The Economic Rationale for Rent and Positioning of Shops in Shopping Centers

Sumanta Deb
Assistant Professor, Indian Institute of Engineering Science and Technology, Shibpur, How-711103, E Mail: sumanta04@gmal.com
Cell: 9477002117

Abstract

Human activity in general and retail consumer behavior in particular is profoundly influenced by built environment. This has necessitated the growth of research in this particular area. This influence can be measured in its degree and shaped through design interventions. Space Syntax, in this context, is an evidence-based approach in planning and design of buildings and urban areas. The purpose of the paper is to identify the spatial-economic rationale behind determining the optimal store area and rent of non-anchor shops and positioning of shops within shopping centers. The paper develops a formal model of bid-rent, based on store location within shopping centers. The model is specified and solved with an objective function of profit maximization. It also considers integration value, which may be understood as a measure of the accessibility of a location, as an aid in explaining the spatial distribution of retail rents.

Key Words: Bid-rent model, Integration value, Metric depth, Space Syntax

1.0 Introduction:

Studies on retail have paid little attention to the micro-level spatial aspects of store location and rent within shopping centers. An understanding of such location behavior within the mall, though, can aid considerably in optimizing design, space allocation and tenanting decisions. Studies conducted on shopping centers have explored the micro-economic foundations of the lease price discrimination and allocation of a particular store in the overall spatial arrangement (Benjamin, Boyle and Sirmans (1992); Brucckner (1993); Eppli and Shilling (1995); Pashigan and Gould (1998)). The studies were non-locational and based on inter-store externalities. It can be concluded that, locational aspect of a particular store, which is necessarily based on agglomeration economics of their spatial properties, will be a possible extension of the studies done so far.

Brown (1991), Sim and Way (1989) suggested that, bid-rent theory should describe customer circulation and movement in regional or super-regional shopping centers and explain location characteristics of stores. Normally customers prefer shops that can be easily accessible. The main purpose of this paper is to provide economic rationale for rents of non-anchor stores based on the assumption that, a higher number of customers will lead to higher sales. The optimal store area and rent are intended to be calculated from the analyzed model of bid-rent. The bid-rent model is specified and solved with an objective function of profit maximization in the presence of comparative and impulse shopping behavior. Like other areas of economics, spatial arrangement of shopping centers has a lot of externalities and those have to be internalized through rational rent discrimination and mall space allocation.

2.0 Conceptual Model:

Brown (1991), Sim and Way (1989) suggested that, bid-rent theory should describe customer circulation and movement in regional or super-regional shopping centers and explain location characteristics of stores. Each store's actions represent a balance between the goals of maximizing its own profit, and maximizing profit for the entire shopping center by lowering prices and attracting more consumers to the mall. The latter mechanism of attracting more consumers to the mall allows the stores to exert externalities on each other. In this setup, the developer's choice variables do not include price (unlike in the typical vertical integration model) but include the type and size of anchor and non-anchor stores selected to occupy the mall. These choice variables can be thought of as a means to regulate competition among stores for location and horizontal externalities in a way that maximizes the profits of stores in the mall, which in turn maximize the profit of the developer through store rents.

If we consider a planned shopping center (n number of shops), where

P_i= Total profit

p_i = Average price per unit of goods sold for a particular store i

α_i = Quantity of goods sold per purchasing customer visit for that store

A_i = Area of the store i

$u_i(A_i)$ = Proportion of customer traffic per unit of store area, that actually leads to purchase

d_i = density of customer traffic

Quantity of goods sold for store S_i:

$$q_i = \alpha_i u_i(A_i).A_i.\beta_i \prod_{\substack{j=1 \\ j\neq i}}^{n} .S_j^{\delta_{ij}} \quad (1)$$

δ_{ij} is the cross store elasticity between shops i and j, stores and δ_{ij} need not be same as δ_{ji}. And β_i denotes natural density, total density for the store i is $\beta_i. \prod_{\substack{j=1 \\ j\neq i}}^{n} .S_j^{\delta_{ij}}$

Total sales for store i will be

$$p_i.q_i = p_i.\alpha_i u_i(A_i).A_i.\beta_i \prod_{\substack{j=1 \\ j\neq i}}^{n} .S_j^{\delta_{ij}} \quad (2)$$

Total sales of the entire mall will be,

$$\sum_{i=1}^{n} p_i.q_i = \sum_{i=1}^{n} p_i.\alpha_i u_i(A_i).A_i.\beta_i \prod_{\substack{j=1 \\ j\neq i}}^{n} .S_j^{\delta_{ij}} \quad (3)$$

Cost of store i is:

$$c_i = \varphi_i.q_i^{\tau_i} \quad (4)$$

Where, τ_i is the operating cost efficiency.

