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Economic Dimensions Of Gated Communities In Egypt

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ABSTRACT

The Gated communities represent a rather new development product on the housing market in Egypt. This type of development is spreading fast since the nineties of the last century. A large number of research has been conducted on the topic of gated communities in a number of different countries. However, in Egypt, this topic needs to be more discussed and researched. Therefore the topic of gated communities in Egypt will be further explored and analyzed, focusing on the economic dimensions and the impact of such developments on the Egyptian real estate market. This study specifically focuses on the city of El Sheikh Zayed where most of the gated communities are located. The objective of this research is to identify the main factors that can influence the housing prices in Egypt in order to know in what extent the gated communities affect positively or negatively the housing price especially for those units located inside. In this sense, a comparative study is applied between the prices of gated and non-gated housing units using simple regression analysis as well as Hedonic Pricing Model, in order to understand the influence of gated communities on the value of the housing units. This study analyzes the sales prices of middle class housing units in El Sheikh Zayed City.

KEYWORDS: Gated Communities - El Sheikh Zayed City - Hedonic Pricing Model- Economic Analysis - Real Estate Valuation

الأبعاد الاقتصادية للمجتمعات العمرانية المغلقة في مصر

ملخص

ظهر في مصر منذ التسعينات من القرن الماضي نمط جديد من الاسكان وهو إسكان التجمعات العمرانية المغلقة والتي شهدت انتشارا كبيرا خلال هذه الفترة مما يتطلب أهمية تناول البعد الاقتصادي لهذه التجمعات العمرانية ومدى تأثيرها على السوق العقاري المصري، ومن ثم يهدف البحث إلى التعرف على العوامل المؤثرة في تحديد أسعار الوحدات السكنية وما إذا كان وجود هذه الوحدات داخل التجمعات العمرانية المغلقة يؤثر سلباً أو إيجاباً على سعرها.

ومن هذا المنطلق تم اعداد دراسة مقارنة لأسعار الوحدات السكنية فئة الاسكان المتوسط الموجود داخل التجمعات المغلقة بنظيرها خارج التجمعات بإستخدام Hedonic Pricing Model في محاولة لفهم العلاقة بين التجمعات العمرانية وقيمة الوحدة العقارية، وذلك عن طريق تناول عمليات البيع وشراء التي تمت في السنة الماضية للوحدات السكنية ذات الاسكان المتوسط سواء داخل أو خارج التجمعات العمرانية المغلقة في مدينة الشيخ زايد.

الكلمات الدالة: المجتمعات العمرانية المغلقة - مدينة الشيخ زايد - السوق العقاري - Hedonic Pricing Model - الابعاد الاقتصادية - القيمة العقارية

1 BACKGROUND

Gated communities are defined as groups of residential units that are separated from the outer environment by gates or walls. The gated communities represent a rather new development product on the real estate market in Egypt. Therefore, this paper will discuss and analyze the economic impacts of gated communities and their influence on the real estate market in Egypt.

Gating a housing estate is a way for developers to market a property as more exclusive. For developers, they can be a marketing angle, another way to target specific submarkets. Developers build gated communities to meet niche markets: demand for security-by-design, for prestige living and for life-style of community living. For some property owners, gating is a mechanism to protect property values from being affected by changes in the city. For many urban planners, gated communities represent a physical withdrawal from civic, urban life. For residents, gated communities are lifestyles choices[1].

A large number of research has been conducted on the topic of gated communities focusing on the economic dimension. Most of this research confirms that the walls and gates that are surrounding a group of housing units have a positive effect on the prices of those units. One of these studies is" Gated Communities in Prague-general overview and econometric analysis". This study used a regression model to investigate the differences between the housing prices in gated and non-gated communities in Prague. The hypothesis that gated communities add value is confirmed in the study. The study showed that the value of a gated community unit is higher due to higher security provision[2]. "Gated Communities and Residential Property Value" is another study that is conducted in the USA. This study analyzed the sales prices of single-family homes located in six different neighborhoods in a medium-size metropolitan area. The study used a traditional hedonic pricing model to study 284 sales that occurred during the period 1996-1998, and it included an additional variable to indicate whether or not a home is located in a gated community in this model. The results indicated that the benefits provided by the gate add value to a given property[3]. Another research discussed the issue of gated communities in Los Anglos and in what extent this type of development produces changes in housing market patterns and favor property values. This study concluded that larger and wealthier gated communities are successful in shielding their property values. They also generate enough revenue to pay for a cost of private governance. On the other hand, a majority of average middle class gated enclaves do not succeed in creating a significant price premium, and/or did not maintain significant growth of price during the last decade. Such gated neighborhoods are at risk of a market failure in the private provision of urban infrastructure, leading to a potential decay. This study also showed the importance of the sustainability of these gated communities by supplying government infrastructure and do not rely only on

[1] T. Baycan Levent and A. Gulumser, 2004.

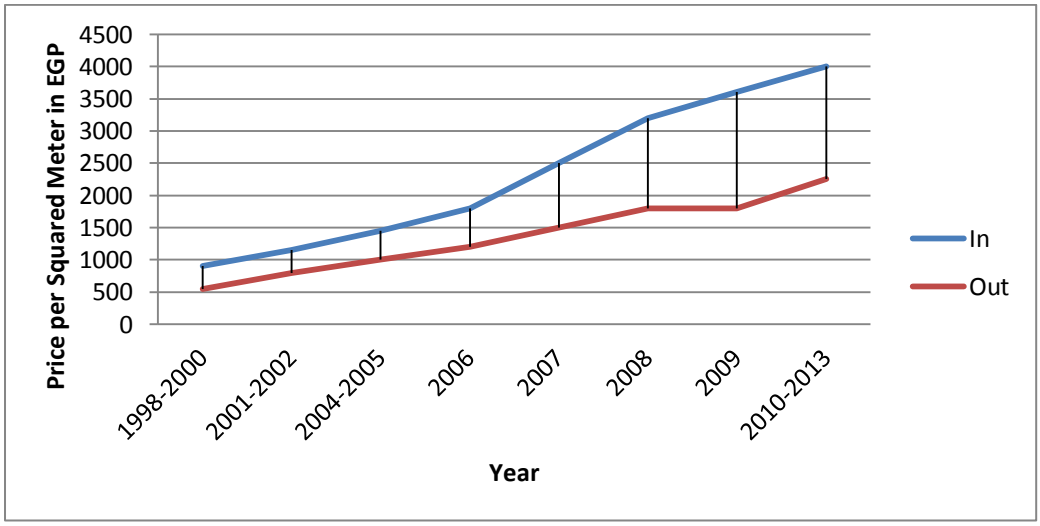
[2] Kolarikova, 2010.

[3] Bible and Hsieh, 2001

private infrastructure, which leads to an increase in the cost of maintenance and a deterioration of the area over time[4].

Likely in Egypt, by comparing the sales prices of gated and non-gated housing units in El Sheikh Zayed City during the period 1998 to 2013, it was found that the prices of gated housing units were higher than the non-gated ones within the same city (figure 1). This can explain that gated communities provide excellence factors such as security, landscape, private swimming pools, social clubs, privacy, as well as other factors that make residents willing to pay for them. In order to verify this hypothesis it was necessary to study the relationship between housing unit price and its location using a scientific methodology "Hedonic Pricing Model" which will be addressed later.

Figure (1) Gated and non-gated housing units prices during the period 1998-2013 in Egypt (the researchers)



2 REAL ESTATE APPRAISAL FACTORS

Real estate appraisal is the process of valuing real estate properties[5]. All properties differ from each other according to certain factors: the physical characteristics of the property, the location, the context and finally the real estate market constrains[6]. These factors are identified through a set of database used in determining the Housing Price Index and some studies in this field[7]. The following are the factors influencing the housing unit appraisal:

2.1 Housing Units Physical Characteristics

Housing units physical characteristics such as area, number of rooms, number of bathroom/toilets, finishing, availability of infrastructure and views have a considerable influence on housing unit value. Table (1) shows a list of these characteristics and their units of measurements.

Table (1) Housing Units Physical Characteristics (the researchers)

Characteristics	Units of Measurements	References

[4] Goix, 2005
[5] Eldred, 2009
[6] Ling and Archer, 2010
[7] Gomaa, 2006.

Sale Price	Egyptian Pound	Real estate appraiser
Meter Square Price	Egyptian Pound	Real estate appraiser
Sale Transaction Date	Year	Real estate appraiser
Unit Area	Meter Square	Field study
Area	Number of Closed Room	Field study
Area	Number of Bath/Toilets	Field study
Finishing	Half/Full Finishing	Real estate appraiser
Finishing Condition	Good/Fair/Bad	Field study
Infrastructures (natural gas availability)	Yes/No	Field study
Views	Yes/No	Field study

2.2 Residential Buildings Physical Characteristics

The residential building and its physical characteristics have an obvious effect on the values of the housing units. These characteristics include the number of housing units per floor, number of floors, availability of lifts, the finishing of the main entrance and stairs, date of establishment, design quality, elevation quality, maintenance, availability of parking areas, and the owner of the building. Table (2) shows a list of these characteristics and their units of measurements.

