TRACKING BACK THE PROGRESSION OF THE CITY FRAMEWORK'S PROTOTYPES UP TO THE ANCIENT CIVILIZATIONS

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Javeria Shaikh Hanyang University e-mail: <u>ar_javeria@hotmail.com</u>

Sugie Lee Hanyang University e-mail : sugielee@hanyang.ac.kr

Abstract

This paper examines the chronological history of the city framework in the ancient civilization where the grid pattern was used for human settlements. The grid is an orthogonal framework which is an innovative system in the history of urban morphology. In addition, it is an important algorithm in the practice of urban spatial engineering progressing along the entire history of urban planning. The most powerful characteristic of the urban grid framework is that it creates a foundational map amenable to producing efficient use of space. However, not much research was done about the primary origin and prototype of the urban grid system. This study illustrated that the origin of urban grid at the Indus Valley Civilization is related with the prototype of urban grid found in the Devil's mouth the first cave Rohri Hills, Pakistan. The methodological approach employed primarily the examination of the theoretical backg¬rounds and historical perspectives of the urban grid pattern through a comprehensive literature review. Secondly, we have conducted field surveys to examine and evaluate urban grid patterns in four Pakistani cities during the Late Paleolithic era. Our case study areas included Balochistan (Mehrgarh Civilization), Mohenjo Daro Indus Valley Civilization) and Rohri City at Sindh.

Despite the dominant use of grid system in the ancient cities as well as modern cities, urban scholars have not rigorously explored the prototypical origin of urban grid system in the history of urban morphology. This study has a potential to expand the understanding of the urban grid pattern during the pre-pottery period (cavemen period) of human history and make a significant contribution to research on the evolution of urban morphology in the history of human settlement.

Key words: Ancient Cities, Indus Valley Civilization, Space Syntax, Urban Morphology, City Framework

Theme: Historical Evolution of Built Form

Introduction

According to Conzen (2001) gridiron pattern is fixing lines and urban framework is fixing of an urban belt according to the water front line and fixing geometry for defining urban segments. The property is freewheeling market; this definition well defines Indus cities of Mohenjo Daro where the sites were designed according to the Indus River. Furthermore he defines city framework as morphology influenced and affected by the railroad and superhighway this second part of definition, defines the city frameworks after industrialization. The archeologist and historians, request the urban planners to systematically design the gridiron, due to its aftereffects in history, gridiron once embedded in urban mass after that it is difficult to revise for further change (Conzen 2001). Therefore this study is an important contribution to understand the after effects of historic city frameworks for future urban assessments.

The urban grid system has a long history, notably; the colonial Greek city of Miletus was rebuilt on a grid system around BC 479 by the first recorded town planner Hippodamus. It is well known that the Greek orthogonal planning tradition was influenced by ancient civilizations such as Egypt and Mesopotamia. However, much earlier prototype of grid system has been found in ancient cities such as Mohenjo Daro in the Indus Valley civilization. A few scholars have tried to identify the original location of urban grid system in the history of human being (Stanislayski, 1946; Rose-Redwood, 2008). Since they focused on whether urban grid system had been appeared in the multiple locations at the same time, they did not address the prototype of urban grid and its origin.

Hillier (1999) indicates that the good space is space that is used by people, and that urban spaces have been shaped by movement patterns. He also argued that the urban grid pattern creates a space with efficient movement patterns and the combination of the urban grid and these patterns creates a multiplier effect that results in distinct land use patterns and building densities. In addition, the surrounding land uses and buildings themselves are influenced by the grid and movement patterns. In other words, it is these patterns that give cities their structural characteristics. With practical approach as an objective the prototypical grid was devised as an ordering system and urban functions for interactive behaviors. tries to connect the evolution of urban grid system from the cavemanfor the urban grid pattern till late Paleolithic in Mohenjo Daro.

Literature Review

This study conducted a comprehensive literature review to examine the theoretical backgrounds and historical perspectives with regard to the grid system. Primarily, grid provides space organization and content management and it facilitated time and cost management along with the efficient function of the grid. Syntactically it provides positional, proportional, divisional, and sequential morphology. Moreover grid is a kind of module for a semantic space division and hierarchical plan.

On one hand, the morphology is the relations between different components of urban characteristics described by Hillier (2012) as a movement which could be described as an arrangement of alignments, and the urban grid which supplements the distribution of land uses, and built form densities in the historically evolving city. Rose-Redwood (2008) argued that the grid made several coincidental comebacks. The historians predicts that the grid plan was exported from Mohenjodaro to Greece, through anonymous travelers. Urban grid system in Mohenjo Daro is as precise as New York. The right angle and the Pythagoras theorem was a

natural characteristics related to the city planning for the Hellenistic way of usage for the orthogonal plan (Higgins, 2009).

