Complexity as a mechanism to reconstruct the urban pattern of the Iraqi marshes in the ancient city of Ur and marsh villages

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ABSTRACT

This research deals with the characteristics of life complexity which was found by Christopher Alexander and used in the process of measuring and comparing to find the Common physical properties of the architectural shape between the ancient city of Ur and the marsh cottages, according to this, the measuring factors for these characteristics were developed through the table related to it to create the complex sample which eventually reflects the natural characteristics of the pattern language shared between Ur as urban dueling and the cottages of the marshes as a natural environment through the assumption that there is a similarity of the fractal scale between the physical blocks of Ur and the marsh village cottages due to the use of the same scale material shared between them. The measurement was the association of the Sumerian human scale with the reed plant's scale in the fractal triangular style and hexagonal fractal style and the factor (2.7mm) and according to the practical proofs and experiments. The difference in measurements between reed knots is equal to this number and around it. The architectural scales resulted from these measurements associated with civilizations, including Ur civilization's ancient city from the smallest scale to the smallest tool in it to the largest building used in the ziggurats. It was essentially a result of the development of complex environmental patterns. In the fine, the research has some conclusions and recommendations.

Keywords: The pattern language, Complexity, Interconnection, Fractal, Traditional Construction

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1.   Introduction

In the triangular area surrounded by Emarah city in Missan prefecture, the Southern Iraqi marshes in the triangular area, Nasiriya in Thi–Qar prefecture, and Basrah city are considered a natural environment and breathtaking beauty created by nature with the help of local people living in this area. Those people made in high craftsmanship the beautiful marsh cottages since the beginning of civilization in this area where the archaeological finds prove the beautiful symmetries between the art of building a cottage and its decoration made of reed and the shapes of districts reed and papyrus planted around it and the decorations found on the Sumerian tools. As shown in figure 1 (Muhammad 2018 page 1) and according to Alexander's theory, the analyses of complexity states that traditional regional depends on the adaptation, the climate, the community, and the people's culture [1]. This culture from which the traditional decoration the tools and things made despite their local symmetries lacks the organized structure according to scales that lead to its complexity according to an organized style. Therefore, this research depends on the characteristics of complexity put by Alexander Christopher to illustrate the nature and the extent of the relation between the marsh cottages and the environment around them and the residential fabric of the ancient city of Ur from the shape and environmental sides to find the complex patterns. Considering that the marsh area is located in the region of the Tigris- Euphrates river system (also known as Mesopotamia), which is found in the books of history referred to as Aden paradise.

Figure 1. The embroidering (decorations) similarities between reed embroidering on cottages and the embroidering found on the shapes of tools made by the Sumerians [2]

There is a shortage of knowledge in illustrating the connection between the characteristics of the urban patterns' complexity in the historical Sumerian environment represented by Ur's ancient city with the marsh areas' cottages' complex characteristics. The research hypothesis is that the Iraqi marsh area's urban environmental patterns have complex fractal characteristics on which the complex patterns in the historic urban environments. (The ancient city of Ur) [3]. The pattern is considered one of the designing tools needed to solve a designing problem. This problem is repeated in our environment at different ages then it describes the basic solution of the problem in a way that the solution can be used different times without using it in the same way twice [4] as for the language of the pattern when called more than one pattern to solve a specific designing problem (some patterns may interlock to provide suitable solutions for the designing problems. Between these patterns, there are connectors to judge the selection process. A pattern language is a collection between the selected patterns and their connectors. Alexander considers these connectors in the net of patterns more important than the patterns themselves [5]. The complexity concept in architecture by Phentory is the combination of the essence of the idea in its core and its appearance. The delicate feeling towards the natural things and the shapes close to the handmade crafts reflects energy from its surroundings and the style used in building. In addition to the simplicity of its inner beauty, it is a means to find complex architecture. Simplicity may be a means to reach a type of art characterized by a kind of complexity [6]. Jencks [7] concentrated on organizing and organizing as a scale of complexity between the geometrical and living shapes whenever organizing increases, no organizing also increases. This study mentioned the sources of the theory of complexity (the chaos theory) in mathematics, considering that chaos and determinism are natural environments. Salingaros [1] used the complex sample to estimate the living in a building and the quantity that measures the visual information organization and said that the sample was built on comparing with thermal physics processes.