Cost of entire center can be expressed as:

$$\sum_{i=1}^{n} c_i = \sum_{i=1}^{n} \varphi_i.q_i^{\tau_i} = \sum_{i=1}^{n} \varphi_i.\left[\alpha_i u_i(A_i).A_i.\beta_i \prod_{\substack{j=1 \\ j\neq i}}^{n} .S_j^{\delta_{ij}}\right]^{\tau_i} \quad (5)$$

There are a number of constraints in this model, and they are to be included in the problem formulation. First, there is a capacity constraint or physical constraint, where the area requirement for all n shops will not exceed total available area of S*. Second is the availability constraint, where quantity of goods sold for all the stores cannot exceed a specific level of Q^* and total customer density cannot exceed D^* depending

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on the locational characteristic of the shopping center. Then there are control constraints. The area A^L_i and A^U_i are the lower and upper bounds for space allocated to store i. Lower bounds may be set for retailers pre-conceived notion of "image", irrespective of immediate profitability, and upper bounds for sustenance and design obligations. Finally there are non –negativity constrains on S_i to ensure reasonable solution values.

The profit of the center will be:

$$P = \sum_{i=1}^{n} p_i \cdot \left[\alpha_i u_i(A_i).A_i \cdot \beta_i \prod_{\substack{j=1 \\ j\neq i}}^{n} S_j^{\delta_{ij}} \right] - \sum_{i=1}^{n} \varphi_i \cdot \left[\alpha_i u_i(A_i).A_i \cdot \beta_i \prod_{\substack{j=1 \\ j\neq i}}^{n} S_j^{\delta_{ij}} \right]^{\tau_i} \quad (6)$$

As the objective is to maximize profit, the model will be:

$$max \sum_{i=1}^{n} p_i \cdot \left[\alpha_i u_i(A_i).A_i \cdot \beta_i \prod_{\substack{j=1 \\ j\neq i}}^{n} S_j^{\delta_{ij}} \right] - \sum_{i=1}^{n} \varphi_i \cdot \left[\alpha_i u_i(A_i).A_i \cdot \beta_i \prod_{\substack{j=1 \\ j\neq i}}^{n} S_j^{\delta_{ij}} \right]^{\tau_i}$$

Subject to

$\sum_{i=1}^{n} A_i \le S^*$

$\sum_{i=1}^{n} d_i \le D^*$

$\sum_{i=1}^{n} \alpha_i u_i(A_i).A_i \cdot \beta_i \prod_{\substack{j=1 \\ j\neq i}}^{n} S_j^{\delta_{ij}} \le Q^*$

i=1,2,3……n

$A_i^L \le A_i \le A_i^U$

i=1,2,3……n

$A_i \ge 0$

i=1,2,3……n

Because of intrinsic non-convexity of the model, linear programming cannot be used because neither the objective function, nor the constraints are linear. For the purpose of simplicity and convenience, a linear, symmetric mall is considered. This describes the situation of non-anchor stores. There are 'n' different types of mall tenants, and for each type of mall tenant, a store ' i ' will have the following profit function:

$$P_i = p_i.\alpha_i u_i(A_i).d_i.A_i - C_{Fi} - C_{Mi}.A_i - C_{Li.}.\alpha_{i.}.u_i(A_i).d_i.A_i - C_{Oi}.\alpha_{i.}.u_i(A_i).d_i.A - r.A_i \quad (7)$$

C_{Fi} =Fixed cost for the store i

C_{Mi} = Variable cost of the store i, (maintenance, utilities and tenant finish-out etc)

