

Mechanisms of Generating Mosques Types

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1-Abstract:

Mosques are one of the religious buildings; their designs and diverse forms reflected the high degree of civilized interaction between cultural values and concepts of Islam and the architectural heritage of the various countries, where the Mosques are built in. This interaction assists in giving birth to mosques models which are characterized by their unity and diversity of forms in each region and elsewhere in the Islamic world. This unity and diversity were caused by the emergence of these models, from one generative type (AL-Masjid AL-Nabawy) the Mosque of the prophet Muhammad in Al-Madina, whose design characteristics (plans, its general and detailed components, materials of building and its construction system, and decorative, and ornamental treatments), represents the basis which the rest of the mosques models in the Islamic world consist of.

It is assumed that the occurrence of operations for generative models from the type mentioned referred to using a variety of methods and mechanisms, which will be investigate in this research through a process of formal analysis of these models and compared with the first generative type.

A group of mosques types of different parts of the Islamic world and of different periods was selected as an intentional sample as each type represents a generation of a new model.

The choosing of these samples based on the fame of the buildings, the abundance of Documentation information's of the buildings, and the fact that it represents a new models delivered from the first generative type.

The research is concluded by referring to a group of methods and mechanisms which were used to achieve the birth operations in addition to identification of the frequently used mechanisms and the percentages of use which will give clear indication for the designers about the most important mechanisms in the birth operations of the new mosques models.

2- Introduction:

Generative art is currently receiving increasing attention for its relation with many modern topics like evolutionary ^{1Page} systems, genetic algorithms, software art, emergent design and interactive installations and fractal art.

The importance of such topic in architecture in general and mosques architecture in particular lies in its role in examining the development and generation of this architectural types out of its generative type (the Prophet mosque in Al

Madina) in order to fully understand the generation of the new mosques models in each type. The study argues that there are certain mechanisms used in generating new mosques models within each type. It also argues that there is a certain type for using such mechanisms clear through focusing on using some of the mechanisms largely which will provide the contemporary designer with a clear indicator for the importance and weight of each mechanism within the architectural design of new mosques models. Thus, the study aims at revealing such mechanisms used within the generation process of the mosques types and establishing use ratios within each of the mechanisms. The study will start with clarifying the generative type in mosques architecture and its characters to be compared with the generated mosques and reveal the used generated mechanisms then fixing the basic types of mosques to be study. Then studies dealing mechanisms of development and generation of types will be fully examined to make a theoretical frame for such mechanisms to be explored in a detailed practical study.

3-Generative Type of Mosques Architecture and its Main Characteristics:

Recent studies[1-3] dealing with mosques architecture have indicated that Al Masjid Al Nabawi built by the Prophet in Al Madina is the main and base type in constructing other mosques. The designing characteristics of this mosque represented the generative type that other mosques in other parts of the Islamic world resulted from. In this study we summarized the designing characteristics that are mentioned by Thunoon in a previous study [2] for its important in the process of comparing the generative types and reveal the used generative mechanisms: (the general plan of Al Masjid Al Nabawi is a square one (50m×50m) with an area of about (2500m²) with a horizontal and rectangle oratory towards Kaaba (15m * 50m). There are two corridors enclosing the uncovered mosque. There are nine pillars in the horizontal lines parallel to qiblah and three pillars in the vertical lines towards qiblah. According to the religious architectural terms, the mosque consists of three *bilata* and ten *asakeeb*. Rooms are located along the eastern side, beside the mosque wall. There are three doors for the mosque, located within the northern, eastern and western sides of the mosques. There is also the first model for the minaret like a square mass outside Al Masjid Al Nabawi, as illustrated in Figure (1).

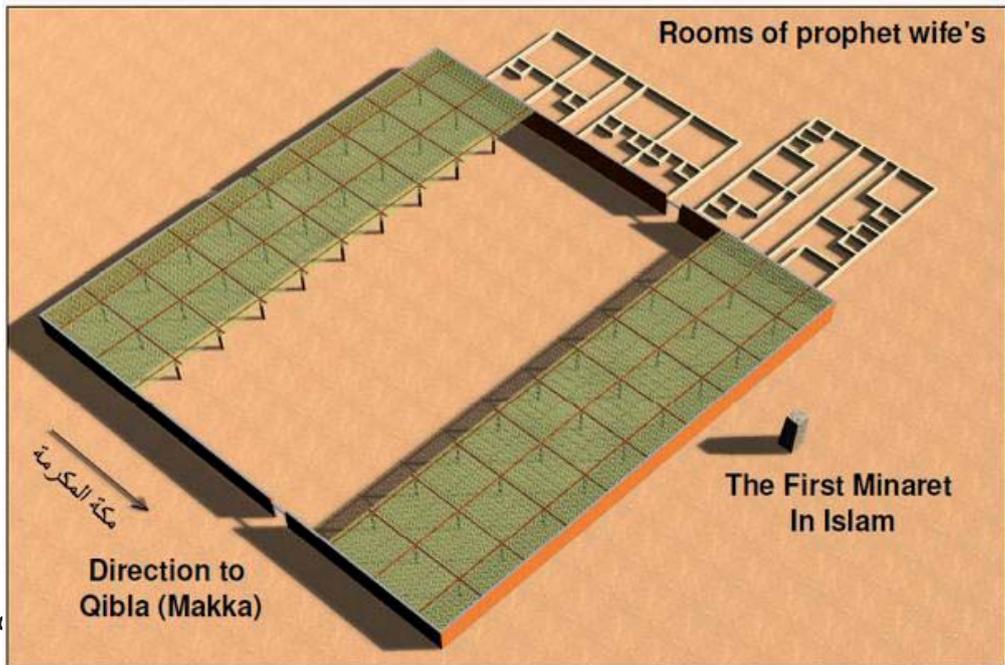
4- Types of Mosques:

Through reviewing the literature that classified mosques[4 -10], similarity among some types are clear despite some differences in naming and classification into minor types, like the Arabic type described by Yaqub Zaki as North Africa and Spain type [6] described by Ardalan as multipillars with being classified into three types [9] while Al Joburi used both descriptions [8] There is also a similarity within the Eywan type described by most of the studies as the Iranian type due to its spread within that area. The Ottoman type is described such in most of the studies except Ardalan where it is described as central dome type [9] and Prochazca where it is classified into two types [7]. In most of the studies, the Seljuk type is combined with the Arabic type except Al Omari [5] and Ardalan where it is classified into two minor types, namely multipillars and multipillars with dome [9]. Prochazca has mentioned eastern south of Asia type despite being affected by the

Chinese buildings [7].