The term complexity was found from the similarity with biological shapes; whether organized or not, organized stands on biology with the old positive advantages. There is not a thing organized 100%, and it follows a vital system as a simple mathematical equation based on considerations of the nature of life structure. No matter how primitive it is but it leads to kinds of absolute results. In later analyses, it is evident that it can measure the potential life levels in architecture [1], [8]. The study dealt with two areas. The first is southern Iraq's marshes as a natural area; reed cottages were built on it. It is a group of shallow water areas covering the low lands in the south of Iraq; its water comes from the two great rivers, the Tigris and the Euphrates, surrounded by desert lands [9]–[11]. A triangular area, the cities of Emarah, Nasreyah, and Basrah are on their heads; these lands expand in the flood time in winter and spring and shrink in summer. The Arabs named these lands ALBATAEH for water quantity in them [12]. Migrating birds from the source of wealth in these marshes; these marsh woods formed from reed and papyrus form the best nesting areas for birds (the reed and papyrus plants provide food for all living creatures in the marshes) in addition to the livestock (cows, buffalos, and sheep) and fish industry. Though it is considered a wealthy area, it is the place where Mesopotamia flourished, where the ancient cities of (ALWARKAA, AREEDO, and Ur) in addition to the sank places underwater) some of these cities survived for more than 2000 years. The most important reason for their survival was plenty of marsh waters. In addition to these cities' economic roles, they were places where art, writing, literature, music, architecture, and poetry flourished. For some periods, these areas left humanity a bright history filled with Sumerian writings like the Gilgamesh epic [13]. This study's second area is the ancient city of Ur to show the extent of the connection between the two areas taken in this study according to the characteristics of complexity mentioned above.

1.1. The fractal style

The fractal is considered an organizational mechanism that plays a vital role in sensory perception. Most modern evolutionary biology parts accept that evolution depends on natural environment geometry; therefore, it is allied by the morphological and biological environment [14]. Large ancient buildings and common architecture (popular architecture) worldwide have a similarity in mathematics. Each one of these is the fractal structure, which can be recognized in all magnification levels and between different levels where a strong connection is available in the organization [15].

The fractal appears in the following levels:
1. Buildings that complexity appears in every magnification edges and connections either be perforated or complex, not homogeneous.
2. The fractal has a connective structure on different levels. The ancient cities are organized in good shape in every magnification, while in new cities, see this organization on one level only.

3. When urban areas interact, they are complex like a snaky river or a curved curtain (the edge of the building embraces the space nearby where a kind of fractal appears). This curve is the result of natural forces of the urban areas, for example, parts of the buildings that appear on the pavement.

(the pavement that goes along a river) Alternatively, single small buildings built on edges of rivers that are in a natural shape despite the apparent danger for general places it appears that they represent the natural development of edges, any kind more stable. Salingaros, [16] and according to levels above, the fractal structures' scales are evident widely in small scales as ladders and building materials [15].

Living natural structures, as in traditional architecture, are fractal structures they are evident in traditional and environmental architecture (if take silk and allow pressure on it, the silk will be complicated to form fractal boundaries with more than one distance). The distance is more than one line because it fills the area with waves. The distance will be more than 1 or equal to 2 when the waves occupy the whole area [15]; when it has been pulled from the two sides, the silk will form small shapes aligned on its length as shown in figure 2.
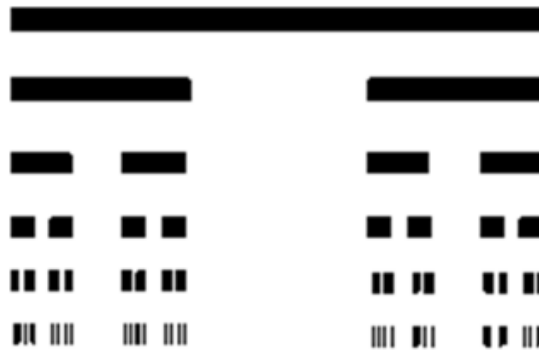

Figure 2. The fractal resulted from erecting silk [17]

As for curves and circles and broken lines, the fractal from the math space's geometric repetition's repeated functions can be found. The frequent fractal system mostly comes from strong tools that may become the fractal generator; therefore, frequent fractal system gives us a connection between the fractal and the natural picture. It is the result of pressing and bending [18].
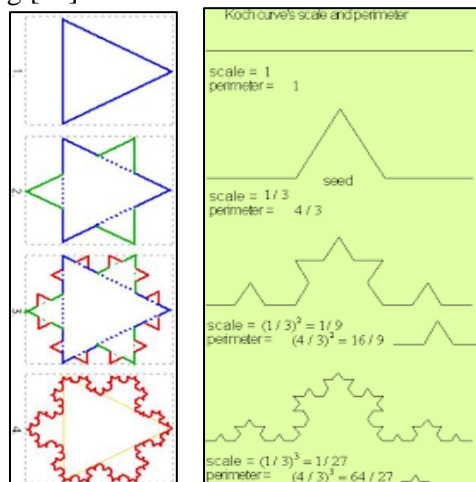

Figure 3. The way of breaking into pieces, the Hexagon and triple resulted from the straight line in the fractal style [19]

### 1.2. The characteristics of the complex urban system

Some architecture engineers lately found the need for plants and nature. However, the Biophilic connection to unify the theory of constructions with humans and nature not evident in total until now for the profession of architectural engineering but the continuity of tests and the negativity of the architectural theories and the results of studies on animals revealed an alternating preference for the complex life data regularly; therefore they are not agreed upon, but other new experiments proved using monitoring devices for the body and its high preference to organized complexity Their bodies relived instead of them, and they revealed that environmental

responsibility is innate. It is separated from personal preferences that appeal to us, not necessarily good for us. When differentiation between buildings and the spaces that own life characteristics and those lack them several examples were available for the researcher on which found the fifteenth characteristics well benefit from to understand the phenomena of life which pushed us to a different studying for the ancient buildings since the dawn of civilization up to the twentieth century [1]. These characteristics may be evident in a large or small way, but there are ancient times environmental places that need to distinguish a feature from another. These characteristics are levels of scales, strong centers, boundaries, alternating repetition, positive space, good shape, local symmetries, deep interlock and ambiguity, contrast, gradients, roughness, echoes, the void, simplicity, and inner calm, not separateness [1]. Table (1) illustrates the markers of these characteristics and their measuring way.