C_{Li} = Labour and operating cost of the store i

C_o = Cost of goods sold

r= rent

Normally, Stores have an incentive to limit the size to a level, where the relationship $u_i(A_i).A_i$ has decreasing returns to scale, $u(A).A = k_1.A^{k_2}$, where, $0<k_2<1$ considering decreasing returns to scale

If, for convenience, we ignore the subscripts, the relationship will become:

$$P = p.\alpha.u(A).d.A - C_F - C_M.A - C_{L.}.\alpha.u(A).d.A - C_O..\alpha.u(A).d.A - r.A \quad (8)$$

Differentiating equation (8) with respect to A, we have:

$$\frac{dP}{dA} = p.\alpha.u(A).d[p - C_L - C_O] - C_M - r + A.\{\alpha.d.\tfrac{dU}{dA}.[p - C_L - C_O]\}$$

As the purpose of the store is to maximize profit,

$$\alpha.u(A).d[p - C_L - C_O] - C_M - r + A.\{\alpha.d.\frac{dU}{dA}[p - C_L - C_O]\} = 0$$

$$\therefore \alpha.d.[p - C_L - C_O][u(A) + A.\frac{dU}{dA}] - C_M - r = 0$$

$$\therefore \alpha.d.[p - C_L - C_O]\frac{d[u(A).A]}{dA} - C_M - r = 0$$

$$\frac{d[u(A).A]}{dA} = \frac{C_M + r}{\alpha.d.(p - C_L - C_O)} \quad (9)$$

If $u(A).A=k_1.A^{k}{}_2$, where, $0<k_2<1$ considering decreasing returns to scale

$$k_1.k_2.A^{K_2-1}=\frac{C_M+r}{\alpha.d.(p-C_L-C_o)}$$

$$A=[\frac{C_M+r}{\alpha.d.(p-C_L-C_o).k_1.k_2}]^{\frac{1}{k_2-1}}$$

(10)

In a competitive market excess profits are bid away by increases in rates of lease, so that P=0, so the profit function in equation (2) becomes

$$P=0=\alpha.u(A).A.d(p-C_L-C_O)-C_F-C_{M.}A-r.A$$

$$r=\alpha.u(A).d.(p-C_L-C_O)-C_M-\frac{C_F}{A}$$

(11)

From equations (10) and (11):

$$k_1.k_2.A^{k_2-1}=\frac{C_M+\alpha.u(A).d.(p-C_L-C_O)-C_M-\frac{C_F}{A}}{\alpha.d.(p-C_L-C_O)}$$

$$=\frac{\alpha.u(A).A.d.(p-C_L-C_O)-C_F}{A.(p-C_L-C_O).\alpha.d}$$

$$k_1.k_2.A^{K_2}=\frac{\alpha.u(A).A.d.(p-C_L-C_O)-C_F}{\alpha.d.(p-C_L-C_O)}$$

$$=u(A).A-\frac{C_F}{\alpha.d.(p-C_L-C_o)}$$

$$\Rightarrow k_1.k_2.A^{k_2}=k_1.A^{K_2}-\frac{C_F}{\alpha.d.(p-C_L-C_O)}$$

$$\Rightarrow k_1.A^{k_2}(1-k_2)=\frac{C_F}{\alpha.d.(p-C_L-C_O)}$$

$$\Rightarrow A^*=[\frac{C_F}{\alpha.d.(p-C_L-C_O).k_1.(1-k_2)}]^{\frac{1}{k_2}}$$

(12)

and,

$$r^*=C_F.\frac{k_2}{1-k_2}.[\alpha.d.(p-C_L-C_O).k_{1.}(1-k_2)/C_F-C_M]^{\frac{1}{k_2}}$$

$$=C_F[k_2/(1-k_2)]./A^*-C_M$$

(13)

Where, A^* is the Optimal store area and r* is the optimal rent.

