13	2	2	4	3
Liked	LPN18	3	3	5	5
	LPN03	4	4	2	2
	LPN17	5	5	3	4
	DLPN09	6	10	10	8
	DLPN16	7	6	7	6
Disliked	DLPN01	8	7	8	7
	DLPN04	9	8	6	9
	DLPN06	10	9	9	10

values attributed by architects. Both have chosen the same set of five buildings, under "liked" category and same set of buildings under "disliked".

All pictures that were categorized as disliked by the public have also been ranked lower by the architects in terms of their Gestalt values as seen in Table 1.

When both, the public's as well as the architects' ratings are taken together into consideration, the ranking order of the buildings changes (column 6 in Table 2).

Here too it is noted that while within group rank positions changed, the buildings under each category of Liked & Disliked have remained the same indicating that as far as perception of aesthetics goes both architects and public share commonalties at a broad level even though there is difference in the attributed rank.

6. Inferences from FAPIL as an Index Range

A combined reading of Table 1 and Fig. 3 which is visually depicted as a combined bar graph in Fig. 4 the following can be observed:

(a) When FAPIL > 1, a building's frontage has a high probability of being perceived as "liked" by both public and architects (Fig. 4—dotted line 1 right hand side vertical scale).

(b) If FAPIL is < 0.18, it is seen that building has a high probability of being "disliked" by both public and architects (as seen in Table 1 and Fig. 4, DLPN04 has a FAPIL value of 0.14 and DLPN06 has a FAPIL value of 0.046).

(c) When FAPIL is between 0.26 and 0.74 (as seen in Table 1) a building has a high probability of getting a mixed response of either "liked" or "disliked" from the public even though architects may tolerate otherwise.

(d) It is also observable in Table 1 and Fig. 4, for a building frontage to be liked with certainty by both architects and public put together, quantum of perception difference between frontage features exhibiting "order properties" and "complexity properties" has to be at least 2.33 (as seen in Table 1, LPN17 has M = O/C as 2.33).

(e) If the quantum of perception difference between features having "order properties" and "complexity properties" is less than 0.6 times, the building frontage has a high probability of being definitely "disliked" by the public even though architects may feel that it has sufficient aesthetic qualities (see Table 1, DLPN 09 & DLPN 06 have M = O/C as 0.36 and 0.46 respectively).

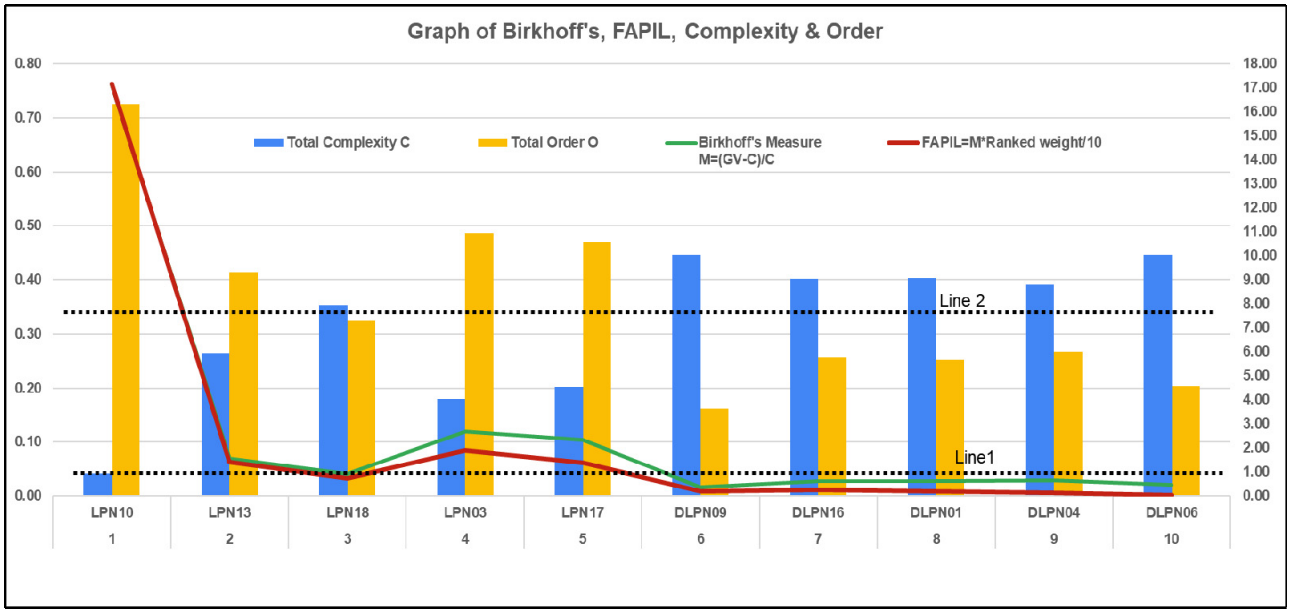

Fig. 4 Graph showing values of Gestalt namely order & complexity, corresponding Birkhoff's measure and derived FAPIL.