Table 1. way to measure the fifteenth characteristics of the research

Properties of complexity	Definition	General characteristics indicators	The scale of candidate properties
Levels of scales	Apply the scales, repeat and grade them according to humans' moral and material needs through Fibonacci retracement 2,7=0 logarithmic follow or gold ratio of the human sense of psychological and visual comfort.	Moral and material characteristics for humans contain these moral scales.it forms an environment the core of the biological structure from the side of the scale	Diversity by scale
Strong centers	Centers of knowledge hierarchy in the scale between them carries inner knowledge meanings.	Carries formative and moral characteristics resulted from grading	
Boundaries	Carries material meanings to identify the implicit centers, locate them materially and define them from the meaning side.	Its material characteristics give meaning to its neighbors	The contrast between the height and the boundaries around it resulted from the grading in height
Alternating repetition	Alternating repetition consolidates alternative repeated elements and locates them in a better way.	It is beyond monotony and boredom in shape and measure	Alternating ln appearance and disappearance of selected items
Positive space	The area of the void and its shape and the psychological and environmental comfort provided the perception of the surrounding environment.	Perception characteristics (the meaning of the environmental void)	The contrast between the height of the void and the borders surrounding it is the result of the gradients in heights
Good shape	The good shape standard is to perceive it easily through symmetries that lessens the information with a comma between the corresponding shapes.	the simplicity of perception so as not to bother the mental calculating mechanism	Repeated elements and relations within the designs and facials.

Properties of complexity	Definition	General characteristics indicators	The scale of candidate properties
Local symmetries	There is a hierarchy of gradients with repetition and symmetries on the shape; it means that the shape is reserved when the scale turns big or small.	The characteristics of the complex organic structure that it owns implicit hierarchy symmetries.	Diversity by scale
Deep interlock and ambiguity	The sudden breakthrough between two things with the relativity of the area interacted with them.	The interlock characteristic generates the ambiguity in the interacted area's relation to generating the shapes' connection.	The number and kind of the interlocks
Contrast	Contrast is important to distinguish the neighboring units	Contrast consolidates relativity	Similarities and differences in shape and scale.
Roughness	Roughness in geometrical structure breaks symmetries and total organization; it makes condition with the domestic circumstances.	Rough touch helps in thermal change because it creates shaded structures and losses in shape.	The number of structures and losses and shadow and light sequences.
Gradients	Gradient within the model with the feeling of the traveling person in the change from one level to the other	Carries structural properties	career
Echoes	Echoes are two types; the first is a result of transitional symmetries, and the other is the result of symmetries on the scale.	The characteristic of symmetries of shape and the gradients on the scale.	Diversity by scale
The void	The fractal's greater scale remains empty; the blocks concentrate within the small scales that enclose the larger scale to define boundaries and create a balance between the void and the block.	The balanced characteristic within the scales gives us the feeling of embracing the void.	Diversity by scale
Simplicity and inner calm	Created by symmetries in shapes to simplify and limit information to make a solid design though it is firmly complex	Complexity is the result of solid and simple design for the low information symmetries of shapes resulted from the repetition of information.	The lowest scale of shapes and elements
Not separateness	The solidity between shape and boundaries causes a shape to be connected as possible with its environment. Nothing attracts attention for itself only.	The characteristic of solidity between shapes and their environment resulted in not - separateness.	Elements, repetition similarity with gradients, and information between the shape and its boundaries
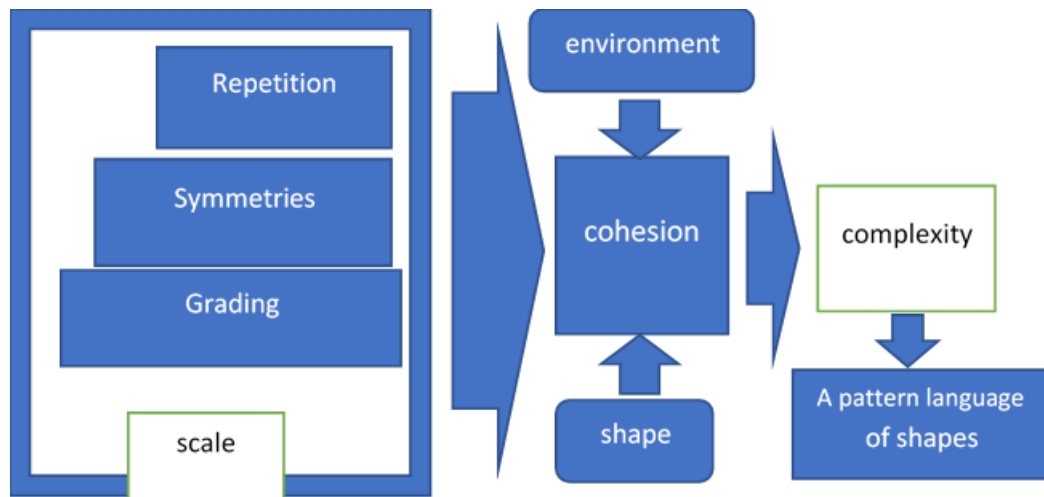
Scheme 1. The results of the above table

2. The practical study

This study is about two samples.

