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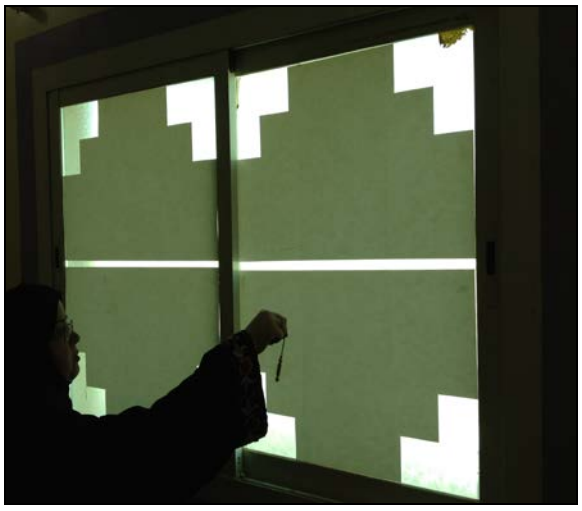

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THE INTEGRATION OF GIS AND SPACE SYNTAX FOR URBAN MORPHOLOGY ANALYSIS

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Abstract

Several urban planner researchers emphasized a need to establish a scientific basis for urban design analysis methods based on quantitative model. Researchers also argue that such methods must also take into consideration the social and spatial aspects that affects the perception of the urban morphology. The paper presents the main principles and the analysis tools of space syntax and its methodological perspectives within the GIS environment, which the outcomes should be of interest for many urban planners. The paper argues that applying such model of space syntax theory within the GIS spatial analysis environment leads for a better understanding and modeling of real-world phenomena. The paper experiments the proposed methodology and its practical evaluations of using the potential of the space syntax approach within GIS on Darb Al- Ahmar Kessm in historic Cairo.

Keywords: GIS, space syntax, urban planning and design

الملخص

ينادى عدد من الباحثين إلى الاحتياج لتطبيق نظريات علمية مقاسة كمياً في مجال التصميم العمرانى معتمدة على نماذج مكانية كمية، وانه لابد الأخذ في الحسبان الخصائص الاجتماعية والاقتصادية ونظريات الحركة وسلوك المشاة في الفراغات العمرانية وإدماجها بتلك الدراسات والتي تؤثر وتتأثر بالتشكيل الفراغى والجيومورفولجى العمرانى. ويقترح البحث التركيب الفراغى كأحد نظريات التصميم العمرانى ويعرض من خلال البحث المبادئ الأساسية والرئيسية لنظرية التركيب الفراغى. ويقوم البحث بتناول المنهجيات المتبعة في التطبيق ومدى أهمية تطبيقها من خلال بيئة نظم المعلومات الجغرافية والتي يضيف إلى النظرية أدوات مكانية وإحصائية ترفع من كفاءة التحليل والمخرجات. كما يتناول البحث عرض الأدوات التحليلية وكيفية الاستفادة منها في تحليلات التصميم العمرانى والعلاقات الوظيفية للفراغات والتشكيل العمرانى ويعرض في النهاية المخرجات ومدى الاستفادة منها للمصممين العمرانيين. والبحث يؤكد ان تطبيق نموذج التركيب الفراغى من خلال بيئة النظام المعلوماتى الجغرافى يؤدى إلى إدراك وفهم النموذج الحقيقى للطبيعة والعلاقات الفراغية العمرانية ووظائفها المختلفة. والبحث يحاول إثبات ذلك عن طريق تطبيق تلك الأداة والمنهجية المعروضة بالبحث على منطقة الدرب الأحمر بالقاهرة التاريخية وقد تم استخدام وعرض أدوات التقييم المكانية المختلفة والتي تمتاز بانها كمية وليست موضوعية والتي تساعد متخذى القرار من المصممين العمرانيين في اتخاذ القرارات الصحيحة.

1. INTRODUCTION

Spatial analysis is one of the characteristics, which differentiate GIS from other spatial information processing. In the last decade, much effort has been made in developing Spatial Data Analysis (SDA) theories and methods for a better understanding and modeling of real-world phenomena [9]. Recent research and applications in SDA have developed many sophisticated analytical techniques for studying spatial patterns and processes. However, it is largely recognized that GIS still needs an integration of new analysis and modeling methods to achieve its potential as a general-purpose tool for environmental and urban planning [16]. The

current demand for analytical tools in GIS covers a wide range of applications from the study of environmental phenomena to the analysis of urban and regional systems [14]. Over the past two decades, Space Syntax theory has provided important computational support for the development of spatial morphological studies, in particular for the analysis of urban systems. It has been widely used for pedestrian modeling [9], criminal analysis [13] and traffic pollution control [7]. Space Syntax provides a configurationally description of an urban structure, and attempts to explain human behaviors and social activities from a spatial configuration point of view. Most of the space syntax studies concern urban pattern issues, but the method is also relevant for studies on the scale of urban design and architecture.

The researcher believes that space syntax could provide an alternative vision and model of space for the representation of urban systems within GIS environment. As such, an integration of space syntax into GIS would stimulate researches oriented toward the analysis of urban systems at different levels of abstraction. GIS provides a rich set of spatial data integration, analysis and visualization capabilities that support urban studies on the one hand. Furthermore, the principles that underline space syntax theory can extend the modeling capabilities of GIS on the other hand, particularly in terms of the diffusion of recent advances and experimentation in the analysis of urban systems. Such integration can be of value for GIS users involved in the management and planning of urban systems.

2. RESEARCH OBJECTIVE

The objective of this paper is to introduce the computational and cognitive perspectives of space syntax principles to support an alternative model of space within GIS environment. The paper develops a comparative analysis of space syntax modeling concepts with conventional GIS modeling capabilities, given relevant case studies on historic Cairo region. In general, the paper identifies relevant application areas of space syntax in urban planning science. The remainder of this paper is organizing as follows. Sections 3 and 4 introduce the main principles of the space syntax approach and the space syntax GIS modeling and objects. Sections5 and 6 present the spatial analysis tools of urban morphology using the Space Syntax GIS. All these sections will be applied on Darb Al Ahmar Kessm on historic Cairo region as a case study. Finally, section 7 draws the conclusions.

3. SPACE SYNTAX CONCEPT

In the past, many methods of spatial analysis have developed for a better understanding and modeling of real-world phenomena. However, there is still a need for exploration of new analytical techniques for modeling urban spaces. Space syntax models the spatial configurations of urban spaces by using a connectivity graph representation. Such a configuration of space identifies patterns that are used to study urban structures and human behaviors.

Space Syntax is based upon the theory that the form-function relation in buildings and cities passes through the structural properties of its configuration [10]. Space syntax is a science-based, human-focused approach that investigates relationships between spatial layout and a range of social, economic and environmental phenomena. These phenomena include patterns of movement, awareness and interaction; density, land use and land value; urban growth and societal differentiation; safety and crime distribution [13]

The space syntax approach considered as a simulation tool for planners, architects of the likely effects of their designs, urban plans on the people who occupied and moved around in the buildings or urban settlements. It has since grown around the world in a variety of research areas and practical applications including archaeology, criminology, information technology, urban and human geography, anthropology and cognitive science. In practice, space syntax provides a set of planning and design principles as well as a toolkit for the generation and evaluation of ideas.

Space syntax is a kind of spatial language that is able to explain the relationship between a spatial form and the human behavior developed by Bill Hillier and his colleagues at the Bartlett School at University College London in the 1980s [10]. Space syntax theory and its analytical methods have been applied for morphological analysis in architectural design and urban form. Previous research indicates that space has its own social logic that affects human behavior such as pedestrian movement from one place to another [8,9,10].

Over the past two decades, space syntax theory has provided important computational support for the development of spatial morphological studies, in particular for the analysis of urban systems. Space syntax provides a configurationally description of an urban structure, and attempts to explain human behaviors and social activities from a spatial configuration point of view.

3.1. Space Syntax and GIS

Space Syntax is based on a complex technique of describing the configuration that is based on topological relationships rather than on metric distances. In many cases, it has been used to inquire into social formations [16,10]. Space syntax could provide an alternative vision and model of space for the representation of urban systems within GIS. As such, an integration of space syntax into GIS would stimulate researches oriented toward the analysis of urban systems at different levels of abstraction. GIS provides a rich set of spatial data integration, analysis and visualization capabilities that support urban studies on the one hand. Furthermore, the principles that underline space syntax theory can extend the modeling capabilities of GIS on the other hand, particularly in terms of the diffusion of recent advances and experimentation in the analysis of urban systems. Such integration can be of value for space syntax users involved in the management and planning of urban systems.

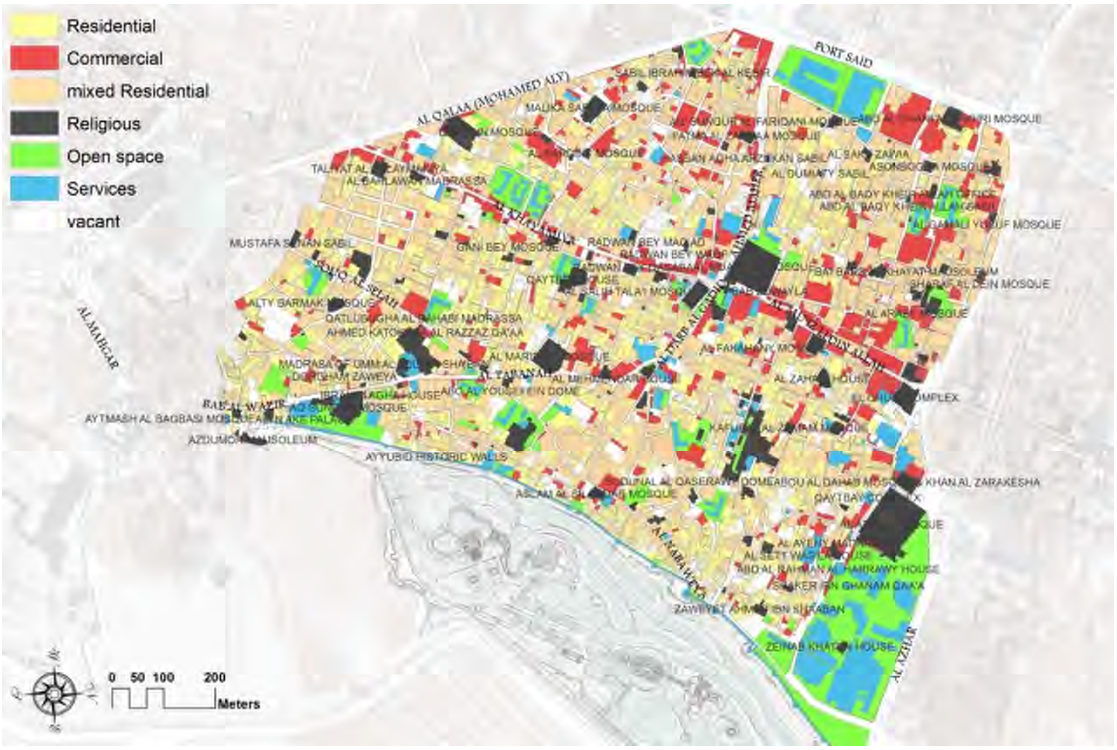
The implementation of an analytical space syntax tool within a GIS provides some important advantages from both computational and user points of view. Incorporating space syntax in GIS promotes both GIS and urban morphology research. It enhances GIS functionality in spatial analysis into the domain of urban morphological analysis. On the other hand, GIS provides rich geo-referenced data, spatial data analysis and visualization capabilities for urban morphological research.

3.2. Historic Cairo as Study Area

The historic Cairo is located in the Cairo city Centre. The Centre of Cairo groups numerous streets and old dwellings and thus maintains, in the heart of the traditional urban fabric, forms of human settlement, which go back to the middle ages. The historic Centre of Cairo constitutes an impressive material witness to the international importance, on the political, strategic, intellectual and commercial level, of the city during the medieval period.

Conventional analysis of historical sites depends heavily on researches that focused on physical and social aspects of historical sites. The main emphasis of such approaches are to analyze the architectural style and characters, social life and activities within the urban fabric, and to different extents, to examine other issues related to the environmental and physical conditions of buildings. However, these analyzes exhibited an apparent lack in perceiving the "spatial configuration–social behavior" relationship. There have been various attempts to read the historical sites, particularly Fatimid Cairo. The research use a region of historic Cairo shown on Figure (1) as the case study to apply the space syntax approach on a GIS environment.

Figure (1) Darb Al-Ahmar Kessm Study area in historic Cairo



4. SPACE SYNTAX SPATIAL MODELING

The GIS spatial modeling of an urban environment for space syntax approach consists of two main objects: *physical objects* that are the spatial obstacles like buildings, and *space objects* that are defined as the parts of an urban space available for people movement, excluding by definition physical obstacles. This spatial data modeling constitutes the cognitive fundamental modeling reference of the space syntax approach, which differ from the ones generally used in GIS modeling, where free space is not represented as such by these models. The space objects are represented by two fundamental's concepts: the axial line, which is the one dimension space, which is relatively linear and the convex space concept, which is the two dimension non-linear space.

4.1. Axial lines

The axial lines are linear property represents the fact that the physical environment is relatively dense so the free space is stretched in one orientation at most points. When humans are walking along this type of free space is perceived as a "Vista" which can be approximately represented as an axial line. Axial lines are used in space syntax to simplify connections between spaces that make up an urban morphology. Usually they are defined by partitioning the space into the smallest number of largest convex subdivisions and defining these lines as those that link these spaces together. These can then form the basis for ranking the relative importance of the underlying spatial subdivisions and associating this with measures of urban intensity, density, or traffic flow. The axial line has been shown to produce a specific representation of the city that is closer to the cognitive representation that people use to navigate the city [16,10]. The axial model of the street network is a representation of the accessibility and visibility axis that the built environment allows through its structure. The axial representation is constructed through the drawing of lines that show the longest lines of accessibility and visibility within a given built environment.

Figure (2) shows the automatic construction of axial lines in historic Cairo region using a GIS/Space syntax package. The axial lines is an essential element for the sequential vision analysis and it reflects the possible visual experience of passersby and was captured by sequential photo images while approaching or moving on the visual corridors.

For the urban analysis purpose, the axial lines are classified with respect to its length using a natural break statistics classes. The short axis within a zone characterize the visual corridors with an interactive, interesting and surprising visual perception for the passers of the visual elements of corridors. On the other hand, long axial line corridors are characterized by the dull, uninteresting visual perception for corridor passers. The historic Cairo has overcome the dull effects of longest axis by the activities along he long visual corridors and can be solved by the intrusion of landscape elements within the corridors such as change level by stairs, hardscape and landscape elements.

Figure (2) Axial lines map of historic Cairo study area

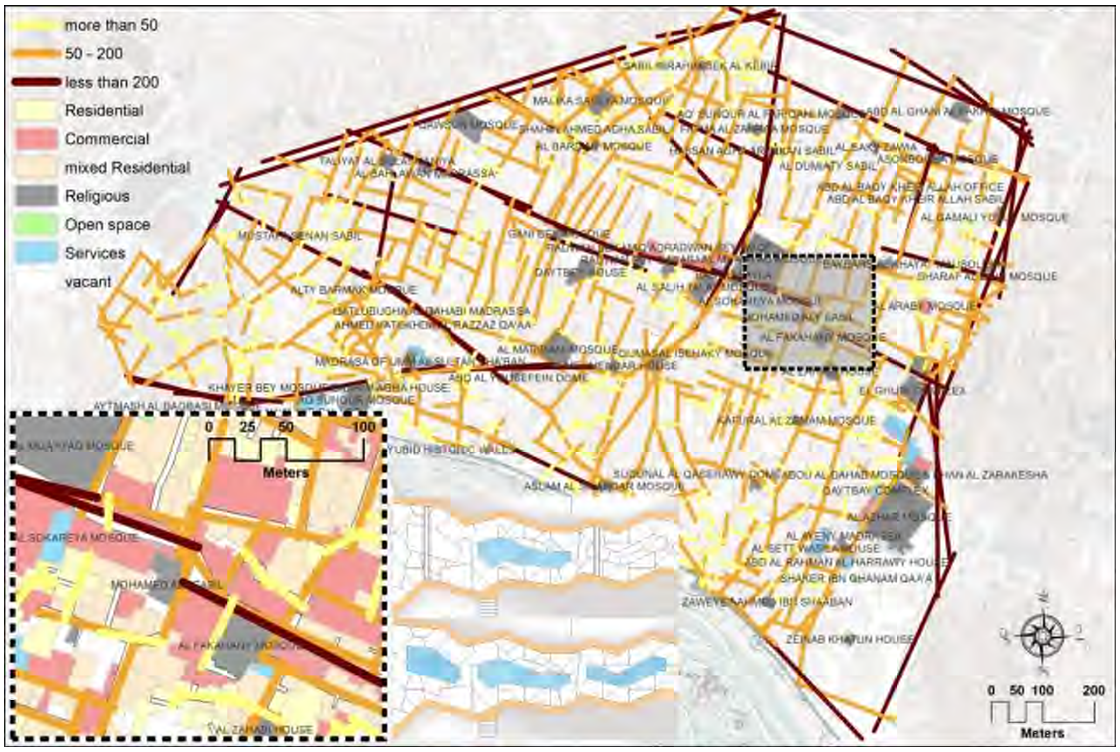


Table (1) shows that the Darb Al-Ahmar is characterized by short and medium visual axis which formed around 95% of axial lines. The relationship of the street network and the surrounding built environment and its characteristics such as land use and socio-economic indicators is an important factor that cannot be overlooked. Using this relation, axial lines can be used for location of landmarks and special land uses.

Table (1) Numbers of axial map and classification

Axial Line Type	Count	Cumulative Frequency
Short axis (less than 50m)	543	54.03
Medium axis (50m - 200m)	413	41.09
Long axis (200m and higher)	49	4.88
	1005	100.00

4.2. Convex spaces

A convex space is the convex polygon of a space where no line drawn between any two points in that polygon goes outside the polygon. Therefore, the second representation partitions the free space as a finite number of convex spaces that are represented by convex polygon in 2D maps. The second representation, so called convex representation, should comprise the least set of the fattest spaces that covers the completely free space.

Space syntax describes and analyzes the space form. The convex space analysis predict human behavior in space and how they perceive its form. People behavior showed that a person prefer to pause and linger on in the 'inside corners' of spaces

[25]. GIS and space syntax attempts to define the convex spaces and guide the urban designer for the different spaces as pedestrians will perceive them as shown on Figure (3).

Figure (3) Convex space

5. SPACE SYNTAX SPATIAL ANALYSIS

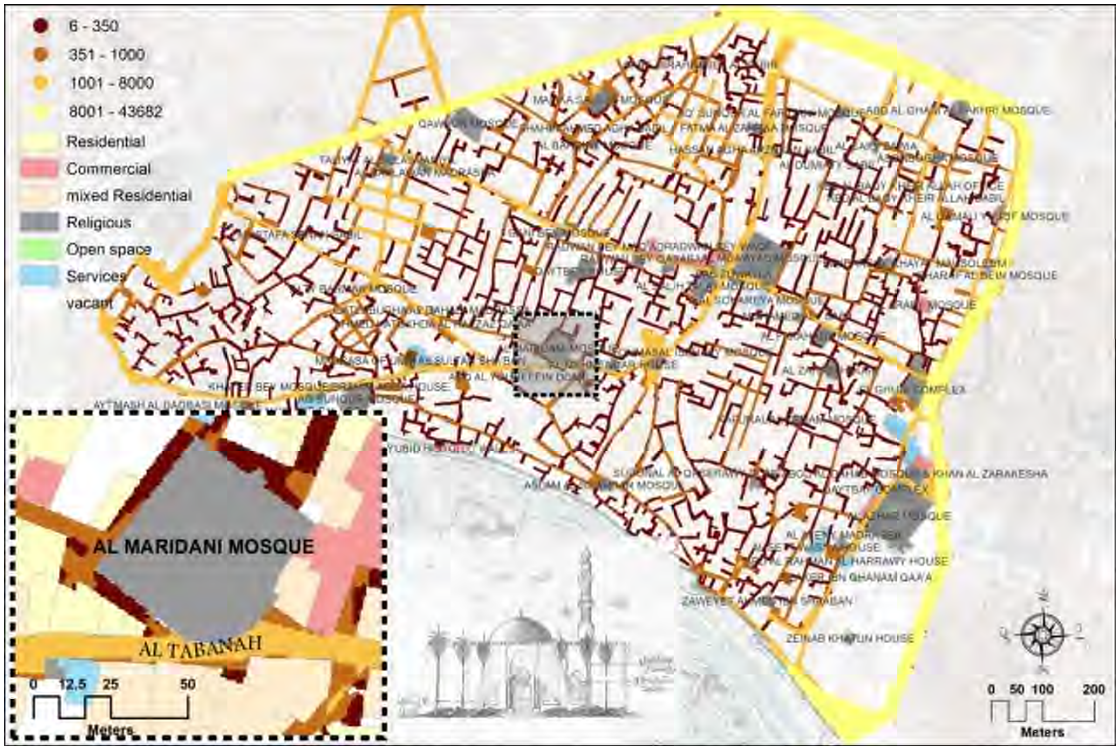
The theory of Space Syntax offers a method and spatial models of quantifying the various levels of topological relationships within a layout with respect to visual and pedestrian movement and behavior on city spaces. The Space Syntax theory offers different order levels of parameters and spatial analysis measures. The paper in next sections will discussed and applied those parameters and measure on the historic Cairo study area.