Accordingly, the current study will deal with the following types as the main ones generated from the first type of mosque:

1. The Arabic type.
2. The Eywan type
3. The Seljuk type.
4. The Ottoman type.
5. The Indian type.



AH)[2].

out of other forms through using certain *3Page* mechanisms. Ching indicated that all of the various forms could be understood as being generated from the basic forms (circle, square and triangle). This production of forms is generated from using three mechanisms, dimensional transformations, addition and subtraction [11] (Figure 2). The study then indicated to examples for architectural works generated from basic forms (Figure 3).

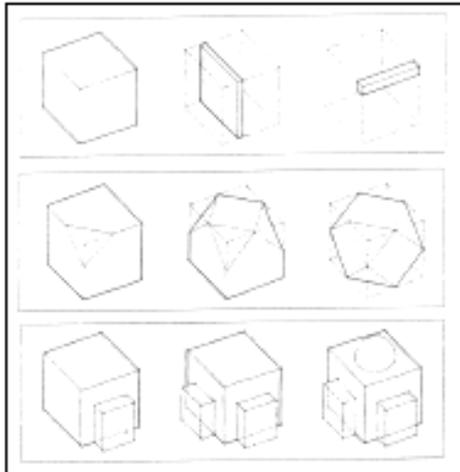


Figure (2)
Generating forms using the mechanisms: dimensional transformations, addition and subtraction [11].

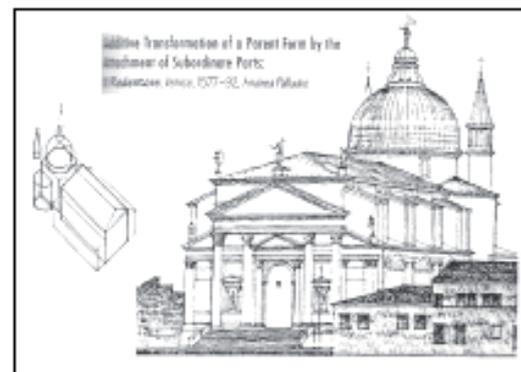
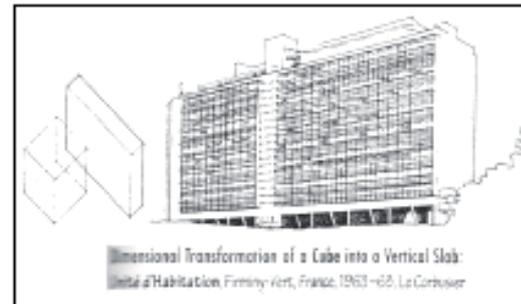
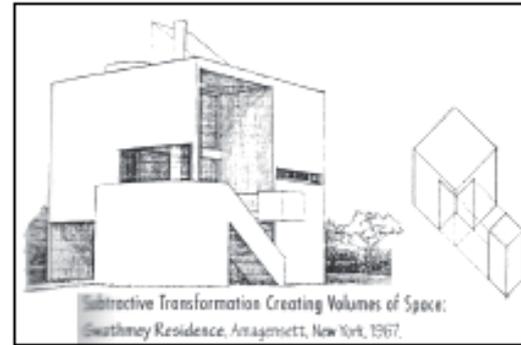


Figure (3)
Architectural works generated from basic forms [11].

Laseau pointed out that transformation within forms and new forms generation could be done through four basic methods: transformations within type, transformations of arabesque bases, reflection and inversion transformations and distortion transformations [12]. The first method is a transformation keeping the form within the same type, despite form differences, through pushing and attraction, like pie transformation into a cup [Figure 4]. The second method is arabesque basics through using four detailed mechanisms: displacement, rotation, reflection and inversion (Figure 5) and the study presented examples for architectural works generated through using this method (Figure 6).

The third method is transformation of the form from the first state into the opposite or vice versa. The study presented some architectural examples like walls and holes, 4Page construction materials and joints and architectural plans that could be reflected into the opposite. The fourth method is distortion through drawing a network on the plan and then changing some parts of the network through maximizing and minimizing and a new form is generated. This method could be done through using some of projection techniques like 360 degrees

perspective.



Figure (4)
Transformations
Within type like pie
transformation into
a cup [12].

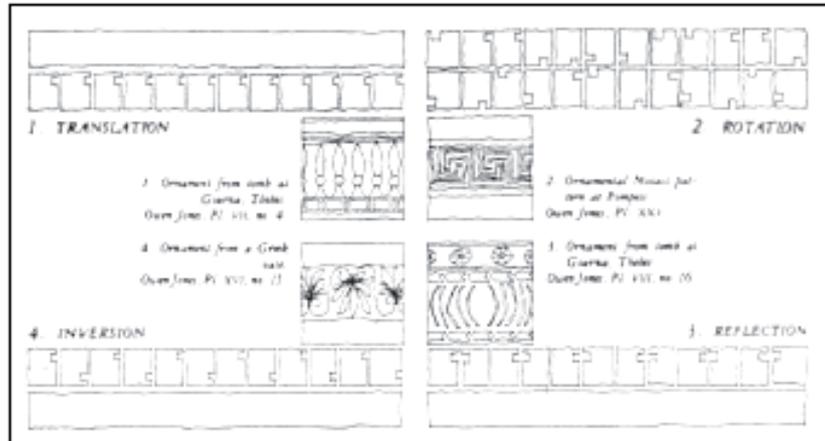


Figure (5) Arabesque basics mechanisms:
Displacement, rotation, reflection and inversion [12].