The study identifies the origin of urban grid system which is a longitudinal temporal research it is constructed on retrogressive model, using the determinants derived from literature review. There is an illustration of possible linkage between cavemen in the Stone Age and urban grid system in the Indus Valley Civilization. This research makes a significant contribution about the evolution of urban grid system in the history of urban morphology.

Methodological Approach

For testing cases a tool as a research model to analyze individually five morphological studies, which occur in the temporal span of time in a chronologically longitudinal way. A cross-sectional research method is applied on this retrogressive diagram, which is to study the earlier first and the older latter and eventually arriving at the origin of the urban grid system respectively. Here in this paper there is an answer for Dan Stanislayski's quest, the archeological evidence have found further primary resource which leads to a further earlier in longitudinal temporal session, the onetime invention of the grid, this is at Rakas jo Rohro, and Shadee Shaheed Rohri Hills and Lusbella hills cave city 10,000 BC. Here the prototype for the gird urban planning for Mohenjo Daro and Harrappa is suggested to be the orthogonal grid plan for the Seven Caves at Kai, (10,000 BC)

On the other hand our research methods consent with the argument presented by Rose-Redwood (2008) he suggested grid is not a platonic ideal nor it is an eternal form, it is just resemblance of geometry, grid is a misnomer for a variety of morphologies varying from rectilinear blocks to, radial curvilinear or less rigid forms. It cannot be confused with an unbroken tradition. He recommends to recognize the underlying conflicts under the surface of homogeneous appearance of grids then a critical analysis for predictability of spaces is needed rather than fancying the finished product. Grid is a partition; the origin pinpointing for grid is already abandoned grid has no identity. Even then we decided to trace back the prototype for the origin of the grid.

Ancient cities were planned on the basis of urban morphology and they followed common sense notions for urban girds, Michael Smith (2007). As Spiro Kostof (1993) is one of the few scholars to use the term *grid lay out*, which referred to orthogonal planning, that the earliest city in the Middle East Jericho (8000-6000 B.C). Later, on the other advanced civilization arose along the Nile in Egypt and in Mesopotamia along the Tigris and the Euphrates; these towns were also planned on doctrinaire orthogonal grid systems.

Analysis based on Conceptual framework

The mixed used overlap in form of semi lattice (jointed) in cases of Rakas jo Roon the first and second, compared to tree diagram (disjointed) C. Alexander (1966) as shown in case of Mohenjo Daro. Mohenjo Daro does not represent the earliest settlement of this people; the grid city is completely planned and established as a unit. We can therefore, postulate that the ancestors of the people inhabiting Mohenjo Daro had a long history of social organization in this region or elsewhere. The clue was found in the precise cave architecture as shown below

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Nature as Configuration of grid system in ancient cities

Diagram one : Conceptual frame work the determinants of grid configuration

The literature review defines orthogonal grid, by synthesis of five different determinants of urban grid system, which are firstly 'circulation of people', secondly 'and and then 'division of space on equal basis' and finally alignment and geometry and the geometrical components of the grid, are right angles and straight lines. Moreover, the conceptual framework is designed as shown in diagram one, to analyse individually three morphological studies, which occur in the temporal span of time in a chronologically longitudinal way. A cross-sectional research method is also applied on this retrogressive diagram, which is to study the earlier first and the older latter and eventually arriving at the origin of the urban grid system respectively.

Case Study

Justifying that the grid plan is the most modern as well as the most primitive type of approach towards urban morphology, this study focuses on Mohenjo Daro BC 3000) which is inferred here as today's most primitive type of approach towards orthogonal grid plan. Then, there is analysis of the ancient city of Mehargarh (BC 7000) located at the eastern Baluchistan area, which is contemporary to the Neolithic site of Çatalhöyük (BC 7500), Turkey. Finally, the Paleolithic sites of Gundrani Caves Lusbella, and Rohri Hills, Shadee Shaheed *Rakas jo Rohro*; Seven caves at Sehwan which showed prehistoric initiative towards the grid system.