2.1. Cottages of the Marshes

These cottages are the houses of the people living on the marshes. These houses are built from reed and papyrus on small islands in the marshes formed from a dense spot of reed, and papyrus stands on the water of the marsh and can support the whole house (a colony of reed and papyrus in the marsh) called in the marsh areas (AL-CHIBAYESH, Al-.CHIBSHA or Al-TEHILLAH) attached to plants and weeds, these islands float on the water. It is as if reed and water represent life in the marshes and one of the secrets of this.

Figure 4. the presence of cottages drawings in Gilgamesh epic in ancient history

That goes deep into the past. The northern, western wind moves AL-CHIPSHAT towards the marshes in Iran, and the southern-eastern wind moves it towards the Iraqi marshes. Most tales, stories, and legends were written about it in Gilgamesh's epic. It is noticed that there is an arched structure of reed embroidered on the Sumerian tablets, as shown in figure 4. The people of these areas tend to break the reed and papyrus and turn it on each other. They add Al shill (dry dust with weeds) not more than half a meter above the water surface on this platform they build their cottage, which consists of large bunches of reed called al Shibbab (building columns) their base is larger than their top to help stand easily, tided firmly with ropes made of reeds and papyrus, these Shibbabs are put in opposite pits then they are bent and tied with each other to form arches to hold the reed mats. These pillars are tied together. Their length is related to the length of the cottage. The number is 5 for a small cottage to 31 for a guest's room. A buckle of reeds and a small door are made for the front of the cottage, the corner is called (ALLOTHAH), and the end of the cottage is called (ALCOSER). The diameter of one SHIBBAB is about (38,19 cm), and the shortest length between sibbabs is 57 cm. from a visit to the site); therefore the shortest length of the cottage is about (3,78 m), and its width is (3.49 m) the length of the guest room may be (100 feet); guest rooms are built on high lands or hills in the marsh. All cottages are closed in winter with papyrus to protect people from cold as it is an insulating material. As for toilets, a hole is made on the surface that reaches the water used as a toilet covered by reed mats for isolation [20].

2.2. The ancient city of Ur

Many factors and determinants affected Sumerians' cities' selection (Mesopotamian cities), like the land's topography, the two great rivers' presence, and the marshes. They are considered the main source of life and their importance transportation with the environmental factor's effect. The destination of wind is north-west and southeast. As the ground is flat everywhere, there were no protection aids: therefore, the marsh people built high fences where the committee of urban cities was found there it consists of: The city Center (the urban center), which is considered the most important factor in a Mesopotamian city, is the place of temples representing the gods' headquarters. Therefore, it has a special sanctity in the eyes of the Mesopotamians. The temple's sanctity led to more temples of different ages in the same place [2], [21]. The building of temples on platforms came as a copy of the natural reed GIBSHET in the marshes. Reed was the model on where the flood story and the epic of creation depended on. In the epic of Gilgamesh that the goddess MERDOKH landed on a platform of reeds on the water's surface. The world was created from it. Everything was created from water and reeds (Gilgamesh epic) gives evidence [13]. Ur's ancient city people took the reed platforms in the marshes as a model in building the temples though they dominated all other buildings. After the breakup of the Legislative and executive powers, palaces appeared on platforms in the city nob these were in an organized way or not organized, the connection between them was organic and followed the relation between one Gibbsha and the other. The name of the king URNAMMU the founder of Ur's third strain was named after reeds the word URNAMMU means the king of reeds. These platforms were developed to be Ziggurat, the place where goddess MERDOKH landed on earth. The float was also made from reeds, small boats, arched buildings. It is also used for cooking and melting [22]. Every temple was protected by an outside wall added to the sidewall of the temple. The wall contains fronts and backs and T-like losses. The entrances are hidden inside the walls. It is either one door or two doors entrance inside it a circular path behind the wall; it is noticed that there is a dual space sequence that is to say there is a direct or indirect vertical axis from the entrance to the main yard (within space Al EWAAN) leads to a transverse silo [22] as for the royal mansions they are separated from the outside world with thick walls with few holes. The inside parts of the mansion are separated from each other, with few connections between them. The Royal mansion has a multi-level space sequence between the general and special use, and the main movement from the entrance to the inside yard is with numeral cuts, and the main yard has not got a central distributor for the movement. Its relation is only with the Throne Hall. You can see the relation of the throne hall with the Royal suite. The entrance is behind the throne hall and not in front of it [23].