5.1. Visibility Graphs Analysis VGA

Visibility graphs analyze the extent to which any point in the spatial system is visible from any other. Where points are not directly visible, graph measures of a matrix of points can be calculated to test how many intervening points are needed for one point to see others. Published research, such as the Tate Gallery [20], findings on the extent to which the occupancy of a space by visitors could be explained by a combination of their area and mean depth within the visibility graph. The VGA analysis is used for visual analysis of building's façade and the corridor exposure studies and distribution of activities. Figure (4) shows the VGA analysis on Al Maridani mosque on Al Tabanah Street on Ghouriya shiyakha. The VGA support the decision of the urban designer to maximize the visual perception of such building.

The urban designer might use lighting and landscape elements distribution to ensure the visual attraction of the mosque.

Figure (4) Visibility Graphical Analysis (VGA)



5.2. Integration measure

The concept of integration is depends on the idea of depth and not only the metric distance to define a space in relation to all other spaces in the system. The integration measure is the value of the function of the mean number of axial lines and connections that need to be taken from one space to all other spaces in the system. This integration value measures the relative position of any space or axial line with respect to the overall system. Thus, from a space with a high integration value, fewer changes in direction are necessary in order to move from that space to all other spaces in the system. The space segments that require the least amount of turns to reach all other streets are called 'most integrate. Integration can be analyzed in local scale with limited turns and is named local integration measure while the global integration measure used the whole space system for the analysis.

Integration measure is often argued to 'predict' the pedestrian use of a space. It is argued that the easier it is to reach a space, the more popularly it should be used. While there is some evidence of this being true, the method is also biased towards long, straight axial lines that intersect with lots of other spaces. Integration measure depends mainly on three spatial property parameters derived from space syntax theory and topological spatial analysis of GIS. These parameters is the fundamental of morphological analysis of integration.

a. Connectivity Parameter

The connectivity is the most apparent parameter for morphological analysis. Connectivity is an important Space Syntax parameter. This refers to the number of other axial lines or spaces that are directly connected to any one line or space. Since this information is directly observable from a space, it is considered a local measure.

$$C_i = k$$

b. Control Parameter

The second parameter is control value. The control value is by definition a parameter, which expresses the degree of choice each node represents for its directly linked nodes. The control value (*ctrli*) of a node (*i*) is determined according to the following calculation:

$$Ctrl_i = \sum_{j=1}^{k} \frac{1}{C_j}$$

Where *k* is the number of directly linked nodes of a considered node (*i*), and *Cj* is the Connectivity of the *j*th directly linked node.

c. Depth Parameter

Another space syntax parameter is the depth. Depth is defined as the number of steps from a considered node to all other nodes. A node is said to be deep if it is many steps far from other nodes; in contrast, a node is said to be shallow if it is only a few steps far from other nodes. Depth is not an independent parameter of the space syntax. However, it is an important variable for calculating the integration of a node. Let d*ij is* the length of the shortest path joining between the two points *i* and *j*, then the total depth of node *i* is the sum of distance and accordingly mean depth is defined by *MD*

$$MD_i = \frac{\sum_{j=1}^{n} d_{ij}}{n-1}$$

Where *n* is the number of nodes of a whole study area.

These parameters can be used to describe both local and global properties of a spatial Configuration in the sense of integration or segregation. This concept is measured the depth parameter for global integration. Similarly, connectivity and local integration measure the degree of integration or segregation at the local level. The integration analysis, local integration and global integration, has applied on historic Cairo as shown on Figure (5). The integration of a node is by definition a value which indicates the degree to which a node is more integrated or segregated from a system as a whole (global integration), or from a partial system consisting of nodes within a few depth away (local integration).

Figure (5) Local Integration Measure (LIM)

The local integration measure analyze how is each space is integrated within the local system of the space. The local integration measure shows the cognitive complexity of reaching a street by living pedestrians, and is often argued to 'predict' the pedestrian use of a street. It is argued that the easier it is to reach a street, the more popularly it should be used [20]. While there is some evidence of this being true, the method is also biased towards long, straight streets that intersect with lots of other streets [12]. As shown, we can conclude that the Shyakha Megharbelin is characterized with low local integrated corridors and there is disintegration between the corridors of this shykha.

Figure (6) shows the global integration measure GIM of the study area. The GIM shows that the corridors along AL-Moaz Street have their visual and mentally perceived by the visitors of the study area. The GIM index also is low for shyakha El Ghouriya,Haret El Room and Al-Batneya which lead for security risk on such shyakha.

5.3. Intelligibility measure

Basically there is a correlation between local and global parameters. Such correlation is termed as intelligibility, which is used to describe the part-whole relationship within the spatial configuration. It is defined by the co-efficiency of correlation between local and global parameters. A local area is said to be intelligible if its co-efficiency value is higher than the one of global area. Intelligibility analysis using the correlation between connectivity and the global integration (Rn) to give a clue of how the urban system is clear to its users. Applying the intelligibility for two zones

on the study area to compare between the perception of both zones and how the visitors mentally and visually perceive them.

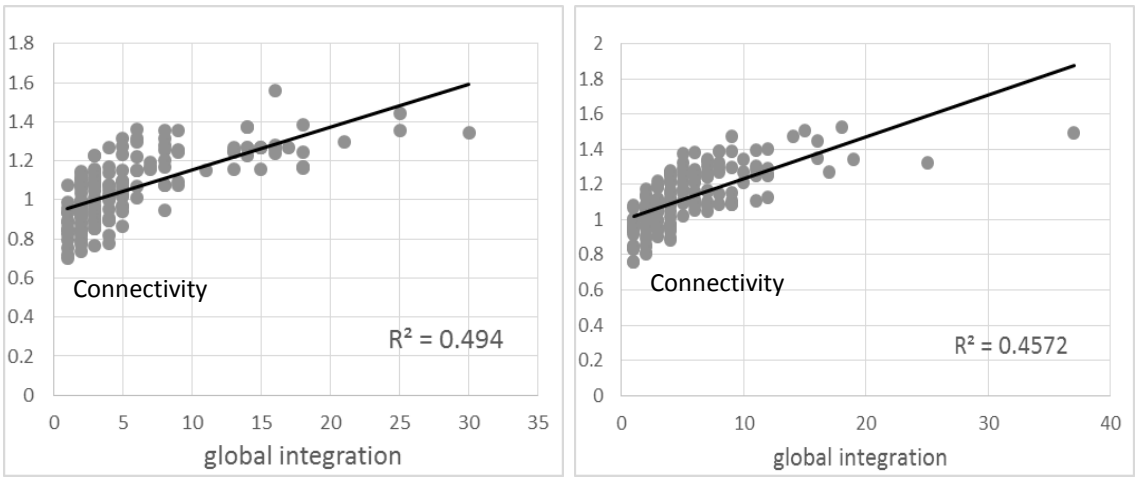
Figure (6) Global Integration Measure (GIM)

Figure (7) shows a comparative study for intelligibility of two zones on the study area Zone1: Darb Saada and Taht Al- Rabaa and Zone2: Quarbiya and Dawwoudiya.

The intelligibility of zone 1 is higher than zone 2 which means that the passers can find their way easier in zone 1 and they can perceive their location easier. In an intelligible zone, such as zone 1, the correlation between local and global properties of space is perfect, so the whole can be read from the part. Conversely, if the correlation is poor, zone 2, the product will be unintelligible environment, so the people may lose their way [21]. (Figure 8)

Figure (7) Intelligibility comparative zones

Figure (8) Scatter diagrams for intelligibility measure

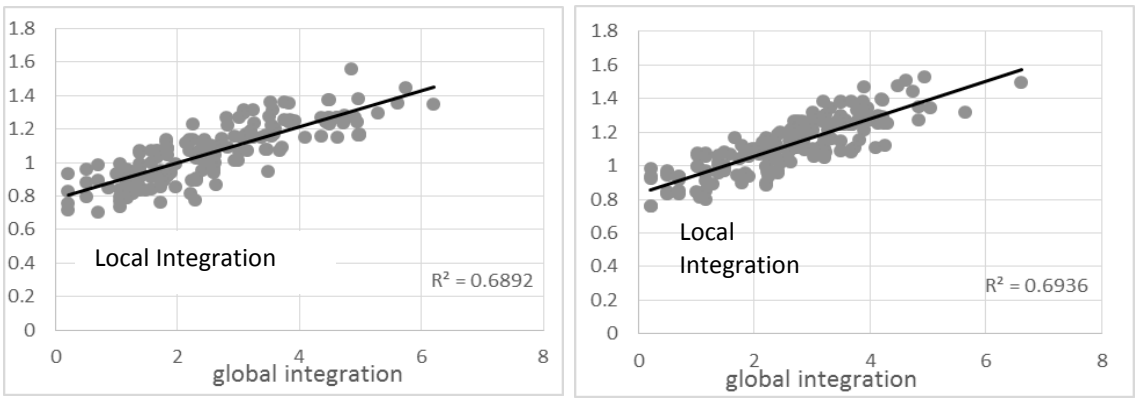


Zone 1 Zone 2

5.4. Synergy measure

Synergy measure is a correlation between global integration and local integration. It is used to indicate the relationship between local parts and global parts [23]. Synergy indicates the relationship between the local economy of a zone and the whole study area economy. The synergy answer the question do the corridors which connect the whole spaces through the zone as those which form the heart of the study area?. From the scatter diagram of figure (9) we can conclude that zone 1 and Zone 2 have same visual pattern characteristics and almost the same as the study area as whole.

Figure (9) Scatter diagrams for synergy measure



Zone 1 Zone 2

6. Movement Core Analysis (MCA)

The Space Syntax methodology investigates relationships between spatial layout and a range of social, economic and environmental phenomena. These phenomena include patterns of movement, awareness and interaction; land use density, land use mix and land value, safety and crime distribution [16].

A study of local movement core LMC and global movement core GMC that identify the relation between urban morphology parameters for pedestrian movements and land use analysis. The movement core attempts to correlate the control parameter representing the spatial parameter for the urban morphology and the integration measure as a pedestrian behavior indicator.

Figure (10) shows the multiple variables where integration and control parameter will take H: high value and L: low value consequently.

The Global movement core relates the global integration with the control parameter to evaluate the relocation for activities and residential land use. The corridors with H-H values are corridors for visitors land use such as Al Moaz street.

In the other hand, the local movement core studied the local pedestrian behavior. The analysis will lead to evaluation of the locations of local services and commercial land uses as schools, public buildings for inhabitants on corridors with H-H values, while residential areas must be located on L-L and L-H values - Figure (11).

7. CONCLUSIONS

A successful development of GIS still implies the integration of new analysis and modeling methods for environmental and urban planning. Over the past years, space syntax has provided an important experimental contribution to the analysis of urban morphology. However, the diffusion of space syntax principles requires the diffusion of its modeling principles and capabilities within the GIS community, which is nowadays largely involved in urban studies.

The research described in this paper introduces the principles and modeling concepts of space syntax and some of its main spatial measure and parameters that support computational modeling and analysis of a spatial configuration for urban planning and design. The implementation of space syntax parameters and measure are within a GIS platform, namely, the Axwoman and Depthmapx UCL prototype.

The research illustrates different quantified, analytical functions for urban morphological analysis in the context of historic Cairo case studies.

The space syntax approach within GIS environment provides an efficient experimental approach to the understanding of spatial configuration and a new quantification tools for urban design.

Figure (10) Global Movement Core (GMC)

Figure (11) Local Movement Core (LMC)

REFERENCES

1. Batty, M., R. Conroy, et al. 1998. *The Virtual Tate. London*, CASA.
2. Conroy Dalton, R., Bafna, S., 2003. The syntactical image of the city: A reciprocal definition of spatial elements and spatial syntaxes, in: Hanson, J. (Ed.), 4th International Space Syntax Symposium. UCL, London, pp. 59.51-59.23.
3. Dhanani, A., L. Vaughan, C. Ellul, and S. Griffiths. 2012. From the Axial Line to the Walked line: Evaluating the Utility of Commercial and User-Generated Street Network Datasets in Space Syntax Analysis, 8th International Symposium
4. Flanagin, A.J., Metzger, M.J., 2008. The credibility of volunteered geographic information. *GeoJournal* 72 (3), 137-148. Proceedings: Eighth International Space Syntax Symposium. Santiago de Chile: PUC, 2012. 8211:32
5. Fotheringham S. and Wegener M. 2000. *Spatial Models and GIS: New Potential and New Models*, Taylor and Francis, London.
6. Haklay, M., 2010. How good is volunteered geographical information? A comparative study of Open Street Map and Ordnance Survey datasets. *Environment and planning B: Planning and design* 37 (4), 682-703.
7. Haklay, M., Weber, P., 2008. Open Street Map: User-generated street maps. Pervasive Computing, IEEE 7 (4), 12-18.
8. Hillier, B., 2003. The architectures of seeing and going: or, are cities shaped by bodies or minds? And is there a syntax of spatial cognition?, in: Hanson, J. (Ed.), Fourth International Space Syntax Symposium. University College London, London.
9. Hillier, B., Penn, A., 2004. Rejoinder to Carlo Ratti. *Environment and planning B: Planning and design* 31, 501-511.
10. Hillier, B. 1998. *Space is the Machine*. Cambridge University Press.
11. Hooper, A; Punter, J. (2006) *Capital Cardiff 1975-2020, Regeneration, Competitiveness and the Urban Environment*. University of Wales Press
12. Jung, C. and M. Choi. 2010. "Analysis of traffic volume using space syntax model supplemented byaccessibility factor in downtown Daegu." *Journal of Korean Planning Association* 45(5): 1129-140.
13. Morello, E., Ratti, C. 2009. A digital image of the city: 3D isovists in Lynch's urban analysis. *Environment and Planning B: Planning and Design*. 36, 837 – 853.
14. Chih-Feng, S.S., 2000. Housing layout and crime vulnerability. *URBAN DESIGN International* 5, 177-188.
15. Miller, H., 2000. Geographic representation in spatial analysis. *Journal of Geographical Systems* 2 (1), 55-60.
16. Miller, H., Wentz, A,. 2003. Representation and spatial analysis in geographic information systems. *Annals of the Association of American Geographers* 93 (3), 574-594. OSM., 2011. www.openstreetmap.org website, access date 12/07/2011.
17. Penn, A., 2003. Space Syntax And Spatial Cognition: Or Why the Axial Line? *Environment and Behavior* 35 (1), 30-65.
18. Ratti, C., 2004. Rejoinder to Hillier and Penn. *Environment and planning B: Planning and design* 31, 513–516.

19. Rao, X.J., and H.F. Wang. 2012. A Morphological History of Urban Centers in Qingdao. 8th International Symposium

20. Ratti, C., 2004b. Space syntax: some inconsistencies. *Environment and planning B: Planning and design* 31(4), 487–499.

21. Suleiman, W., Joliveau, T., Favier, E. 2011. 3D Urban Visibility Analysis with Vector GISData.. University of Portsmouth, UK , 27-29 avril 2011.

22. Turner, A. and A. Penn. 1999. Making Isovists Syntactic: Isovist Integration Analysis. *Proceedings of the Second Space Syntax Symposium*, Brasilia, Brasil.

23. Turner, A., 2001. Depthmap: A Program to Perform Visibility Graph Analysis, in: Peponis, J., Wineman, J.,Bafna, S. (Eds.), Third International Space Syntax Symposium, Atlanta, Georgia.

24. Turner, A., 2007. From axial to road-centre lines: a new representation for space syntax and a new model of route choice for transport network analysis. *Environment and Planning B* 34 (3), 539-555.

25. Turner, A., 2009. Stitching Together the Fabric of Space and Society: An Investigation into the Linkage of the Local to Regional Continuum, in: Daniel Koch, Lars Marcus, Jesper Steen (Eds.), Seventh International Space Syntax Symposium. Royal Institute of Technology, Stockholm, Stockholm, pp. 116:111-116:112.

26. Vaughan, L., 2011. The nature of suburbia - change and continuity, in: Centre for London (Ed.), The big (suburban) society - community, identity and amenity in outer London. Demos and London School of Economics and Political Science, London.

27. Whitehand, J. W. R. and Morton, N. J. (2006) The Fringe-belt Phenomenon and Socioeconomic Change. *Urban Studies*, Vol. 43, No. 11, 2047-2066, October 2006

28. Wilson, A. (2000) *Complex Spatial Systems. The Modeling Foundations of Urban and Regional Analysis*. Prentice Hall.

DUALITY OF LAND VALUE AND LAND USE:
An Analytical Study of the Guidelines Affecting Riverfront Revitalization in Cairo

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Abstract

Land value can be defined as a product where supply and demand theory is applied. Land valuation depends upon the capability of development to be utilized in the best use and consequently the highest return. Waterfronts' parcels of land are of high land value being a strategic valuable urban resource for a city. This paper is concerned with studying the different factors influencing land value and land use, focusing on the physical factors, as well as extracting guidelines related to the factors previously analyzed. In addition, this paper investigates the perception of three categories: architects and urban planners, real estate experts, and lay people towards the relative weights of the extracted guidelines in their positive impact on land value and land use using a questionnaire. It is suggested that these guidelines would enhance compatibility between land value and land use, and accordingly it is expected to assist in the Nile riverfront revitalization process. Architects and urban planners, and lay people didn't rate the impact of any guideline with less than moderate impact. Moreover, results showed that the three categories agreed upon rating the guideline of public transportation and infrastructure to be of a very high impact on land value and land use. As well, they all agreed on rating the guideline of divided zones at river walk and sidewalk to be of a high impact on land value and land use.

Key words: Land value, Land use, Physical factors, Riverfront, Revitalization, Guidelines

الملخص

قيمة الأرض يمكن تعريفها كمنتج حيث يتم تطبيق عليها نظرية العرض والطلب . تقييم الأراضي يتوقف على القدرة على تنمية الأرض لاستخدامها في أفضل استخدام ، وبالتالي أعلى عائد . قطع الأراضى الواقعة على الواجهات المائية هي ذات قيمة عالية كونها ذات موردا حضريا استراتيجياً قيما للمدينة. هذا البحث معني بدراسة العوامل المختلفة التي تؤثر على قيمة الأراضي واستخداماتها ، مع التركيز على العوامل المادية . وكذلك استخراج المبادئ التوجيهية المتعلقة بالعوامل التي سبق دراستها و تحليلها . بالإضافة إلى ذلك، هذا البحث معني بدراسة تصور ثلاث فئات : المهندسين المعماريين و مخططي المدن و خبراء العقارات والغير متخصصين في هذا المجال نحو الأوزان النسبية للمبادئ التوجيهية المستخرجة في تأثيرها الإيجابي على قيمة الأراضي واستخداماتها، وذلك عن طريق استخدام استبيان. من المقترح ان تنفيذ هذه المبادئ التوجيهية يعزز التوافق بين قيمة الأرض واستخدامها ، وبالتالي المساعدة في عملية تنشيط الواجهات المائية لنهر النيل. اوضحت النتائج أن الثلاث فئات اتفقوا على تقييم مماثل لبعض المبادئ التوجيه و اختلفوا فى تقييم مبادئ توجيهية . هذا إلى جانب ، فئات المهندسين المعماريين و المخططين و الغير متخصصين لم تقيم تأثير أي مبدأ توجيهي أقل من تأثير معتدل . ايضا، الثلاث فئات اتفقوا على تقييم المبدأ التوجيهى المتعلق بالمواصلات العامة و البنية التحتية بانه ذو تأثير عالى جدا ، و اتفقوا جميعا على تقييم المبدأ التوجيهى المتعلق بتقسيم الممشى النهرى و الرصيف انه ذو تأثير عالى.

1. INTRODUCTION

Land value can be defined as a product where supply and demand theory is applied (Arizona Department of Revenue, 2001). Land valuation depends upon the capability to develop it to be utilized in the best use and consequently the highest return (Heikkila, 2000). One of the aspects that leads to high land value, is that a parcel of land having to be waterfronts premium or having accessibility to waterfront views (PA Consulting Group, 2009).

Waterfront is considered a 'strategic' valuable urban resource for a city. Its territorial position provides it with this major value for being precious, limited and non-renewable asset. Actually, waterfront reflects the image of a city and emphasizes its urban identity. However, this identity has been weakened and altered over the years in many cities (Bruttomesso, 2006). This paper is concerned with Nile Riverfront in Cairo City. Actually, "Nile is a public resource for urban revitalization" in Cairo, (Kondolf, 2011, p.94). The Nile Riverfront has environmental, touristic, scenic, recreational and economic potentials. However, there are about 67% of riverfront parcels of land that are having land uses incompatible with their land value (URC, 2005). There are different factors, whether physical, social or political that influence both land value and land use (Arizona Department of Revenue, 2001). This goes back to the dual relationship between land value and land use, as according to Heikkila (2000) and Hubacek & Bergh (2006), the urban land value is considered as a product in real estate economics, where its valuation depends on its utilization in the best land use. On the other hand, according to Olayiwola, et al. (2005) and Chakir and Parent (2009), to determine urban land use, land value is of major importance and should be considered.

This paper first studies the different factors influencing land value and land use, especially physical factors. Then, it focuses on studying the various guidelines extracted from the different factors previously analyzed. The paper suggests that implementing such guidelines at the Nile riverfront in Cairo is expected to have a positive impact on land value and land use, thus enhancing their compatibility, and accordingly assisting in the Nile riverfront revitalization process. Studying the factors influencing land value and land use, and the extracted guidelines is based on qualitatively analyzing data from previous studies and literature related to the field. After that, paper uses a questionnaire in quantitatively analyzing the perception of different categories towards the different relative weights of the extracted guidelines in their positive impact on land value and land use, and accordingly their impact on the revitalization process.