The overall satellite map indicated in the following figure 1 are outstanding remains of ancient city which marked an important primeval stage for the grand era of man's first endeavor, his integral rise, his phenomenal fall and the great existence of city scape. Mohenjo Daro was not built casually (pattern less, ill formed, irregularities as a product of individual response towards growth). The precision is not accidental but rather a concept design to house highly urban natives. The parallel straight streets was an organic city, with trained, skilled organized people, they had a long history of using grids. Creel 1400 BC China was following an Assyria capital 800BC then the Hippodamus applied gridiron pattern in Greek. Though it looks disconnected but in reality it's not, Mohenjo Daro plan, was been used all over Indus Area before Christ grid is an outcome of evolution, where a lot of thinkers helped it evolved over centuries and they exported this idea to upcoming planned cities. This paper in continuation, with Stanislawski (1946) efforts finds a link earlier then Mohenjo Daro as a prototype for the grid plan, Mehargarh (7000 BC) was designed on orthogonal grid system as shown in figure 3.



Figure 1: shows the urban morphological pattern of Mohenjodaro, white represents the unearthed areas, the main two parallel streets are 10 meters wide runs east west. This means mid-day the sun light is coming onto the street at 10 clock.



Tree like planned city: Mohenjo Daro Depth map

Figure 2: SD Area plan, Further excavation at mohenjo daro, page I, Being an official account at Mohenjo Daro carried out by the government of Indua between the years 1927 and 1931, by, E.J Mackay, M.A, D. Litt, FSA late special officer for exploration, Archeological survey of India, with Chapters by A.S Hemmy, B.A M.Sc and by B.S. Guha, Ph.D. and P.C. Basu, M.Sc, M.B., volume II, Plates I- CXLVI, published by the Manager of publication, Dehli, printed in New Dehli, 1937.

Note: The bellow grid pattern shows the structure which is sandwich between Stupa and Great Bath, Marshall discovered the Great Bath and many other structures which prompted Ernest Mackay to speak

later of a "community of priests" from his documentary, and the bellow map has been re traced, to explain the grid pattern. Describing a "priest's bath" north of the Great Bath, Mackay wrote enthusiastically: "This Bathing establishment is one of the most interesting building unearthed at Mohenjo Daro and affords much room for speculation... Most probably bathing was a religious duty, as with most Indians today and I am inclined to regard the bathrooms in Block 6 (shown under in figure 2, flanking the Great Bath) as provided for the members of some kind of priesthood. This priestly community lived, I imagine, in rooms above the bathrooms, to which they descended at stated hours to perform the prescribed washing. (this space is orthogonally designed on strict grid pattern as shown under, in the upper part of the traced diagram of this described building). Possibly they were monks or ascetics who occupied this building, and they kept themselves apart from the world: the extreme narrowness of the door ways of the bathrooms ensured the utmost privacy... the narrow passages between the bathrooms was probably only used by the servants whose duty it was to provide each room with water from the nearby well. (as shown in the diagram, left side is the passage, and upper part represents the bathroom). (Mackay. E. 1938 page number 20) cf. Plate. 23-28)



Case Study: Sath Ghariyoon

Figure 3 : Tree like form for the first planned city, The site map from Google earth, with section of the site for the caves. Accessed on 15 January 2013

Note: The axial grid provides space organization and content management and it facilitated time and cost

management along with the efficient function of the axial pattern. Syntactically it provides positional, proportional, divisional, and sequential morphology. Hillier, (1999). This phenomenal concept could be seen in the primitive habitat of caveman

Rakas jo Rohro 1st:

Archeologist and architects have identifies several theories that qualifies an ancient city as a capital city. Hence the first groups of Indus flint quarries were discovered in 1986 near Shrine of Shadee Shaheed (Figure. 4) by Paolo Biagi, (1991) at Rohri Hills and this represented the most intriguing and complex extractive zone. Hence the site of Devil mouth the first, present at this located, could be habitat for these business man who were sculpting these stones, and exporting them





Figure 4: Semi lattice form, abov for the naturally growing city along the fringe belt. section of Rakas jo Rohro. Figure 6: Google earth, Shadee Shaheed site drawn on 4th February 2013

The study examines the role of grid according to the topographical constraints (contextual sectional geographical-analysis); since the grid was used at Devils Mouth the first and second (*Rakas jo Roon*), in a totally reverse way that it provide complete closure against the threat from wild animal at the same time facilitating hierarchical places for classes.