Rent

$$r=f(p_i,\alpha_i,u_i(A_i),d_i,C_{Li},C_{Oi},C_{Fi},C_{Mi})$$

(14)

Where, $\delta r/\delta d>0$,

And

Area

$$A=f(p_i,\alpha_i,u_i(A_i),d_i,C_{Li},C_{Oi},C_{Fi},C_{Mi})$$

(15)

Where, $\delta r/\delta d<0$,

From equation (14) and (15) it can be concluded that, considering the assumption of *ceteris Paribas* or other things remaining constant, optimal area of the non-anchor stores decreases with increasing customer density and vice-versa and the optimal rent of the non-anchor stores increases with the increasing customer density and vice-versa. Researches in the field of retailing express customer density as a function of metric distance from the centre of the mall or from the access point of the spatial arrangement. But the studies on environmental psychology or architecture focus on syntactical values. Space syntax method decomposes the overall spatial arrangement into constituent units and assigns them numeric tags. One of the important variables for space syntax analysis is the integration value, which describes the connectedness of the area with the overall spatial arrangement. So, customer density can be expressed as a function of:

$d = f(t, i)$ (16)

Where t denotes metric depth and i denotes syntactical integration, $\delta d/\delta t<0$ and $\delta d/\delta i>0$

3.0 Customer Density and Metric Distance from the central position:

As it was previously mentioned, consumers prefer stores that can be easily accessible. Vandell and Carter(1993); Drezner et al.(2002), Dellaert et al.(2008) and Popkowski Leszczyc et al.(2004) supported the concept that consumers prefer closest stores *ceteris Paribas.* So, shops that are most accessible than others in a particular arrangement will generate more customer density when all other factors remain unchanged. Assuming a higher number of footfalls lead to higher sales, competition for accessible locations should drive up rents for shops that are accessible. Now, if it is considered that, the density is dependent upon distance from the center of the mall where the customer density is dependent on the depth from the center of the entire spatial arrangement ,density can be expressed as a function of depth,
i.e., d=d(t).

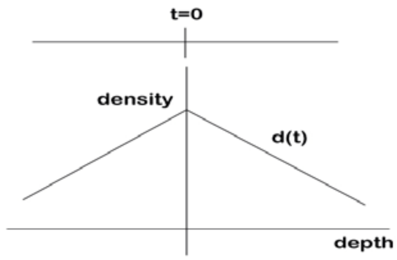


Figure I: Depth density relationship

Considering the linear symmetric spatial arrangement, as mentioned at the time of describing the model, t=0 at the center and changes with increasing depth. There is a significant evidence that d(t) is downward sloping. The customer circulation study by Brown(1991), Sim and Way(1989) and from the general observations of Fisher and Yezer(1993) show highest concentration of shoppers at the center of the mall with decrease in density from the center.

The slope of d(t) can vary depending upon various other non-spatial factors but it will slope downward nevertheless. So, metric distance is one important factor for determining customer density and therefore retail rents. But, the idealistic situation of symmetrical mall will not always hold and there can be difference of density at equal distances from the shopping mall center. So, some other variable for analyzing customer density is required.

4.0 Space Syntax analysis and Integration value:

Space syntax analysis can be considered as an important tool in this regard. It analyses built environment from a spatial perspective with some quantitative tools. The underlying concept is that, ‘form’ and ‘function’ are closely related. The analysis starts by decomposing the space into small components using some set of rules to measure spatial properties and interrelationship of the components. Various studies conducted on Office rent or hedonic model of retail rents based on integration values prove the method to be a fertile ground of study on retail rents. The purpose of space syntax analysis is to analyze, explain and predict the outcomes in terms of some aspects of human behavior and measure morphological and topological characteristics of the components.

There are various methods of space syntax analysis. With reference to the works of Hillier and Hillier and Hanson, the method is the graph-mathematical approach and using that, the integration value can be calculated. The integration value refers to how well the subspace is integrated. Integration value may be understood as accessibility of a certain location within spatial network pattern. So, it is a measure of accessibility of a location. For conducting the space syntax analysis, a plan diagram is covered with convex spaces- a convex space is a space where one can see every point in the space from every point in that space.