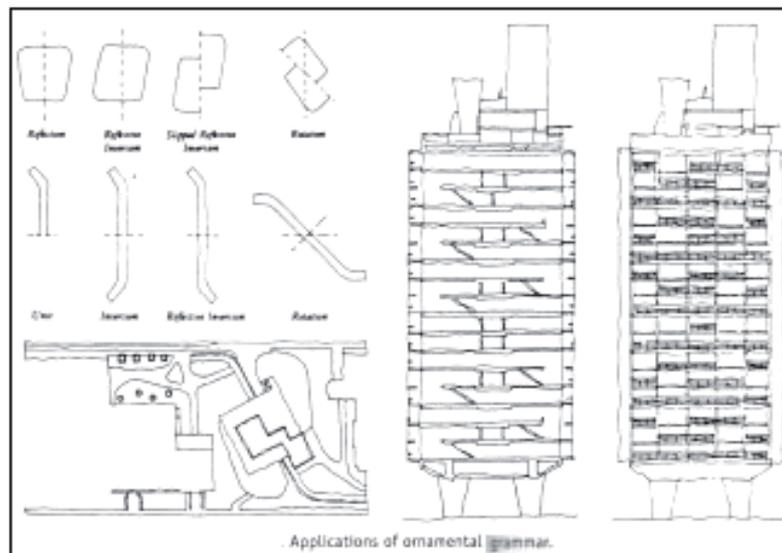


Figure (6) Architectural works generated through using
arabesque basics mechanisms [12].

Mitchell indicated two groups of the mechanisms used to achieve transformation and generation within forms. There are conservative or closed transformation within the type done through using mechanisms (displacement, rotation, reflection, Scaling) [13] (Figure 7). There are destructing or open transformations within the type through using mechanisms (destruction, burning, abstraction, stretch, cut, perspective transformation) [13] (Figure 8).

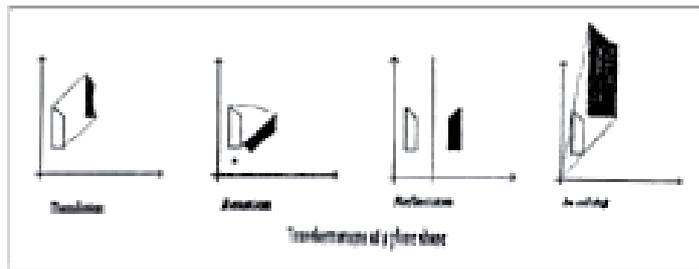


Figure (7) Conservative or closed transformation within the type done through using mechanisms (displacement, rotation, reflection, scaling) [13]

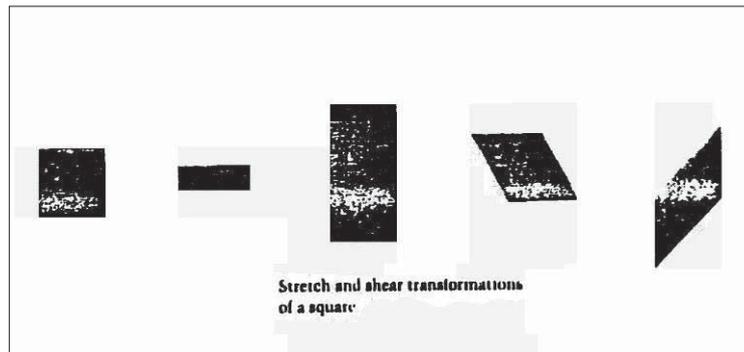


Figure (8)

Destructing or open transformations within the type through using mechanisms (destruction, burning, abstraction, stretch, cut, perspective transformation) [13]

It could be deduced that there are many mechanisms used in realizing transformation and generating new forms that could be classified into two main kinds:

1. Transformation and generation mechanisms where the generated forms are kept within the same type. Dimensional transformations, addition and subtraction, mentioned by Ching, are included within this kind. There are also arabesque basics transformations, displacement, rotation, reflection and inversion, mentioned by Laseaue and displacement, rotation, reflection and Scaling, mentioned by Mitchell.
2. Transformation and generation mechanisms where the generated forms didn't kept within the same type. Deconstruction, burning, abstraction, stretching, cutting and perspective transformation are included as mentioned by Mitchell.

The current study is dealing with models generated from one generated type and the first kind of mechanisms will be selected to avoid repetitions as follows:

- | | |
|---------------------------------|------------------------------|
| 1. Displacement. | 2. Rotation. |
| 3. Scaling. | 4. Reflection and inversion. |
| 5. Dimensional transformations. | 6. Addition. |
| 7. Subtraction. | |

6- Practical Study:

A practical study will be made in order to realize the study aim and verify the

hypothesis according to the following steps:

- 6-1 Determining The designing characteristics for the Archetype included by the study.
- 6-2 Selecting samples representing mosque types.
- 6-3 Performing the practical study using segmentation and formal analysis to examine stages of mosque types development in comparison with the original type of mosque using some drawing software like 3Dmax 10, AutoCAD 2008.
- 6-4 “Results” Putting down information derive from segmentation and formal analysis within tables for each of the samples and making statistical analysis for establishing mechanisms to be used in addition to ratios of use.

6-1 Determining The designing characteristics for the Archetype included by the study:

There four basic designing **characteristics** of Al Masjid Al Nabawi including plans, general and detailed components, building materials and construction system, decorative and arabesque treatments. Due to the limits of the current study, plan and general and detailed components will be dealt with in the practical study while building materials and construction system, decorative and arabesque treatments will be avoided to be examined later by other studies.

6-2 Selecting samples representing mosque types:

In order to start the practical study, samples representing mosque types, mentioned in paragraph (4), were selected to be represented in three dimensional solids and then to be segmented and formally analyzed. One sample will be selected for each of mosque types because of long procedures of segmentation and formal analysis, thus the total number of samples are five. The architectural and civilized importance of the sample selected in addition to clarity of plans and general components are the main conditions in selecting each of the samples. Accordingly, the samples include the following:

Sample No.1					
Mosque type	mosque Name	City	Time	Reference	Figure
The Arabic type	Al Ummawi mosque	Damascus/ Syria	706-715	Richard Yeomans [14]	

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Sample No.2					
Mosque type	mosque Name	City	Time	Reference	Figure

The Eywan type	Al Shah mosque	Asfahan/ Iran.	1611-1638	Richard Yeomans [14]	
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Sample No.3					
Mosque type	mosque Name	City	Time	Reference	Figure
The Seljuk type	Ulu jami mosque	Bursa/ Turkey	1395	Aptullah Kuran[15]	