2. FACTORS INFLUENCING LAND VALUE AND LAND USE

Arizona department of Revenue (2001) and Topcu and Kubat (2009) pinpointed that accessibility, visual, environmental and security factors, and government regulations are the main factors influencing land value and land use. Beside, Arizona department of Revenue (2001) added the factors of location and physical characteristics of a

parcel of land as well as supply and demand theory. In addition, Heikkila (2000) added the alternatives for land use. Moreover, Bourassa et al. (2004) and PA Consulting Group (2009) studied the view factor, being one of the important factors that influence land value. Topcu and Kubat (2009) classified the factors into four groups of factors, and some of these groups are broken down into tangible and intangible aspects. These groups are accessibility, environmental features, security and street density relationship. The Arizona department of Revenue (2001) classified the factors into four categories: economic; social, governmental and political, and physical factors. This paper focuses on the physical factors, as different literature discuss that their presence was one of the main reasons behind the success of riverfront revitalization projects causing a positive impact on land value and land use (Rodriguez et al, 2001), (PA Consulting Group, 2009), (PPS, 2010), (Chang and Huang, 2011), (Gunay and Dokmeci, 2011).

The physical factors are closely related to the urban context and are influencing the economic land value and land use. The physical factors are divided into two groups: factors related to the parcel of land, and factors related to context (Arizona Department of Revenue, 2001). The following section studies comprehensively the two groups of factors and the guidelines extracted from analyzing those factors that would have positive impact on land value and land use, hence enhancing their compatibility.

2.1 Factors related to the parcel of land

The factors discussed in this section are related to the parcel of land that influence its land value and land use. These factors are location of the parcel of land, its physical properties, the view from it, and alternatives of land uses for it.

2.1.1 Location

Land value varies according to the geographical location of the parcel of land. Some locations have their prestige which attract people more than other ones (Arizona Department of Revenue, 2001). The bid-rent theory that was developed by Alonso (1964) emphasizes that land rent tends to decrease with increasing distance from the central Business district. Land use changes as well with this change of land rent. Also, parcels of land overlooking a river; which are acting as waterfront are of high land value (PA Consulting Group, 2009). In addition, Cho (2009) studied that a parcel of land located nearby an open space, is of a high value, while Hartwick (2006) studied that a parcel of land located nearby an industrial area is of a low land value. Actually, the location of parcels of land overlooking a river is the main concern of this paper.

2.1.2 Physical properties

The physical properties of the parcel of land affects the costs of construction, operation and maintenance thus influence its land value. Concerning topography, flat land having the same level of the street is of high land value (Kok et al., 2011).

The presence of varying degrees in the slope of land where the parcel of land isn't in the same level of the street leads to a low land value (Kok et al., 2011). Concerning area of water-level parcels of land, the dimension of the frontage is more concerned than that of the depth (Colwell and Dehring, 2005). Hence, the extracted guideline from the factor of physical properties is that the ratio of frontage to depth of riverfront's parcel of land shouldn't exceed 1:3 (Charter of Township Waterford, 2013).

Not excceding the ratio of 1:3 results in a dual relationship between land value and land use. It would allow for maximum benefit of the frontage, hence raising land value of parcels of land at riverfront, and consequently attracting different compatible land uses. On the other hand, this ratio attracts different land uses leading to increase of demand on land which results in raising land value.

2.1.3 View from parcel of land

The views that have positive impact on land value and land use are the panoramic scenes of garden or water whether river, lake or ocean (Bourassa et al., 2004). Parcels of land on the waterfront are of limited supply and usually appeals to consumers for recreation or investment purposes. The factor of view differentiates between one parcel of land and the one next to it in terms of economic value. In Perth, Australia, the view of river added 28% to the value of land, and the view of garden, of a higher than average quality, adds 3% premium (Bourassa et al., 2004).

Bourassa et al (2004) and PA (2009) concluded that the view of river or park raises land value and agreed upon that the scope of view whether wide, medium or narrow, and the distance from river or park affects its view, and accordingly influences differently the value of a parcel of land. Moreover, providing facility for pedestrian's proximity to the river for totally viewing it influences land value and land use (Richmond City Council, 2012). Furthermore, Colwell and Dehring (2005) emphasized that parcels of land having lake fronts differ; lake-level parcels of land are of higher value than bluff parcels of land. Hence, there are different guidelines that could be extracted from the factor of view that can help in achieving an appropriate land value and a compatible land use at riverfront parcels of land such as:

- **Public Parks and green areas:**
  Should be present at wide river banks with where there could be canopy trees, shrubs, ground cover, pedestrian & bicycle lanes and pathways linking to them, and suitable hardscape for accommodating different uses as restaurants and pavilions (Fig. 1), (Port of Los Angeles, 2011). The presence of public parks or green areas results in a dual relationship between land value and land use. They provide the view of the green areas and river together resulting in raising land value of parcels of land at riverfront, and consequently attracting different compatible land uses. On the other hand, the view of green areas and river together attracts different land uses leading to increasing demand on land which results in raising land value.

- **Visual Corridors:**
  They are pedestrian landscaped open areas providing an unobstructed view of the river from the streets leading to the river bank (Fig. 2), they should be present at regular intervals such as 400-600m or corresponding to the existing street grid (URC, 2006) and (Department of New York City Planning, 2013).

  The presence of landscaped visual corridors resulted in a dual relationship between land value and land use. As they allow unobstructed view of the river resulting in raising land value of parcels of land at riverfront and urban depth as well, and consequently attracting different compatible land uses. On the other hand, this unobstructed view of the river attracts different land uses leading to increaseing demand on land which results in raising land value.

Figure (1) Riverfront Park at Little Rock City in the U.S. State of Arkansas

Source: (Little Rock, 2008)

Figure (2) Visual Corridor

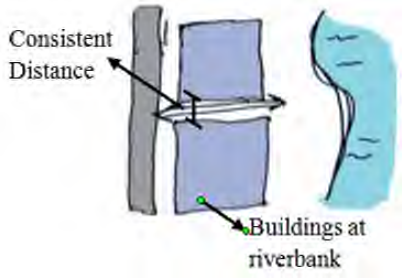
Source: (Hamilton City Council, 2012)

- **Pedestrian's view of the river:**
  Pedestrian's at riverfront parcels of land sidewalk and river walk should easily view the river. View of the river should be repeated every consistent distance between the public or private buildings at river bank (Fig.3), (Kruse, 2009).

- **Pedestrian's proximity to the river:**
  Pedestrians should have the opportunity to get closer to the water's edge and view clearly the river. This could be through designing terraces and developing the river bank to be of a gradual slope with built in stairs (Fig.4), (Kruse, 2009).

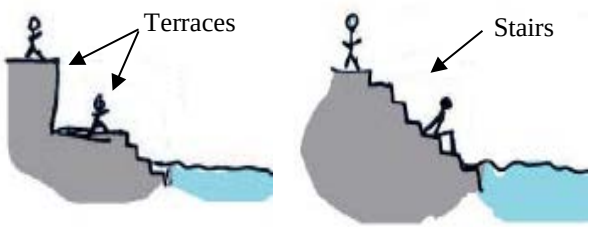
Pedestrians' view of the river and proximity to the river enable better view of the river from both: sidewalk & river walk leading to higher land value of parcels of land at riverfront, and consequently attracting different compatible land uses, such as restaurants and cafes, where guests can view the river while eating & drinking. On the other hand, allowing better view of the river attracts different land uses leading to increasing demand on land which results in raising land value.

Figure (3) Consistent distance between buildings at river bank



Source: (Kruse, 2009)

Figure (4) Terraces & stairs at river bank.



Source: (Kruse, 2009)

2.1.4 Different Alternatives of land use for a parcel of land

The presence of various alternatives for utilizing a parcel of land raises its value. These alternatives vary between residential, commercial, industrial and place of worship, where each use leads to a different economic return. Also, the presence of a mixed use system where a parcel of land can have different land uses leads to higher land value.

There are two different alternatives of land use allocations: zoning allocation and market allocation. Zoning allocation, which is also known as government allocation is the presence of parcels of land with defined land uses, while market allocation is the presence of parcels of land with undefined land uses. (Heikkila, 2000). In case of market allocation, the price of comparable parcels of land are equal across all uses, however in case of zoning allocation, price of comparable parcels of land differ according to the different uses (Heikkila, 2000). Also, Hubacek and Bergh (2006) studied that the land use of a parcel of land would affect the value of the surrounding parcels of land. Hence, the extracted guideline for government allocation of land use for riverfront parcels of land is to abide by the following preferred land uses: residential, touristic such as museums, hotels, restaurants, and cafes, flowers trade or green areas (General Administration of Urban Planning in Egypt, 1996). This will lead to a planned and zoned area resulting in higher land value of parcels of land at riverfront. On the other hand, this would attract the land uses decided by the method of government allocation of land use especially the non-residential ones to benefit from the agglomeration factors so increases demand on land which results in raising land value. While, the extracted guidelines for market allocation of land use, is implementing the mixed use system for riverfront parcels of land (PPS, 2010). This attracts different land uses, as the investor is having the free of choice for the use or mixed uses to allocate in this land, hence increasing demand on land, leading to higher land value of parcels of land at riverfront.

2.2 Factors related to context

This section discusses the factors related to the area where the parcel of land is situated which influence the land value and land use of this parcel of land. These factors are accessibility, visual factors, and streetscape.

2.2.1 Accessibility

Olayiwola et al. (2006) proved that there is a positive relationship between accessibility and improvement of transportation facilities. As transportation facility is available for a certain district which easies its accessibility; land value in this district starts to be higher. Also, Debrezion et al. (2011) emphasized that access via roads is not the only important aspect of accessibility, but also reliable public transportation and the availability of parking lots are important aspects. Hence, areas where transportation facilities is limited, when improving it, land value will consequently be raised. This was proved by Giuliano et al. (2010) that accessibility influences residential land value as households consider travel costs concerning the house they are willing to purchase. According to Du and Mulley (2007), in Tyne and Wear, which is a Metropolitan Region located in the North East of England, houses that are just 200-500 meters away from metro station are having positive premium ranging from 5% to 50.09% of the houses price, and consequently land value is higher in this area. Moreover, Debrezion et al, (2011) and Waddell and Moore (2008) proved that accessibility influences the land value of offices, as land value of offices located nearby railway stations and airports increases, for easier accessibility of customers and labor force. Hence, accessibility influences land use as well, as it has an impact on the locations of houses and firms (Thakur, 2009 and Forkenbrock, 2001). Hence, there are different guidelines that could be extracted from the factor of accessibility that can help in achieving an appropriate land value and a compatible land use for riverfront parcels of land such as:

- **Providing appropriate public transportation and infrastructure** (Bloomberg, 2013):
  a. Implementing Public buses' routes with bus stops at riverfront
  b. Implementing Subway systems or tram line with stops at riverfront (Fig. 5).
  c. Implementing vehicular bridges crossing the river
  d. Providing river taxi (Fig. 5).

Figure (5) Public Transportation

Tram line along Nervion River in Bilbao City

Source: (Skyscrapercity, 2005)

Water Taxi in Malacca River

Source: (Skyscrapercity, 2011)

The presence of transportation infrastucture and different facilities lead to easier access of people to riverfront and river bank by road and river, resulting in raising land value of parcels of land at riverfront, and consequently attracting different

compatible land uses. On the other hand, these publict transportation facilities attract different land uses which increases demand on land and results in raising land value.

- **Pedestrian Accessibility:**
  a. Crosswalk: with a different texture and paving materials for pedestrians to cross the road and reach the riverbank (Luckett, 2007).
  b. Pedestrian Bridges: connecting the city with the river bank (Fig.6), (Baraboo City Government, 2007).

Figure (6) London Millennium Bridge

Source: (Tripadvisor, 2006)

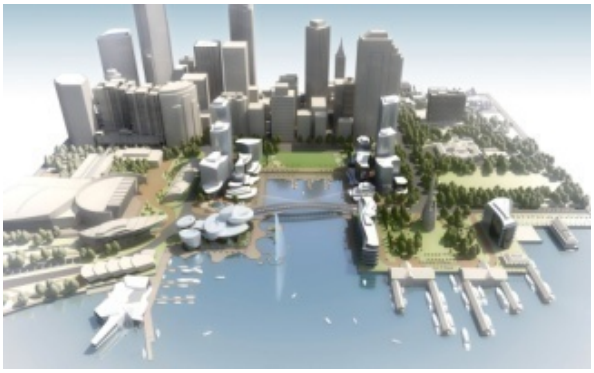
The presence of different facilities of pedestrian accessibility leads to safe access of people to riverfront and river bank without the need of using a car, bus or ferry boat, resulting in raising land value of parcels of land at riverfront, and consequently attracting different compatible land uses. On the other hand, pedestrian accessibility attracts different land uses, and so increasing demand on land which results in raising land value.

2.2.2 Visual Factors

Visual factors are concerned with the architectural characteristics of the area where the plot of land is located. According to Topcu and Kubat (2009), there are visual factors which raise land value while others have little influence. Concerning buildings, harmony between buildings' facades and colors has the highest effect on land value, then the historical and architectural factors, and the least effect is that of the construction type and building structure. According to Gao and Asami (2007), visual factors including continuity of external walls, conformity of buildings' colors and materials, compatibility of buildings styles and beauty of skylines formed by buildings led to increase of land values in Tokyo and Kitakyushu by 1-1.5% and 3% respectively. Hence, there are different guidelines that could be extracted from the visual factors that can help in achieving an appropriate land value and a compatible land use for riverfront parcels of land such as:

- **Building Heights:**
  Buildings should be stepped back in height allowing view of the river and preventing the riverfront area from being dominated by the buildings (Fig.7), (Port of Los Angeles, 2011).

Figure (7) City Vision at Elizabeth Quay in Perth at Swan River

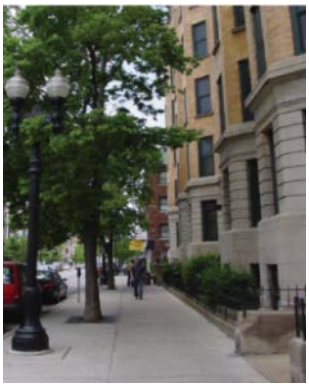


Source: (City Vision, 2013)

- **Building Setback:**
  Front and side setbacks have to be consistent with other neighboring buildings. Front Setback is an outdoor room between the building and sidewalk can be used as residential building front zone where raised planters could be placed containing trees and shrubs adjacent to the building. Also, could be business front zone in case of a business use in the ground floor where it could be a window shopping zone or an outdoor seating area (Fig. 8), (Urban Code Handbook, 2004).

Figure (8) Building Front Setback

Residential building front zone



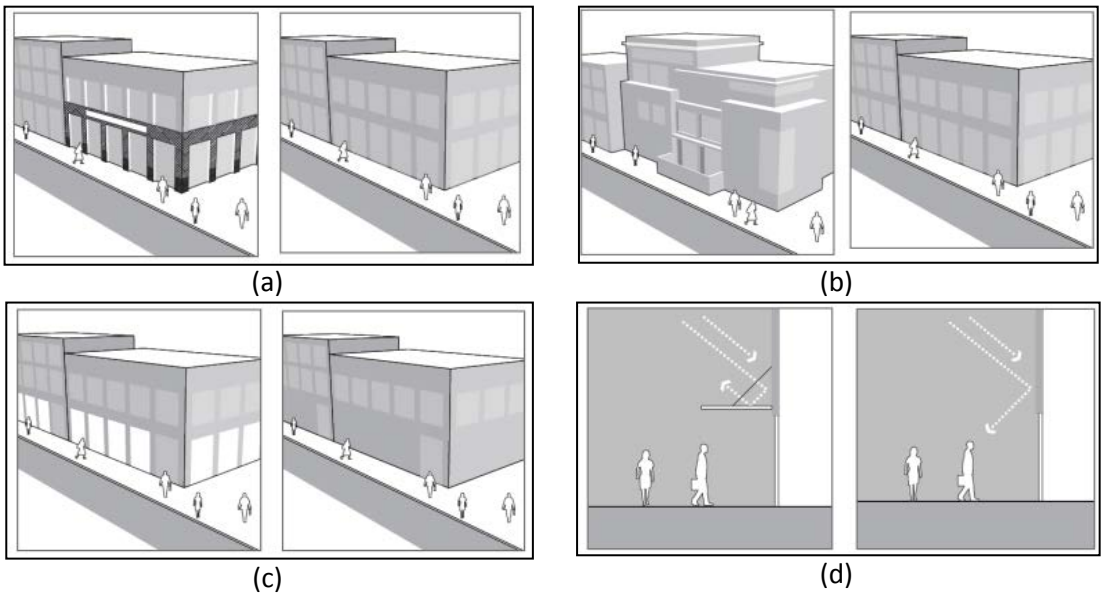
Source: (Chicago Department of Transportation Bureau of Bridges and Transit, 2003)

Business front zone

Source: (Playerbase, 1999)

- **Building Façade:**
  Should enhance pedestrians' visual interest through architectural details, articulation, visual continuity and environmental solutions, especially at ground and first floors in (Fig. 9), (Baraboo City Government, 2007 & (City of Los Angeles Department of City Planning, 2008).

Figure (9) Building Façade with and without (a) Architectural Details, (b) Articulations, (c) Visual Continuity and (d) Environmental Solutions



Source: (City of Los Angeles Department of City planning, 2008)

- **Building Signage:**
  Sign banners attached at building façade has to be either flush with the façade of the building, or at the façade's awning or projected perpendicular on the façade, (Fig. 10). They should enhance the heritage of the building, don't hide it's architectural details and be scaled with respect to pedestrians (Baraboo City Government, 2007).

Figure (10) Building Signage

Projected Signage

Source: (Total Branding Solutions, 2012)

Awning Signage

Source: (Sign Source, 2011)

Signage flush at building façade

Source: (The Shop at Willow Bend, 2012)

The presence of stepped height of buildings, building setback and interesting building façade at riverfront building enhances the visual character of the built environment surrounding the riverfront area, leading to higher land value of parcels of land at riverfront, and consequently attracting different compatible land uses. On the other hand, this enhanced visual character would attract different land uses lading to increase of demand on land which results in raising land value.

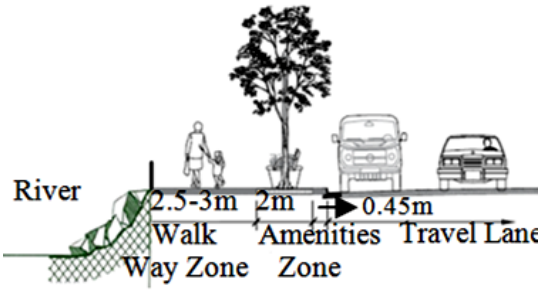
2.2.3 Streetscape

Eves (2009) proved that good streetscape has a positive significant impact on value of residential properties and so on land value and land use. Elements of good streetscape include hardscape elements as covering materials of sidewalks, lighting, planters & furnishing elements, and softscape elements as trees and plantings (Luckett, 2007). According to Gao & Asami (2007), streetscape elements including greenery of open pedestrian spaces, decorations and street furniture raised land value. Hence, there are different guidelines that could be extracted from the factor of streetscape that can help in achieving an appropriate land value and a compatible land use for riverfront parcels of land such as:

- **River walk/ Sidewalk:**
  There should be a river walk which is a sidewalk separating the road overlooking the river from the river bank (Fig. 11), (Westchester County Planning Department, 2005), as well as a sidewalk separating riverfront building from the road overlooking the river (Fig. 12), (Downtown Alliance Streetscape Committee, 2006). River walk/ Sidewalk should be divided into amenities zone and walking zone, in addition to building zone at sidewalk. Their most recommended paving materials aesthetically and functionally are concrete and brick (Capital City Development Corporation, 2009).

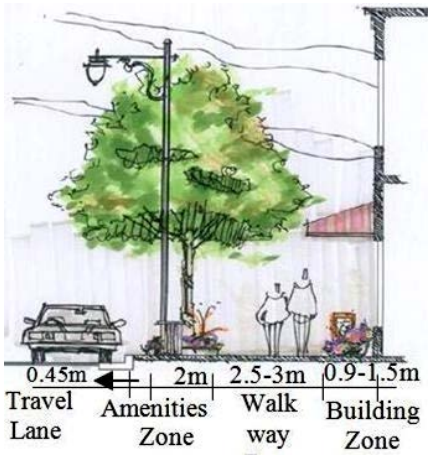
  The well maintained riverwalk and sidewalk will enhance them visually and functionally leading to higher land value of parcels of land at riverfront, and consequently attracting different compatible land uses. On the other hand, the well maintained river walk and sidewalk atrracts different land uses, so increases demand on land which results in raising land value.

Figure (11) River Walk



Source: (Westchester County Planning Department, 2005)

Figure (12) Sidewalk

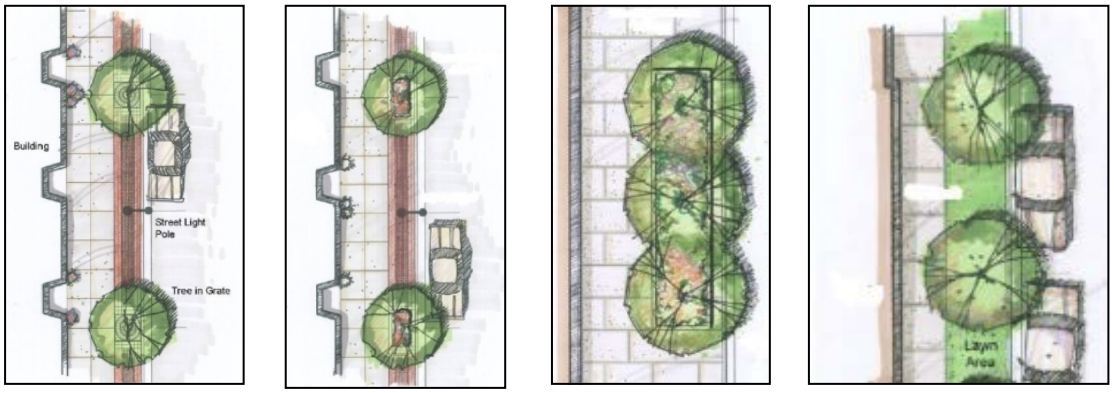


Source: (Downtown Alliance Streetscape Committee, 2006)

- **Trees:**
  There should be a line of trees at the river walk/ sidewalk for reducing air pollution and acting as a shade for pedestrian, and are recommended to be

deciduous trees (Luckett, 2007). They could be fixed either as single tree in tree grate or single tree in raised planter or grouped tress in planter or trees in a grassed parkway, (Fig. 13), (Downtown Alliance Streetscape Committee, 2006).