Figure 5: Sath gharioyn grid plan according to the North orientation and multi layer grids

Notes: The rock of Sindh: غارون لـڳ لڪيءَ ۽ سـيوهڻ during 60's Mr. Taj Sehrai, found seven caves at Kai, though there has not yet been any tools, from Stone Age, all seven caves are very close to each other,

hence it could be inferred that the people occupying these caves would have been attached in a social relationship of a clan, only last one is slightly away, which could be a storage space. The entrance for the cave is very shallow, only 3 feet wide, this represents, that it is due to the factor of external fear, which is wild beasts. The bigger chambers, where smaller and were dived further earlier, but when the population of this particular urban settlements reached more than 70 inhabitants, then the urban morphology was revised and the internal chamber, was expended by demolishing the dividing wall, though to support the structure they kept a column to support the ceiling of the structure. أي المنافية عنه المنافية عنه المنافية المنافية



The grid above shows the orthogonal organization, to carve out the caves by applying grid modern patterns are already visible, and city starts as an organism or organic growth in form of the primitive city flourishing10,000 years ago, in the area of Lake Manchar.



6:00 AM on 21 June 10,000 B.C,





11:00 AM on 21st June 10,000 B.C. 3:00 PM on 21 June 10,000 B.C.

Figure 6: the cerography shows how the light is entered the from the openings of the cave, at 6 in the morning then 11, and 3, the sun time.



Picture taken at 5:00 PM on 9 February 2013

The well calculates, geometrical, and proportionate, architectural feature; represent in the (figure 3- 6) represents the understanding of the cave dweller intellectual capability and precision of spatial configuration. Moreover the 1:2 rectangular proportions for the room, and the 45 degree parallel with North, show the high precisions of urban design for this earliest city.



Figure 7: the Devil Mouth the 1st or Rakas jo Rohro first

The *formal grid* in history refers to cities whose organizational principals are legible to an urban planner's observation, as Nancy Steinhardst (1999) phrases it "clearly articulated and directed space". Thus as clearly articulated as Mohenjo Daro, there exist much more primitive habitat from earlier, stage of evolution at Kai, where a set of seven cave; these are directed space as well as highly clearly articulated as described in figure seven. The stone implements belonging to upper Paleolithic period around 30,000 BC, there are more similar caves at Rohri Hills (the case study of this area is analysed in figure ten). In the lower Indus Valley, this is the region where the cave architecture and cave communal compact dwelling earliest urban forms are formulated, this consist of the tubular compact city, of Shahdee Shaheed Rohri hills.

Table 1: Radiation penetration on the longest day for Kai

In the morning the radiation is maximum, hence the grid is designed to bring in light in the morning time.

	-										
		Readings on 21 st JUNE									
Elevation	Glazed Area (m^2)	Timings	Wall Azimuth	Altitude	Solar Azimuth	Wall Solar Azimuth	Angle of Incidence	Direct Rad. 850 W/m2	Direct Rad. through Window	Diffused Rad. 350 W/m2	Total Radiation
East	2	6:00 AM	90	13	70	20.00	0.92	778.27	1167.40	525.00	1692.40
	2	7:00 AM	90	25	77	13.00	0.88	750.62	1125.93	525.00	1650.93
	2	8:00 AM	90	39	85	5.00	0.77	658.06	987.09	525.00	1512.09
	2	9:00 AM	90	51	90	0.00	0.63	534.92	802.38	525.00	1327.38
	2	10:00 AM	90	63	101	11.00	0.45	378.80	568.20	525.00	1093.20
	2	11:00 AM	90	75	120	30.00	0.22	190.52	285.78	525.00	810.78
	2	12:00 PM	90	82	180	90.00	0.00	0.00	0.00	525.00	525.00
	2	1:00 PM	90	75	240	90.00	0.00	0.00	0.00	525.00	525.00
	2	2:00 PM	90	63	259	90.00	0.00	0.00	0.00	525.00	525.00
	2	3:00 PM	90	51	270	90.00	0.00	0.00	0.00	525.00	525.00
	2	4:00 PM	90	39	275	90.00	0.00	0.00	0.00	525.00	525.00
	2	5:00 PM	90	25	283	90.00	0.00	0.00	0.00	525.00	525.00
	2	6:00 PM	90	13	290	90.00	0.00	0.00	0.00	525.00	525.00
									4936.79	6825.00	11761.79

Kai Seven Cave Radiation for the 22nd June 10000BC

Total Radiation



Graph one: shows that the cave town at Kai, is planned to bring in light early morning, till 11, after the mid day the direct sun light does not enter the caves.



Graph two: shows that the cave town at Shahdee Shaheed, is planned to bring in light early morning, after 9:00, till the mid-day the direct sun light enter the caves though the Devil's Mouth Entrance then again reduces towards 6:00pm evening, hence the entire curve is symmetrical and highest in the middle

Table 2: Radiation penetration on the longest day for Shahdee Shaheed Devil's Mouth the first.This cave is designed introverted; it's a semi lattice and naturally growing cave.