2.2.1.   The Residential Area

This sector is specialized by the natural growth of the narrow paths and neighborhoods around the residential hob (nucleus); it is characterized by a network of narrow roads and canals that simulate the marsh paths that go through thick reed areas. These narrow roads began after the wall of the city nucleus (gates of the nucleus wall) and were distributed into basic directions that go towards the outside wall gates and take closed directions inside the residential area. This sector contains residential buildings in addition to other commercial and civic spaces [21]. It has been supposed to have a look at the sketch plan of the services and residential part. In that case, it starts by designing the measurements and the directions of the paths and then came the stage of sorting and building the residential plots, especially the narrow paths that go through and this was made clear by the designing of the buildings found in it especially in the corners and narrow paths because the shape and the slope of the narrow path affects the shape and the design of the building and not the contrary. The city center's design came as symmetries to designing GIPSHITS of the marshes and the narrow paths for the small boats and canoes in it. Even the paths and the buildings' front yards came according to the prevailing wind's directions in the area from the climate side [2], [21]. In the residential area from general to private places in an evident gradient from the narrow path to the house door then the Ewaan wherein it the axis bends and then the courtyard and from it to the parts of the house. Figure 5 illustrates the residential area of Ur city [21]. There are decorated curved arches over the outside walls and windows with shining white plaster coating with two storehouses. These

houses contain a central area opened to the sky for ventilation and illumination. There are stairs near the house's main entrance to the first floor, where you can find a kitchen, private rooms, and a WC [22].
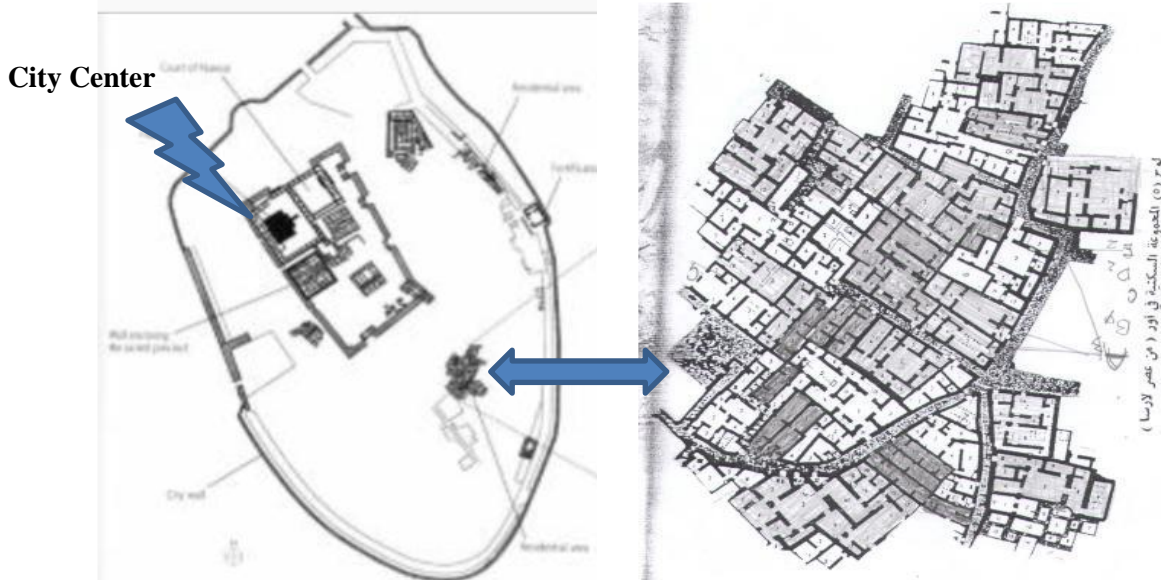

City Center

Figure 5. The residential area in Ur city and also the central area in the city [24]

The solid wall blocks were built from mud-covered by burnt mud, which provides long life for the building and gives it a touch of fine art. This style was taken to build Al Ziggurats known in this era (the third Ur dynasty). The huge structure was built from mud using a new technology by spreading layers of reed mats between specific spaces of mud to increase the tying strength; this tech is used up to now to increase the tying strength in GIBSHAT when building cottages on them, moreover the use of Gibson to cover the walls and to be engraved to mark the religious events and the works of Kings. For building roofs, they used date palm trucks which cannot support heavy things. Therefore they made short spaces to build the roofs. They also invented domes and cellars in roofing the spaces with reed mats and layers of bitumen as an insulating material of humidity, and it was developed using layers of mud first then using burnt mud [22].