Figure (13) Types of tree fixation:
(a) Single tree in grate, (b) Single tree in raised planter,
(c) Grouped trees in concrete curbed planter and (d) Grouped trees in grassed parkway



(a) (b) (c) (d)

Source: (Downtown Alliance Streetscape Committee, 2006)

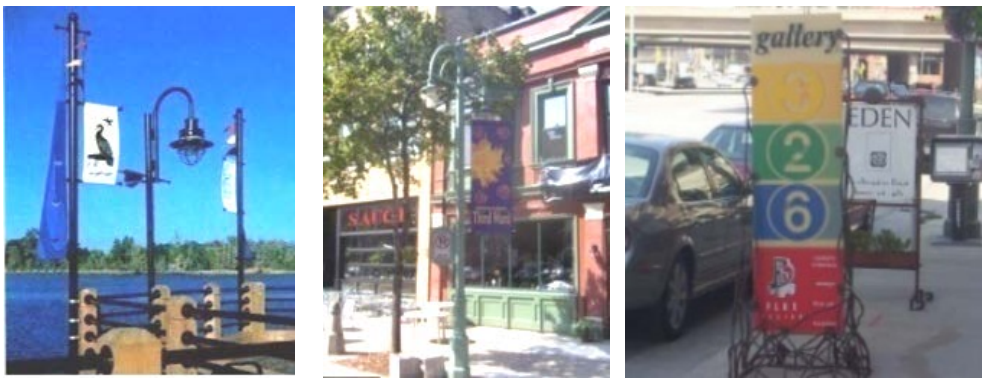
- **Lighting:**
  There should be post mounted lights at the river walk/ sidewalk for vehicles and pedestrians (Fig.14), (Luckett, 2007).

Figure (14) Lighting Posts for Vehicles and Pedestrians.

Source: (SFMTA, 2013) and (Chicago Department of Transportation Bureau of Bridges and Transit, 2003)

- **Signage and advertisement banners at river walk/sidewalk:**
  Banners can be fixed at lamp posts at amenities zone, where banners are positioned perpendicular to the river walk/sidewalk or fixed at posts built in the fence at river walk or advertisement banners could be fixed in "sandwich board signage" which should be structurally stable under all weather conditions, (Fig. 15), (Piwoni, 2006) and (Wilmington Area Metropolitan Planning Organization, 2008).

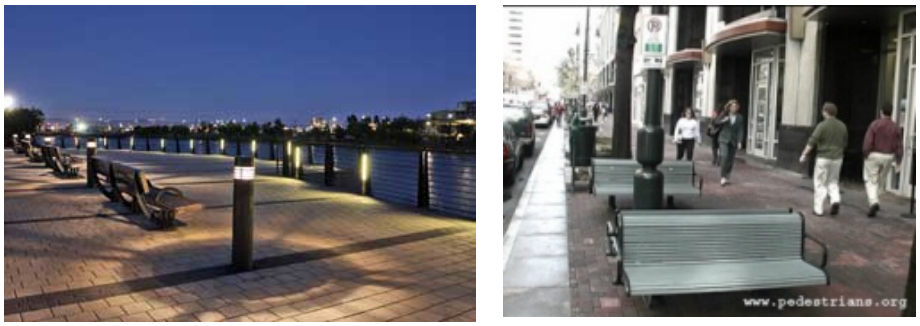
Figure (15) Streetscape Signage



Source: (Wilmington Area Metropolitan Planning Organization, 2008) and (Piowni, 2006)

- **Furniture:**
  It includes benches, litter receptacles and bicycle racks, bollards and fences as seen in Fig. (16) & fig. (17), (Luckett, 2007). Seating elements and benches could be placed parallel to the river walk/sidewalk, or perpendicular to the street facing another one for encouraging group conversation or placed back to back for privacy, as seen in Fig. (16), (PPS, 2009).

Figure (16) Benches



Source: (HLB,2006) Source: (Pedestrians, 2012)

Litter receptacle should be having a side opening, and should be placed near the seating and away from direct sunlight rays, (Fig. 17) (Luckett, 2007) and (Capital City Development Corporation, 2009). Bollards are arranged in a line acting as a barrier at river walk/sidewalk against motor vehicles. They should be spaced allowing wheel chairs and preventing vehicles, shouldn't be shorter than standard to be prevent tripping hazards, and can be having built in light for pedestrians, (Fig. 17) ,(TransAlt, 2007). Fences: are located between river edge and river walk, should be designed with minimum obstruction of the view of the river, preferred that its handrail be made of wood to be more comfortable and to have built in lighting bollards, (Fig.17), (FEMA, 2007).

The presence of lighting, signage and furniture elements at the river walk and side walk enhances the sence of comfortability, security, vitality and interaction between people leading to higher land value of parcels of land at riverfront, and consequently attracting different compatible land uses. On the other hand, those enhanced senses

atrracts different land uses, so increases demand on land which results in raising land value.

Figure (17) Furniture Elements

Litter receptacle

Source: (Downtown Alliance Streetscape Steering Committee, 2006)

Bicycle rack

Bollards

Fence

Source: (FEMA, 2007)
(City of Oshkosh Community Development Department, 2006)

Hence, it is clear that the riverfront revitalization guidelines extracted from the different physical factors, summarized in Table (1), impact land value and land use and result in a dual relationship between them in different ways. However, there are different levels of the impact of these guidelines, which is the main concern of the following section.

Table (1) Different Guidelines extracted from each factor

Factors	Guidelines
Physical Properties	Riverfront parcel of land's frontage to depth ratio not to be exceeding 1:3
View	Public parks or green areas
	Visual corridors
	Pedestrian's view of the river
	Pedestrian's proximity to the river
Different Alternatives of Land Use	Residential, touristic as museums or hotels or restaurants and cafes, flowers trade or green areas, through government land use allocation
	Mixed Use System through market land use allocation
Accessibility	Public transportation and infrastructure through implementing public buses' routes, subway metro systems or tramline with stops at riverfront
	Pedestrian Accessibility through cross walks and pedestrian bridges
Visual factors	Low river front's building height
	Building front setback
	Building façade having architectural details, articulations, visual continuity and a environmental solutions
	Building signage enhance the heritage of the building, not hiding it's architectural details , and scaled with respect to pedestrians
Streetscape	Wide river walk and sidewalk
	Divides zones at river walk and sidewalk
	Tress at river walk and sidewalk
	Vehicular & Pedestrian lighting post
	Signage at river walk and sidewalk
	Furniture elements: benches, litter receptacles, bicucle racks, bollards and fence

3. RELATIVE IMPACT OF GUIDELINES AS PERCEIVED BY DIFFERENT CATEGORIES

The extracted riverfront revitalization guidelines are suggested to have positive impact on land value and land use on different levels. To investigate this, the perception of three different categories towards the relative weights of the impact of the extracted guidelines is conducted using a questionnaire. The following section is discussing the questionnaire's objective, methodology and results.

3.1 Objective of the Questionnaire

The objective of this questionnaire is to investigate the perception of three categories: architects and urban planners; real estate experts; and lay people towards the relative weights of the extracted guidelines through determining the extent of positive impact each guideline has on land value and land use of parcels of land at river front. The results of this questionnaire are expected to aid in the Nile Riverfront revitalization process.

3.2 Methodology of the Questionnaire

The questionnaire is handled using five-point Likert scale (Sekaran &Bougie, 2009), where 1= *very low* impact, 2 = *low* impact, 3 = *moderate* impact, 4 = *high* impact and 5 = *very high* impact. The 20 guidelines mentioned on Table (1) was asked about in the questionnaire as seen in the example on Fig. (18). The respondents were 30 from each category, all living and working in Cairo, where 70% of the category of architects and urban planners were having more than ten years of experience, while all real estate experts were having more than ten years of experience. The sample chosen for the lay people category was chosen to be homogeneous between the different categories of the society, with diversity in gender, socio-economic level, and occupation. The results are analyzed statistically using the mode to obtain the average, which reveals the rating with the highest number of respondents, as according to Chandan (2009), the mode is the most suitable measure for qualitative data.

Figure (18) Questionnaire Format

Ratio of Frontage to Depth at riverfront parcels of land shouldn't exceed 1:3

	Low positive impact			High positive impact	
Land value	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
Land Use	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

3.3 Results of the Questionnaire

Most of the respondents rated the impact of the same guideline on land value and land use equally in the different questions, except for 5% to 15% of the respondents in the three categories rated land value and land use differently (Fig.19). Hence, emphasizing the duality of land value and land use, as they are inter-reliant, where

land value influences land use and vice versa. The three categories of architects & urban planners, real estate experts and lay people, have different perceptions for the relative weights of the guidelines in affecting land value and land use. However, their perceptions are not extremely different, as they all agree on the same rating for some guidelines, and other guidelines that are not having equal rating from all of the categories; the difference between them is one degree rating in most of the cases. Architects and urban planners agreed on the following order of guidelines from these of higher impact to those of lower impact on both land value and land use:

Very high impact

- Public parks and green areas at river bank
- Public transportation & infrastructure

High impact

- Riverfront parcel of land's frontage to depth ratio not to be exceeding 1:3
- Visual corridors
- Pedestrian's view of the river
- Pedestrian's proximity to the river
- Wide river walk and sidewalk
- Divided zones at river walk and sidewalk
- Trees at river walk and sidewalk
- Vehicular lighting posts at river walk and sidewalk
- Pedestrian lighting posts at river walk and sidewalk
- Streetscape Furniture as benches, litter receptacles, bicycle racks and bollards

Moderate impact

- Government land use allocation
- Market land use allocation
- Pedestrian bridges
- Crosswalks
- Low river front's building height,
- Building front setback
- Building façade having architectural details, articulations, visual continuity and a environmental solutions
- Presence of signage at river walk & sidewalk.
- Presence of trees at river walk and sidewalk

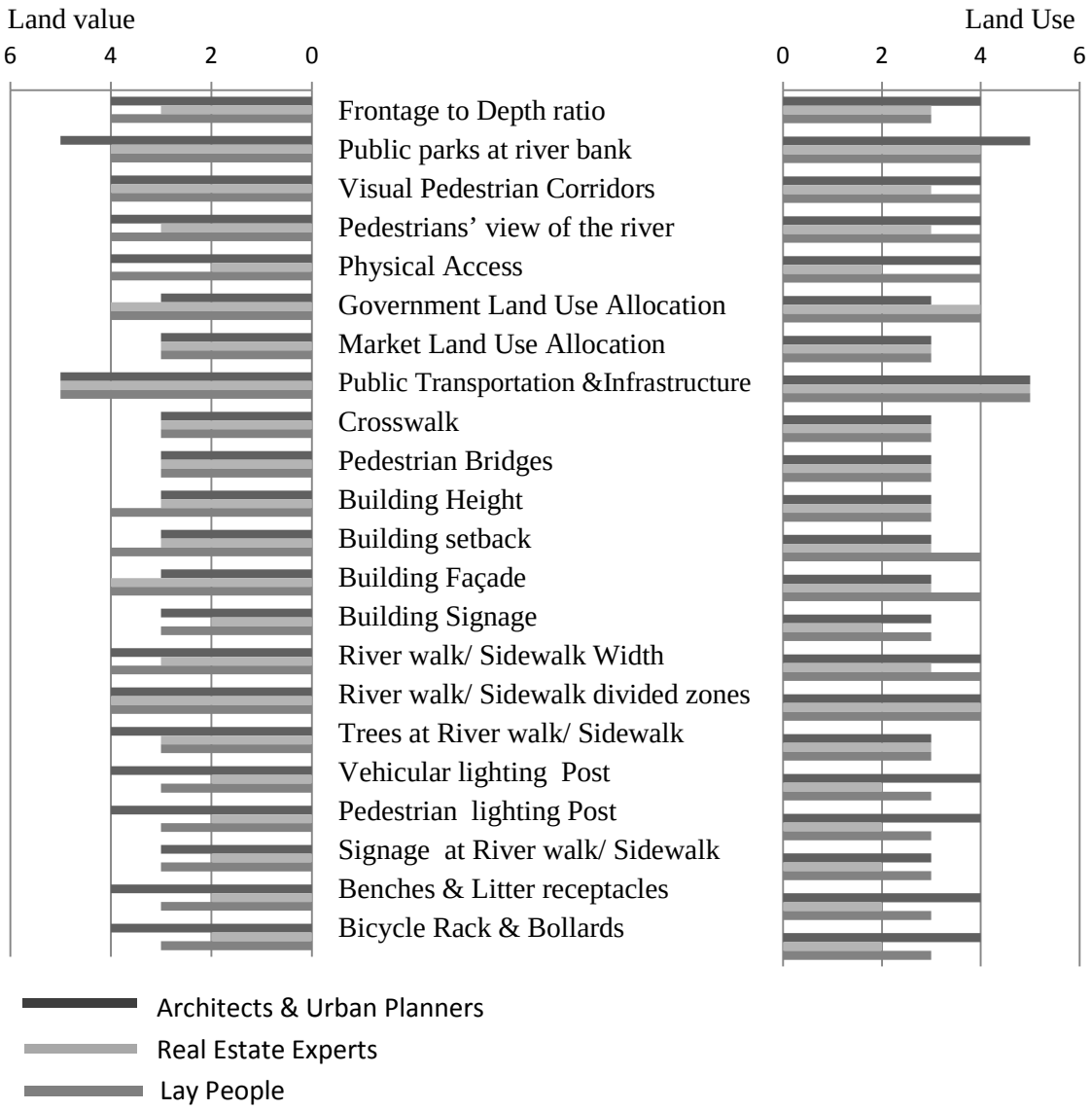
Hence, according to the category of Architects and urban planners, there weren't any of the extracted guidelines that were rated as having *low* or *very low* impact.

While real estate experts agreed on the following order of guidelines from these of higher impact to those of lower impact on both land value and land use:

Very high impact

- Presence of public parks and green areas at river bank

Figure (19) Questionnaire Results



High impact

- Presence of public parks and green areas at river bank
- Visual corridors
- Government land use allocation
- Building façade to be having architectural details, articulations, visual continuity and environmental solutions
- Divided zones at river walk and sidewalk
  But visual corridors and building façade were rated to be of moderate impact on land use

Moderate impact

- Riverfront parcel of land's frontage to depth ratio not to be exceeding 1:3
- Provision of pedestrian's view of the river
- Market land use allocation,
- Pedestrian bridges
- Crosswalks

- Low river front's building height
- Building front setback
- Wide river walk & sidewalk,
- Trees at river walk and sidewalk

Low impact
- Pedestrian's proximity to the river,
- Building signage
- Vehicular lighting posts at river walk and sidewalk
- Pedestrian lighting posts at river walk and sidewalk,
- Signage at river walk and sidewalk
- Streetscape furniture as benches, litter receptacles, bicycle racks and bollards

Hence, according to the category of real estate experts, the guideline concerning public transportation & infrastructure was the only one rated to be of very high impact. Besides, most of the guidelines that were rated to be of low impact were related to streetscape.

As well, lay people agreed upon the following order of guidelines from these of higher impact to those of lower impact on both land value and land use:

Very high impact
- Presence of public parks and green areas at river bank

High impact
- Riverfront parcel of land's frontage to depth ratio not to be exceeding 1:3
- Public parks and green areas at river bank
- Visual corridors
- Pedestrian's view of the river
- Pedestrian's proximity to the river
- Government land use allocation,
- Low river front's building height
- Building front setback,
- Wide river walk and sidewalk
- Divided zones at walk and sidewalk

Moderate impact
- Market land use allocation
- Pedestrian bridges
- Crosswalks,
- Building façade to be having architectural details, articulations, visual continuity and environmental solutions
- Building signage,
- Vehicular lighting posts at river walk and sidewalk
- Pedestrian lighting posts at river walk & sidewalk,
- Trees at river walk and sidewalk,

- Signage at river walk and sidewalk,
- Streetscape furniture as benches, litter receptacles, bicycle racks and bollards

Hence, the category of lay people is common with the category of architects & urban planners in that there weren't any guideline that was rated as of low or very low impact. Besides, the category of lay people is common with the category of real estate experts in that the only guideline that was rated to be of very high impact was that related to public transportation and infrastructure.

It is clear from the results of this questionnaire that the three categories agreed on public transportation and infrastructure to be of very high impact. As well they all agreed on rating the guideline of divided zones at river walk & side walk to be of high impact. In addition, they all agreed on rating market allocation of land uses through being of mixed use system, presence of pedestrian bridges and cross walks to be of moderate impact.

4. CONCLUSION

For a successful revitalization process of Nile River Fronts, this paper studied the different factors influencing land value and land use. The factors are divided into four categories: economic, social, governmental and political, and physical factors; focusing specifically on the physical factors. The physical factors are divided into two groups: factors related to parcel of land and factors related to context. Guidelines, related to each factor were extracted, as shown on Table (1), that if were applied, are expected to help in achieving an appropriate land value and hence, a compatible land use for riverfront parcels of land. This paper studied the extracted guidelines and investigated the relative weights of these guidelines in their positive impact on land value and land use, through quantitatively analyzing the perception of three categories: architects and urban planners, real estate experts, and lay people using a questionnaire. The questionnaire results emphasized the duality between land value and land use as the three categories almost rated equally the impact on land value and land use of the same guideline. In addition, the results showed that three categories rated the guideline of public transportation and infrastructure to be of a *very high* impact on land value and land use. Also they all rated the guideline of divided zones at river walk and sidewalk to be of a *high* impact. Besides, they all agreed on the rating of a *moderate* impact for the guidelines of market allocation (allowing mixed use system), presence of pedestrian bridges, and cross walks. Hence, the factors of accessibility, different alternatives of land use and streetscape are the most factors having positive impact on land value and land use. Therefore, the results of this questionnaire are expected to aid in the Nile Riverfront revitalization process as it shows clearly the important guidelines that need to be taken into consideration in order to guide a successful revitalization process enhancing the compatibility between land value and land use.

In fact, more research and studies related to the revitalization of Nile River fronts in Cairo, in general, are needed taking into consideration all other aspects of the

revitalization process. This may include the implementation techniques, strategies, priorities, feasibility and frameworks organizing the relation between the different parties involved in the revitalization process.

References:

Arizona Department of Revenue. (2001). *Land Manual*, Phoenix. Property Tax Division

Alonso, W. (1964). *Location and land use: Towards a general theory of land rent*. Cambridge, MA, USA: Harvard University Press

Baraboo City Government. (2007) *Ringling Riverfront Design Guidelines*. [Online] Available from: http://www.cityofbaraboo.com/vertical/sites/%7BD06131C5-F452-44C7-954E-97BD998BCA20%7D/uploads/%7BE67F168B-3F12-41D0-98D9-5F417496D0A8%7D.PDF [Accessed 1st May 2013]

NYCEDC. (2013) *A Stronger, More Resilient New York.* [Online] Available from: http://www.nycedc.com/sites/default/files/filemanager/Resources/Studies/Stronger_More_Resilient_NY/Ch14_Brooklyn_Queens_FINAL_singles.pdf

Bourassa, SC.et al. (2004) What's in a view? *Environment and planning A*. 36(8). p. 1427-1450.

Bruttomesso, R. (2006) Waterfront redevelopment: A strategic choice for cities on water. *International Waterfront Speakers Luncheon IV.* 3rd March 2006, Venice: Harbor Business Forum

Capital City Development Corporation. (2009). *Downtown Boise Streetscape Standards & Specifications Manual*. [Online] Available from: http:// www.ccdcboise.com [Accessed 1st July 2013]

Chakir, R. & Parent, O. (2009) Determinants of land use changes: A spatial multinomial profit approach. *Papers in Regional Science.* 88(2). p. 327-344.

Chandan J. (2009) *Statistics for Business and Economics.* Noida: Vikas Publishing House, Pvt Ltd.

Chang, T. & Huang, S. (2011) Reclaiming the City: Waterfront Development in Singapore. *Urban Studies.* 48 (10). p. 2085–2100.

Charter of Township of Waterford. (2013*) Code of Ordinances*. Michigan: *Order of Township Board*.

City Vision. (2013) Elizabeth Quay: City Vision Alternative Concept Feb 2013. [Online] Available from: http://www.cityvision.org.au/wp-content/uploads/2013/03/cityvision-waterfront-1.jpg [Accessed 30th November 2013]

Cho, S. et al. (2009) Spatial and Temporal Variations in the Housing Market of Lot Size and Open Space. *Land Economics*. 85(1). p. 51-73.

Chicago Department of Transportation Bureau of Bridges and Transit. (2003). *Streetscape Guidelines.* [Online] Available from: http://www.cityofchicago.org/dam/city/depts/cdot/Streetscape_Design_Guidelines.pdf [Accessed 5th November 2012]

City of Los Angeles department of city planning. (2008). *Walkability Checklist Guidance for Entitlement Review.* [Online] Available from:

http://www.urbandesignla.com/walkability/LA_Walkability_Checklist.pdf [Accessed 20th July 2013].

City of Oshkosh Department of Community Development. (2006) *Fox River Corridor Riverwalk Plan and Design Guidelines.* [Online] Available from: http://www.ci.oshkosh.wi.us/Community_Development/Planning_Services/ [Accessed 15th July 2013].

Colwell, P. & Dehring, C. (2005). The Pricing of Lake Lots. *The Journal of Real Estate Finance and Economics*. 30 (3). p. 267–283.