Sample No.4					
Mosque type	mosque Name	City	Time	Reference	Figure
The Ottoman type	Shah Zada mosqu	Istanbul/ Turkey.	1550-1556	Miles Danby[16]	

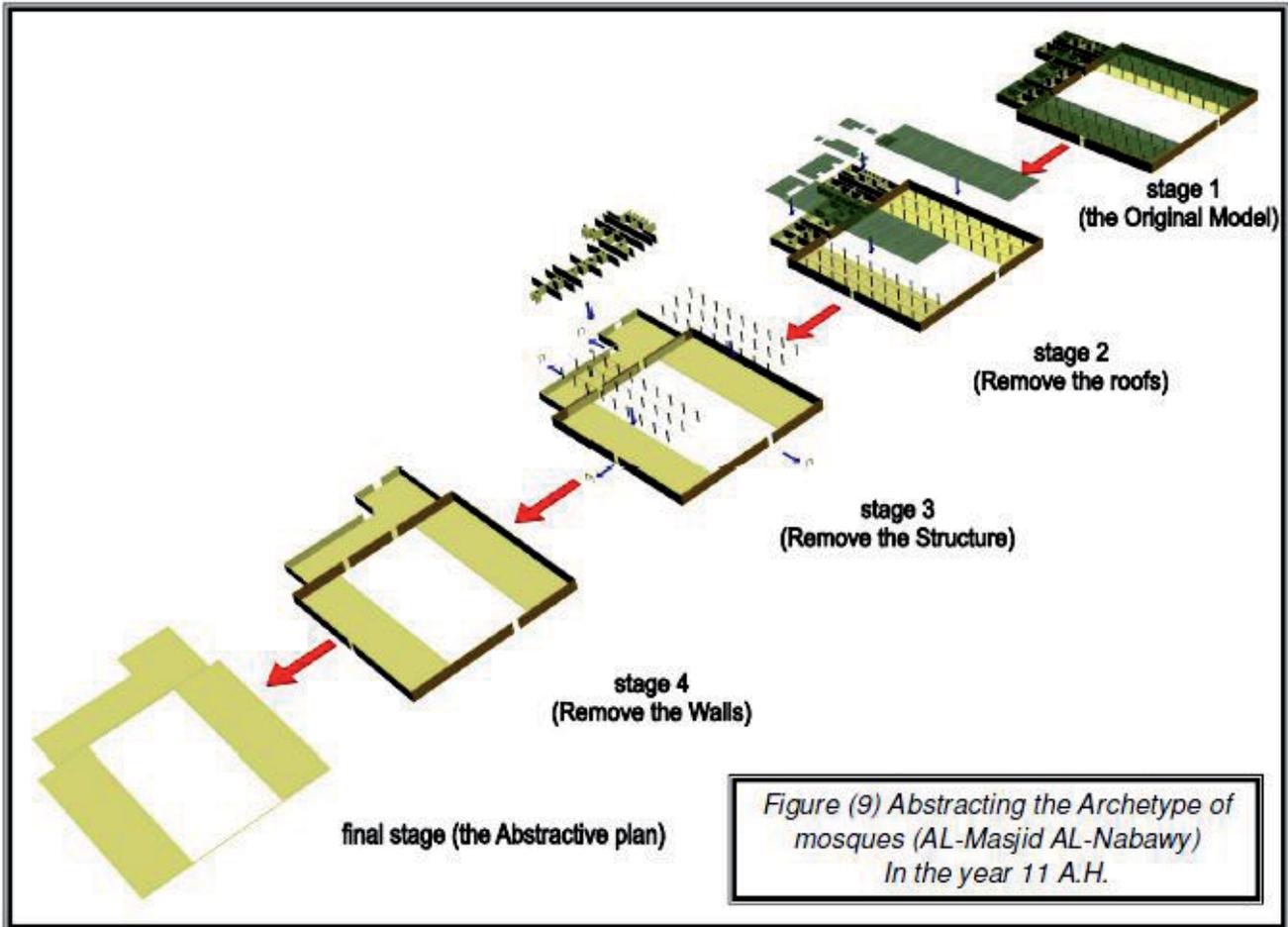
Sample No.5					
Mosque type	mosque Name	City	Time	Reference	Figure
The Indian type	Pearl mosque "Moti Masjid"	Agra/ India	1648-1655	Alexandre Papadopoulo [17]	

6-3 Performing the practical study:

The practical study will be classified into two parts according to the sequence of analysis stages which will be examined as related to the mechanisms used for generation processes out of the Archetype as follows:

1. Abstracting the Archetype of mosques:

A formal Abstraction to the Archetype of mosques will be made using 3D Max9 and AutoCAD 2008 software in order to reach the primitive plan which represent the first stage in development and generation processes as shown in Figure (9).



2. Exploring mechanisms used within mosques type:

In order to explore mechanisms used within **mosques type**, three dimensional solid models for the selected samples will be made using 3D Max9 and AutoCAD 2008 software through segmentation and formal analysis to be compared with the Archetype of the mosques in order to explore the mechanisms used in development and generation processes, as shown in Figures (10, 11, 12, 13, 14).

6-4 Results:

The results of the practical study are presented in the attached table Which illustrate the Generating Stages of mosques samples (3-5 stages), beside the mechanisms use in each stage(8 Mechanisms), and the frequency of use for each mechanism, and the Affected Elements by each mechanism in each stage of generation.

7- Final Conclusions:

- 1- The Study shows that there were a group of Mosques generating stages ranged between 3-5 stages, as follows: (The plan Generating stage, The Walls & Structure generating stage, The Roofs & Minarets Generating stage), beside the (The Four Eywans Generating stage) and (The general Components Generating stage) in both the Eywan type and the Indian type.
- 2- In each of the previous stages there were a certain kind of mechanisms used to achieved the presses of generating, the will be mention in a gradually arranged from the most used mechanism to the lower used mechanism in each stage as follow :

2-1 Mechanisms of The plan generating stage :

[Dimensional Mechanism(%33.4), Subtractive mechanism(%25), Rotation Mechanism(%20.8), Additive Mechanism(%12.5), Scale Mechanism(%8.3)].