Table (2) Residential Buildings Physical Characteristics (the researchers)

Characteristics	Units of Measurements	References
Age	Year	Field study
Number of units per floor	Number	Field study
Number of flats	Number	Field study
Lifts	Yes/No	Field study
Floor	Number (1-2-3-4-5)	Field study
Finishing of entrance and stairs	Good/fair/bad	Field study
Finishing of elevations	Good/fair/bad	Field study
Owner	Government/Developer/Private	Field study
Maintenance	Yes/No	Field study
parking	Yes/No	Field study

2.3 Neighborhood Physical Characteristics

The value of the housing unit is usually affected by its location and the physical characteristics of the surrounding neighborhood. These characteristics include the location inside or outside gated communities, the socio-economic level, calmness, parking, services, infrastructure, transportations, density, project size, the average of housing units price, the average of housing units area, the age of the project, occupancy rate, the future of the project during the next five years, quality of the environment, liveability, quality of urban design, quality of street network, percentage of green spaces, entertainments and the developer. Table (3) shows a list of these characteristics and their units of measurements.

Table (3) Neighborhood Physical Characteristics (the researchers)

Characteristics	Units of Measurements	References
The average of housing units price	Egyptian Pound	Real estate appraiser
Location	Gated/Non-gated	Field study
Maintenance	Regular/Non-regular	Field study
Socio-economic level	High/Medium/Low	Field study
Calmness	Calm/Noisy	Field study
Parking	Yes/No	Field study
Transportation	Yes/No	Field study
Density	Floor area ratio	Satellite Maps

Project size	Hectares	Satellite Maps
The average of housing units area	Meter square	Real estate appraiser
Project age	Year	Real estate appraiser
Occupancy rate	Percentage	Field study
Liveability	High/Fair/Low	Field study
Green spaces percentage	Percentage	Satellite Maps
Accessibility to services and transportations	Percentage	Satellite Maps
Street network quality	Good/Fair/Bad	Field study
Urban spaces quality	Good/Fair/Bad	Field study
Services	Yes/no	Field study
Developer	Government/Developer/ Private	Field study
Context	High/Medium/Low	Field study
Environment quality	Considered/ Not considered	Field study
The future of the project during the next 5 years (Existence of future stages)	Yes/No	Real estate appraiser

2.4 Real Estate Market Conditions

The general conditions of the real estate market are factors that influence the housing unit value. For example, the unbalance between the supply and the demand can affect the housing unit value as well as other factors such as the national and international economic stability, the unemployment rate, the income level, laws, legislations, taxes, construction material prices, labor force and the percentage of vacant units[8]. Table (4) shows a list of these factors and their units of measurements.

Table (4) Real Estate Market Conditions (the researchers)

Factors of influence	Units of Measurements	References
Demand and supply	Surplus in Supply/ Surplus in Demand	Real estate appraiser
Laws, legislation and national politics	Incentivizing/Hindering	Real estate appraiser
Economic stability nationally and internationally	Growth/Stability/Depression	Real estate appraiser
Construction material prices	Higher than average/Stable/Lower than average	Real estate appraiser

3 HEDONIC PRICING ANALYSIS

The hedonic price method is commonly applied in real estate economics in order to determine the added value of housing characteristics on parcel and housing sales prices. Application of the hedonic price method yields estimates of the implicit prices of the quality of environmental functions[9]. For example, Song and Knaap (2004) use the hedonic pricing model for measuring the effects of mixed land uses on housing values, while Chin and Foong (2006) consider the influence of school accessibility on housing values. This research aims to trace to what extent gates and walls favor property values using hedonic pricing model.

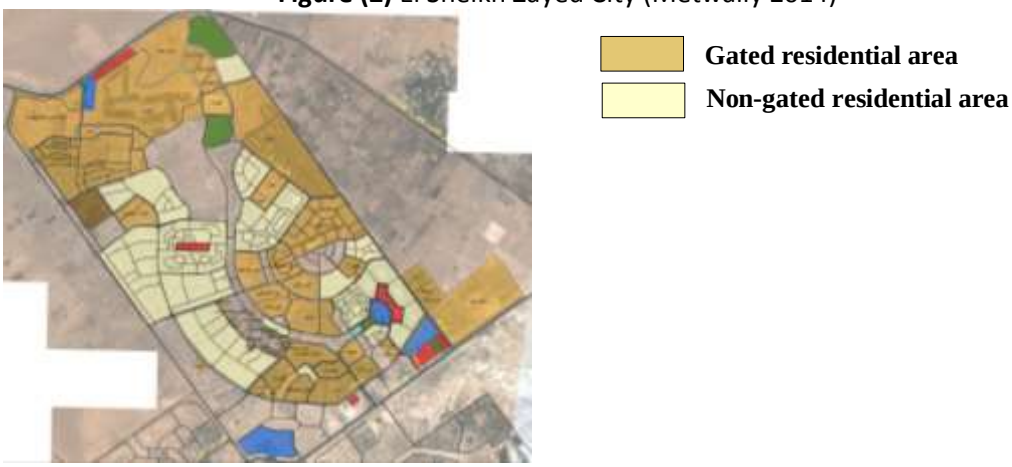
[8] Stringham, Miller, and Clark, 2010

[9] Deakin, Mitchell and others, 2007

3.1 Site Selection (Case Studies)

The study area, El Sheikh Zayed City, is founded in 1995. It is one of Cairo suburbs and is considered as Cairo's west extension. Its area is 10386.65 feddans with 29,422 inhabitances according to the census of 2006. The study area contains nearly 50 gated communities[10] as well as number of non-gated housing areas (figure 2). The study selects 60 transactions for middle class apartments that occurred during the year 2013 and that include 21 apartments inside gated communities and 39 non-gated apartments. There was a difficulty in collecting data, so this study will use a merely set of basic data for the purpose of the research as shown later in (appendix 1).

Figure (2) El Sheikh Zayed City (Metwally 2014)



3.2 Variables Selection

In order to fulfill the research objective, the housing unit sale price has been identified as the dependent variable while the housing unit location (gated or non-gated) has been identified as an independent variable. To control the influence on sale price of other factors, the study includes five additional variables. A variety of physical housing attributes are included. These attributes include unit area, number of closed rooms, number of bathrooms and toilets, finishing level, floor number, and a dummy variable, which takes a value of 1 if the community is gated and 0 otherwise (Table 5). Our data come from four primary sources: developers internet sites, field study, real estate developers and real estate brokers.

The variables chosen on the model are based on their accuracy and easiness. Some variables have been omitted as they do not differ between case studies, such as the views where most of case studies have a view. In this study all the sales transactions occurred within the same area and within the same period, so the research has ignored the variables concerning the real estate market conditions, as they are the same and thus do not have any influence on the sale price in the present study.

[10] Housing and Building National Research Center (HBRC), 2013

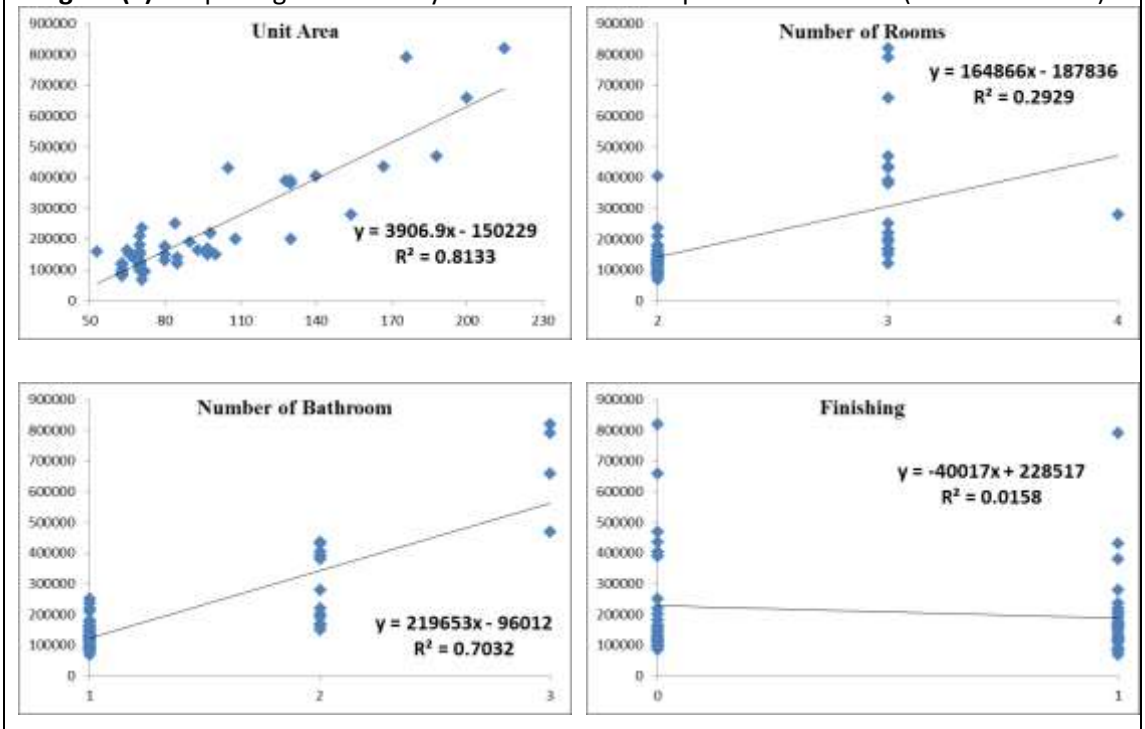
Table (5) Variables Definition (the researchers)