(f) In Table 1 it is observed that as the quantum of order O and quantum of complexity C start becoming equal to each other, the building's "likeability" attribute becomes uncertain.

(g) As seen in Table 1 (under LPN18) and Fig. 4 (dotted line 2), if quantum of complexity in a building's frontage increases beyond 0.35 (35%) the building has a high probability of being "disliked" by both public and architects.

7. Conclusions

Our recommendation to architects is—while conceptualising frontage designs they need to ensure that built features that contribute to "Order" should be at least twice of those that contribute to "Complexity", given a design. When alternative design concepts are under comparison, an agile semantic differential test can be conducted to estimate FAPIL to ascertain which of the design concepts under consideration have higher probability of being "liked" and accepted both by the public users of the building as well as the architects. If FAPIL turns out to be > 1 the building frontage design is in all probability liked by all. If FAPIL is < 0.18, the design has a high probability of being disliked by both public and fellow architects. The paper proposed and developed an FAPIL that can be an aid for decision making by the architect. FAPIL holds for shopping center frontages and will need further testing for consistency and applicability.

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References

[1] Lynch, K. 1964. *The Image of the City*. Cambridge. USA: MIT Press.

[2] Hirschman. 1981. "Retail Research and Theory." In *Review of Marketing*, edited by Enis, B. M., and Roering, K. J. Chicago, IL: American Marketing Association.

[3] Bearden, O. 1977. "Determinant Attributes of Store Patronage: Downtown Verses Outlying Shopping Areas." *Journal of Retail* 53: 15-22.

[4] Ghosh, M., Nag, S., and Roy, S. 2015. "Evolving Process of Application of Methodology for Visual Perception of Urban Place: Case Study of Kolkata." In *ICoRD'15—Research into Design across Boundaries*, Vol. 1, 443-55.

[5] Houston, M. J., and Nevin, J. R. 1980. "Retail Shopping Area Image: Structure and Congruency between Downtown Areas and Shopping Centres." In *Advances in Consumer Research*, edited by Monroe, K. B. Vol. 8, Ann Abor: Association for Consumer Research.

[6] Sinha, P. K., and Banerjee, A. 2004. "Store Choice Behaviour in an Evolving Market." *International Journal of Retail Distribution and Management* 32 (10): 482-94.

[7] Baker, J., and Haytko, D. 2000. "The Mall as Entertainment: Exploring Teen Girls' Total Shopping Experience." *Journal of Shopping Centre Res* 7 (1): 29-58.

[8] Doyel, P., and Fenwick, I. 1974. "How Store Image Affects Shopping Habits in Grocery Chains." *Journal of Retail* 50: 39-52.

[9] Bloemer, J., and Ruyter, K. D. 1998. "On the Relationship between Store Image, Store Satisfaction and Store Loyalty." *European Journal of Marketing* 32 (5/6): 499-513.

[10] Koffka, K. 1935. *Principles of Gestalt Psychology*. Boston, MA: Routledge.

[11] Birkhoff, G. D. 1933. *Aesthetic Measure*. Cambridge: Massachusetts' University Press.

[12] Arnheim, R. 1954. *Art and Visual Perception—A Psychology of the Creative Eye*. London: Cambridge University Press.

[13] Gibson, J. J. 1979. *The Ecological Approach to Visual Perception*. Boston: Houghton Mifflin.

[14] Nasar, J. L. 1994. "Urban Design Aesthetics: The Evaluative Qualities of Building Exteriors." *Environment & Behaviour* 26 (3): 377-401.

[15] Eysenck, H. J. 1941. "The Empirical Determination of an Aesthetic Formula." *Psychological Review* 48 (1): 83-92.

[16] Boselie, F., and Leeuwenberg, E. 1985. "Birkhoff Revisited: Beauty as a Function of Effect and Means." *The American Journal of Psychology* 98 (1): 1-39.

[17] Marin, M. M., and Leder, H. 2013. "Examining Complexity across Domains: Relating Subjective and Objective Measures of Affective Environmental Scenes, Paintings and Music." *PLoS ONE* 8 (8): e72412. doi: 10.1371/journal.pone.0072412.

[18] Das, P. G., and Chithra, K. 2015. "Aesthetics Evaluation

of Buildings—A Methodological Framework." In *ICDPCA 15 Proceedings of the International Conference on Reinventing Design Pedagogy and Contextual Aesthetics*.

[19] Douchova, V. 2015. "Birkhoff's Aesthetic Measures." *Acta Universitatis Carolinae Philosophica et Historica* Vol: XXI/2015 , Issue 1 , p 39-53, Publisher Univerzita Karlova v Praze, Nakladatelstvi , Karolinum.