A map containing convex spaces on a plan diagram is known as convex map. The convex space is converted into axial map by drawing axial lines. The axial lines are straight lines connecting each convex space in that map and the axial lines are as few as possible and may be interpreted as sight lines. Axial map may be viewed as a graph where the axial lines are represented as nodes. Distance mentioned here are between nodes is the topological distance that one has to make and is different from metric depth and distance mentioned earlier. As one moves from node i to node j, the depth is called d_{ij}. Depth is conceived as the minimum number of turns a pedestrian must make to walk from one node to another node.

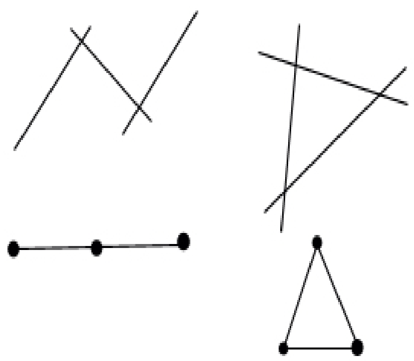


Figure II: Enstrom and Netzell(2008): axial maps and corresponding graphs

Total depth of node i is the sum of all other nodes in the spatial arrangement,

$$d_i = \sum_{j=1;\, j\neq i}^{n-1} d_{ij}$$ [n=total number of nodes in the spatial system]

Mean depth $\bar{d}_i = \frac{d_i}{n-1}$

Mean depth measure is significant it denotes average number of turns one need to take from one spatial segment to other segments.

Enstrom and Netzell(2008) defined relative asymmetry as,

$$RA_i = \frac{2(\bar{d}_i - 1)}{n-2}$$

Relative asymmetry is the ratio between the difference between

Mean depth and theoretical minimum mean depth and the difference between theoretical maximum mean depth and theoretical minimum mean depth.

Real relative asymmetry:

$$RRA_i = \frac{RA_i}{RA_D}$$

Where, RA_D is the relative asymmetry of a root node of a diamond shaped graph of same size as node i's graph.

Finally the integration value can be expressed as:

$$i = \frac{1}{RRA_i}$$

Where, a higher integration value signifies that the space is highly integrated.

5.0 Customer density and integration Value:

The link between integration value and human movement has been investigated by Hillier et al.(1983), Hillier et al.(1987), Hillier et al.(1993), Hillier and Hanson(1984), Hillier (1988), Peponis et al.(1989), Marcus(2000). Penn (2003) suggested that integration value captures how people cognitively perceive a space. His argument is that our understanding of space is not only metric but depends on non-metric factors also. It has a wide impact on movement in particular, as it can be considered as a standardized, unambiguous measure of how many turns to take. Sadalla and Magel(1980) proved that changes in direction affects cognition of distance and the depth and makes people cognize the metric distance to be longer than it actually is. Yun et al.(2007) showed that depth has a power of spatial cognition prediction of 72% and distance vis-à-vis has 53%. When two elements are highly important, with depth has a higher relationship. So, importance is not only on metric distance but also on cognitive distance. Sadalla and Staplin(1980) explained that a change in direction is an important element in cognition of psychological distance. They argued that, the more a person have crossing points (or turns) in a path, the more they cognize them to be longer.

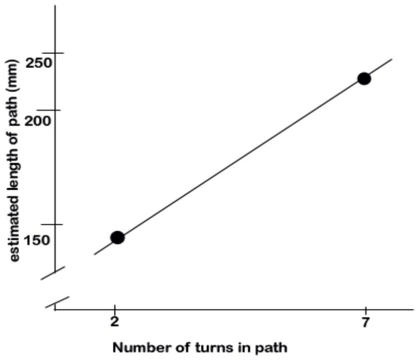


Figure III: The rate of spatial cognition according to turn in path

The figure explains that more changes of direction a path has, the longer it seems to be. So, built environment makes people cognize the metric distance to be longer than it actually is.

6.0 Conclusions

From the relationship in equation (16) the density of customers depend both on metric and non metric property of a particular space and as the rent is dependent on density, it can be concluded that, when other things remain constant (without any inter store externality), rent decreases with increasing distance from the center and rent increases with increasing integration value. This considers customer density as natural customer density generated within a spatial arrangement.