2.3.   The characteristics of the complex system and its application on the ancient city of Ur and the marsh cottages

The designing characteristics of the ancient city of Ur and the marsh cottages were analyzed in table 1 of the complex system as follows:

The ancient city of Ur, the city center (city's nucleus) differs from the other parts of the city in design; it is surrounded by a thick fence enclosing a central void named after the fence and buildings erected on a high bench enclosing related voids. These buildings include the ziggurats, temples, Royal mansions, and the Royal cemeteries that carry spiritual and political meanings; these were consolidated and illustrated through domination by large measure and building compared to the other buildings outside the nucleus [21]. It has been concluded that the characteristic of scale gradients due to the importance of the nucleus area creates the contrast characteristic in scale and the great difference between the nucleus and the area around it because of the difference of function between the center of the city and the other parts of it. The public houses were built outside the fence of the nucleus, that is to say, between it and the city's outside fence, with gradients in scale according to the place's function. The cottages of the marshes are considered empty of the central space, the importance is in marsh water, and to know the borders with the land, the inner aspect is enclosed between the cottages built on the GIBSHATS, which are located in the middle of the cottages. The functional, social and economic center is the marsh area [12]. It can be noticed that the benches of the ancient city built under the central area buildings are similar to the benches of the GIBSHATS found in the center of the marsh, which is like hills floating on the marsh water. The relation between one bench and the other and their directions in the central city nucleus is similar to the shape and directions of the GIBSHATS in the marshes centers where the

word SUMER refers to a floating hill [25-29]. The two environmental characteristics of gradients and contrast came with an equal value for the marsh and the GIBSHATS, where no one can spare the other. In the ancient city of Ur, there were clear boundaries that separate the religious and political area from the residential area and the city as a whole from what surrounded it consolidated by water canals, especially the outside city walls where water surrounds the city of Ur from every direction except on side. Borders are limited to walls and include natural and artificial waters and the land's topography. These boundaries consolidated the central area's domination as a break from the rest of the city areas and impacted the city's parts' functional grading. As for designing the temples and mansions, each one of them is surrounded by dual walls with a path to separate the buildings from each other and people. These boundaries were found in Art murals to say that Art murals do not tell the same story that they show, and each fine art piece has a separate subject and pictures to give us a judgment that the people of the area are interested in the details and the domination of the part on the whole part. Though the city walls were not as old as the city itself, the city may be connected with the marsh cottages (with the other villages as one unit), which means the wall surrounding the city nucleus [21]. The GIBSHAT area in the marshes and what surround it of the marsh water is considered thick boundaries that surround the GIBSHATS that cottages are built on it and the reed colonies as thick walls that separate the residential GIBSHATS in the middle of the marsh from the edges and land which are thick boundaries for the marsh that provides privacy and great suppuration for the GIBSHATS and the cottages. The environmental confrontation and contrast relation from the gradients between the water and land level creates the thick boundaries (walls) [25]. Ur's ancient city's residential part is characterized by parity in shape for the houses and their yards with transitional symmetries between them. Sometimes it changes its area and sometimes keeps the same size and area, and other changes its size on purpose or echoes. It reflects the fractal residential fabric representing completeness and formal overlap with the bending of the narrow roads and the openings on the neighborhood units that give us a clear picture of the water paths that the canoes go through the marshes. As for the city's nucleus, the sudden planning for it gives us different echoes due to its distinguishing measurements of the opened spaces and the presence of benches and the temples and mansions it has. This echoes impact the importance of the nucleus religiously and politically [21]. Clear transitional parity symmetries characterize the cottages found in the marshes among the cottages' shapes that do not reach the minute details, but its general shape says there are symmetries in it. This judgment came from the use of one unified building primary material. Thus, it gives us echoes in its repetition in shape sizes and measurements. If it has the same shape, it echoes for other properties that it is found but not at the same grade of purity and the difference of the angles of the slope of units that gives us echoes in a dynamic movement that is available in nature. Prisms and losses, terminations, decorations found on the walls of external facades of the ancient city of Ur, and floor tiles and materials related to them [21], have evident roughness touch; this roughness lessens the rigor and monotony between the geometrical shapes. It allows for the defects to appear to differentiate between one unit and the other without canceling the similarity between them on the levels of nucleus buildings and the residential district, which gives an image of repetition between the finishing materials. The characteristic of roughness creates adaptation with the local conditions where the roughness of the finishing materials' surfaces creates shaded areas and illuminated ones that accelerate heat exchange due to the speeding from the nearby currents of these surfaces. However, it breaks the complete parity and order between these parts. Moreover, the building's directions (North - East, and South - West) with the northeast wind direction and the narrow vertical paths support heat exchange and provide a lovely breeze to the people living in, found in the building of the nucleus also. As for the sight of the marsh cottages, the use of reeds only in its natural shape without using any finishing material gives the cottage the sight of roughness without allowing the building to appear, and it also makes the units alike but not identical with the repetition of using reeds and its binding way. Besides the Alternating repetition between the water and the browses of the GIPSHATS, which creates land and sea currents, which help lessen the degrees of heat and moderate the weather. The researcher made a sample of the marsh cottage from reeds only with (1 /20) measurements, paying a visit to the marsh areas to ensure its heat exchangeability and lessen July and August heat. The researcher found that it lessens the heat in spring by three degrees and five degrees in winter at peak

heat because reeds are empty from the inside that increases their isolation property in addition to their lightweight, which allows them to float at the surface of the water when the level of water is high (A site visit and measure) as in the figures (6 and 7).