Debrezion, G. et al. (2011). Chapter 3: The Impact of Accessibility on the Value of Offices. In Nunen, J. et al. (eds.). *Transitions towards Sustainable Mobility*. Heidelberg: Springer. p. 41- 57.

Department of New York City Planning. (2013) *Zoning Tools: Waterfront Zoning.* [Online] Available from:http://www.nyc.gov/html/dcp/html/zone/zh_ztools_waterfront.shtml [Accessed 1st December 2013].

Downtown Alliance Streetscape Steering Committee (2006). *Downtown Streetscape*

Design Guidelines. Grand Rapid: Downtown Alliance.

Du, H. & Mulley, C. (2007) Transport accessibility and land value: a case study of Tyne and Wear. *RICS Research paper series*, 7(3). p.1-48.

Federal Emergency Management Agency (FEMA). (2007) *Risk Management Series: Site and Urban Design for Security, Guidance Against Potential Terrorist Attacks.* Oakland: Earthquake Engineering Research Institute.

Forkenbrock, D. et al. (2001). Transportation Investment and Urban Land Use Patterns. Public Policy Center: Transportation Policy Research, University of Iowa

Eves, C. (2009) Assessing the impact of streetscape on residential property in lower to middle socio-economic areas. In*: 16th Annual European Real Estate Society Conference*, Stockholm: Royal Institute of Technology.

Gao & Asami (2007). Effect of urban landscapes on land prices in two Japanese cities. *Landscape and Urban Planning*, Vol. 81. p. 155–166.

General Administration of Urban Planning. (1996). Nile Cornishe development project in Greater Cairo. Cairo's Governorate, Planning Research Department. (Arabic Reference)

Giuliano, G. & Agrawal A. (2010) Public Transit as a Metropolitan Growth Strategy, in Pindus et al (Eds), *Urban and Regional Policy and Its Effects*, Vol.3, Washington, DC: Brookings Institution Press. p. 205-252.

Gunay, Z., & Dokmeci, V. (2011) Culture-led regeneration of Istanbul waterfront: Golden Horn Cultural Valley Project. *Cities.* 29(4). p. 213-222.

Hamilton City Council (2012). Proposed district plan. [Online] Available from: http://www.hamilton.co.nz/ourcouncil/councilpublications/districtplans/proposeddistrictplan/appendix1/Pages/Appendix-1-4-Design-Guides-and-Assessment-Criteria-2.aspx [Accessed 1st December 2013].

Hartwick, E.(2006). The Impact of Environmental and Aesthetic Factors on Riverine Property Values. http://www.imagin.org/awards/sppc/2006/2006_grad_ed_hartwick.pdf (Accessed 12 April 2012).

Heikkila, E. (2000). *The Economics of Planning*. Center for Urban Policy Research, Rutgers University: CUPR Press

Horton Lee Brogden (HLB). (2006) Mission Creek Park North. [Online] Available from: http://www.hlblighting.com/HLB25/index.php/portfolio/mixed-use/122-mission-creek-park-north#!MCPark_1 [Accessed 20th November 2013]

Hubacek, K. & Bergh, J. (2006). Changing concepts of 'land' in economic theory: From single to multi-disciplinary approaches. *Ecological Economics*, Vol. 56. p. 5 – 27.

Kok, N. et al (2011). Economic Geography, Jobs, and Regulations: The Value of Land and Housing. [Online] Available from: http://urbanpolicy.berkeley.edu/pdf/KMQ_Geography_JMQ_021811.pdf [Accessed 15th April 2012].

Kondolf G.M., et. al. (2011). *Connecting Cairo to the Nile: Renewing life and heritage on the river.* Berkeley: Department of Landscape Architecture & Environmental Planning, University of California.

Kruse, G. (2009).*Take Me to the River: Designing the Intimate Waterfront*. Master's Thesis Faculty of Virginia Polytechnic Institute and State University.

Little Rock (2008). Riverfront Park at Little Rock City. [Online] Available from: http://www.littlerock.com/!UserFiles/business-listings/attractions/Peabody%20Park.jpg [Accessed 15 December 2013]

Luckett, M.(2007). *Design Strategies for Waterfront Revitalization in Clayton, New York.* Thesis (Masters). Syracuse*:* State University of New York College of Environmental Science and Forestry.

Olayiwola, L., et al.(2005). Correlates of Land Value Determinants in Lagos Metropolis, Nigeria. *J. Hum. Ecol.*, 17(3). p. 183-189

Ottawa. (2001) Design and Planning Guidelines: Street Design. [Online] Available from: http://ottawa.ca/sites/ottawa.ca/files/migrated/images/con027358_123464493.jpg [Accessed 22nd November 2013].

PA Consulting Group. (2009) Cleveland Waterfront Market, Demand and Development Options: Evaluating the Strategic Options for Waterfront Development on the Site of the Arlington: Cleveland- Cuyahoga County Port Authority.

Pedestrians. (2012) Sidewalk Placement. [Online] Available from: http://www.pedestrians.org/images/whysetbacks/furnzone.jpg [Accessed 10th October 2013]

Piwoni, J. (2006) The Historic Third Ward Neighborhood Design Guidelines, City of Milwaukee, U.S State of Wisconsin [Online] Available from: http://city.milwaukee.gov/ImageLibrary/Groups/cityDCD/planning/plans/ThirdWard/pdfs/ThirdWardDesign.pdf [Accessed 30th August 2013].

Player base. (1999) A Sidewalk Café in Paris. [Online] Available from: http://www.playerbase.com/elysium/travel/europe99/europajpgs/france/paris%20sidewalk%20cafe.JPG [Accessed 25th December 2013]

Port of Los Angeles (2011). La Waterfront Design Guidelines. [Online] Available from: http://www.lawaterfront.org/images/LAWaterfront_Design_Guidelines2011.pdf Accessed (30 August 2013)

Project for Public Spaces (PPS).(2009). Benches. Public Space Amenities: Guide to Benches' Design and Management in Downtowns, Neighborhood Commercial Districts, and Parks URL: http://www.pps.org/reference/benches/. Accessed (22 September 2013)

Project for Public Spaces (PPS). (2010) How to Transform A Waterfront. [Online] Available from: http://www.pps.org/reference/turnwaterfrontaround/ [Accessed 4th January 2013].

Richmond City Council (2012). Richmond Riverfront Plan. [Online] Available from: http://www.richmondgov.com/planninganddevelopmentreview/documents/Riverfront_Plan_Draft_20120611.pdf [Accessed 15th October 2013].

Rodriguez, A. et al. (2001). Uneven Redevelopment: New Urban Policies and Socio-Spatial Fragmentation in Metropolitan Bilbao, *European Urban and Regional Studies* 8(2). p. 161–178

San Francisco Municipal Transportation Agency (SFMTA). (2013) Castro Street Design Parking Summary. [Online] Available from: http://www.google.com.eg/imgres?imgurl=x-raw-image [Accessed 15th December 2013]

Sekaran, U. & Bougie, R. (2009) *Research Methods for Business: A skill Building Approach*, John Willey & Sons Ltd, 5th Edition.

Sign Source. (2011) Awning with painted graphics. [Online] Available from: http://www.sign-source.com/gusto.html [Accessed 28th October 2013]

Skyscrapercity. (2005) The tram of Bilbao. [Online] Available from: http://www.skyscrapercity.com/showthread.php?t=210184&page=3 [Accessed 20th November 2013]

Skyscrapercity. (2011) Malacca Water Taxi. [Online] Available from: http://m6.i.pbase.com/g1/92/667992/2/127775836.CeDI6bKc.jpg [Accessed 20th November 2013]

Thakur, P. (2009). Assessing Land Use and Urban Form Impacts of Changes in Relative Accessibility

The Shop at Willow Bend. (2012) United Colors of Benetton. [Online] Available from: http://www.shopwillowbend.com/directory/united_colors_of_benetton [Accessed 20 November 2013]

Topcu, M. & Kubat, A (2009). The Analysis of Urban Features that Affect Land Values in Residential Areas. *Proceedings of the 7th International Space Syntax Symposium.* Stockholm: KTH.

Total Branding Solutions. (2012) Projection Signs. [Online] Available from: http://www.total-branding-solutions.co.uk/projection-signs [Accessed 28th October 2013)

TransAlt. (2007). Rethinking Bollards: How Bollards can save lives, prevent injuries, and relief traffic congestion in New York City, [Online} Available from: http://transalt.org/files/news/reports/rethinking_bollards.pdf [Accessed 22nd September 2013].

Tripadvisor. (2006) Millennium Bridge. [Online] Available from: http://media-cdn.tripadvisor.com/media/photo-s/00/18/76/67/millennium-bridge.jpg [Accessed 22nd November 2013]

Urban Code Handbook. (2004) The Renaissance Plan for the Heart of Wake Forest, North Carolina.

Urban Research Consulting Center (URC). (2006). General Plan for the Banks of the Nile River in Greater Cairo, Third Report. *Faculty of Urban and Regional Planning, Cairo University* (Arabic Reference)

Waddell, P. & Moore, T. (2008). Forecasting Demand for Urban Land in: Marzluff et al. (eds.) *Urban Ecology*. New York: Springer Science.

Westchester County Planning Dept. (2005). Guidelines Manual: Westchester River Walk; A Green way Trail, New York: Westchester Gov.

Wilmington Area Metropolitan Planning Organization (2008) *Chapter Five: Marketing, Way finding, & Interpretive Program. In: Cape Fear Historic Byway: Draft Corridor Management Plan.* [Online] Available from: http://www.wmpo.org/PDF/2008-03_CFHBP_Chap5.pdf [Accessed 15th September 2013].

THE EFFECTS OF OCCUPANCY, WWR, AND ORIENTATION ON ENERGY USE OF SCHOOL BUILDINGS IN GAZA, PALESTINE

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Abstract

Palestinian schools are designed due to the standards of ministry of education (MOE) in cooperation with UNESCO. Local school building designs are required to be more efficient climate-based and energy-conscious while maintaining indoor comfort levels. In addition, these schools suffer from classroom high occupancy density of up in the Gaza Strip to 40 students, while the target value is 30 students per classroom.

The paper aims to study the effect of occupancy, orientation, and window to wall ratio (WWR) factors on total energy consumption of school buildings in Gaza, Palestine and optimized the best for minimum energy use intensity. The method started by analyzing local climate and defined the reliable weather data for the software. A simulated model, that presented the common existing school building situation and located at Gaza strip, was developed. This model results was set as a reference value. The study investigated the effect of changing the occupancy density rates with considering international and local standards, orientation at the four basic directions, and WWR with regards to its impact on the amount of HVAC loads and lighting energy demand for the building. These investigations will optimize the best occupancy density and window size on energy consumption.

The results indicated that the increasing of occupancy had significant effect rather than opaque and glazing on energy consumption. It showed that density use in school buildings affect energy use about (27%) above the international standard, where the building envelope characteristics still determine a large part of the energy use in a school building (37.5%) for HVAC and lighting loads. East orientation has more effect on increasing energy consumption than other orientations as a result the amount of exposure to solar radiation for a longer period of the western façade due to the school schedule.

Keywords: Orientation, WWR, Building Envelope, Occupancy, Energy Use

الملخص

يتم تصميم المدارس في فلسطين تبعا وفقا لمعايير وزارة التربية والتعليم الفلسطينية وبالتعاون مع منظمة اليونسكو، ولكن نظرا لمحدودية الاراضي بالمنطقة تعاني الفصول الدراسية من نسبة إشغال عالية الكثافة تصل في قطاع غزة إلى 42 طالب بينما تقل هذه النسبة إلى 32 في مناطق الضفة الغربية، كما تعاني المدارس المحلية في فلسطين من التزايد المستمر في استخدام الطاقة نتيجة التزايد المستمر في استخدام نظم تكييف الهواء وزيادة ساعات تشغيل وحدات الاضاءة الصناعية على مدار اليوم الدراسي الناتج عن محدودية الضوء الطبيعي في داخل الفراغ.

تهدف الورقة البحثية إلى دراسة تأثير كل من عوامل إشغال الفراغ وتوجيه المبنى ونسبة فتحة الشباك إلى الحائط على كمية استهلاك الطاقة وتحسينها تم اختيار هذه العوامل الأكثر تأثيراً على كمية استهلاك الطاقة بمباني المدارس. تقوم الدراسة على تحليل المناخ والوضع القائم لمباني المدارس في مدينة غزة لتحديد نموذج لمبنى مدرسة قائم في مدينة خانيونس بقطاع غزة يمثل الحالة العامة القائمة للمدارس بالمنطقة واعتباره مرجع يمكن مقارنة نتائج تحسين الأداء عليه ، ثم دراسة تأثير العوامل الثلاثة على كمية استهلاك الطاقة بالمبنى من خلال دراسة تأثير تغير نسبة الإشغال والتوجيه في الاتجاهات الأساسية الأربعة ومقارنتها بالمعايير العالمية، ودراسة تغيير نسبة فتحة الشباك للحائط وتأثيرها على كمية الإضاءة والاحمال الحرارية بالمبنى.

وتم تطبيق نموذج المحاكاة باستخدام برنامج *Designbuilder 2.4* لحساب استهلاك الطاقة السنوية والشهرية والاكتساب والفقد الحراري خلال عناصر غلاف المبنى من السقف والحوائط الخارجية والفتحات على نموذج ثابت مفترض يحقق نسبة إشغال 0.8 طالب/م2ونسبة فتحات 25%. وأشارت النتائج إلى أن زيادة الازدحام بالفصل الدراسي يزيد من كمية الطاقة الداخلية وبالتالي يزيد أحمال التبريد بنسبة تصل إلى 27% من كمية الطاقة المستهلكة. ولا يزال خصائص غلاف المبنى يشكل عبء إضافي بنسبة 37% على أحمال التبريد والاضاءة. تعتبر الواجهة الشرقي هي الأكثر تأثراً بالمناخ وذلك نتيجة تعرضها لكمية الاشعاع الشمسي لفترة أطول من الواجهة الغربية وذلك تبعاً للجدول المدرسي مما يتطلب الأخذ في الاعتبار معالجات الاظلال، نسبة فتحة الشباك 25% لا زالت تحقق أفضل أداء.

1. INTRODUCTION

Occupant, lighting, and equipment heat gain are the major sources of internal heat gains. For this reason, each source can be estimated separately and then summed to provide an estimate of the total energy consumption [1]. Changes in internal loads could affect the energy balance that would be used in an optimization based on feedback from an energy simulation.

Occupancy results in building heat gains due to both occupant metabolism and electric consumption in lights and equipment. The impacts due to building external envelope production had a small but significant environmental benefit as WWR increasing such as for daylighting. [2]. Increasing window area for better daylighting will increase heat transfer through envelope, since even the best performing glazing units do not possess that same thermal resistance of a sufficiently insulated opaque assembly. Depending on the window materials, the impact is reduced by 9–15% by change. Using daylighting to cut reliance on artificial light can reduce the electricity used to power the lighting, and additionally reduce cooling loads induced by the waste heat created by lighting fixtures [3].

Size and specifications according to (Tanner K., 2000) at his study for reviewed schools and achievement of students, was that the major problem may not be size, but density. His conclusion was that no one has completed definitive research on the relationship of distance among students and the amount of learning that takes place in defined spaces. One thing is for certain, crowding is a negative factor for student outcomes [4].

Three factors affect the classroom standard size such as the introduction of new technologies that has been brought requirements for more equipment in classrooms like computer. And, of course, new approaches to teaching and learning have had an impact on the added space to permit more flexible fit outs. In addition to, the new architecture designs of school building [5].

There are significant differences between countries, ranging from over 32 in Japan and Korea to 19 or below in Estonia, Iceland, Luxembourg, Slovenia and the United Kingdom. Standards however need to change over time. Factors such as the height and size of people, both of which have increased over the last century in many countries, have led to larger, wider seats and greater area requirements. [6]

The overall number of Palestinian schools operating on a double shift system was reduced from 86% in 2012 to 71% in 2013 and the class occupancy density was maintained at 38 students per classroom, down from 49 students per classroom in 2000, in spite of the population increase [7]. The government targets to reduce density to 30 students per meter square. Due to the increasing number of students, Many local schools have been forced to operate on double and triple shifts, leading to reduced learning time. It is estimated that an additional 260 schools (160 schools for the MOE and 100 for UNRWA) are needed to accommodate new students and to reduce the pressure on schools operating on a double and triple shifts [8].

Finding the right balance for a particular situation for internal and external heat gain would allow the designer to provide the solution that provides sufficient daylighting potential while maintaining a window to wall ratio that provides a good thermal performance with minimum energy consumption for heating, cooling and electrical lighting.

2. OBJECTIVE

This paper studied the effect of occupancy, orientation, and window to wall ratio (WWR) on total energy consumption through building envelope of school buildings in Gaza, Palestine. The questions are how drastically these possible changes in building orientation and WWR will alter the optimized solution, and what are the recommended occupancy density that can make to minimum energy consumption.

3. METHODOLOGY

The methodology adopted in this paper was carried out as follows:

1. The method starts by analyzing local climate and define the reliable weather data for the software.
2. The base case model were carried out on energy use intensity for Gaza City location (31° N, and 34°E) to calculate monthly and annual energy consumption and heat gain balance through the building envelope elements such as external walls, glazing, and roof. The base case model was assumed to be 0.8 student/m^2 occupancy, WWR 25%, and no fixed orientation.

The study investigated the effect the study of the effect of changing orientation at the four basic directions, the occupancy density rates with considering local standards, and WWR with regard to its impact on the amount of lighting and thermal loads of the building. These investigations will optimize the best occupancy and window size on energy consumption.

An existing school building was created by using *Designbuilder* 2.4 software as full air-conditioned building. Its simulation results set as a reference value "common case" can be compared to the results of improving the performance. The comparative analysis have been done based on heat gain balance and total energy use by HVAC and artificial lighting with the common case simulation results which express the existing school buildings.

The output values collected from Energy plus were cooling, heating and lighting energy (electricity) required respectively. These values upon summation yield total electricity consumption which need to be minimized. It was referred to as Energy Use Intensity EUI.

$$EUI = E\_cool + E\_heat + E\_light$$

4. GAZA CLIMATE ANALYSIS

Gaza has occupied a dividing position between the desert in the south and the Mediterranean climate in the North. The average daily mean temperature ranges from 25ºC in summer to 13ºC in winter. Daily relative humidity fluctuates between 65% in the daytime and 85% at night in the summer, and between 60% and 80 % respectively in winter [9]. Gaza Strip has a relatively high solar radiation. It has approximately 2861, annual sunshine -hour sunshine throughout the year. The daily average solar radiation on a horizontal surface is about 222W/m^2. [10] Gaza strip is divided into two climate zone [11], There was no available weather file data constructed on Energy Simulation Software.

Figure (1) Map of Palestinian Territories and Gaza Strip

Source: http://en.wikipedia.org/wiki/Gaza_Strip

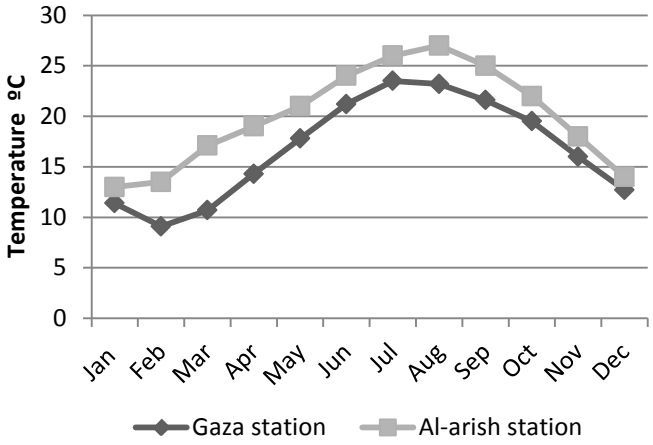
The study used the weather data of the nearest city which was Al-Arish city in Egypt. Figure (2) shows the difference in mean temperatures for Gaza and Al Arish weather stations.

Table (1) shows comfort design strategies. Al-Arish comfort zone is less 15% than Gaza and need for more cooling design. Despite Gaza zone required considering on shading strategies. From the weather data analysis of Al Arish, cooling hours was higher than the comfort zone in 44% the occupied period while it was lower than the comfort levels in 36%. This indicated that the building envelope design and composition should be thoroughly considered to mitigate the effect of external climatic conditions.

Table (1) Climate characteristics for Gaza and Al-Arish zone
Source: [11], [12]

Zone	Wind velocity m/s	Extreme temperature (˚C)		Relative Humidity (%)	
		Max	Min	Max	Min
Gaza	2.8	31	9	65	49
Al-Arish	3	32	5	72	50

Figure (2) Average mean temperature for Gaza and Al-Arish stations



4.1. The Common Reference Value

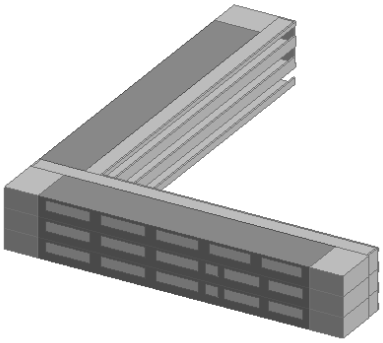
Palestinian school buildings follow a prototype design with single loaded corridors serving and spaces like classrooms, labs, library or administration. The simulations applied at monthly and annual energy consumption on a model that presents the common school building situation in Gaza is located in Khan-Younis, Gaza strip. The common case school model properties, as in Table (2), is a three story primary school building constructed in 2005. The total floor area is about 1245.5 m^2 with 31 total classrooms. The building oriented at south east. The building material is hollow cement block covered with plaster layer. The windows all use a single 6mm clear glass with a U-value 6.17 $W/m^2.k$ and Aluminium frame with non-thermal breaks as commonly used in local practice. The building workdays schedule input starts from 7:00am to 16:30 am from September to 31st of May. The school works from 7:00am to 14:00 am at 1st June to 31st August, Friday is the weekend. The study proposed that this school building model is a stand-alone building without overshadow from any adjacent buildings. Therefore, there is no consideration for any shading devices and site unless the windows on the inner façade are shaded by corridor.