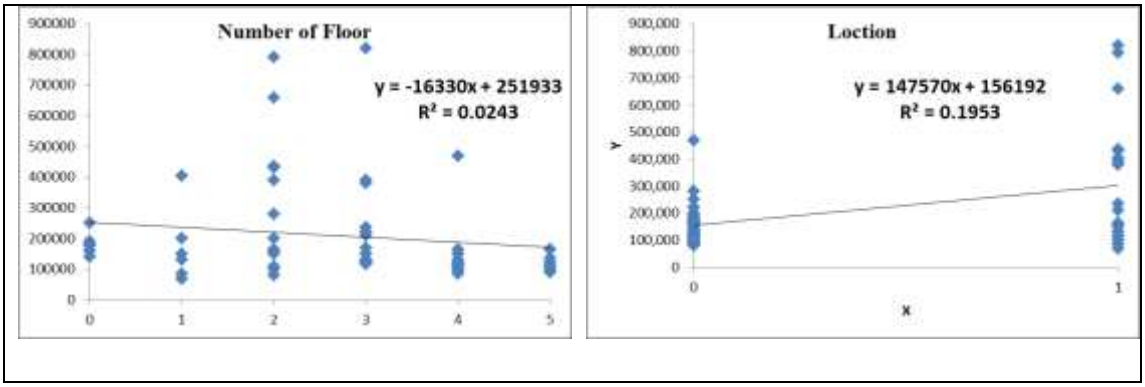
Variable	Definition
Dependent Variable	
Housing unit price	Sale price (Egyptian Pound)
Independent Variable	
1) Housing Units and Residential building Physical Characteristics	
Unit area	Housing unit area (meter square)
Number of closed rooms	Number of closed rooms in the housing unit
Number of baths and toilets	Number of bathrooms and toilets in the housing unit
Finishing	Dummy variable which takes on a value of 1 if the finishing is completed and 0 otherwise
Number of floor	Number of floor where the unit is available (from 0 for the ground floor to 5 for the fifth floor)
2) Neighborhood Physical Characteristics	
Location	Dummy variable which takes on a value of 1 if the community is gated and 0 otherwise

3.3 Simple Regression Analysis

First, the study uses the simple regression analysis in order to find the correlation between the dependent variable, which is housing unit price, (Y) and each one of the independent variables (X) separately. The two variables are related by an expression of the form $y = bx + \varepsilon$ (figure 3); where b is the x coefficient, the slope estimate for different independent variables. From these linear regressions shown in figure 3 it can be deduced that the unit area, number of rooms, number of bathrooms, and the location in gated communities prove a positive correlation with the housing unit price. On the other hand, finishing level and the number of floor where the unit exists illustrate a negative correlation with the housing unit price.

Figure (3) Simple regression analysis for different independent variables (the researchers)





In simple linear regression one predictor variable is considered at a time. When more than one predictor variable are included, a multiple linear regression model might be used. This model is just an extension of the simple model. The coefficient values for each predictor represent the estimated slope. As with simple linear regression, there are one Y or response variable (also called the dependent variable), but with multiple linear regression there are more than one X variable, also called explanatory, independent, or predictor variables. For this reason the hedonic model is used in order to predict the combined influence of the selected variables on the housing unit's price.

3.4 Hedonic Price Model

To explore the effect of gated communities on property values the study uses a standard hedonic price model including all variables mentioned above. The study specifies the dependent variable as the unit sale price. Then the equation will be as follow:

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k \qquad \text{(equation 1)}$$

where as

- Y Dependent variable (the sale price of housing unit)
- α Constant
- β_k Coefficients which refers to the true average change in the sale price when the independent variable X_k changes by 1 unit and the values of all the other variables remain constant

Summary statistics for the dependent variable and all independent variables of the data set are provided in table (6). This table shows that the average sales prices of the included housing units are 207,842 LE. The average area of the units is 92 m2 with an average of 2 rooms and 1 bathroom per unit.

Table (6) Summary Statistics for All Variables (the researchers).

Variable	Units	Minimum	Maximum	Mean	Standard deviation
Dependent Variable					
Housing unit price	Egyptian Pound	68,000	820,000	207,842	16,062
Independent Variable					
1) Property Physical Structural Characteristics					
Unit area	Meter square	53	215	92	37.076
Number of closed rooms	Number	2	4	2	0.527

Number of baths and toilets	Number	1	3	1	0.613
Finishing	Binary	0	1	1	0.504
Number of floor	Number of floor	0	5	3	1.533
2) Urban Design Characteristics					
Location	Binary	0	1	0	0.481

3.5 The Results of the Multiple Regression Analysis

Multiple Regression results were developed as shown in table 7 based on the collected data shown in appendix (1).

Table (7) Results of the Multiple Regression Analysis (the researchers)

Regression Statistics	
Multiple R	0.93193177
R Square	0.868496824
Adjusted R Square	0.853609672
Standard Error	61454.38609
Observations	60

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	6	1.32195E+12	2.20324E+11	58.33868169	1.34053E-21
Residual	53	2.00162E+11	3776641570		
Total	59	1.52211E+12			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-52427.92422	44402.07638	-1.180753886	0.242972389	-141487.209	36631.36059	-141487.209	36631.36059
Unit area	3347.389793	562.3275555	5.952740107	2.15269E-07	2219.503576	4475.276009	2219.503576	4475.276009
Num of rooms	-55027.41578	25203.48644	-2.183325545	0.033461003	-105579.2066	-4475.624958	-105579.2066	-4475.624958
Num of Baths	60303.66169	32246.2437	1.870098802	0.06699742	-4374.110964	124981.4343	-4374.110964	124981.4343
Finishing	9132.441873	17140.95357	0.532784937	0.596409392	-25247.95631	43512.84006	-25247.95631	43512.84006
Num of floor	-7674.847255	5272.132483	-1.455738694	0.15136316	-18249.40562	2899.711114	-18249.40562	2899.711114
Location	51802.02347	18638.84897	2.779250133	0.007522497	14417.22766	89186.81927	14417.22766	89186.81927

By using the results shown above and based on the available data the linear equation for housing unit price will be as follow (refer to equation 1):

Housing unit price = (-52427.92) + [(+3347.39) × (unit area)] +

[(-55027.42) × (num of rooms)] +

[(60303.66) × (num of baths)] + [(+9132.33) × (finishing)] +

[(-7674.85) × (floor number)] + [(51802.02) × (location)]

Before interpreting the results, we need to make sure that the model can explain the variations in the prices of the housing units. By checking the adjusted R^2, this linear model is reasonably good since about 85% of the variations in housing prices can be

explained by this model and through the chosen six variables. The results of the Analysis of Variance ANOVA are reviewed in order to show the validity of the model. By reviewing the F-test and F Significance shown in table (7), the value of F Significance is very small. Therefore, there is a great deal of evidence that this model is valid and can be used for understanding the variance of housing price value based on the used variables.

Thus the linear model could be interpreted as follow:

According to the results of the model and the available data, each additional meter in the area of the housing unit leads to an average increase in the price by 3,347 LE assuming that the values of all other independent variables in this model are held constant. Similarly, in this model, each additional closed room in the housing unit cause an average decrease in the price by 55,027 LE assuming that the values of all other independent variables in this model are held constant. As for the number of bathrooms and toilets, each additional bathroom/toilet in the housing unit leads to an average increase in the price by 60,305 LE assuming that the values of all other independent variables in this model are held constant. In this model, the price of the fully-finished housing unit is higher than the semi-finished unit by an average of 9,132 LE assuming that the values of all other independent variables in this model are held constant. For the floor number, the rise of one floor leads to an average decrease in the housing unit price by 7,675 LE assuming that the values of all other independent variables in this model are held constant. Finally, in this model, the price of gated housing unit is higher than the non-gated one on average by 51,802 LE assuming that the values of all other independent variables in this model are held constant.

It should be noted that the negative value of intercept might not affect our evaluation of the model where it refers to a hypotheses situation considering that the area of housing unit is zero, the number of rooms is zero, the number of bathrooms/toilets is zero, as well as the number of floor, finishing and location which is irrational.

The next step is to test whether there is enough evidence of the existence of a linear relationship between each independent variable and the dependent variable, which refers to the housing unit price in order to determine which variables influence this model and which ones do not. This can be checked by reviewing the t-stat and P-value for each independent variable. Whenever the absolute value of t-stat is about “1” or less and the P-value is “0.05” or more, there is not enough evidence to infer that the independent and dependent variables are linearly related in this model; and vice versa, if the absolute value of t-stat is more than “1” and the P-value is less than “0.05”, there is evidence to infer that the independent and dependent variables are linearly related in this model. Consequently, by referring to the model results and reviewing the t-stat and P-value for the independent variables, there is enough evidence to infer that there is a linear relationship between the housing unit price (dependent variable) and each of unit area, number of closed rooms and the location (independent variables) in this model. Meanwhile, there is not enough evidence to infer that the housing unit price (dependent variable) and each of number of baths/toilets, finishing, floor number (independent variables) are linearly related in this model.

Accordingly, it can be deduced from the analysis of the model results that the unit area has a positive influence on housing unit price, while the number of closed rooms has a negative influence whereas the increasing number of closed rooms with small lot size may leads to small closed rooms which seems to be not favored by people. As for the location, the positive and significant coefficient in the model shows that the gates and fences do significantly increase property value, and house owners do generally consider the gated communities in their decision of home purchase.