Figure 5. temperature readings and the difference between them on (01/04/2019) inside and outside AL-Chibayesh marsh cottages locally

Figure 6. A model of (1/20) scale for a marsh cottage to measure temperature

In Ur's ancient city centre, there is the central void of it; a fence identifies it. This big void is considered outside the fractal scale, but it is connected to the small scale through a hierarchical chain of scales from the small to the big at the same time the city nucleus needs it due to the huge building blocks found within it kings mansions, Temples and Ziggurat [21]. Its presence is important in such a void to identify it and at the same time creates a balance in contrast between mass and vacuum with the absorption of the random distribution of it. The brightness of the mass of the sacred building that carries heavy details in their facades needs a huge void to see it in addition to the creation of a balance between the size of the buildings and the area of the void they are found in, that creates two balance sides (scales) to see the heavy details and to host mass gatherings of people during ceremonies. As for the residential area, it has three kinds of voids according to its area, its sequence from the big to the small stars from the void found near the external walls and the internal walls of the nucleus (functional), then the voids between one residential area and the other comes then the voids within one residential fabric and an internal void that represent the unity between neighbors through the narrow paths to the internal void [22]. There are water voids in the middle of the marsh where the GIBSHATS float on its surface; on some of them, you can find cottages. These water voids are separated from land (the edges of the marsh) with colonies of reed and papyrus that grow in the marsh waters where animals and migrating birds live and nest. Moreover, it is considered a source of food for livestock [25]. The colonies of the reed marked the water void. They divided the marsh into huge numerous water surfaces outside the areas of GIBSHATS and small areas between the GIBSHATS, which creates a balance between the water voids and the areas of the reed colonies. This gave the sense of enclosing the void in transforming it from the negative void to the positive void where social and economic activities are practised [12]. Ur's city has an evident gradient from general to private from the shape side (the buildings' size) and the social and functional sides. The shaped side can be seen grading in size from Al Ziggurat, then the mansions, and then the Temples to the residential buildings. As for the functional grading on the city level, there is grading from the residential, public area which is closed to the outside walls to the inside wall of the nucleus area and the nucleus represented by the central area, which contains the political and religious center (the Ziggurat, the Temples and the mansions) in it there is grading from general to special represented by the throne of the king and the chamber of temple special for the gods. There is a functional and formal grading from the general narrow path to the residential area's special central

void. According to the resident's movement, the narrow paths are from voids with large areas that lead to the city's outside walls or Temples or the outside city gates and from the other side to the central nucleus's gates. There were not loose endings. The gradient's characteristic confirms the characteristics of the urban fabric of the ancient city of Ur [21]. Transportation in the marshes starts from the marsh's edge towards the GIBSHATS through narrow water paths through reeds and papyrus colonies. These narrow paths provide privacy and protection to the marsh people. Some of them are considered natural reserves, in conclusion, the presence of natural environmental gradients in the marsh areas. As for the presence of voids (spaces) in the area of GIBSHATS in each cluster of cottages, there is a void in the middle for these cottages. (It is considered semiprivate for the space gradients) where the activities of this gathering are practised. It is directly connected to the vehicles. The canoes (AL-Mashhoof), as shown in figure 8.

Figure 8. Transportation from the Canoe (AL-Mashhoof) to the open space on CHipshah [20]

2.3.1. Alternating repetition

The alternating repetition enhances architectural concepts better than simple repetition considering the central area of the ancient city of Ur (the nucleus) [21] for a concept of the sketches of the Temples, ziggurats, and the Royal palaces the presence of formal symmetries on the level of an area. There grading in the areas of buildings or alternating in areas that go bigger and turns smaller. As for the level of the materials of the facades, there are symmetries in the areas of covering units used in finishing the walls and outside cylinders; each unit is framed with a prominent frame that characterizes and separates it from the other units. Therefore, repetition on the unit level but what stories, decorations, and personalities these units contain are different from one to the other. The presence of prisms and losses on the walls creates an exchange between shadow and lighted areas. All that gives us alternating repetition on the level of elements of facades. It can be noticed that the built area is more than the open area in the residential area. However, the presence of blocks and voids creates alternative repetition between the shadow and lighted areas [21]. There are simple, repeated, and exchanged prisms and losses for the facades, but the narrow paths and their bending with their openness on the spaces cause the air currents (figures 5 and 9). As for the reed cottages in the marshes, it could be noticed an evident repetition in the areas and materials, and their way of building the essential lines is repeated. Looking carefully, symmetries close to the Alternative repetition between the forms and areas of the cottages. In the façade of a single cottage, Alternative repetition between the reed arches.