2-2 Mechanisms of The Walls & Structure generating stage :

[Repetition Mechanism(%25), Additive Mechanism(%25), Structure Change Mechanism(%33.3), Subtractive mechanism(%16.6)].

2-3 Mechanisms of the Roofs & Minarets generating stage :

[Additive Mechanism(%44.4), Repetition Mechanism(%37.03), Structure Change Mechanism(%11.1), Repetition& Scale Mechanism(%7.4).

2-4 Mechanisms of the Four Eywans generating stage :

[Repetition Mechanism (%57.2), Additive Mechanism(%42.8)].

2-5 Mechanisms of the general Components generating stage :

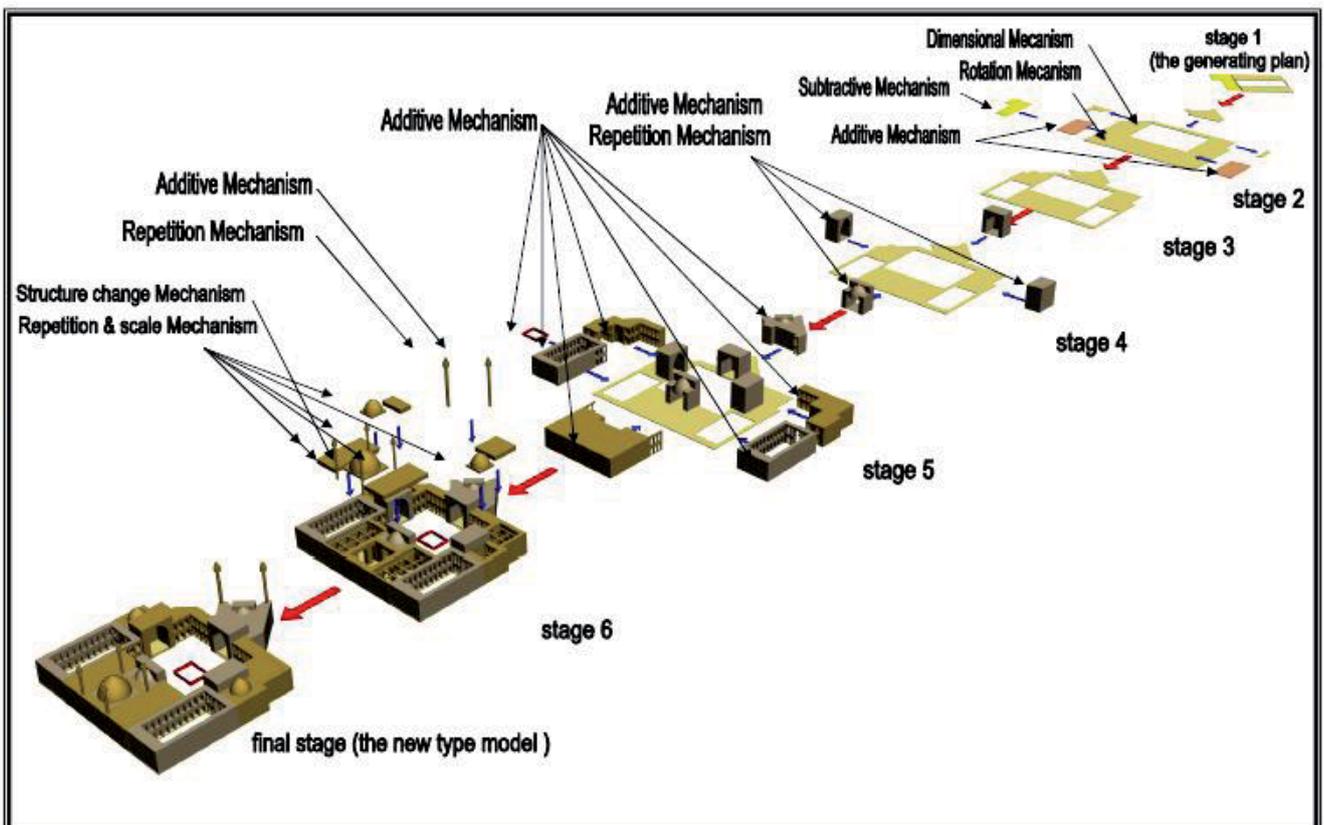
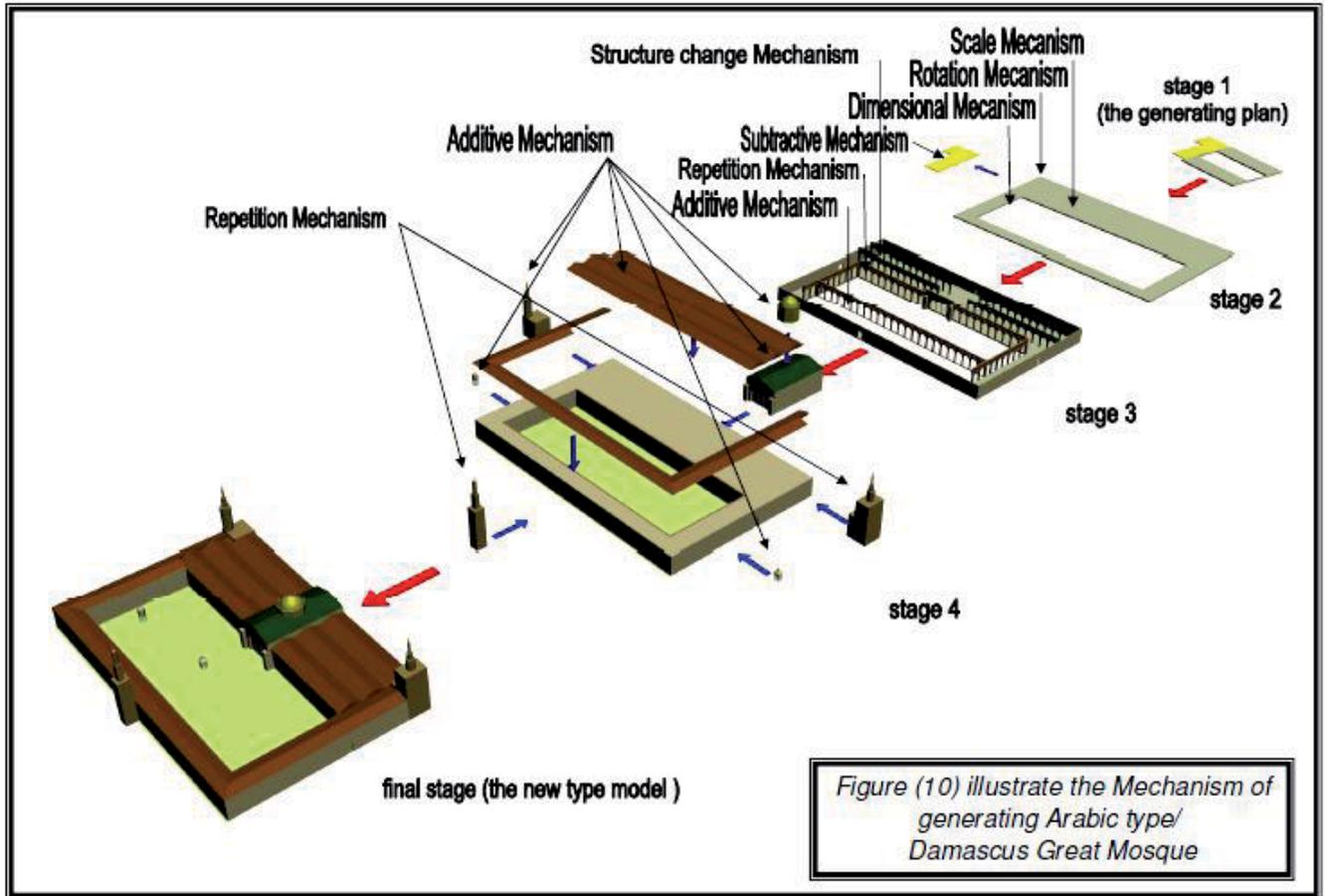
[Additive Mechanism(%75), Structure Change Mechanism(%12.5), Repetition Mechanism(%12.5)].