Although the model indicates that the number of bathrooms/toilets and the finishing level have positive influence on the property value, while the floor number has a negative effect, there is no enough evidence showing the existence of a linear relationship in this model.

4 CONCLUSION

This study examined the impact of gated communities on the price of housing units in Egypt. The study applied a Hedonic Pricing Model on a sample of 60 housing units at Sheikh Zayed City to provide a model to determine the price of the housing units including an independent variable to determine the location of the unit inside or outside a gated community. The study confirmed that gated communities have a positive impact on the price of the housing units. It showed that there is an average increase in the price of the housing unit by about 51,802 EGP compared to the unit outside the gated communities in this model assuming that the values of all other independent variables in this model are held constant. This shows that the owners are willing to pay a higher price in order to be inside a gated community.

It should be noted that this model helped to prove the hypothesis of the positive impact on the price of the housing unit that is located inside a gated community. However, we need to a larger sample with a larger number of independent variables that are affecting the unit price in order to reach a more accurate model in determining the prices of residential units.

The research emphasizes the importance of databases and the need to start preparing detailed databases in Egypt at the levels of the housing unit, building, and the surrounding area since the findings of the research are considered initial indicators. By using more detailed data for all variables shown in section 2 of this study along with a larger number of units for the sample, we can use the same methodology applied in this study to determine the effect of different variables on housing units prices in Egypt, including the existence of the unit within a gated community, in a more accurate manner.

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APPENDICES

Appendix A: Housing Units Data

	Unit Price	Meter Price	Unit Area	Num. Room	Num. Bath	Finishing	Floor Num	Location
1	170,000	1,753	97	3	2	1	3	0
2	165,000	1,701	97	3	2	1	4	0
3	85,000	1,349	63	2	1	0	1	0
4	190,000	2,111	90	3	2	1	0	0
5	90,000	1,429	63	2	1	1	5	0
6	150,000	1,875	80	2	1	1	3	1
7	115,500	1,650	70	2	1	1	4	0
8	250,000	2,976	84	3	1	0	0	0
9	108,000	1,543	70	2	1	0	4	0
10	140,000	1,647	85	2	1	0	0	0
11	165,000	1,774	93	3	2	1	5	0
12	80,000	1,270	63	2	1	1	2	0
13	160,000	2,286	70	2	1	1	2	1
14	150,000	2,143	70	2	1	1	2	0
15	100,000	1,429	70	2	1	0	4	1
16	120,000	1,905	63	2	1	0	3	0
17	110,000	1,571	70	2	1	0	5	0
18	120,000	1,714	70	2	1	0	5	0

19	165,000	2,538	65	2	1	0	2	1
20	95,000	1,319	72	2	1	0	4	0
21	100,000	1,587	63	2	1	0	2	0
22	180,000	2,571	70	2	1	0	0	0
23	150,000	2,143	70	2	1	0	4	0
24	100,000	1,429	70	2	1	0	5	0
25	160,000	3,019	53	2	1	0	0	0
26	150,000	2,273	66	2	1	0	3	0
27	85,000	1,349	63	2	1	1	4	1
28	120,000	1,412	85	3	1	1	4	0
29	125,000	1,786	70	2	1	1	3	0
30	220,000	2,245	98	3	2	0	3	0
31	175,000	2,188	80	2	1	1	0	0
32	160,000	2,286	70	2	1	1	0	0
33	130,000	1,857	70	2	1	0	3	1
34	115,000	1,825	63	2	1	0	3	1
35	130,000	1,857	70	2	1	0	4	1
36	135,000	1,985	68	2	1	1	5	0
37	210,000	3,000	70	2	1	1	3	1
38	150,000	1,500	100	3	2	1	4	0
	Unit Price	**Meter Price**	**Unit Area**	**Room Num**	**Bath Num**	**Finishing**	**Floor Num**	**Location**
39	235,000	3,310	71	2	1	1	3	1
40	108,000	1,543	70	2	1	1	4	0
41	110,000	1,571	70	2	1	1	5	0
42	200,000	1,538	130	3	2	0	2	0
43	150,000	1,546	97	3	1	1	1	0
44	130,000	1,625	80	2	1	0	1	1
45	200,000	1,852	108	3	2	1	1	0
46	110,000	1,571	70	2	1	1	2	0
47	68,000	958	71	2	1	1	1	1
48	280,000	1,818	154	4	2	1	2	0
49	165,000	1,701	97	3	1	1	5	0
50	435,000	2,605	167	3	2	0	2	1
51	470,000	2,500	188	3	3	0	4	0
52	220,000	2,245	98	3	1	1	3	0
53	430,000	4,095	105	3	2	1	2	1
54	792,000	4,500	176	3	3	1	2	1
55	820,000	3,814	215	3	3	0	3	1
56	404,000	2,886	140	2	2	0	1	1
57	660,000	3,300	200	3	3	0	2	1
58	390,000	3,047	128	3	2	0	3	1
59	380,000	2,923	130	3	2	1	3	1
60	390,000	3,000	130	3	2	0	2	1

The sources: Engineering Office for Project Management and Appraisal (Eng. Ali Bayoumi), the real estate investment companies' websites, field study.

The Internal Courtyard's Daylighting For The Environmental Architecture Of Masjid In Cairo

Dr. Ahmed Fekry – Dr. Ihab Elshazly – Eng. Ahmed Almrazky

ABSTRACT

Internal courtyard played a vital role in the architecture of many civilizations in various countries, centuries and building's kinds. It was a major element in the architecture of MASJID in a variety of natural environmental conditions for nearly thousand years, then gradually disappeared nowadays. So the aim of this theoretical and practical study, is to present the importance of the internal courtyard's DAYLIGHTING for the environmental architecture of MASJID in the city of Cairo, to raise the values of DAYLIGHTING's factor and intensity, with the quality of its distribution inside the space around the day, in addition to its role in meeting the human needs of ventilation, thermal comfort, de-noising, availability of sky and hosting various religious, cultural and social activities, which support the ecosystem. On the other hand, clerestory, dome, exterior windows, and artificial lighting do not meet the functional needs, and they increase energy consumption, in addition to their psychological and social negative impacts, which increase the pollution loads on the environment. So we have to support the internal courtyard in architecture, using suitable technology to take advantages of DAYLIGHTING and the natural resources for supporting the ecosystem.[11]

KEYWORDS: Courtyard, DAYLIGHT, Environment, Architecture, MASJID, Energy.

الإضاءة الطبيعية للفناء الداخلي في العمارة البيئية للمسجد بمدينة القاهرة

الملخص

لعب الفناء الداخلي دوراً هاماً في عمارة المسجد تحت ظروف بيئية مختلفة، حتى اختفى تدريجياً من عمارة المسجد المعاصر، وتهدف تلك الدراسة النظرية والتطبيقية لبيان أهمية الفناء الداخلي في تحقيق المتطلبات من معامل الإضاءة الطبيعية وشدتها وجودة توزيعها على مدار اليوم، بالإضافة إلى تحسين البيئة العمرانية، مما يقلل من استهلاك الطاقة وخفض أحمال التلوث على البيئة الطبيعية.

لذا يجب دعم وجود الفناء الداخلي في عمارة المسجد، واستخدام أحدث التقنيات المناسبة لتطويره، للاستفادة من الإضاءة الطبيعية والمصادر والنظم الطبيعية في العمارة، ومساندة النظام البيئي.

كلمات البحث: الإضاءة، الفناء، المسجد، العمارة، البيئة، الطاقة.

1 INTRODUCTION

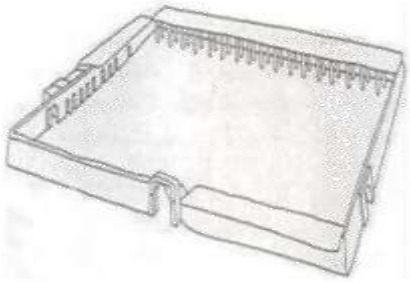
The purpose of man's creation is the worship of Almighty God, and one of this worship's means is developing the universe, in the built and natural environment, according to integrated mutual relation. MASJID as a house of worship is one of the most important architectural requirements for a person, so KAABA is the first house established for the people in MAKKA. and planning MASJID was the first actions taken by the Prophet MOHAMMAD after his emigration and arrival to MEDINA[12] .

[11] Ahmed Almrazky, 2010.

[12] Brenister Fletcher, 1996.

Fig (1) Courtyard around KAABA.[13]

Fig (2) Early courtyard inside Prophet's MASJID.[14]



The courtyard is an important architectural element, since it has been associated with MASJID at various time and place (around KAABA or inside Prophet's MASJID and in other MASJIDs in many different countries for centuries). It provided a suitable space that accommodate growing numbers of worshipers, doing various activities like holding councils of science, judiciary, nursing and entertainment... etc, till it gradually disappeared from the contemporary architecture of MASJID, in a phenomenon calls into question.