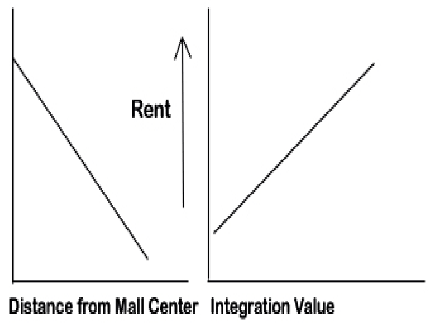


Figure IV: The relationship between Distance from the mall centre, integration value and rent

So, the spatial bid-rent model can be shown in the following pattern of 2X2 grid. Here, integration value is shown in the vertical axis and distance from the center is shown in the horizontal axis.

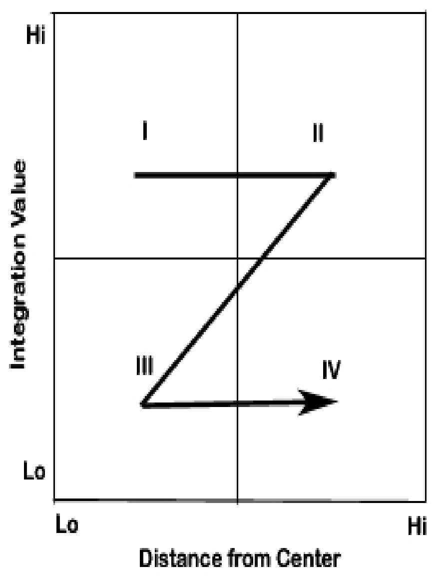


Figure V: 4 cell retail rent model

In this 4 cell model, the first cell is high integration value and low distance from the center and it enjoys maximum rent. It is the area in the overall spatial arrangement that is most accessible and therefore enjoys maximum consumer density. The second cell is high integration value and high distance from the center, whereas, the third cell is low integration value and low distance from the central area in the spatial configuration. As, non-metric parameters are more influential than metric distance as mentioned above, the rent will be higher in cell number 2 than in cell number 3. The cell number four will have lowest rent as it has low integration value and high distance from the center, therefore least accessible with minimum consumer density.

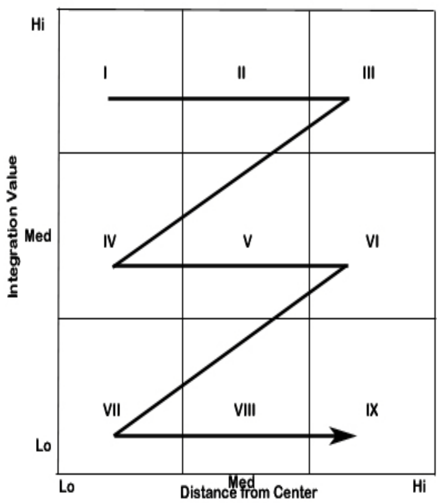
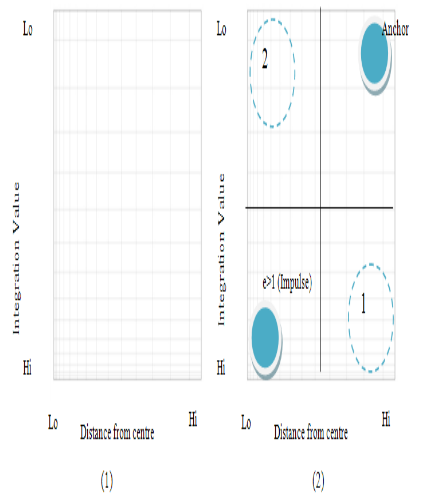


Figure VI: 9 cell retail rent model

Similarly, the concept can be extended to a 9 cell grid also. The changes in rents are shown in figure: VI. So, it can be concluded that, when the integration value, being more significant in determining rents, remains same for some areas, the rent decreases with increasing distance from the



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enter of the mall.

The integration value can thus be utilized alongside the metric distance from the center in determining the optimal rent for a shopping mall.