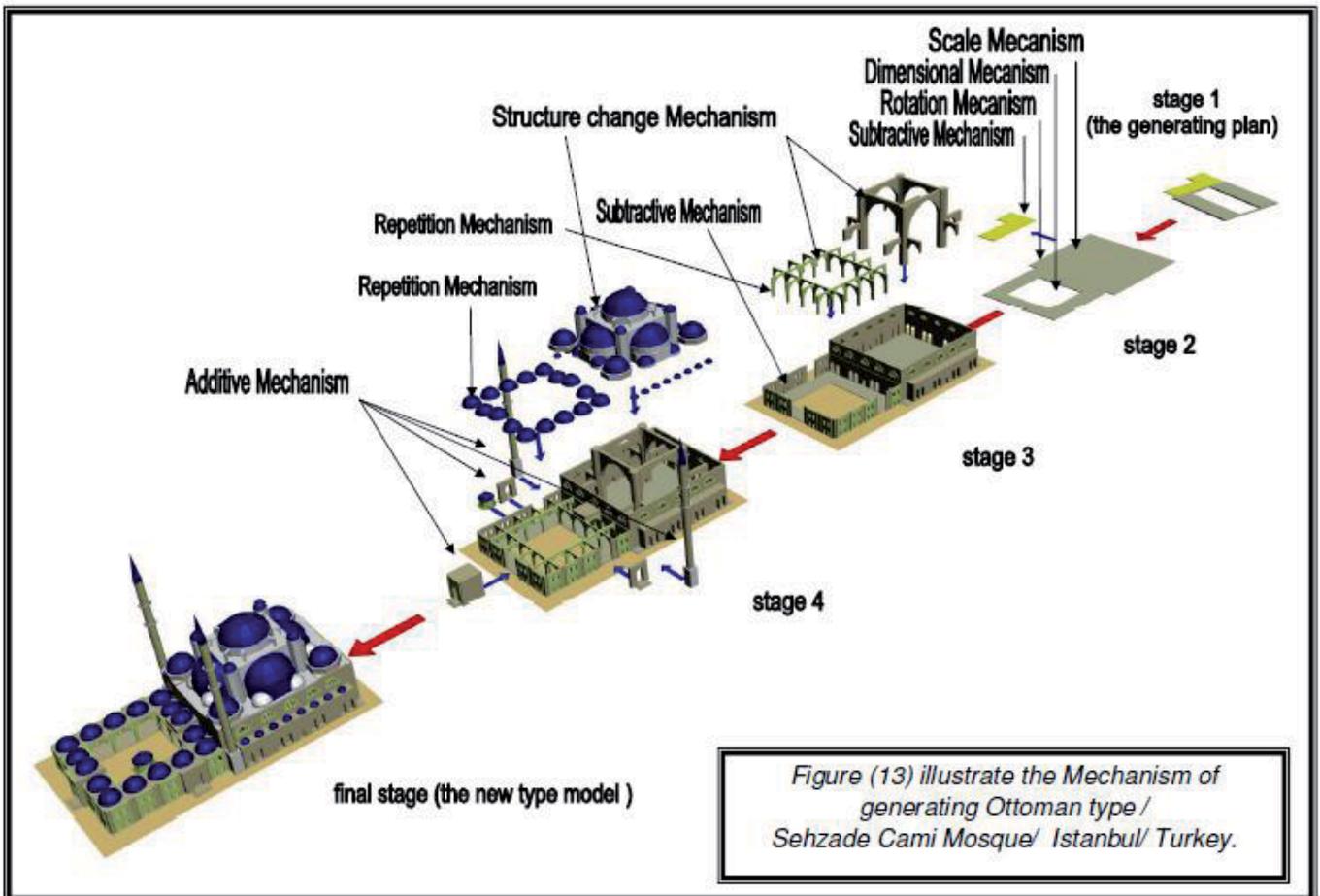
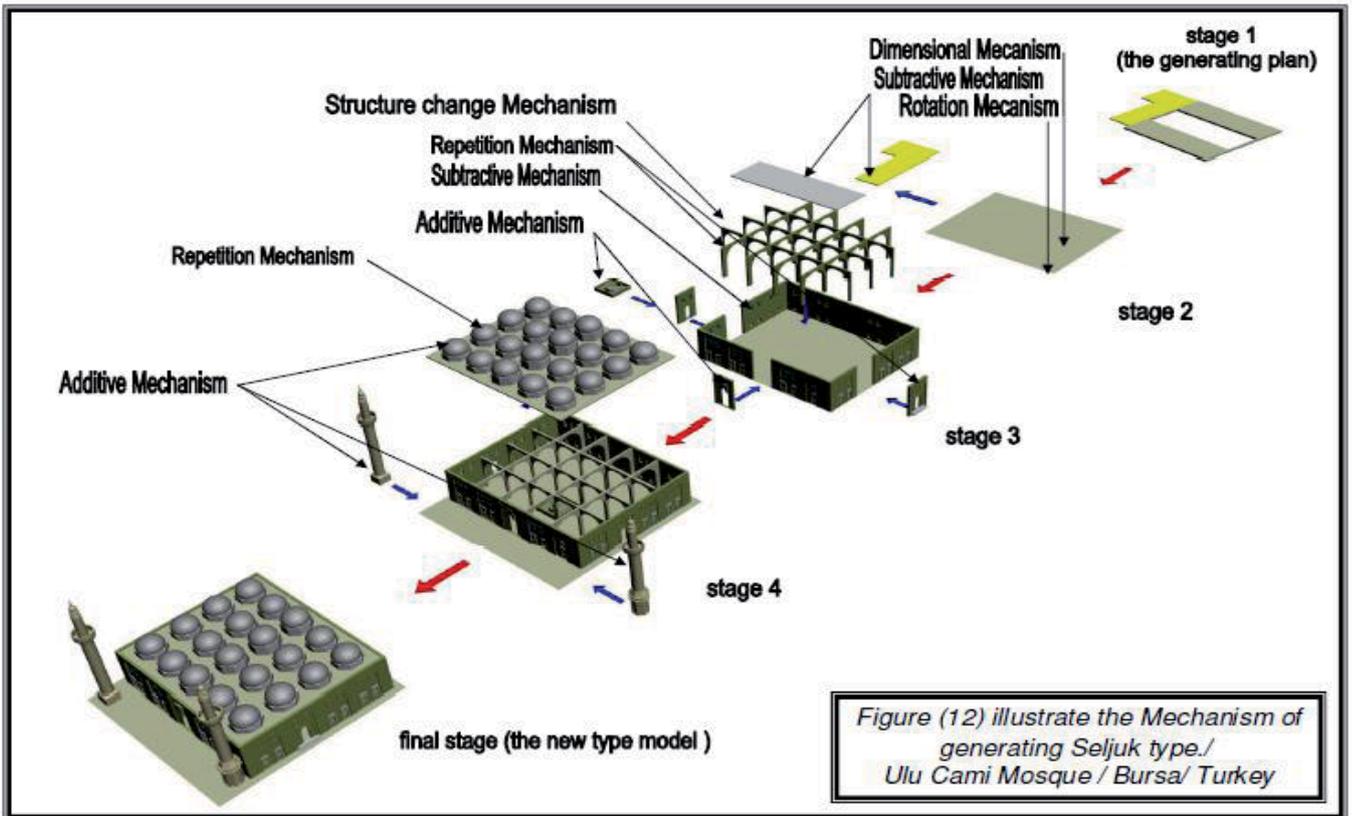
3-The final Mechanisms which used in all generation stages are (8 Mechanism) arranged in a gradually from the most used mechanism to the lower used mechanism as follows :