2 PROBLEM

Some of the countries facing the harsh climatic conditions divided MASJID to prayer's hall and covered internal courtyard to protect it from heavy rain and stinging cold. This trend was Then spread in the rest of the countries, even Cairo city, without taking into account the importance of the different environmental conditions effect from a region to another. Then MASJID became covered by clerestory and dome, till the inner courtyard disappeared gradually from the architecture of MASJID causing the following:

Fig (3) MASJID SULTAN QAYTBAY covered by Clerestory [15]

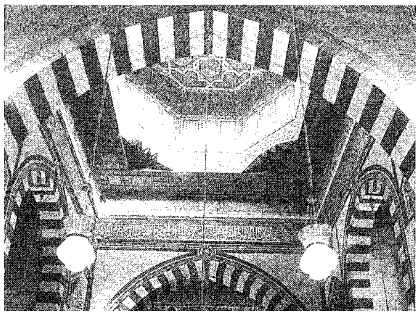


Fig (4) MASJID SULAYMAN PASHA covered by Dome [16]

[13] Ira G. Zepp, 2000.
[14] Syed I. Ariffin, 2005.
[15] Doris Behrens-Abouseif, 1989.
[16] Caroline Williams, 2008.

- Openness to the outside world and increased areas of external windows to address the imbalance in poor lighting and ventilation distribution inside MASJID, due to the lack of the inner courtyard leads to suffering from external noise damage and deterioration of thermal comfort.
- Avoid outside disadvantages by reducing windows areas leads to suffering from darkness, poor lighting and bad distribution of ventilation.
- The use of artificial systems of bulbs, fans, air-conditioners, to provide lighting, ventilation and thermal comfort of MASJID, leads to raise the consumption of different sources of energy like oil, diesel fuel and electricity.
- Difficulty of doing various activities in a closed space of MASJID because of the interference and inconvenience to each other, leads to increase needs to specialized buildings for these activities independently from MASJID such as schools, libraries, courts, hospitals, clubs ... etc.

3 OBJECTIVES

To clarify the role of the internal courtyard to provide DAYLIGHTING for the Environmental architecture of MASJID through:

- The importance of the internal courtyard's DAYLIGHTING of MASJID.
- The environmental impact for the internal courtyard of MASJID.
- Thinking of development possibilities of the internal courtyard of MASJID.

4 IMPORTANCE

The study addressed the internal courtyard's DAYLIGHTING for the environmental architecture of MASJID because of:

- The importance of achieving the humanitarian requirements of DAYLIGHTING and other natural ecosystems for supporting lifecycle system.
- The importance of worship activities diversity in human life.
- The importance of MASJID in accommodating diverse worship activities.

So the study worked to present the role of the internal courtyard's DAYLIGHTING to achieve the maximum possible benefits, provide a practical means by which to assess the DAYLIGHTING[17] because of its impact on human health, the quality of construction and safety of the environment, and provide statement of how it is needed and the damage resulting from its lack through:

- Diversity of MASJID cases studied in terms of area, design and style.
- The impact of the presence of the internal courtyard against the clerestory and dome coverage.

5 METHODOLOGY

- Theoretical framework contains display of main concepts underlying the studying accordance with scientific and cultural variety of backgrounds, and the historical evolution of the correlation between courtyard and architecture till the internal courtyard of MASJID in Cairo, and the most

[17] Bangali Jayashri, Shaligram Arvind, 2013.

important results of previous studies concerned with the elements of this research.

- Practical framework contains the collection and monitoring of lighting, climatic data, and field measurements including lighting intensity, noise levels, temperature, relative humidity, and the inventory of technical equipment in the cases studied of MASJID, and a psychological and social questionnaire, and analysis of all previous data using computer programs.[18]

5.1 Main Concepts

Noticing multiplicity of the main concepts and terminologies of the study, led to take advantage of this variety to achieve a possible integration among themselves, to reach the nearest perception of real meaning and right understanding as follows:

- DAYLIGHT[19] is a critically important component of the immense flux of short wave photonic energy that flows continuously onto the surface of our Earth from our Sun.
- Courtyard[20] is an uncovered space inside or outside the building, while the atrium is the covered or uncovered interior space which building's elements meet around.
-

Fig (5) Courtyard in MASJID of IBN TULUN.[21]

Fig (6) Covering the atrium of MASJID with dome. [22]

- Environment[23] is a balanced system around us materially, morally and physically such as land, water, air, biotic like humans, animals, plants, and balanced relations between them.
- Architecture[24] is providing physical and moral framework that meets human needs supporting life ecosystem.
- MASJID[25] as a place characterized by holiness, is a house of worship to get closer to God (ALLAH) and where that kneeling (SOJOD) of prayer is as close as possible from God (ALLAH), it is called the name of MASJID.

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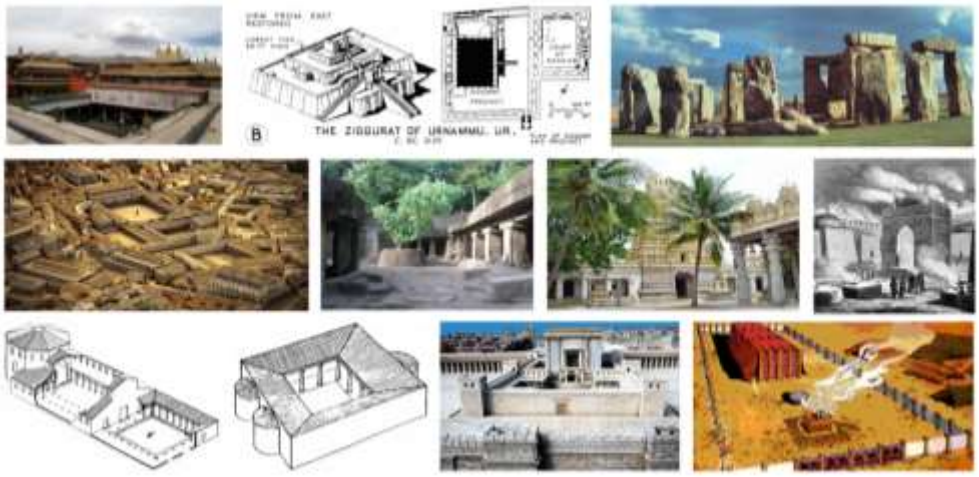
[18] R. G. Bhavani and M. A. Khan, 2011.
[19] Richard Kittler, Miroslav Kocifaj, Stanislav Darula, 2012.
[20] Par Roger Garaudy, 1985.
[21] Titus Burckhardt, 2009.
[22] David Macaulay, 2008.
[23] J.L. chapman & M.J. Reiss, 1995.
[24] YEHIA ABDALLAH, 2013.
[25] Robert Hillenbrand, 1994.

6.1 Historical Evolution

- Availability of sky in architecture is one of Human interests throughout centuries in different cultures and religions[26].
- So the courtyard was a key element in the architecture of successive civilizations especially religious in different eras and countries.

Fig (7) The relation of internal courtyard to the houses of worship in different cultures.



- The courtyard was linked to MASJID closely, playing a vital role in meeting the physical needs for providing a place to accommodate the congregation, natural lighting, ventilation, thermal comfort and distracting noise. Also in meeting the morals needs for contacting sky visually, providing privacy and tranquility that are commensurate with humility required to the houses of worship.

Fig (8) The relation of internal courtyard to MASJID in different countries and centuries.

[26] Karen Farrington, 2002.

Fig (9) The relation of internal courtyard to Egyptian architecture specially religious.

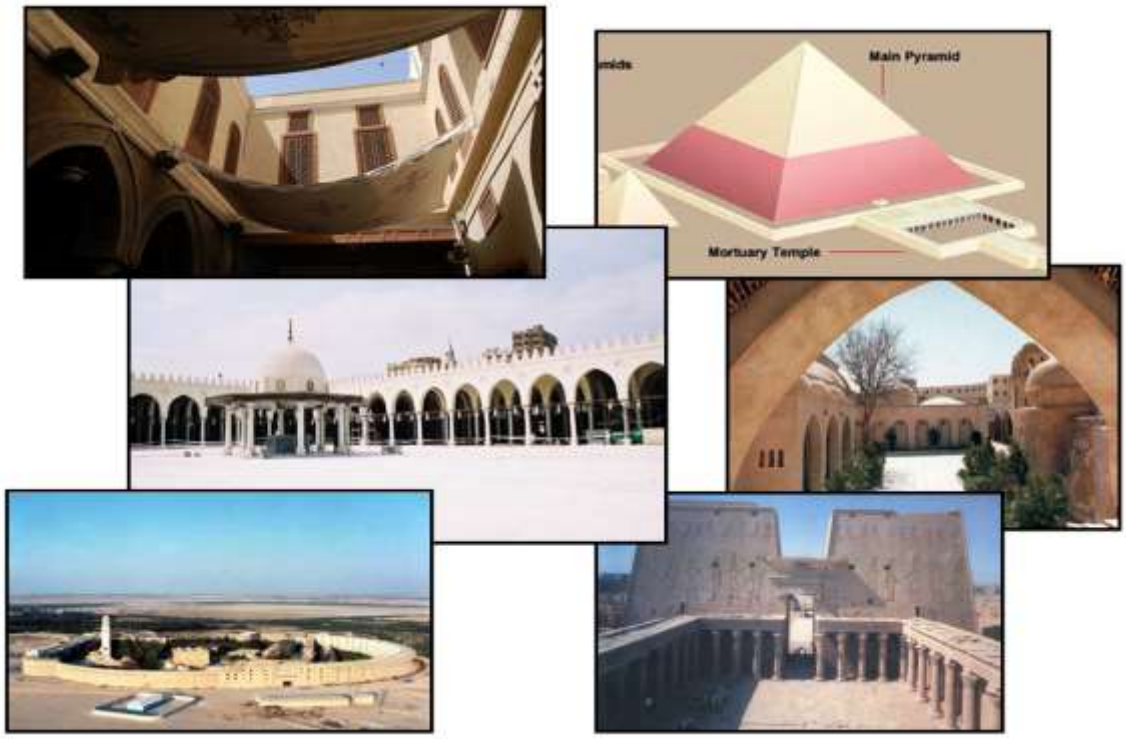


Fig (10) The relation of internal courtyard to MASJID in Cairo city.