Simulation results showed that the total EUI_{MOE} = 191 kWh/m^2, of which 96% were used for cooling and only 4% for lighting. It was clear through monthly results that energy for cooling increased at the period from April to October. It was observed that internal heat gain from occupancy was larger than heat gains from external loads by about 9%. This result indicated that the occupancy is a main parameter that had to be considered.

Table (2) The common case model properties

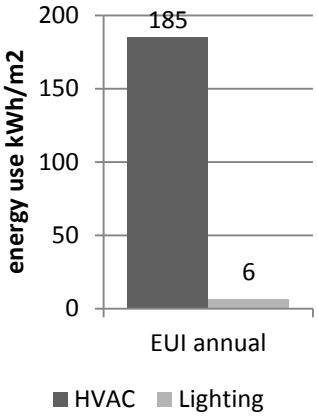
Parameter	Values	U value (W/m2-K)
Roof	4mm Single ply plastic bitumen	0.64
	11cm Foam concrete	
	0.25m Reinforced concrete slab	
	0.02m Cement plaster	
Wall	15cm Hollow cement block	2.74
	25cm Cement plaster (external & internal)	
Glazing	Single glazed 6mm, **VLT:** 0.88%, **SHGC:** 0.81	5.7
Illuminance task	300 lux	
HVAC	Heating set point 20 Cooling set point 24	

Figure (3) the common school model isometric

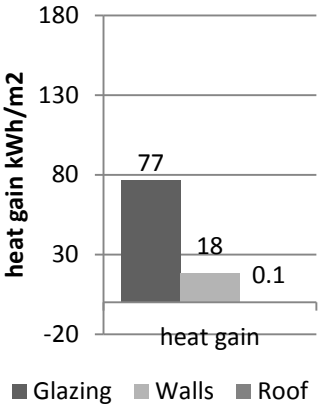


Total floor area= 1245.5m2

Figure (4) The simulation results for the common case



Monthly HVAC and lighting Loads of the common-case

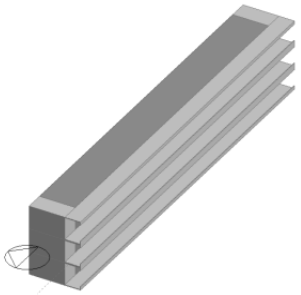


Monthly heat gain from windows, roof and external walls of the common-case

4.2. Setting the Base Case

The base case was assumed to be a rectangular block of group of 7 classrooms with three floors height with WWR 25% and 0.84 occupancy. The building model orientation was not fixed. The investigated variables are shown on Table 3. This included building orientation, occupancy density, and window-to-wall ratio (WWR). Internal loads from different occupancy and artificial lighting at 300lux only were accounted for. First, alternatives of each single parameter were tested, and then based on the results; the optimum performing alternatives of all tested parameters were combined, applied on the model and simulated. This represented the suggested optimized best practice case.

Figure (4) The base case model



Floor Area : 336m^2
WWR: 25%
Flat roof 0.64 W/m^2.K
External walls 2.74 W/m^2.K
Windows 5.7 W/m^2.K
Lighting 300 lux
Occupancy 0.8 student/m2

Split & mech. Ventilation

Table (3) Investigated variables for the base case

Parameter	Rage of value
Building orientation	N, E, S, and W
Occupancy	0, 0.4, 0.6, 0.8, and 1.0student/m^2.
Window-to-wall ratios	15%, 20%, 25%, 30% and 35%, the ratio of glazed area to both inside and outside facing wall.

5. SIMULATION RESULTS AND ANALYSIS

5.1. Effect of Building orientation on energy use

Firstly, the simulation runs on no occupancy *"No internal gain"* for 4 basic orientations in order to understand the envelope performance without internal loads. The changes in annual EUI for heating and cooling (HVAC) loads and artificial lighting have been illustrated in Figure (5) were 2%, 18%, 20%, and 12% significantly. The chart showed that the south-orientation had the maximum loads and its external heat gain from envelope element reduced from 33% to 13% when the school was occupied. The east orientation was still sensitive for solar gain. The study becomes quite evident that orientations might have significant effect for external loads on building. For improvement the occupancy heat gain loads should be considered.

Figure (5) The annual heat gain loads for walls, window, and roof, at occupancy 0.0 and 0.84 student/m2

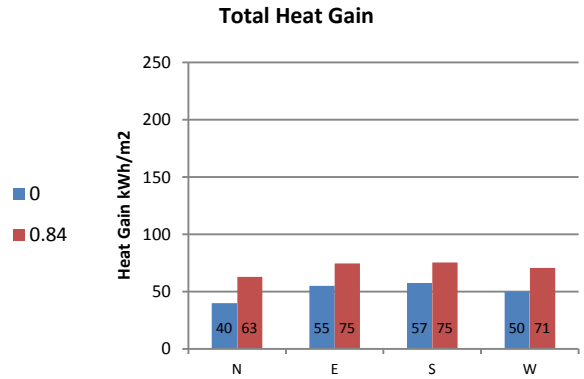
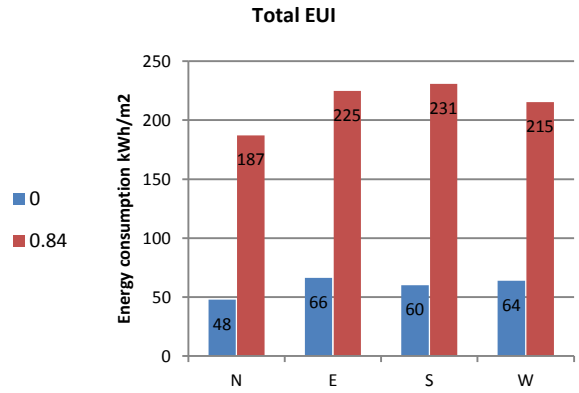


Figure (6) The annual EUI for heating, cooling and lighting loads, at WWR 25% and occupancy 0.0 and 0.84 student/m2



5.2. Effect of Occupancy on energy use:

The international standard occupancy for school recommended by UNESCO, (2004) for different countries it ranges 30 to 36 students. The local government standards specify 30 students per classroom as a target density [13]. The study suggested that the investigated variables are 0, 0.4, 0.6, 0.8, and 1.0 student/m^2 densities. Internal heat gain per student equal 2.8kWh/m^2 where the classroom size is 48m^2, the external heat gain from building envelope was 37.5kWh/m^2, the correlation is linear.

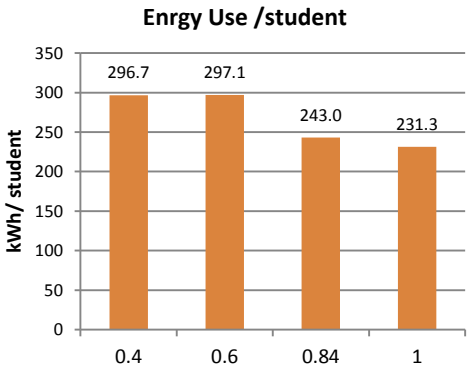
From results, The energy use per student decreased to 49% when classroom density increased to 48 students per class (1.0 student/m^2) while it decreased to 22% when the classroom density is 30 student per class (0.6 student/m^2). Saving of energy consumption reduced to more than a half when occupant density is at the minimum case 20 student per class (0.4 student/m^2). And the EUI saving per meter square was about (26%) below the base case and 32% common case. The effect of heat gain of the envelope may be neglected by increasing the internal heat gain at high densities.

The effect of occupant characteristics and densities might be larger than expected. Therefore, The study suggested occupancy 0.6 student/m^2, optimum density recommended by UNISCO, is recommended for Gaza school.

Table (4) Energy use for different occupancy densities

Occupancy Student/m2	Cooling kWh	Heating kWh	Lighting kWh	Total Energy Use kWh	Energy Use kWh /student
0.4	119869	507	4253	124629	297
0.6	155919	272	4253	160443	297
0.84	199670	207	4253	204130	243
1	228729	175	4253	233157	231

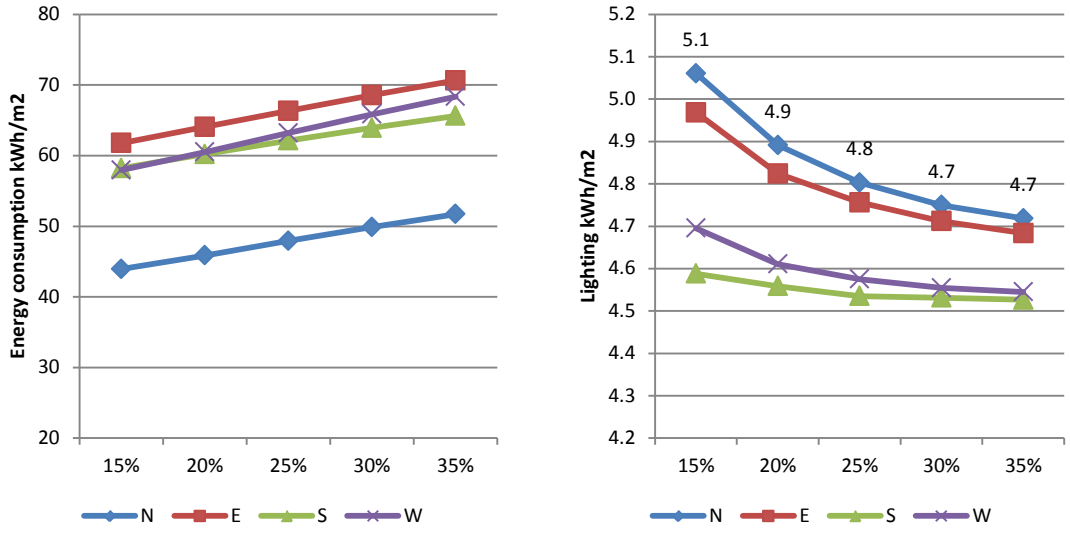
Figure (7) Total annual energy use, at WWR 25%, and different occupancy densities for East orientation



5.3. Effect of WWR on energy use:

The effect of increasing WWR on HVAC and artificial lighting has been shown on Figure (8). HVAC energy loads increase with increasing WWR, on the other hand the trend for artificial lighting energy is just opposite, it decreases with increasing WWR. Thus, the overall impact of WWR on total energy consumption can be seen on Figure (8). The curve of lighting begin to slight smooth at WWR 30% .

Figure (8) Total annual HVAC and lighting Loads, Gaza at different WWR



The heat exchange would be increased for the heat transfer coefficient of window for single glazed being larger than that of wall. Heat gains increased 18% as the WWR increases from 15% to 25% and the cooling loads reached 7%.

On the other hand, the artificial lighting consumption will decrease about 6.25% at WWR 15% as WWR increases to 25% as illustrated on Figure (8). These two opposing facts bring out that an optimum WWR is reached where the total electricity consumption is minimized. The heat gain loads increased.

6. CONCLUSION

The results showed that east and south orientations had more sensitive effect on increasing energy consumption than the other orientations, that because the direct sun radiation along the school schedule from 7:00 to 16:30. Therefore, the building orientation should be considered according to solar path.

From the results, the study recommended for using 0.6 student/m^2 occupancy to be optimized, as it seems to be reasonable for Gaza school buildings because the limited area for building new schools. For saving new classroom, The school building can extended vertically but the study will done on the aspect ratio of building envelope.

The applied WWR 25% still best for balance between daylight and HVAC loads. Increasing of occupancy was more effect than opaque and glazing improvements on energy consumption.

When comparing the results with the common case as actual building (191kWh/m2), the saving of energy was 27%. This study showed that occupant density use in school buildings affect energy use therefore, the effect of occupant characteristics and school schedule might be larger than expected. But building envelope characteristics still determine a large part of the energy use in a school building (37.5%). But the effect of heat gain exchange from the building envelope may be neglected by increasing the internal heat gain at high densities. This fact may lead to no sensitive improvement for building thermal characteristics for saving energy consumption.

Glazing type and window shading devices even though internal or external for air conditioned building is the major considered factor for minimizing solar heat gain with the large window size. This is should take into account the visual comfort and daylighting.

References

(1) Glassman, E. J. and Reinhart C. (2013), Facade Optimization Using Parametric Design And Future Climate Scenarios, 13th Conference of International Building Performance Simulation Association, Chambéry, France, August, pages: 26-28

(2) Vital Sign (2014), Building Balance Point, Level 1: Introduction to First Order Principles, Vital signs curriculum materials project, http://web.utk.edu/~archinfo/EcoDesign/546c/EXERCISES/EX4BalancePt/BalPtDocs/BPnum2.pdf, Inter website at: 23th May

(3) Su, X. and Zhang, X. (2010), Environmental Performance Optimization Of Window–Wall Ratio For Different Window Type In Hot Summer and Cold Winter Zone In China Based On Life Cycle Assessment, *Energy and Buildings Journal*, Volume 42, Issue 2, February, Pages 198–202. http://www.sciencedirect.com/science/article/pii/S0378778809002060

(4) Tanner, C. K. (2000), Minimum Classroom Size and Number of Students Per Classroom, The University of Georgia, School Design and Planning Laboratory, Facilities Planning, Design, & Management at UGA, April, 2000

(5) http://sdpl.coe.uga.edu/research/territoriality.html

(6) Raines, K. (2012), Performance Modelling for a Sustainable Master Plan, 5th National Conference of IBPSA-USA, Madison, Wisconsin, August, pages:1-3

(7) Al-Tamimi, N. A. (2011), The Effects of Orientation, Ventilation, and Varied WWR on the Thermal Performance of Residential Rooms in the Tropics, *Journal of Sustainable Development* Vol. 4, No. 2; April 142-149

(8) PCBS (2013), Palestine in Figures, The Palestinian Central Bureau of Statistics, Ramallah, Palestine, March 2014, http://www.pcbs.gov.ps/Portals/_PCBS/Downloads/book2040.pdf

(9) OECD (2010), The impact of school design on academic achievement in the Palestinian territories: an empirical study,_CELE Exchange, May 2010 OECD (2010), ISSN 2072-7925

(10) Badawy, U. (2014)**,** Climate Conditions Impact on the Architectural Design in Palestine. *European Journal of Academic Essays*, pages:1-7, www.euroessays.org

(11) HPCR (2010), Assessing Human Security Needs in the Gaza Strip, Working paper No.1, Population Projections for Socioeconomic Development in Gaza Strip, Massachusetts, USA, Page: 7

(12) Energy Efficient Building Code (2004), Ministry of Local Government

(13) Al-Arish weather file http://apps1.eere.energy.gov/buildings/energyplus/weatherdata_about.cfm

(14) MOE (2003), Future school in Palestine, a manual for designing schools the ministry of education, The Ministry of Education, UNESCO, Ramallah

A DESIGN APPROACH USING BIO-GEOMETRY IN INTERIOR ARCHITECTURAL SPACES: Reference to Heal Attention Deficit Hyperactivity Disorder (ADHD)

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Abstract

Since the beginning of the universe, people live in a middle of a huge amount of different types of energies which affect them, include what is useful, and what is harmful. The variation of these effects either direct or indirect was because of the role played by both designers architect and interior architect in the formation of voids. Both were responsible for the interior space design to avoid environmental pollution, and negative impacts to take the advantage of the positive energy in improving people performance in the interior architectural spaces, and the society in general. When we consider that at least 90% of our life is spent indoors, the significance of this sentence becomes apparent.[1] Scientists have proved that the interior architectural space contains different types of energy. This energy has a negative and positive impact on human beings, some problems appeared like the absence of the concept "earth energy" and other environmental concepts associated with it, in addition to its impact on human health and performance in the interior architectural spaces, resulting in health problems for people in those spaces, Also the positive impact of bio-geometry on human health, through its application in the interior spaces to achieve a balance in the internal energy, thus helps in the treatment of many diseases.[2]

The main research aim is to use the principles and theories of Bio-Geometry in the interior architectural spaces, to achieve the best results to maintain human health, the efficiency of performance, and modify human behavior. In addition to formulate a clear framework and methodology as a design approach through which the designer either an architect or interior can deal with the negative energy in the interior architectural spaces using the science of Bio-Geometry, the paper followed the mentioned methodology to achieve the best results. This research Paper focuses on the importance of the science of biogeometry on human health as one of the application for the new science, the research will be applied on children who suffers from ADHD that considered as one of the new sciences that give more care to human health and performance, all results after testing the biogeometry will be statically examined by SPAA program and compare them all by the end to proof the ability of the new science to help in healing some health problems.

Key words: Bio-Geometry- Earth Energy-Geo-pathic stress-Attention Deficit Hyperactivity disorder (ADHD) -Bio-Energy- EMF: Electro Magnetic Field.

[1] Baker, Paula-and others-"A Healthy House"-2001,p.11
[2] Ibid.

الملخص

مع التقدم المتصل بعلم الطبيعة والفيزياء ونظرياته مع أواخر القرن العشرين، ظهرت مجموعة من الأفكار والعلوم المتعلقة بالطاقة كأساس لاستيعاب المفهوم الكوني المتكون من مجموعة من الموجات والاهتزازات بترددات مختلفة، وقد أثبت العلماء أن الفراغ المعماري الداخلي يحتوي على مجموعات مختلفة من الطاقة التي لها تأثيرات سلبية وإيجابية على الإنسان الأمر الذي يدعو للحاجة إلى إعادة تصميم هذه الفراغات وفق أسس ونظريات تصميمية خاصة مبنية على التأثيرات ما بين الطاقات والفراغات الداخلية والإنسان المستخدم لها. وتعد الألوان والمواد المستخدمة في الفراغات المعمارية الداخلية من أنواع الطاقة، وبالتالي فإن التصميم الداخلي للفراغات لا يقتصر على التصميم المعماري بل يمتد دوره بعد تشكل الطاقات الجديدة في حدود الفراغ. وفي هذه الحالة، يلزم التركيز على نوعية الطاقة المستخدمة في الفراغ ذات التأثير الإيجابي على الإنسان لإحداث الاتزان المطلوب في المكان، في إطار السعي لتحسين الجانب الصحي للإنسان ورفع كفاءة أدائه في الفراغ المعماري الداخلي.، ويساعد علم البيوجيومتري في المساعدة في إيجاد العديد من الحلول للمشاكل التي يتعرض لها الإنسان في الفراغات المعمارية الداخلية.

1 INTRODUCTION

Bio-Geometry is a science that deals with the Energy of Shape; it uses shapes, colors, motion, orientation and sound produce a vibrational quality that balances energy fields. Bio-Geometrical shapes are two or three-dimensional shapes specially designed to interact with the earth's energy fields to produce a balanced effect on multiple levels of biological systems. They were developed and patented by Dr. Ibrahim F. Karim, D.Sc. In Cairo, Egypt, during research since 1968.[3] It is also defined as a design language of geometric form, color, sound, and motion. The geometrical shapes are based on the science of micro-vibration physics, or radistezia. This science will create a new form of architecture that would enhance the human biological system and give a new meaning to the concept of building spaces.[4]

Bio-Geometry is the science that study effect of shapes and angles on the living organisms and their energy fields. It gives solutions to the negative harmful effects and enhances their positive effects. Bio-Geometry provides answers to the architectural pollution people suffer from, as well as the pollution of the technology (the use of electric, wireless and cellular devices in buildings). [5]

The interior energy system uses the senses and the energy centers (Chakras) to interact directly with all levels of energy in the environment. The peripheral energy systems in turn, are not completely closed to the outside either they are in constant exchange of information with the outside energy environment.[6]

This research will focus on the impact of Bio-geometry on students who are suffering from Attention-Defect Hyperactivity Disorder (ADHD) which can be defined as a group of behaviors found in many children and adults. People who have ADHD have trouble in paying attention at school, home or at work. They may be much more active and/or impulsive than what is usual for their age. These behaviors contribute

[3] http://www.biogeometry.com/english/biogeo.php

[4] Dr. Ibrahim Karim-"What is energy-Back to the Future"-International Union of Architects Conference- Bibliotheca Alex.- Alexndrina-2002

[5] Dr. Ibrahim Karim ," Bio-Geometrical Energy Balancing" cd, 2002

[6] Ibrahim Karim-"Back To A future For Mankind"-publisher: Bio-geometry consultant centre-2009,p.247

to significant problems in relationships, learning and behavior. For this reason, children who have ADHD are sometimes seen as being "Difficult" or as having behavior problems.[7]

The research will concentrate on applying the design approach on the case study to change children medical case "ADHD" in a specialized approved center HDC (Human Development Centre). This is to help in treating those cases in which designers' role can have a successful design approach for helping people to be cured from the pollutant interior environments.

2 DESIGN APPROACH STEPS

The development of science and the appearance of the new research there has been awareness and interest of the interpretation of many of the phenomena seen in life such as art, humanities, and religion. All are sciences that has the nature of the different quality is not measurable or quantitatively ranking and scientifically therefore was necessary to emergence of new concepts that can explain the phenomena of the quality of the universe. These following are concepts related to the Bio-Geometry science:

- Organized Energy
- Golden component at higher levels
- Ultra Violet component at higher levels
- Negative Green
-Energy Key
- Radistezia
- Harmonics
- Measure the Qualities and Quantities

To apply the design approach to the case study the research will go through the following steps:

Stimuli:

Four reasons were behind choosing the case study on ADHD:

- ADHD is a common behavioral disorder that affects about 8% to 10% of school-age children. Boys are about three times more likely than girls to be diagnosed with.
- The reason(s) that causes negative impact on human body in the interior architectural space, such as Geo-pathic stress on children that causes ADHD and LD (Learning Disability).
- The children with this problem should be healed otherwise it will cause increasing in the number of criminals in society according to the latest studies.
- Clarification of the designer's role on interior space as a designer to help the children with (ADHD), and improve their performance using color therapy and bio-geometry cubes and shapes, in addition to windows designs, and interior

[7] -http://www.adhd.com/index.html

architectural space's energy balance, to achieve all requirements and needs of mental health.