Additive Mechanism(%35.3), Repetition Mechanism(%25.6), Dimensional Mechanism(%9.7), Subtractive mechanism(%9.7), Structure Change Mechanism(%8.5), Rotation Mechanism(%6), Scale Mechanism(%2.4), Repetition& Scale Mechanism(%2.4).

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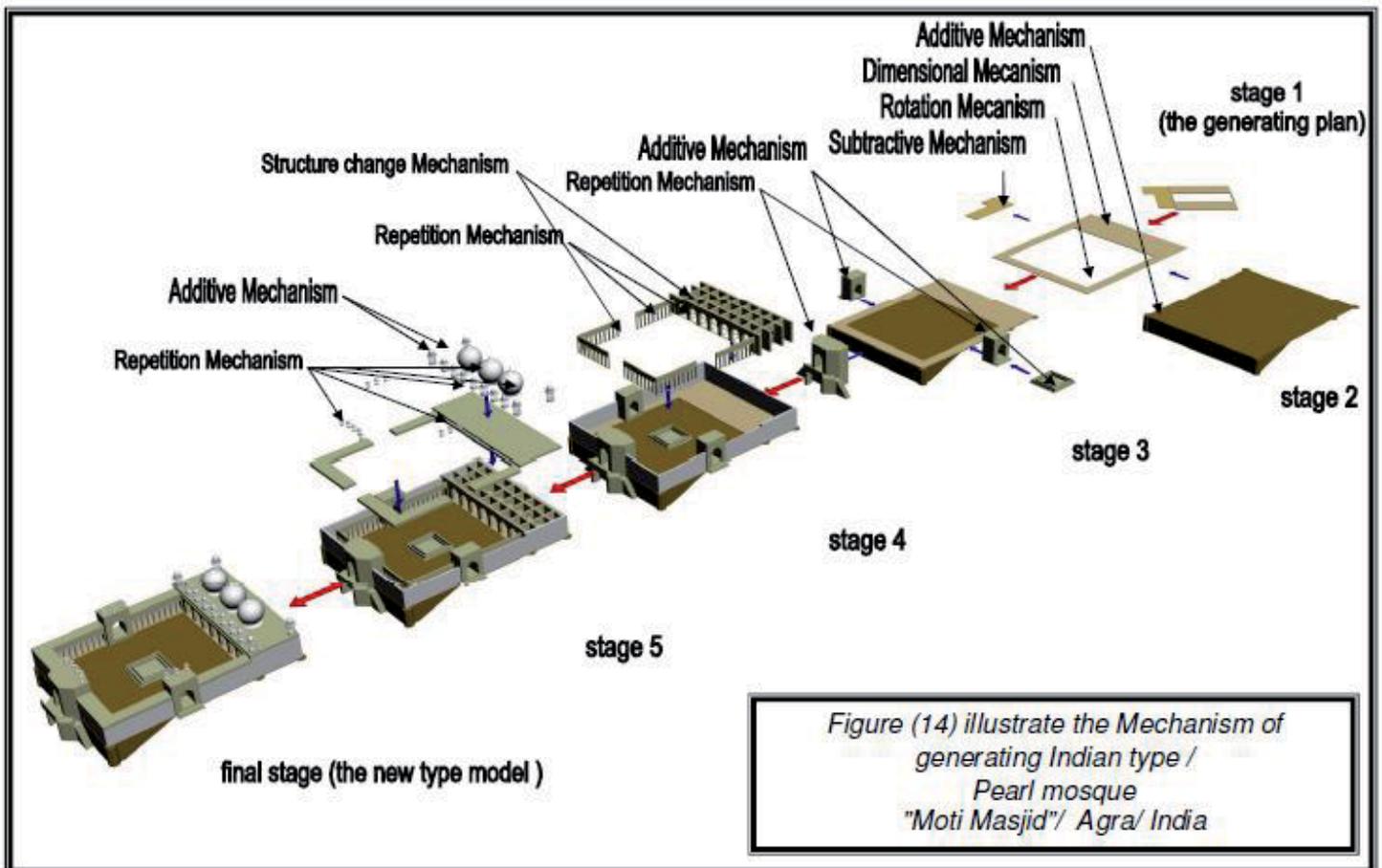