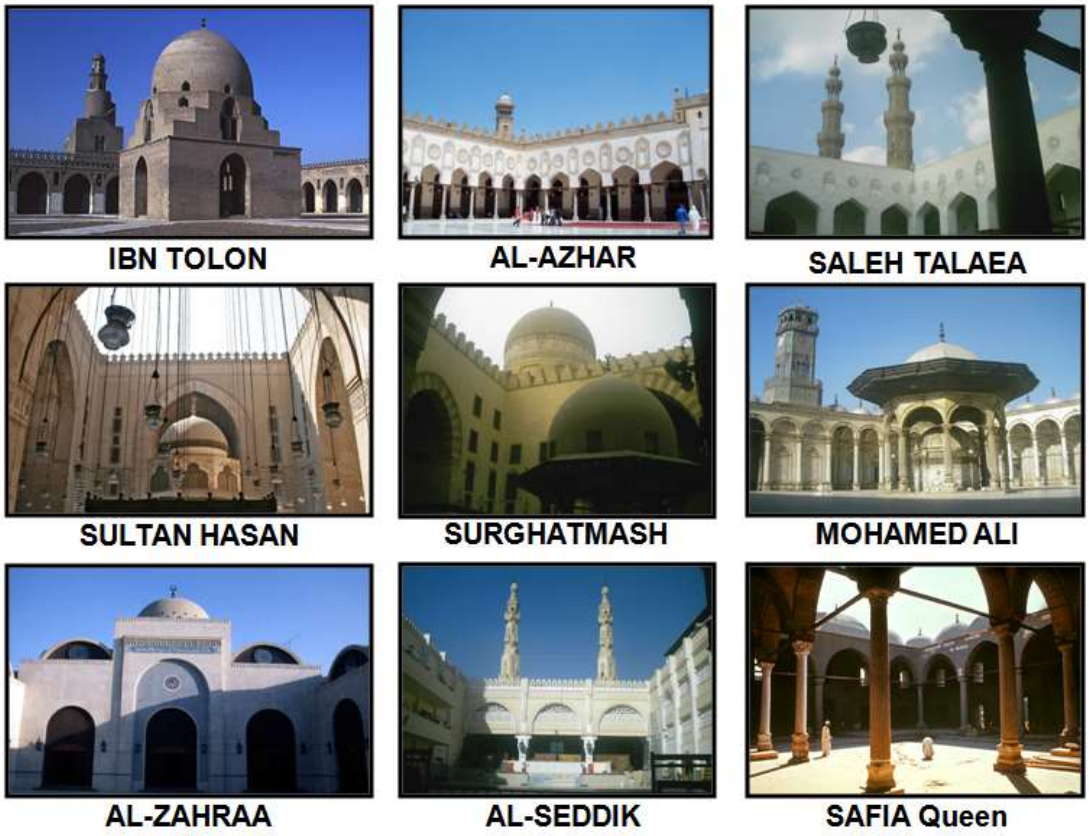


Fig (11) MASJID atrium covered by dome and clerestory in Cairo city.

7.1 Previous Studies

Noted that few studies were about the design of worship's buildings especially the environmental performance[27], generally those studies can be classified in groups:

- A group is interested in the architectural design of worship's buildings especially MASJID in terms of functional relationships, manifestations aesthetic, design criteria, planning of MASJID, and the evolution of its architecture design according to the different spatial and temporal conditions.
- A group is interested in architectural Spaces especially courtyards in terms of its relationship with the activity of building, its importance in architecture, studying its evolution over centuries, many civilizations and design criteria.
- A group interested in the Environmental systems in terms of ventilation, thermal comfort and lighting. As this study addressing the impact of the courtyard by analytical and practical studies, monitoring and documenting qualitative and quantitative internal environmental systems of MASJID.

8.1 Practical Study

We studied groups of MASJIDs that vary in size and layout and style, some of them have an internal courtyard (IBN TOLON, AL-SALEH TALAE, SULTAN HASAN, SARGHATMASH, MOHAMED ALI, SAFIA Queen, AL-ZAHRAA, AL-SEDDIK) while some are covered by clerestory or dome (ABO HREBA, AL-REFAAY, ABDIN, AL-FAROOK, SALAH DEEN) to learn DAYLIGHT and environmental performance with and without the internal courtyard through data and updated information according to the following:

[27] Yasmine Amr Mostafa, 2013.

- Collecting and monitoring and analyzing the climatic data from Cairo city, by climatic architectural design, which encouraged the compacted urban pattern, based on internal courtyards in buildings and minimizing the external openings.
- Collecting, monitoring and analyzing the geometrical and physical data in MASJID, using measuring devices to monitor the daylight intensity, temperature, relative humidity, and the intensity of noise throughout summer and winter from 9.00 am to 6.00 pm every 3 hours to suit the time of pray at a height of 0.50 cm and 1.50 cm from the surface of the floor to fit with the implementation of the activities then comparing all the results.

Table (1) Geometrical Considerations.

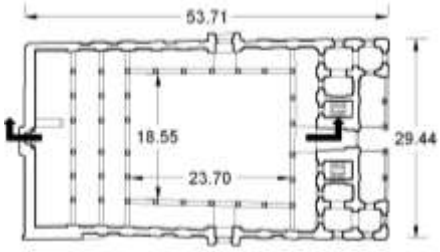
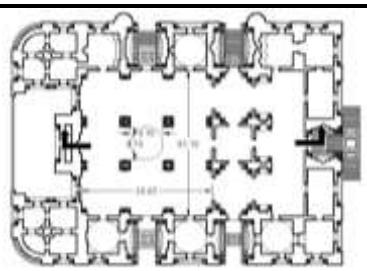
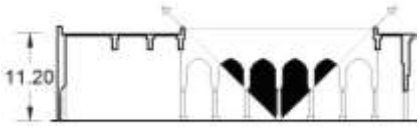
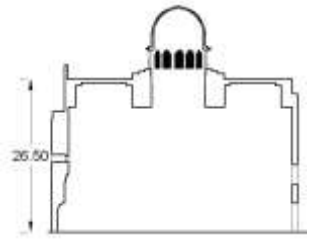
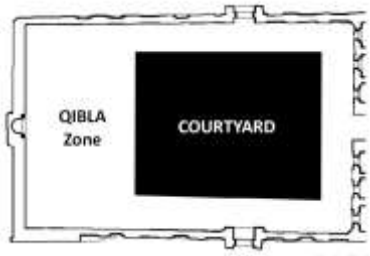
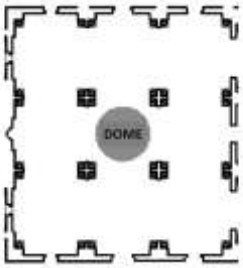
	AL-SALEH TALAE	**AL-REFAAY**
Plan		
Section: Depth Level		
	Average Depth	Average Depth

Table (2) Physical Considerations.

	AL-SALEH TALAE		**AL-REFAAY**	
Ratio of Courtyard Area or Dome Covered Area to the total Area & Location				
	41% - Centered almost		6% - Centered	
Grid of Distribution	2D	3D	2D	3D