Figure VII: Spatial matrix of a shopping mall

Figure IV depicts the density distribution of the entire mall in terms of distance from the centre and integration value (part (1)) and in part (2) the entire configuration is divided into four segments: (a) Low distance from Centre and high integration value, (b) High distance from the centre and high integration value, (c) Low distance from the centre and low integration value and (d) High distance from the centre and Low integration value. The natural spatial customer density diminishes in that order within the spatial configuration. The first cell enjoys maximum customer density and so it is better to locate high density elastic stores in this area which are vanilla stores and enjoys impulse buying. The 4th cell is inelastic and Anchors should be located in that area. The other two cells have moderate customer density, but, as non-metric parameters have higher influence on accessibility, location marked 1 has more density than cell marked 2. The stores in this area will have stores with elasticity between 0 and 1. With higher density elasticity stores near high integration and high density from centre cell. Density elasticity of sales can be shown as $e_d = \frac{\frac{\Delta s}{s}}{\frac{\Delta d}{d}}$ (percentage change in sales /percentage change in customer density).

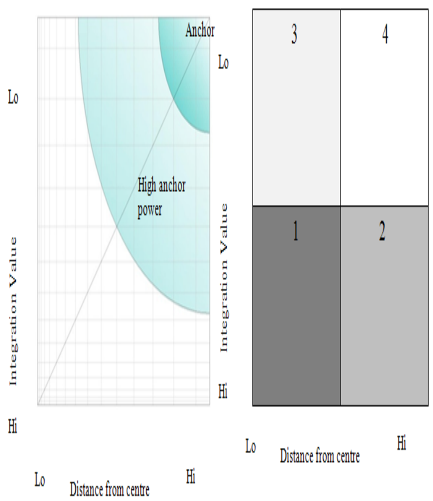

Figure VIII: Anchor influence area and density distribution

throughout the spatial configuration (darkness indicates higher density)

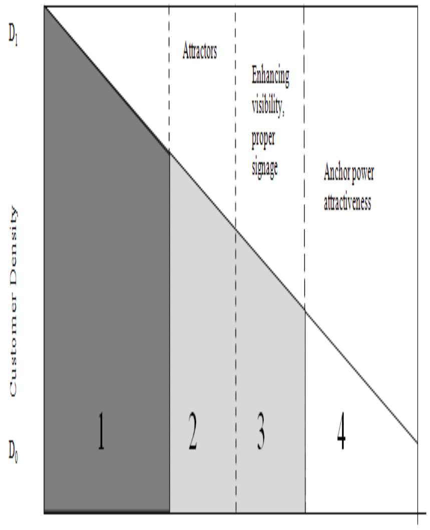

Figure IX: the strategic model for positioning of stores and spatial strategies

Central to the natural movement theory as propagated by Hiiier (1993, 1996), movement density is inherent in the structure "natural movement on each line that is determined by the by the structure of the urban grid itself rather than by the presence of specific atractors or magnets". Hillier(1996). The common logic behind the spatial engineering is to oppose the hierarchy as it desires to equalize movement among the entire center. In a sense shopping mall layout seeks to maximize locales, through strategic placement of attractors throughout the attractors, an attempt to equalize "spatial potential". The shopping center negates the natural forces of configuration. From equation (6), dP/dA_i captures the marginal benefit of the store's own allocation of space and cross derivative dP/dA_j ($i \neq j$) capture the external effect as a function of space. So, space should be allocated to a given store upto the point where its marginal sales are equal to the marginal cost of space minus the incremental sales that the store generates for all other stores in the center. Thus more space should be allocated to them, *ceteris paribus*. To maintain equal distribution of customer density, the strategy for cell one is to create attractors as the spaces are highly integrated but located in a higher distance from the centre or the access point. The strategy for cell 2 is to enhance visibility and place proper signages to influence customer flow in that area because they are closer to the access point but integration is low. For the 4th cell the selection of proper anchor and the stores that have positive externality with the anchor store is necessary.

7.0 Scope for future research:

Despite the fact that the present paper provides a conceptual framework supported by mathematical evidence, it may guide mall management in developing a proper model of bid-rent based on locational characteristics. The approach is theoretical, but empirical verification of the concept can lead to proper development of a bid-rent model and positioning of shops. Justification and analysis of positioning of shops and rent are also possible and the rent, rather than based on a rule-of-thumb approach, can be calculated on a scientific basis.

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