			21 st JU								
Elevation	Glazed Area (m^2)	Timings	Wall Azimuth	Altitude	Solar Azimuth	Wall Solar Azimuth	Angle of Incidence	Direct Rad. 850 W/m2	Direct Rad. through Window	Diffused Rad. 350 W/m2	Total Radiation
	1.1	6:00 AM	180	13	70	90.00	0.00	0.00	0.00	288.75	288.75
South	1.1	7:00 AM	180	25	77	90.00	0.00	0.00	0.00	288.75	288.75
	1.1	8:00 AM	180	39	85	90.00	0.00	0.00	0.00	288.75	288.75
	1.1	9:00 AM	180	51	90	90.00	0.00	0.00	0.00	288.75	288.75
	1.1	10:00 AM	180	63	101	79.00	0.09	73.63	60.75	288.75	349.50
	1.1	11:00 AM	180	75	120	60.00	0.13	110.00	90.75	288.75	379.50
	1.1	12:00 PM	180	82	180	0.00	0.14	118.30	97.60	288.75	386.35
	1.1	1:00 PM	180	75	240	60.00	0.13	110.00	90.75	288.75	379.50
	1.1	2:00 PM	180	63	259	79.00	0.09	73.63	60.75	288.75	349.50
	1.1	3:00 PM	180	51	270	90.00	0.00	0.00	0.00	288.75	288.75
	1.1	4:00 PM	180	39	275	90.00	0.00	0.00	0.00	288.75	288.75
	1.1	5:00 PM	180	25	283	90.00	0.00	0.00	0.00	288.75	288.75
	1.1	6:00 PM	180	13	290	90.00	0.00	0.00	0.00	288.75	288.75
						0.00		485.56	400.58	3753.75	4154.33

Calculation of the sun light

This research calculations on the longest day of the year i.e. June 22nd 10,000 years ago these calculations were subject to the orientations of the building. The following formula can be used for radiation calculations.

 $\cos(\theta) = \cos(A) \times \cos(WSA)$

Where,

A = Angle of Altitude* and

WSA = Wall Solar Azimuth**

The angular positions for different degrees of radiation can be given as below:

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For maximum radiation:

А	=	0°	(For North Orientation)
WSA	=	0°	(For North Orientation)

And for minimum radiation:

А	=	90°	(For East Orientation)
WSA	=	90° (F	or East Orientation)

To measure the angle of the sun in its motion across the sky, we need to take its altitude and azimuth reading².

*Altitude is the angular distance above the horizon measured perpendicularly to the horizon. It has a maximum value of 90° at the zenith, which is the point overhead.

**Azimuth the angular distance measured along the horizon in a clockwise direction. The number of degrees along the horizon corresponds to the compass direction. Azimuth starts from exactly north, at 0 degrees, and increases clockwise

Synthesis

Research by Archeologist and architects have identifies several theories that qualifies cave ancient settlements as capital cities. The first groups of Indus flint quarries were discovered in 1986 near Shrine of Shadee Shaheed by Paolo Biagi(1991) at Rohri Hills and this represented the most intriguing and complex extractive zone. Hence the site of Devil mouth the first, present at this location was habitat for these business men (hunters and gatherers) who were sculpting these stones, and exporting them to far regions. The axial tubular compact settlement of *Rakas jo Rohro* shows the prototypical origins of the primitive grid plan, which was naturally a semilattice planned city as shown in Figure 4 and 7 (along physical nature, alignment with sun movement, wind, river flow and hill as a fringe belt). On the contrary Mohenjo Daro and Seven Caves are tree like based on segregation phenomena. Designs based on the human instinct of growth, connectivity, security and contextual orientation requirements according to wind and sun which act as fringe belts according to the Cozenian theory).

Conclusion

The global ancestor Homo knew anything that drops falls straight (gravitation law), he understood the geometry is a theory of space, and he figured out that the space is defined by order of lines and angles, and in terms of urban morphology, the simplest way of making order is to have horizontal and vertical coordinated in orthogonal relationship. Cave man applied this entire theorem at the Seven Caves at Kai, Gundrani Cave and the Devil mouth the first.

Ihe Devilew anything thatConclusively, this paper proves movement patterns of people, public and private segregations planned over the grids. Moreover orientation needs according to sun, resulted in the geometrical patterns for urban morphology and finally the most natural inherit need which is security, are determinant and precedents of grid pattern since late Stone Age which is otherwise credited to modern philosophy.

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Software used

DEPTH MAP

Google Earth

Google Sketchup