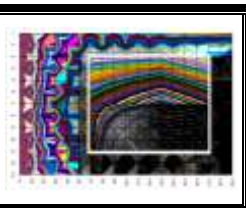
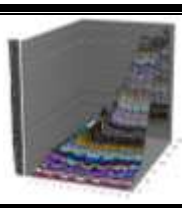
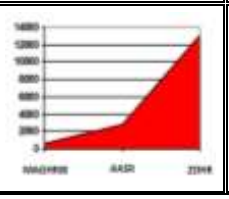
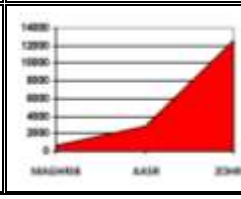
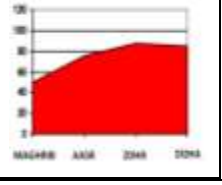
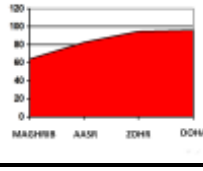
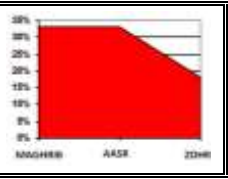
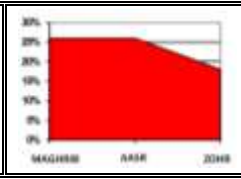
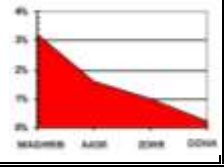
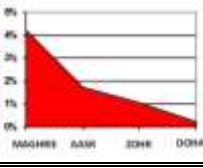
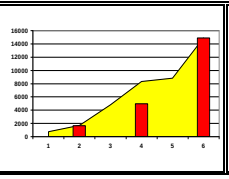
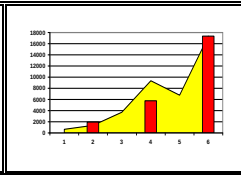
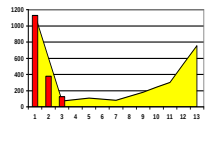
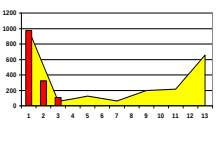
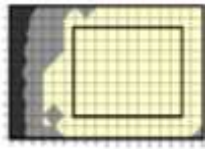
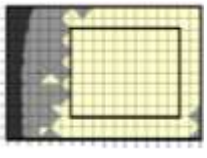
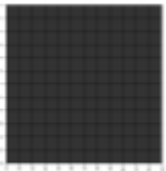
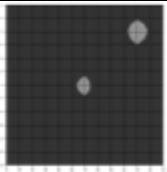
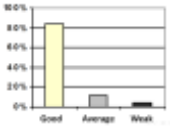
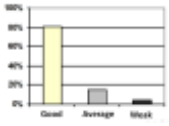
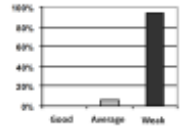
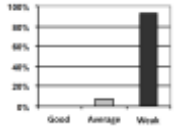
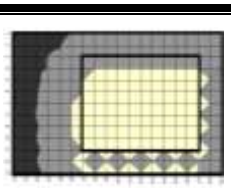
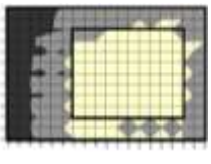
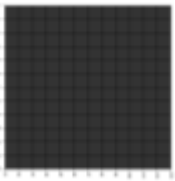
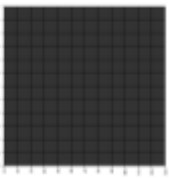
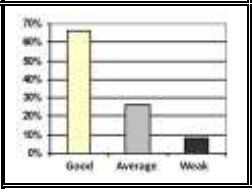
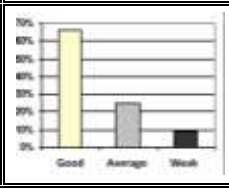
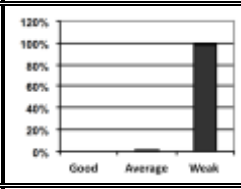
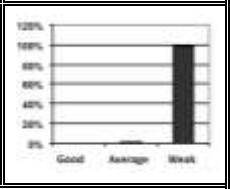
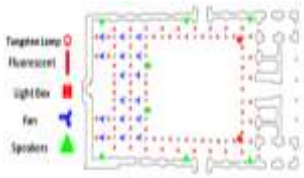
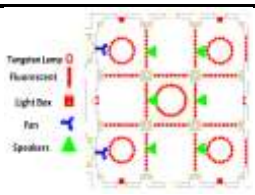
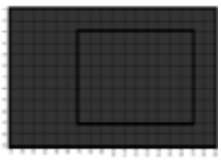
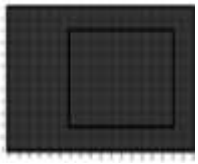
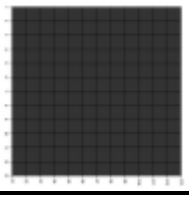
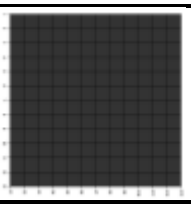
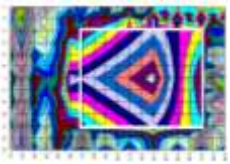
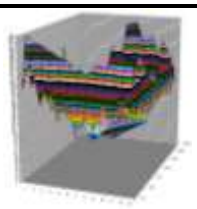
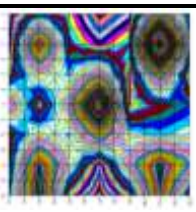
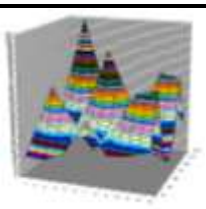
Daylight Distribution				
Gradient Type	Single Gradient		Multiple Gradient	
Height of Monitoring Level	+ 0.5 m	+ 1.5 m	+ 0.5 m	+ 1.5 m
Average of Lighting Intensity				
	5433 Lux		79 Lux	
Average of DAYLIGHT FACTOR				
	25%		2%	
Gradient in Lighting Intensity				
Average Ratio of Glare Area	17%		77%	

Table (3) Analytical Considerations.

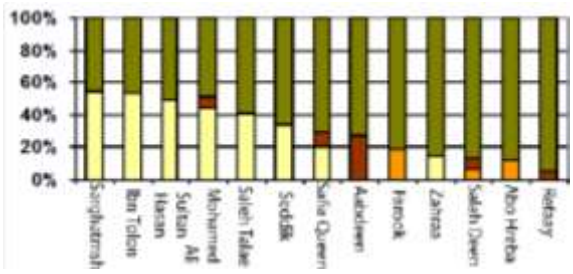
	AL-SALEH TALAE		**AL-REFAAY**	
Height of Monitoring Level	+ 0.5 m	+ 1.5 m	+ 0.5 m	+ 1.5 m
Lighting Level Zones in June				
Average Percentage for each Lighting Zone				
	Good 82% - Average 14% - Weak 4%		**Good 0%- Average 6%- Weak 94%**	

Lighting Level Zones in December				
Average Percentage for each Lighting Zone				
	Good 66%- Average 26% Weak 8%		**Good 0%- Average 2%- Weak 98%**	
Artificial Systems				
Height of Monitoring Level	+ 0.5 m	+ 1.5 m	+ 0.5 m	+ 1.5 m
Artificial Lighting Level Zones				
	Good 0%- Average 0%- Weak 100%		**Good 0%- Average 0%- Weak 100%**	
Grid of Distribution	2D	3D	2D	3D
Artificial Lighting Distribution				
Gradient Type	Multiple Gradient		Multiple Gradient	

6 RESULTS:

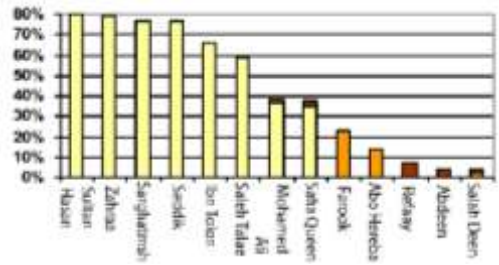
a) The average area of the internal courtyard is about 50% of the total area of MASJID (in some early ones is about 60%) then decreased thereafter. In AL-ZAHRA and AL-SEDDIK is about 24%, while the average area which is covered by the clerestory and dome is about 13% and 11% respectively. (Fig. 12).

Fig (12) the average area of the internal courtyard / clerestory / dome of the total MASJID area.



b) The average area of vertical openings in the internal courtyard is about 73% of its facades area, and in MASJID of MOHAMED ALI and Queen SAFIA is about 36%, while the average area of vertical openings in clerestory and dome is about 13% and 3% respectively. (Fig. 13).

Fig (13) The average area of the openings in the internal courtyard / clerestory / dome to the total area of their facades



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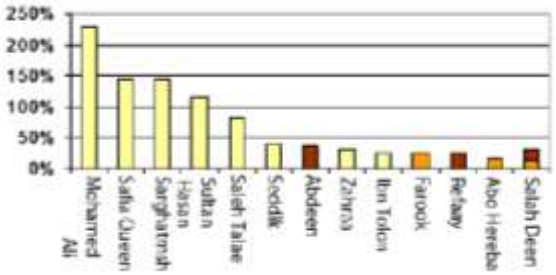
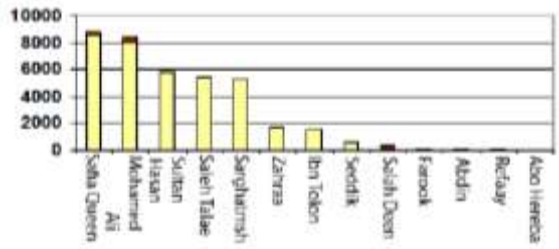
c) The average height ratio of the vertical openings in the internal courtyard is about 143% to a greatest depth of the covered area. In modern MASJID that ratio was about 32%, while the average height ratio of the vertical openings in the clerestory and dome is about 19% and 26% respectively. (Fig. 14).

Fig (14) The average height ratio of the vertical openings in the internal courtyard / clerestory / dome to a greatest depth of the covered area.



d) The average daylight intensity during the year in the covered areas of MASJID around the inner courtyard is about 6631 lx, D.F. is 29% of external daylight. In IBN-TOLON, AL-ZAHRA and AL-SEDDIK is about 1295 lx, D.F. is 6%. On contrary the average daylight intensity during the year in the covered areas of MASJID around the clerestory is about 114 lx, D.F. is 2% and around the dome 201 lx, D.F. is 3%. (Fig. 15).