Method:
The setting of the case study (Input data-Process (method) -Output data) will be through 4 stages of tests and results using the checklists as the following:

- -Stage 1: The base case without any edit in the interior space, and this is used as a scale to compare the results before and after using the Bio-Geometry, monitor the time and performance needed for development through diagnoses and final reports.
- -Stage 2: Depends on using BG energy cubes, shapes, colors, and records the student's performance according to the same limited time that was given to others in the other stages.
- -Stage 3: Depends on using BG energy cubes, shapes, colors, in addition to window designs, interior spaces energy balance, doors balancing energy, and records the student's performance according to the same limited time that was given to other stages.
- -Stage 4:Compare all final results.

3 DESIGN APPROACH ANALYSIS

Analysis for developing the Interior Architectural Space dealt with participants, study area, energy detecting tools and equipment, questionnaires, and observation. All stages will be done by the physicians, specialists in the HDC, and the researchers. The research proceeds according to the following case setting:

3.1 Settings of case study

This experiment examins how designers can deal with the interior space energy problems, which are harmful to people's health and performance. The experiment was one according to the following setting:

3.1.1 Center Selection

The ADHD Treatment Centre (HDC). Site analysis according to latitude and longitude was taken from Google earth.

- Latitude : 24 45 54.00 N
- Longitude : 46 43 55.85 S
- Elev. : 636 m

3.1.2 Class Selection

The team chose 4 groups with total 16 selected children at each stage from different environments, as sample from the community (Figures 1 & 2).

Figure (1) Location of classes in the building

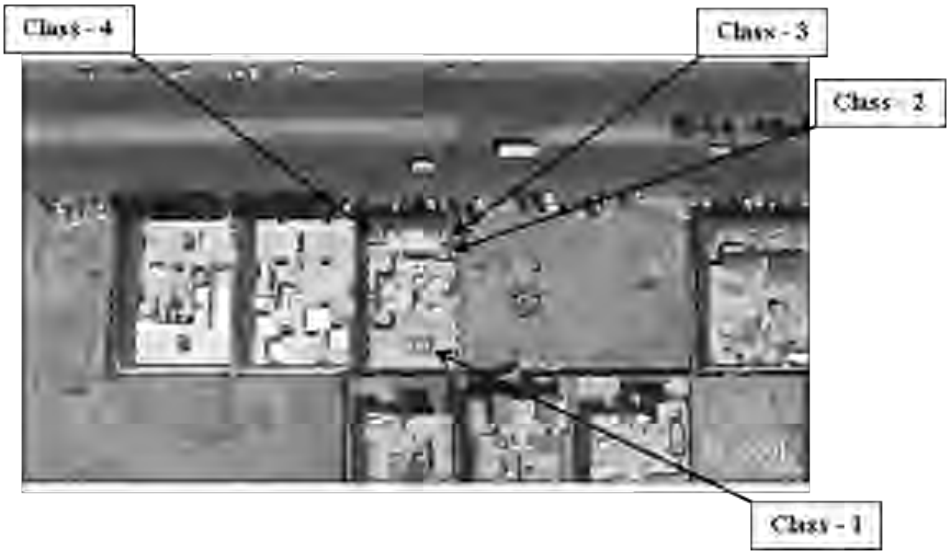
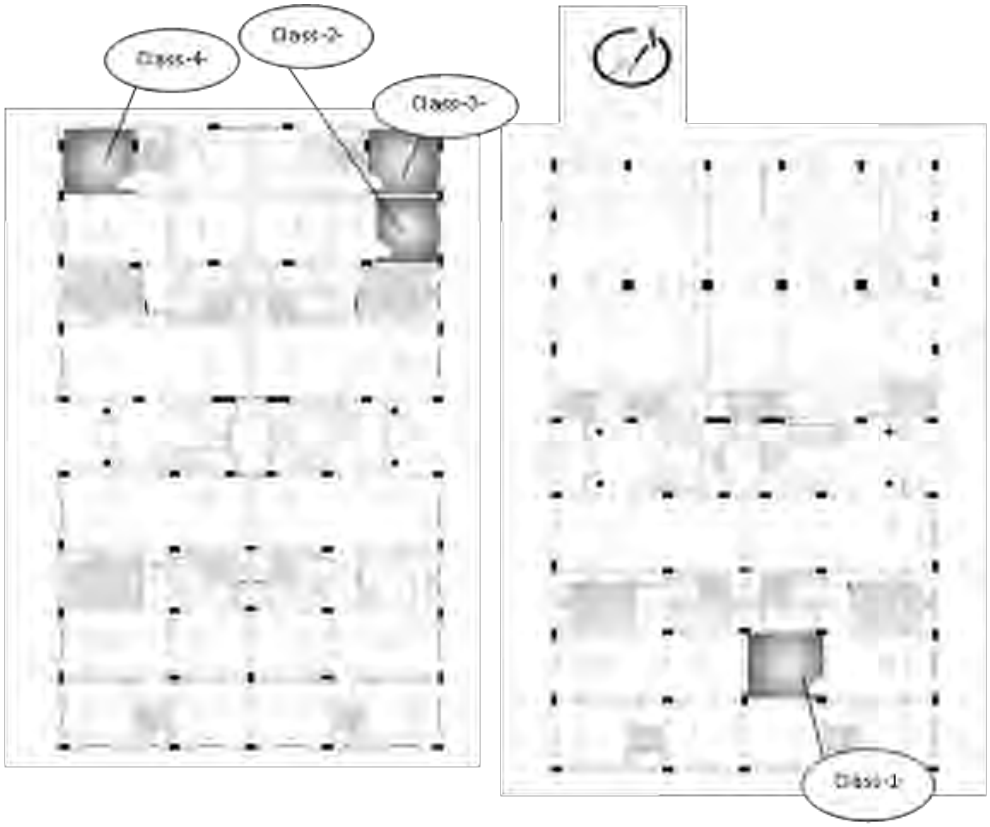


Figure (2) Floor plans of classes



3.1.3 Student Selection

The average age between students is from 6-8 years old boys and girls, and the number of students has been chosen for the experiment with the help of one specialist and one assistant. Those children with normal "IQ" 90 and above, all suffer from ADHD and have difficulty in academic achievement. Other causes of learning disability (LD). Those Children have been taken as a sample from the population of the society to work on as research sample.

3.1.4 The Medical Crew selection

The center has specialists who are trained to do psychological tests and result interpretation.

3.1.5 Time limitation

Limited time will be 3 months in each stage.

3.1.6 Tools

A varity of tools used in this experiment as follows:

Energy Detecting and Balancing Tools and Equipment

- Tools that will be used to *detect* the interior space energy are: IK (IKUP) Pendulum, Convective (Virtual Cone Pendulum).
- Tools that will be used to *correct* the interior space energy are: Dial (for balancing energy coming from doors and windows), and sample collector, in addition to BG cubes (Home Kit), and shapes, and colors
- Tools that will be used to *evaluate* the interior space energy impact are: Play Attention software program, Checklists, and assessment reports.
- Tools that will be used to *analyze and compare* the interior space energy results are: excel and SPSS programs

Figure (3) Energy Detecting and Balancing Tools

The (IK) Pendulum

BG Tools (Home Kit)

Virtual Cone Pendulum

Source: www.biogeometry.com

Play Attention Program:

The child interns game only with mental focus without touching any button or device to increase his attention and improve his memory and attention.

Figure (4) Play attention: Exam for a student

Source: www.ADHD.com

Colors:
Colors have been chosen according to a study on the best colors that suites this case.

- **Yellow:** It stimulates mental ability, focus and a sense of separation and concentration.
- **Purple (indigo):** This color is the "Chakra" crown of the head, top of higher mind, and the color of dignity, honor, self-esteem the treatment of mental and neurological disorders. It is also a tonic for memory, thinking and cures intestinal disorders and cures breathing disorders.

3.2 Design Stages

The Applied study was held in three stages in order to explore the problem, and the role of the researcher was to achieve in order the final results, which have been taken through the experiments stages.

3.2.1 Stage 1: The Base Case

The main purpose of the experiment is to use this base case to compare with the other 2 stages results. The whole data about the experiment steps will be given through the following schedule.

Table (1) Base case experiment steps

Experiment Steps	Time Duration	Methodology	Evaluation Tools	Results
1- Selecting the sample rooms' allocations according to the criteria mentioned in the text before.	From: Jan. -2011	- Select the classes' location close to or above each other, to have the best results for the BG Shapes and Cubes. - Drew Architectural Drawings		(4) Classes (3) in the First floor, and (1) on the ground floor.
2- Keep all Interior Spaces as is with no editing or changing.	From: Jan. -2011 to: March.2011	Taking the photos for classes with no changing or editing.		
3- Receiving all the by weekly evaluation reports from the Centre.	From: Jan. -2011 to: March-2011	1- Select (16) Child diagnosed with ADHD their ages between 6-9 with IQ 90 and above 2- Record physicians' reports and students' progress.	1-Checklists (Doctors, Teachers, Parents) 2-Software Programs (Play Attention) 3-Reports (Doctors, Teachers, Parents)	Document all students' progress results
4- Receiving Final Evaluation Reports	March-2011	1- Analyze the data and Sorting it. 2- Using Excel to compare progress. 3- Use the SPSS at the end of the stages.		

3.2.2 Stage 2: Impact of Colors, BG Cubes and Shapes on Students

Table (2) Stage 2 experiment steps

Experiment Steps	Time Duration	Methodology	Evaluation Tools	Results
1- Examine Interior space Energy: Test the Interior space Energy (done by the researcher). Fig. 8	April-2011	1- Study the site plans (Google Earth). 2- Detect the Interior Grid Lines and interior space energy in the whole building especially the selected classes (site visit). 3- Draw the Grid Lines on the Architectural Floor plan.	1- Special Pendulums (IK), Virtual Cone. 2- Building's floor plan sketches	Hartman grid lines became clear (negative).
2- Selecting Colors: 2-1 Testing and selecting the best colors suit this case. 2-2 Apply and test The colors impact on students Fig. 6	April-2011	1- Select the best colors to apply to the selected classes, regarding the resonance of the colors that relate to the chakras, and monitor the progress. 2 Select wall paint colors yellow and purple (indigo).	1- Special Pendulums. 2- Color studies mentioned in chapter two. 3- Medical Reports. 4- Play attention Software 5- Checklists (Doctors, teachers, Parents)	Students' behavior started to change in classes
3- Adding the BG Cubes and shapes: Using the 3 BG cubes and stripes in the selected classes (done by the researcher), Fig. 7	April-2011	To balance the energy in the interior space. 1- Select the no. of BG cubes to cover the whole area. 2- Daily recharge for the cubes on it is tray 5 min. 3- Washing cubes twice a week. 4- Recieve Physicians report and monitor the progress.	1- Checklists (Physicians, teachers, Parents) 2- Software Programs (play attention) 3- Reports (Physicians, teachers, Parents) 4- Pendulums.	Students' behavior and concentration continued in changing classes to the best.
4- Dealing with EMF in the interior space Fig. 6	April-2011	Strips are placed on the electricity, appliances, lighting wires, on any electrical device wire and in the main electric box.	Same previous Tools	Students continued on getting better and looks comfy and relax
5- Receiving all by weekly reports and all final evaluation reports	From: April-2011 To: June-2011	1-Analyze and Sort the given data. 2-Using Excel program to compare results. 3-Using SPSS to compare results	Same previous Tools	Document students' progress and compare results to evaluate their performance

EMF: Electro Magnetic Fields -BG: Bio-Geometry

Figure (5) Choosing and applying the color

Figure (6) EMF is corrected using BG strips on wires

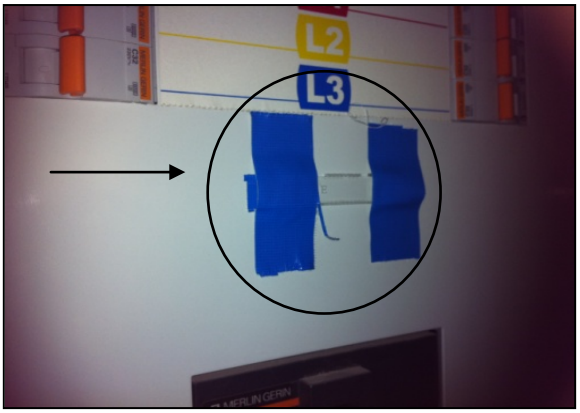
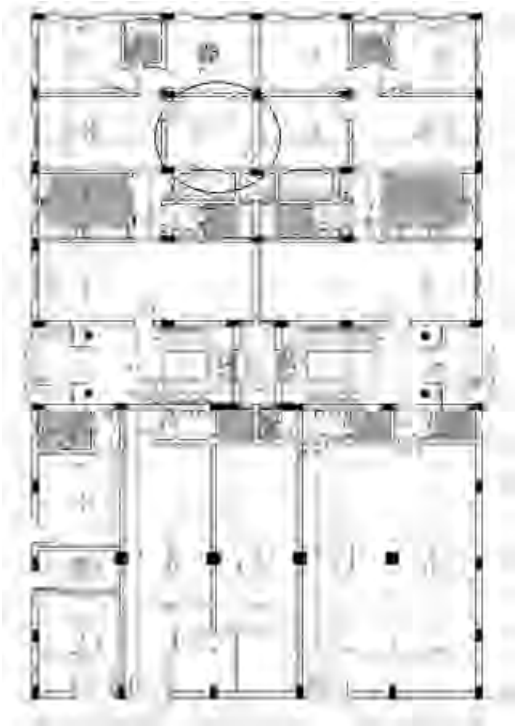


Figure (7) Class-1-after changing the colors in the classes

Figure (8) First Floor Plan



3.2.3 Stage 3: Interior Architectural spaces and window designs to balance energy

Table (3) Stage 3 experiment steps

Experiment Steps	Time Duration	Methodology	Evaluation Tools	Results
Balancing the Interior Space Energy: Windows Designs (done by the researcher).	Oct-2011	1- New designs for windows in all selected classes and monitor the progress. 2- Apply window designs on the selected classes. 3- Measure the energy in the spaces again.	1- Special Pendulums 2- Medical Reports 3- Play Attention Software 4- Checklists	The energy coming from windows has been changed from negative to positive, and energy in the space was balanced. Students' behavior changed in classes.
Doors energy balance (done by the researcher). Collecting material samples to balance the interior space energy	Oct. -2011	1- Measure the energy coming from the doors. 2- Add shapes to the selected classes' doors and re-monitor it again. 3- Monitor the results.	Same previous Tools	The energy coming from doors has been changed from negative to positive, and energy was balanced. Students' behavior and concentration continued in changing in classes.
Receiving all by weekly reports and all Final Evaluation Reports	Jan-2012	1- Analyze and sort the data 2- Using Excel to compare results.	Same previous tools	Document all students' progress and compare results to evaluate their performance

Figure (9) Using dial to balance the energy

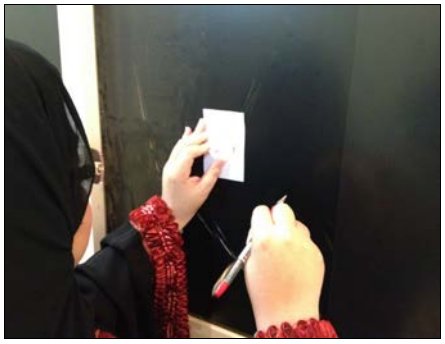


Figure (10) Applying another window design

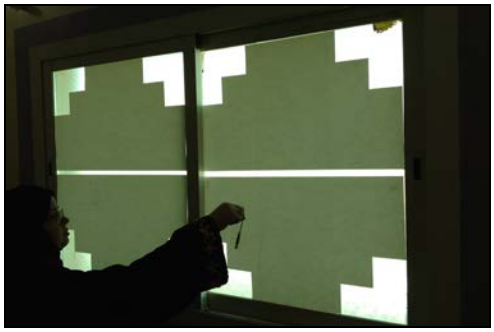


Figure (11) Collecting samples

Figure (12) Balance the doors energy

3.2.4 Pretest

Table (4) Results from the Assessment Diagnoses Reports in Stage 1
(Sample for all stages)

No	Child Name	Focus and attention	Communication	Dynamic behavior	Behavior	Teamwork	Independence	Hyperity	Social Skills	Academic Skills	Average
Stage 1: Group One -Supervisor: Hitaf- **Diagnoses**"Jan-2011"											
1	Motaz	3	2.75	2.8	2.7	3	2	2.9	2.25	2.6	2.85
2	Loai	3	3	3	2.25	2.8	2.25	3	2.25	3	2.81
3	Judi	2.8	3	2.75	3	2.7	3	3	2.25	2.85	2.85
4	Abdul Rahman	3	2.85	3	3	3	2.5	3	2.5	3	2.97
Stage 1: Group Two -Supervisor: Mona- **Diagnoses**"Jan-2011"											
1	Meshal	3	3	3	2.85	2.5	2.5	2.75	2.5	3	2.87
2	Abdulla	2.7	3	2.1	3	3	2	2	3	2	2.76
3	Bandar	3	2.75	3	3	2.8	2	3	3	3	2.91
4	Maria	2.9	3	2	2.75	3	3	2	2.25	3	2.73
Stage 1: Group Three -Supervisor: Hanouf- **Diagnoses**"Jan-2011"											
1	Daoud	3	2.9	3	2.25	2.5	2.5	2.75	2.5	2.85	2.73
2	Ahmad	3	2.6	2.4	3	2	2	3	2.5	2.5	2.60
3	Rayyan	3	3	2.1	3	2.75	2.9	2.85	2	2.8	2.77
4	Turki	3	2.7	3	2.95	2.86	2	2.8	2.5	2.8	2.90
Stage 1: Group Four -Supervisor: Amira-**Diagnoses**-"Jan-2011"											
1	Lama	2.8	3	3	2.5	3	2	3	2.5	2.75	2.86
2	Sara	2.4	2.85	2.75	3	3	2.85	3	2.5	2.85	2.80
3	Ahmad	3	3	3	2.9	2.5	2.25	2.95	3	2.5	2.88
4	Salem	3	2.8	3	3	3	2.8	2.75	2.25	3	2.96
Criteria:		1: Improved		2: Do the action with help				3: Needs much help			

Table (5) The experiment starts assessment diagnoses report –Stage 2

No	Child Name	Focus and attention	Communication	Dynamic behavior	Behavior	Teamwork	Independence	Hyperity	Social Skills	Academic Skills	Average
Stage 2: Group One -Supervisor: Hitaf- **Diagnoses**"April-2011"											
1	Gaidaa	2.9	2.8	2.7	3	3	2	2.9	2.25	2.7	2.88
2	Abdulla	3	3	3	2.25	2.8	2.25	3	2.25	3	2.81
3	Mohammad	2.8	3	2.75	3	3	3	3	2.25	2.85	2.9
4	Nawaf	2.95	2.85	2.7	3	3	2.5	3	2.5	3	2.9
Stage 2: Group Two -Supervisor: Mona- **Diagnoses**"April-2011"											
1	Meshal	3	3	3	2.85	2.5	2.5	2.75	2.5	3	2.87
2	Abdulla	2.7	3	2.1	3	3	2	2	3	2	2.76
3	Bandar	3	2.75	3	3	2.8	2	3	3	3	2.91
4	Maria	2.9	3	2	2.75	3	3	2	2.25	3	2.73

No	Child Name	Focus and attention	Communication	Dynamic behavior	Behavior	Teamwork	Independence	Hyperity	Social Skills	Academic Skills	Average
Stage 2: Group Three -Supervisor: Hanouf- **Diagnoses**"April-2011"											
1	Sara	2.7	2.9	2.5	2.25	2.5	2.5	2.75	2.5	2	2.75
2	Abdul-Aziz	3	2.6	2.4	3	2	2	3	2.5	2.5	2.60
3	Merdas	3	3	2.1	3	2.75	2.9	2.85	2	2.8	2.80
4	Turki	3	2.7	3	2.95	2.86	2	2.8	2.5	2.8	2.90
Stage 2: Group Four -Supervisor: Amira-**Diagnoses** -"April-2011"											
1	Soliman	2.8	2.8	2.6	2.5	2.85	2	3	2.5	2.7	2.70
2	Faisal	2.4	2.85	2.75	3	3	2.85	3	2.5	2.85	2.80
3	Turki	3	3	3	2.9	2.5	2.25	2.95	3	2.5	2.88
4	Ibrahim	3	2.8	3	2.7	3	2.8	2.75	2.25	2.7	2.90
Criteria: 1: Improved 2: Do the action with help 3: Needs much help											