Table illustrate The Results of the Formal Analytic

Sample No.	Sample Name	Stage of Generating		Mechanism used in each Stage				General Notice			
		No.	Stage Name	No.	The Mechanism	Freq.	Affected Element				
1	Al Ummawi mosque	1	Generating the plan	1	Scale Mechanism	1	Size of the Plan				
				2	Rotation Mechanism	1	Direction of the Plan				
				3	Dimensional Mechanism	1	proportion & Shape of the plan				
				4	Subtractive mechanism	1	Rooms of prophet wife's				
		2	Generating the Walls & Structure	1	Structure Change Mechanism	1	Columns & Arches				
				2	Repetition Mechanism	1	Columns & Arches				
				3	Additive Mechanism	1	The Arch				
		3	Generating the Roofs & Minarets	1	Additive Mechanism	6	1)Gabled roof,2)The Minaret,3)Ablution fountain,4)treasury,5)Dome,6)Gabled				
				2	Repetition Mechanism	2	The Minarets				
		2	Al Shah mosque	1	Generating the plan	1	Dimensional Mechanism		2	1)Size& Shape of the Plan,2)Size& Shape of the Court	The study recognize it is a New Stage
2	Subtractive mechanism					1	Rooms of prophet wife's				
3	Rotation Mechanism					1	Direction of the Plan				
4	Additive Mechanism					2	The two Schools plan				
2	Generating the Four Eywans			1	Additive Mechanism	1	Eywan Element				
				2	Repetition Mechanism	2	Eywan Element				
3	Generating the general Components			1	Additive Mechanism	6	1)Entrance,2)The two schools,3)Arches& portico flanked right side the court,4)Arches& portico flanked left side the court,5)Front side flanked the court				
4	Generating the Roofs & Minarets			1	Structure Change Mechanism	1	at Dome				
				2	Additive Mechanism	1	The Minarets				
				3	Repetition& Scale Mechanism	2	The Domes& The Minarets				
				4	Repetition Mechanism	1	The Entrance Minaret				
3	Ulu jami mosque			1	Generating the plan	1	Dimensional Mechanism	1	Size& Shape of the Plan		
						2	Rotation Mechanism	1	Direction of the Plan		
		3	Subtractive mechanism			2	1)Rooms of prophet wife's,2)The Court				
		2	Generating the Walls & Structure	1	Structure Change Mechanism	1	Columns & Arches				
				2	Subtractive mechanism	1	The windows				

		3	Generating the Roofs & Minarets	3	Additive Mechanism	2	1)The Entrance,2)The Fountain			
				4	Repetition Mechanism	3	1)The Archs,2)The windows,3)The Entrance			
				1	Additive Mechanism	2	The Domes& The Minarets			
				2	Repetition Mechanism	2	The Domes& The Minarets			
				1	Scale Mechanism	1	Size of the Plan			
				2	Dimensional Mechanism	2	1)Shape of the plan,2)Shape of the Court			
4	Shah Zada mosqu	1	Generating the plan	2	Rotation Mechanism	1	Direction of the Plan			
				3	Subtractive mechanism	1	Rooms of prophet wife's			
				1	Structure Change Mechanism	2	1)The Great Pillars,2)Columns & Arches around the portico			
				2	Subtractive mechanism	1	The windows			
		2	Generating the Walls & Structure	3	Repetition Mechanism	2	1)The windows,2)the Arches			
				1	Structure Change Mechanism	1	1)The Dome			
				2	Additive Mechanism	3	1)The Minaret,2)The Entrance Gate,3)Ablution fountain			
		3	Generating the Roofs & Minarets	3	Repetition Mechanism	3	1)Domes,1)The Minaret,3)Gate			
				1	Additive Mechanism	1	The platform under the mosque			
				2	Subtractive mechanism	1	Rooms of prophet wife's			
		5	Pearl mosque	1	Generating the plan	3	Rotation Mechanism	1	Direction of the Plan	
						4	Dimensional Mechanism	2	1)Size& Shape of the Plan,2) the Court	
1	Additive Mechanism					2	1)The Gate,3)Ablution pool			
2	Repetition Mechanism					2	The Gate			
2	Generating the Four Eywans			1	Structure Change Mechanism	1	Columns & Arches			
				2	Repetition Mechanism	1	& Arches			
3	Generating the general Components			1	Additive Mechanism	2	1)Domes,2)Wall Towers			
				2	Repetition Mechanism	2	1)Domes,2)Wall Towers			
4	Generating the Roofs & WallsTowers			1	Additive Mechanism	2	1)Domes,2)Wall Towers			
				2	Repetition Mechanism	2	1)Domes,2)Wall Towers			
					No. of Generating Stages3-4		No. of Mechanism=8	82	Sum of Freq.	

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