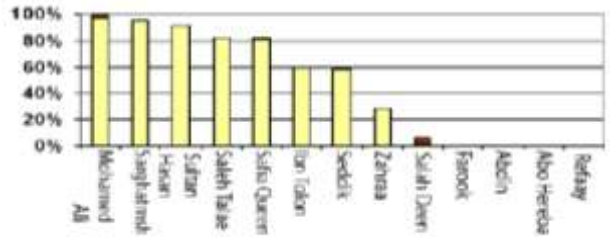
Fig (15) The average daylight intensity in the covered area of MAJID around the internal courtyard / clerestory / dome during the year.



e) The average summery highly lighted area ratio (higher than 600 lx.) in covered area around the internal courtyard is about 90% of the covered area of MASJID. In IBN-TOLON, AL-ZAHRA and AL-SEDDIK is about 49%. On

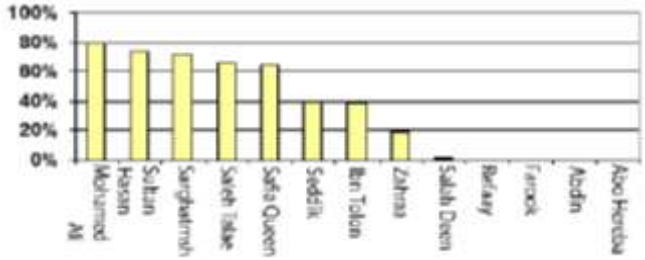
contrary, the average summery highly lighted area ratio in covered area around clerestory and dome is about 1%. (Fig. 16).

Fig (16) The average summery well lighted area around the internal courtyard / clerestory / dome to the total covered area of MASJID.



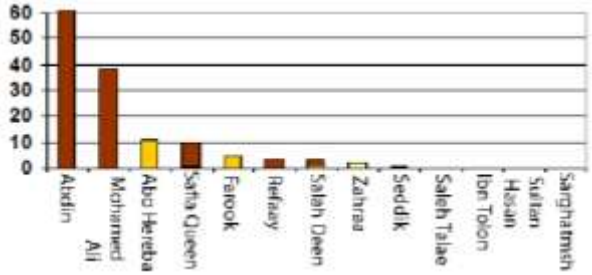
f) The average wintry highly lighted area ratio (more than 600 lx) in covered area around the internal courtyard is about 71% of the covered area of MASJID. In IBN-TOLON, AL-ZAHRA and AL-SEDDIK is about 33%. On contrary, the average wintry highly lighted area ratio in covered area around clerestory and dome is about 0%. (Fig. 17).

Fig (17) The average wintry well lighted area around the internal courtyard / clerestory / dome to the total covered area of MASJID.



g) The average total summery electrical consumption in MASJID with internal courtyard is about 0.19 W / M^2.h. In AL-ZAHRAA and AL-SEDDIK, it is about 1.49 W / M^2.h. On contrary, the average total electrical consumption in MASJID covered by clerestory and dome is about 5.83 W / M^2.h, and 3.31 W / M^2.h, respectively. In MOHAMED ALI and ABDIN, it is about 49.55 Watt / M^2.h. (Fig. 18).

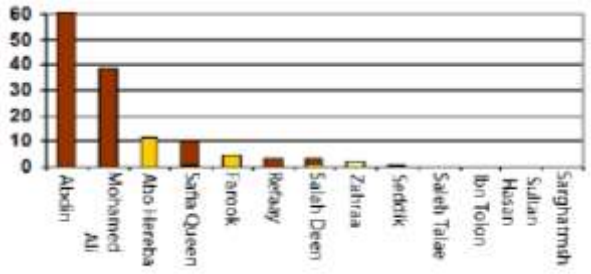
Fig (18) The average total summery electrical consumption in MASJID with internal courtyard / clerestory / dome.



h) The average total wintry electrical consumption in MASJID with internal courtyard is about 0.72 W / M^2.h. In AL-ZAHRAA and AL-SEDDIK, it is about 3.74 W / M^2.h. On contrary, the average total electrical consumption in MASJID covered by clerestory and dome is about 7.53 W / M^2.h, and 4.47 W /

M^2.h, respectively. In MOHAMED ALI and ABDIN, it is about 54.18 Watt / M^2.h. (Fig. 19).

Fig (19) The average total wintry electrical consumption in MASJID with internal courtyard / clerestory / dome.



- Monitoring and analyzing the psychological and social role of internal courtyard's DAYLIGHTING in the environmental architecture of MASJID on a group of worshipers throughout a questionnaire of psychological and social impacts distributed by hand and posted on a specialized Web sites then the Excel program was used for data analysis.

7 DISCUSSION

7.1. Design Parameters

- The area of the internal courtyard is preferred to be not less than half of the total area of MASJID, and any length or width of the internal courtyard is not less than half of the overall length or width of MASJID.
- The internal courtyard is located in the center of MASJID.
- The geometry of the internal courtyard of MASJID is nearly to be a square.
- The height of the vertical openings in the internal courtyard is larger than the greatest depth of the covered area.
- The internal courtyard provides the largest area of vertical openings to the covered space inside of MASJID, and less area of vertical openings on outside.

7.2. Physical Properties:

- The internal courtyard of MASJID provides average intensity of illumination about 6631 lx. around the year, and D.F. of 29% of natural lighting outside.
- The average glared area from the internal courtyard is less than 2% of the area of MASJID around the year.
- The internal courtyard provides the greatest highly lighted area (higher than 600 lx.) with an average 80% of MASJID's area around the year.
- The internal courtyard provides the least poor lighted area (less than 200 lx.) with an average 3% of MASJID's area around the year.
- The internal courtyard reduces the consumption of electricity from the artificial lighting in MASJID for up to 0.19 W / M^2.h in summer, and 0.72 W / M^2.h in winter which is equivalent to about 4% in summer and 12% in winter of consumption in MASJID covered by clerestory or dome.
- The internal courtyard provides a difference in temperature between the inside to the outside of MASJID by factor about 95%.

- The internal courtyard provides a difference in relative humidity between the inside to the outside of MASJID by factor about 96%.
- The internal courtyard reduces the consumption of electricity for the ventilation in MASJID for up to 1.40 W / M^2.h. equivalent to about 20% of the consumption in MASJID covered by clerestory or dome.
- The internal courtyard provides a difference in noise levels between the inside to the outside of MASJID by factor about 83%.
- The internal courtyard reduces the consumption of electricity for the sound systems in MASJID for up to 0.20 W / M^2.h. equivalent to about 20% of the consumption in MASJID covered by clerestory or dome.

7.3. Psychological And Social Properties

- The internal courtyard's DAYLIGHTING and other natural systems in MASJID supports the sense of tranquility, reverence and closeness of God (ALLAH), feeling of security, guidance, light, confidence and certainty.
- The natural systems including DAYLIGHTING provided by the internal courtyard are suitable to achieve psychological comfort in MASJID.
- The natural systems including DAYLIGHTING provided by the internal courtyard allow performance of different social activities in MASJID.

8 CONCLUSION

Understanding the role of the internal courtyard to provide DAYLIGHTING for the Environmental architecture of MASJID through:

8.1 The Importance Of The Internal Courtyard's Daylighting Of MASJID

- Achieving the proper quality of lighting environment to do various activities in MASJID, and increasing the quality of the visual process, and the positive effects on human health.
- Availability to reduce the glare in MASJID.
- Avoiding the disadvantages of artificial lighting in MASJID, such as low intensity, bad distribution, and the stability of light intensity.
- The centrality of the internal courtyard in MASJID provides strong contact to the covered spaces around it which allows using it efficiently and effectively.
- Increasing the capacity of MASJID, and supporting the possibility for different activities of worship, cultural, social and entertainment ... etc.
- Improving psychological effectiveness in MASJID, and supporting them by providing DAYLIGHTING and other natural systems.
- Allows carrying out various social activities in MASJID without the interference of those activities with each other or preventing the worshipers by providing DAYLIGHTING and other natural systems.

8.2 The Environmental Impact For The Internal Courtyard Of MASJID

- Allow advantages of a compacted urban pattern to achieve protection from bad external climatic bad conditions, and openness to the outside world at the lowest possible space, and provide privacy.

- Providing a suitable place to contain fountains working on humidifying the air when exposed to dried hot atmosphere.
- Increase exposure to sunlight as much as possible which is necessary for thermal gain in MASJID to provide thermal comfort in winter.
- Supporting the internal air movement in MASJID that is necessary to reduce the internal temperature and get rid of over humidity.
- Renewing indoor air in MASJID to reduce viruses, various organic volatiles and air pollutants that cause the spread of diseases and epidemics.
- Allowing Efficient contact between inside space and outside of MASJID, where the advantage of opening up to the sky providing protection from external loads.
- Avoiding disadvantage of air conditioning and bad renewal of air.
- Decreasing noise between inside and outside of MASJID to achieve quietness.
- Reducing the heat island phenomenon which is created above cities due to increasing building density that cause the high temperature and relative humidity on the green areas and surrounding desert.
- Reducing noise levels in the residential area.
- Reducing the pollutants resulting from energy generation, materials manufacture, and constructions operation.
- Saving energy consumption used in the stages of manufacture of construction materials and building construction and operation.

8.3 Development Opportunities And Future Potentials

- Shading the internal courtyard by smart sheeting as in the prophet's MASJID.
- Planting the green grass in the ground of internal courtyard of MASJID.

9 RECOMMENDATIONS

- Supporting the internal courtyard's DAYLIGHTING for the environmental architecture of MASJID in Cairo city.
- Applying the design bases of the internal courtyard's DAYLIGHTING, for the advantage of its physical, psychological and social properties in the environmental architecture of MASJID.
- Studying the environmental performance of the internal courtyard's DAYLIGHTING in different activities and building kinds.
- Continuing the study of providing opportunities for the development of the internal courtyard's DAYLIGHTING in buildings.
- Continuing the evaluation of the environmental performance of the internal courtyard's GAYLIGHTING with different natural systems and studying the opportunities for its development.

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