Table (6) The experimental results from diagnoses reports – Stage 3

No	Child Name	Focus and attention	Communication	Dynamic behavior	Behavior	Teamwork	Independence	Hyperity	Social Skills	Academic Skills	Average
Stage 3: Group One -Supervisor: Hitaf- **Diagnoses**"Oct. -2011"											
1	Fahad	2.9	2.2	2.75	2	2	2	2.5	2	2.4	2.4
2	Daoud	3	2	2	3	2	3	2.4	3	3	2.4
3	Ahmad	2.6	2	2.9	2.96	2.7	3	2.6	3	2.4	2.6
4	Rayyan	3	2.3	2.3	3	2	2	2.7	2.9	3	2.5
Stage 3: Group Two -Supervisor: Mona- **Diagnoses**"Oct.-2011"											
1	Abdul-Aziz	2.8	3	2.7	3	2.7	2.8	3	2.8	2.9	2.9
2	Khaled	2.95	2.85	2.95	2.9	3	3	3	2.7	2.9	2.9
3	Naeif	3	3	3	2.8	3	2.25	2.95	3	2.5	3.0
4	Omair	3	2.6	2.8	3	2.7	2.8	2.8	2.5	3	2.8
Stage 3: Group Three -Supervisor: Hanouf- **Diagnoses** "Oct.-2011"											
1	Abdullah	2.6	2.8	2.83	3	3	3	2.5	2.9	2.9	2.8
2	Naser	2.5	2.8	2.85	3	2.9	2.7	2.5	2.6	3	2.8
3	Gazal	3	2.4	2.9	2.96	2.2	2	2.71	2.95	3	2.7
4	Naief	2.9	3	2.85	2.3	3	2.9	3	3	2.2	2.8
Stage 3: Group Four -Supervisor: Amira- **Diagnoses**"Oct.-2011"											
1	Soliman	3	2.9	3	2.25	3	2.5	2.5	2.5	2.85	2.8
2	Faisal	2.9	2.5	2.5	2.6	2.7	2	3	2.6	2.6	2.7
3	Turki	3	3	3	3	3	2.9	2.95	2	3	3.0
4	Ibrahim	3	2.6	3	2.7	3	2	3	2.5	2.8	2.9
Criteria: 1: Improved 2: Do the action with help 3: Needs much help											

3.2.5 Post Test (After the experiment 3-months)

Table (7) Results for Assessment final report - Stage 1

No	Child Name	Focus and attention	Communication	Dynamic behavior	Behavior	Teamwork	Independence	Hyperity	Social Skills	Academic Skills	Average
Stage 1: Group One -Supervisor: Hitaf- **Final Report** "March-2011"											
1	Motaz	2.8	2.2	2	2.1	2	2.2	2.1	2.7	1.4	2.2
2	Loai	2.7	2.2	2	3	2	2.3	2.4	3	3	2.4
3	Judi	2	2	2	3	2	1	2	3	2.4	2.2
4	Abdul Rahman	1.9	2.2	1.6	3	2	2	1.95	2.9	3	2.1
Stage 1: Group Two -Supervisor: Mona - **Final Report** "March-2011"											
1	Meshal	2.5	2.4	2.4	2	2.5	2.8	2.4	2.85	2.7	2.5
2	Abdulla	2.2	2.2	2.8	2	1.4	2	2.1	3	2.2	2.2
3	Bandar	2	2.5	2	2.2	2	2	1.4	3	3	2.2
4	Maria	2.6	2.2	2.1	2.3	2	2.2	2	2.25	2.3	2.2
Stage 1: Group Three -Supervisor: Hanouf - **Final Report** "March-2011"											
1	Daoud	2	2	2	2	3	2	2.1	2.5	2.85	2.2
2	Ahmad	1.75	1.96	1.85	1.85	2.4	1.8	1.6	2.5	2.3	2.0
3	Rayyan	2	3	2	2	2	2	2.1	2	2.8	2.2
4	Turki	1.9	1.8	2	1.9	1.8	2.2	2	2.6	2.7	2.2
Stage 1: Group Four -Supervisor: Amira- **Final Report** "March-2011"											
1	Lama	2	2	2	1.7	2.2	2	1.97	2.5	2.8	2.1
2	Sara	1	1.8	2	1.8	2	2.7	1.8	2.5	2.6	2.0
3	Ahmad	2	1.5	1.7	2	2	2.25	1.85	3	2.6	2.1
4	Salem	1.8	2.3	2.2	2.4	2	2.8	2.14	2.6	3	2.4
Criteria:		1: Improved		2: Do the action with help				3: Needs much help			

Table (8) The experiments Results for The Final Report – Stage 2

No	Child Name	Focus and attention	Communication	Dynamic behavior	Behavior	Teamwork	Independence	Hyperity	Social Skills	Academic Skills	Average
Stage 2: Group One -Supervisor: Hitaf- **Final Report** "June-2011"											
1	Gaidaa	1.4	1.5	1.6	1.5	1.85	1.25	1.7	1.5	1.5	1.5
2	Abdulla	1.7	1.7	2	1.6	1.5	1.5	1.5	2.5	2.5	1.5
3	Mohammad	1.7	1	1.6	1.7	1.75	2	2	2	3	1.6
4	Nawwaf	2	1.75	1.6	1.7	1	2	1.5	2.5	2.8	1.6
Stage 2: Group Two -Supervisor: Mona - **Final Report** "June-2011"											
1	Meshal	1.85	2	1.3	2.25	2	2.5	2	2.5	1.75	1.88
2	Abdulla	1	1.75	2	2.25	1.75	1.7	1	1.25	2	1.75
3	Bandar	1.5	1.7	1.3	2	1.5	2.25	2	1.5	2	1.6
4	Maria	2.75	1.75	2	1.5	1	2.5	1	2.75	2	1.8

No	Child Name	Focus and attention	Communication	Dynamic behavior	Behavior	Teamwork	Independence	Hyperity	Social Skills	Academic Skills	Average
Stage 2: Group Three -Supervisor: Hanouf - **Final Report** "June-2011"											
1	Sara	1.7	1.6	1.7	1.7	1.5	2.0	1.6	2.1	2.0	1.6
2	Abdul-Aziz	1.7	1.6	1.7	1.8	1.5	2.0	1.6	2.1	2.2	1.7
3	Merdas	1.7	1.6	1.7	1.8	1.8	2.0	1.7	2.1	2.2	1.7
4	Turki	1.9	2.4	2.4	1.0	1.0	2.3	1.5	2.3	2.3	1.7
Stage 2: Group Four -Supervisor: Amira- **Final Report** "June-2011"											
1	Soliman	1.7	1.6	1.8	1.8	1.5	2	2	1.7	1.5	1.7
2	Faisal	1.4	1.25	2	1.25	2.25	1.5	1	1.5	2	1.6
3	Turki	2	1	1.5	2	1.5	1.5	2	1.5	2	1.6
4	Ibrahim	1.7	1.5	2	1.5	1.6	1.5	1.2	2	2	1.7
Criteria:		1: Improved		2: Do the action with help				3: Needs much help			

Table (9) The experiments final reports – Stage 3

No	Child Name	Focus and attention	Communication	Dynamic behavior	Behavior	Teamwork	Independence	Hyperity	Social Skills	Academic Skills	Average
Stage 3: Group One -Supervisor: Hitaf- **Final Report** "Jan. -2012"											
1	Fahad	1.3	1.3	1.6	1.5	1.4	2	1.6	1	1.4	1.5
2	Daoud	1.3	1.5	1.7	1.8	1.6	1.5	1.2	1.2	1.5	1.6
3	Ahmad	1.5	1.2	1.6	2	1.9	2	2	1.5	2.3	1.6
4	Ibrahim	2	1.75	2	1.5	1.3	2	1.4	1.8	1.7	1.7
Stage 3: Group Two -Supervisor: Mona - **Final Report** "Jan. -2012"											
1	Abdul-Aziz	1.5	1.6	1.5	1.7	1.5	1.6	1.7	1.4	1.8	1.6
2	Khaled	1.6	1.6	1.4	1.5	1.4	1.3	1.5	1.4	1.3	1.5
3	Naeif Z	1.6	2	1.6	2	1.6	1.7	1.7	1.4	1.8	1.8
4	Omair	1.7	1.6	1.4	1.5	1.3	1.5	1.6	1.5	1.7	1.5
Stage 3: Group Three -Supervisor: Hanouf - **Final Report** "Jan. -2012"											
1	Abdullah	1.8	1.5	1.5	1.3	2	1	1.5	1.2	1.6	1.6
2	Naser	1.7	1.7	1.4	1.3	1.4	2	1.9	1.4	1.6	1.5
3	Gazal	1.6	1.2	1.6	1.2	1.5	2	1.6	1.2	1.5	1.4
4	Naief M	1.9	1.5	2	1.3	1.4	2	1.6	1.3	1.6	1.6
Stage 3: Group Four -Supervisor: Amira- **Final Report** "Jan. -2012"											
1	Soliman	1.6	1.6	1.6	1.4	1.3	2	2	1.2	1.5	1.5
2	Faisal	1.7	1.5	2	1.3	1.6	1.5	1.2	1.5	1.7	1.6
3	Turki	2	2	1.5	2	1.4	2	2	1.5	2	1.8
4	Ibrahim	1.9	1.9	2	2	1.5	1.5	2	2	2	1.9
Criteria:		1: Improved		2: Do the action with help				3: Needs much help			

3.3 Final Results

- Record the progress before and after using BG cubes, shapes, color therapy, in addition to the window designs, then compare the results.
- Performing Final Results.
- All results should be discussed and clarified over data conclusion.

3.3.1 Data analysis

Analyzing the data, will be through compare all the results before and after the experiment, and analysis the data using Excel and SPSS programs.

3.3.2 Questionnaire (Checklist)

Checklists are the appropriate one to measure the progress of the students' performance with the daily observation sent by the specialist. The First test was the T-Test It was used to measure the effect calculators.

Figure (13) Graph showing comparison of mean score before and after on Stage 1

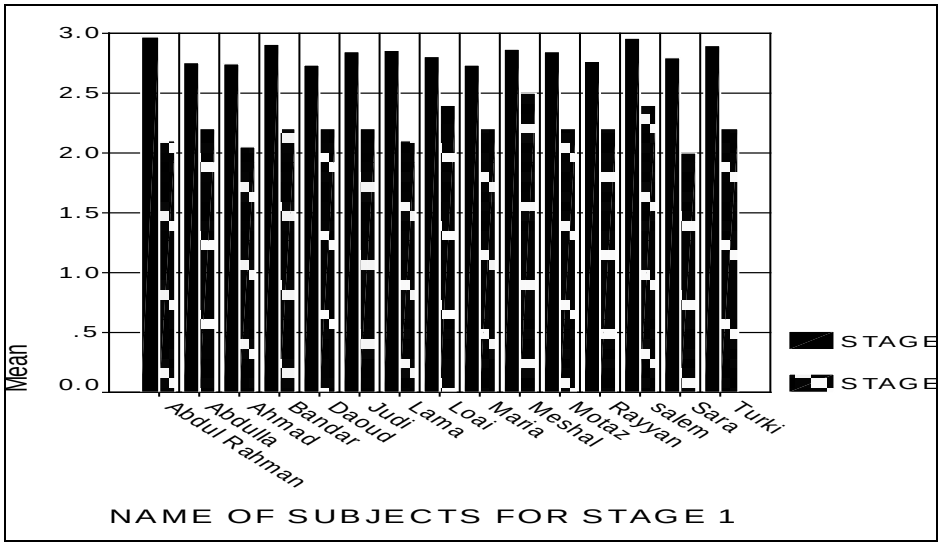
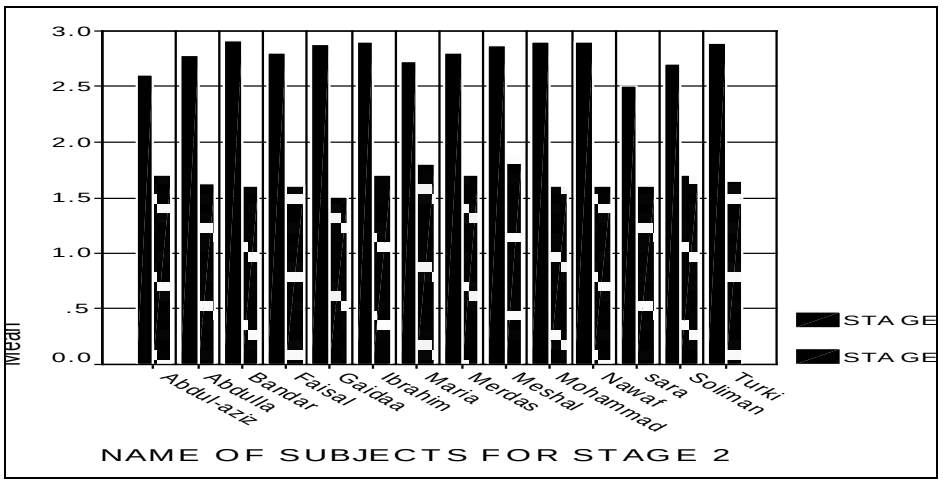


Figure (14) Graph showing comparison of mean score before and after on Stage 2



ANOVA Test

Table (10) ANOVA Test shows experiments final data analysis

Descriptives

STAGE1A

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1	16	2.2000	.1366	3.416E-02	2.1272	2.2728	2.00	2.50
2	16	1.6581	.1023	2.556E-02	1.6036	1.7126	1.50	1.88
3	16	1.6063	.1340	3.350E-02	1.5348	1.6777	1.40	1.90
Total	48	1.8215	.2978	4.298E-02	1.7350	1.9079	1.40	2.50

Table (11) ANOVA shows difference in means

ANOVA

STAGE1A

			Sum of Squares	df	Mean Square	F	Sig.
Between Groups	(Combined)		3.461	2	1.730	110.253	.000
	Linear Term	Contrast	2.820	1	2.820	179.709	.000
		Deviation	.640	1	.640	40.798	.000
Within Groups			.706	45	1.569E-02		
Total			4.167	47			

Table (12) Post Hoc Tests

Multiple Comparisons

Dependent Variable: STAGE1A

Tukey HSD

(I) SUB#	(J) SUB#	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1	2	.5419*	4.429E-02	.000	.4345	.6492
	3	.5937*	4.429E-02	.000	.4864	.7011
2	1	-.5419*	4.429E-02	.000	-.6492	-.4345
	3	5.187E-02	4.429E-02	.476	-5.55E-02	.1592
3	1	-.5937*	4.429E-02	.000	-.7011	-.4864
	2	-5.187E-02	4.429E-02	.476	-.1592	5.547E-02

*. The mean difference is significant at the .05 level.

Table (13) Homogeneous Subsets

STAGE1A

Tukey HSD[a]

SUB#	N	Subset for alpha = .05	
		1	2
3	16	1.6063	
2	16	1.6581	
1	16		2.2000
Sig.		.476	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 16.000.

Table (14) Univariate Analysis of Variance

Descriptive Statistics

Dependent Variable: STAGE1A

SUB#	Mean	Std. Deviation	N
1	2.2000	.1366	16
2	1.6581	.1023	16
3	1.6063	.1340	16
Total	1.8215	.2978	48

Between-Subjects Factors

		N
SUB#	1	16
	2	16
	3	16

Tests of Between-Subjects Effects

Dependent Variable: STAGE1A

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Eta Squared
Corrected Model	3.461[a]	2	1.730	110.253	.000	.831
Intercept	159.250	1	159.250	10147.358	.000	.996
SUB#	3.461	2	1.730	110.253	.000	.831
Error	.706	45	1.569E-02			
Total	163.417	48				
Corrected Total	4.167	47				

a. R Squared = .831 (Adjusted R Squared = .823)

Overall, we may conclude that there is a significant difference between the score for Stage 1 and 2 , and more between Stage 1 and Stage 3 .

3.4 Discussion

The clear framework and methodology "design approach" that can help designers either architects or interiors to deal with the zones of energy in the interior architectural spaces, through the application of Bio Geometry Science in the interior architectural spaces, the study followed the checklists steps and methodology.

3.4.1 Detecting space energy (Diagnoses checklist)

The aim is to detect and record the harmful Geo-pathic stress, measure the negative and positive energy grids, lines, and EMF in the interior spaces.

Table (15) Detecting space energy (Diagnoses checklist)

No	Examines	Achieved	Not achieved	Remarks
1	Study the site plan (Google Earth) and surrounding environment to check the electric towers or high voltage lines.	*		
2	Sketch or use the building's floor plan to clarify the harmful Geo-pathic stress.	*		
3	Identify the chosen space location with reference to the north arrow.	*		
4	Study the plan's shape and position.	*		
5	Use the IKU and / or BG3 pendulums to sense the energy.	*		
6	Pendulums swing inward (clockwise)	*		Indicates Positive energy
7	Pendulums swing outward (anticlockwise)	*		Indicates Negative energy
8	Use the convective (virtual cone) to examine the negative energy lines and grids.	*		
9	Apply all the resulted lines and grids on the floor plan.	*		
10	Identify the EMF sub panels, switches, light units, appliances, and electric points.	*		o
11	Record the EMF's negative energy by the pendulums.	*		
12	Windows and door size, design, and placement.	*		
13	Identify the negative energy that enters from doors and windows.	*		
14	Examine the impact of the space color on humanity (Considering the space and the orientation).	*		
		Achieved: 14		

Score 90%or More: The design approach succeeds
Score 75% to 90%: Needs Improvement
Score 75% to 50%: Failed

3.4.2 Correcting the negative energy (Correcting checklist)

The aim is to correct the harmful Geo-pathic stress, measure the negative and positive energy grids, lines, and EMF by using the BG cubes and shapes, doors balance, and window designs.

Table (16) Correcting the negative energy (Correcting checklist)

No	Examines	Achieved	Not achieved	Remarks
1	Study the best colors suit each case (Yellow& Purple)	*		
2	Examine the color impact on human using the pendulums.	*		
3	Identify the color distribution in the architectural spaces.	*		
4	Apply color in the architectural spaces that need to be balanced.	*		
5	IKU pendulum swing inward (clockwise)	*		Indicates Positive energy
6	IKU pendulum swing outward (anticlockwise)	*		Indicates Negative energy
7	Use the convective (virtual cone) to examine the negative energy lines and grids.	*		
8	Use three of BG cubes to cover the whole area	*		
9	Cleaning the BG cubes twice a week.	*		
10	Daily recharge for the cubes on it is tray 5 min.	*		
11	Use the stripes on the electric appliances, Electric device wire, and the main electric box	*		
12	Design and apply new forms for windows and monitor the progress.	*		
13	Measure the energy in the spaces again.	*		
		Achieved: 13		

Score 90%or More: The design approach succeeds
Score 75% to 90%: Needs Improvement
Score 75% to 50%: Failed

From the previous analysis and design approach steps that relatively has been implemented in the case study and showed the most important way to investigate the energy and dealing with it in the architectural spaces.

T-Test to compare all results for the 4 groups Before and after at each stage:

T-Test (Stage 1 before and after)
Cohen's d = 5.3492
Effect size r = 0.9366
Result: both show large effect

T-Test (Stage 2 before and after)
Cohen's d = 7.84909
Effect size r = 0.9690
Result: Both show very large effects

T-Test (stage 3 before and after)
Cohen's d = 6.964
Effect size r = 0.9611
Result: According to the previous results the study came up with it was clear that both results show a very large effect happened to the children which means improvement in their performance and health

T-Test (Stage 1 after and stage 2 after)
Cohen's d = 4.49057
Effect size r = 0.91349
Both show very large effect

T-Test (Stage 2 and 3 after)
Cohen's d = .43369
Effect size r = 0.2119217
Not, very large e, just medium effect

ANOVA Test:

Table (11) : ANOVA Showed that there is a difference in means
Table (14) : Univariate Analysis of Variance
Result: Very large partial eta value shows large effect size.

Thus it is clear that the research proofed the hypothesis that assumed behavioral and biological changes in humans, as a result of the interior space design changes and energy, in addition to raise in the efficiency of human health and performance, to assist in healing from diseases caused by interior architectural spaces energy.

Therefore since the applied study proofed that student performance had improved between stage 1and 2, and had a medium impact between 2 and 3 stages that means the study achieved its goals, by using the principles and theories of Bio-Geometry in the interior architectural spaces, to achieve the best results to maintain human health and the efficiency of performance and modify behavior.

4. CONCLUSIONS AND RECOMMENDATIONS

4.1 Research Conclusions

- Significance of the presence of energy in the interior architectural space and importance of increasing awareness of the energy impact on human beings in the interior architectural space.
- Identifying a number of sciences and knowledge of energy, with the advancement in instrumentation of qualitative energy led to understand this energy and the new discoveries of unconsciously in architecture and interior design of the built-in environments.

- The presence of many factors and several impacts on humans in the system of interior architectural space, and leads to unbalance at all levels and therefore was able to put the first
- Bio Geometry can cure any deficiency and unbalance in energy, to help in achieving comfort and health in the architectural spaces.
- Some colors provide comfort in the interior architectural spaces. And had an impact on humans' psychological state and activities causes relax or movement. It also have another impact on the physical state that causes discomfort.
- ADHD is common especially among school children; one of the reasons is the interior space's negative energy. It can be healed by using the design approach set by the research to achieve the energy balance in the architectural space.

4.2 Recommendations

- Geologists should prepare detailed maps for cities using the satellite to identify the black streams and geological faults, to be as a guide that helps the designer in the design process to produce building matches with the environment.
- Link the sciences and theories of interior and architectural design, with the other sciences such as bio-geometry, which deals with human energy in the architectural spaces that will help the designer to achieve the human needs into those spaces and raise their performance.
- Designers can use the clear framework and methodology done in the research as a design approach, through which the designers either architect or interior can deal with the zones of energy in the interior architectural spaces to improve the human health and performance in those spaces.
- Designers should concentrate on the relationship between the shape and configuration as the basis for the BG science, in order to achieve balance and harmony between human body as an energy field, and the energy of the interior space in addition to use the color.

References

Baker, Paula-and others-"A Healthy House", 2001

Dr. Ibrahim Karim-"What is energy-Back to the Future"-International Union of Architects Conference- Bibliotheca Alex.- Alexndrina, 2002

Ibrahim Karim," Bio-Geometrical Energy Balancing" cd, 2002

Ibrahim Karim-"Back To A future For Mankind"-publisher: Bio-geometry consultant centre, 2009

http://www.adhd.com/index.html

http://www.biogeometry.com