Figure 9. an enlarged plan for a part of the residential district illustrating the interference and strong interlock, the covered spaces tend to be longer as in the designing of the cottage, and the narrow paths are bending as it was in the paths of the winding marsh alleys for canoes [21]

2.3.2. Positive space

Human cognition plays a vital role in that positive call space, and this depends on what space contains from building blocks or opened places. It depends on the building blocks' ratio to the spaces and the positive space's function to the Sumerian cities, including Ur's ancient city. It is a space where people gather near the Ziggurat and the temple to do their prayers; that is to say, it is a political and religious space and the royal palace's presence within the central area. As for the neighboring units and transforming trading areas, they are considered important positive spaces, but the grading in the areas of these spaces and their positions distinguishes the function of each space from the other that gives each space a positive character that differs from the other as shown in figure 5. There are two kinds of positive spaces for marshes: environmental spaces represented by marsh basins, where every social, economic, and entertainment activity took place. They are considered a nucleus to all residents' activities. These areas have the two environmental characteristics of contrast and gradients between them and the inhabited areas on the GIBSHATS. The other positive spaces are the spaces between cottages within one GIBSHAT, as shown in figure 8. The number and areas of the cottages within one GIBSHAT lead to the absence of the cottages' function with the presence of the form and general details. The residential area in the ancient city of Ur is characterized by similarities and symmetries in shapes and measurements with a fractal difference between them, which gave the central area (the nucleus) the Ziggurat, the mansions, and the Temples, the buildings of the residential area are similar in the concepts and open to the internal void, that the details of its facades are similar in form and measurements [21]. This led to a lack of information and the distinguishing of the interface elements of the nucleus area due to the alternating repetition where no pure repetition is found. There is a little difference in the internal details though there was a functional variant between them with the symmetries of marsh cottages' facades from the form and measurements sides prisms and losses in the ancient city of Ur and the SHIBBABS and reed mats in the marsh cottages. As for the marsh cottages, there is an evident shortcut to the information through the repetition of the forms of them, their shapes and their distribution, and their building on the GIBSHATS they will not trespass the water areas in its building and lead to the disappearance of the urban repetition and the appearance of environmental repetition, gradient, in the scale for the GIBSHATS areas.

2.3.3. Simplicity and inner calm

Regulation in the figure, relationships through repetition, pyramidal grading in scale, and the boundaries mentioned above creates balance and social cohesion with the absence of chaos without paying any effort to reach simplicity and inner calm by creating a kind of self-comfort and affinity between man and the measures and metrics taken from the environment and used in spaces around him. The marsh environment's cohesion and marsh villages came due to marsh people's great respect for the water environment and not altering it. They built their cottages on the floating GIBSHATS without trespassing the water flow. The cottages' shapes have repetition in their forms and measurements to use only one building material. This led to a shortage of information and details, which creates the environmental site's complex characteristics, which leads to environmental simplicity and inner calm. Ur's ancient city's residential fabric is characterized by a great connection that was evident from the space relation grading from general use outside the district to the special use among the spaces among the houses. As for the elements, the Sumerians used grilled mud to make bricks as a building material taking its measurements from fragmenting reed and the rough touch of the front, which provides non-separateness with the environment that leads to it. As for the marsh cottages, the non-separateness between them and the environment is greatly evident by the building material, reed, and papyrus which was built on the GIBSHATS with the good isolation provided by the building material that reaches (3 degrees) with the lovely breeze coming from the openings between the reed mats which controls the heat on the higher heat hours. not-separateness in form and weather environment resulted in not- separateness the cottage from the surrounding environment you cannot differentiate their shapes from the GIBSHATS built on when you look at them from the air as shown in figure 10. The residential area in the ancient city of Ur is characterized by the absence of straight lines that separate one house from the other or one activity from the other even the narrow roads are snaky this interlock characteristic creates ambiguity in the relation of the areas interacted which consequently leads to interlocking, not- separateness, relation, and ambiguity in the residential fabric (as shown in figure 9). The cottages are separated, and there is no interlock between them. Still, there are interlock and cohesion between the water edge and land and the reed colonies and water edges. Ur's ancient city's nucleus area is characterized by a contrast between the huge blocks and the void around them. This contrast leads to the illustration of these blocks within the void. As for the residential area, the residential fabric contains the inner spaces (the voids of the houses and the spaces in the fabric) a dual case of shade and light as an alternating

repetition which creates a positive contrast that illustrates the blocks, edges, and spaces (as shown in figure 7). There is a fractal environmental contrast between water and land between the cottage villages in the marshes and between the reed colonies and water. As for the shapes of the cottages, there is no contrast between them, but there are some simple spaces between the gatherings of the cottages that creates a kind of shade and light not clear in the picture taken from the air, this lead to a vague picture taken from the air that leads to the ambiguity of distinguishing them (as shown in figure 12) due to the similarity between the material used in building them, which consolidates the environmental contrast especially.

2.3.4. Local symmetries

The urban residential fabric (which contains small scales) nears the complex biological fabric in function and form with scales and their pyramidal listing despite the shape symmetries between them. Therefore, the characteristic of scales in the local symmetries is important in organic farming. As for the marsh cottages on the GIBSHATS level, there are general symmetries between one GIBSHAT and the other in the presence of cottages. If there are no cottages, there is not any other different building. Their presence in a way that does not trespass the natural organic environment. As for the organic structure of the cottage, it has a shaped symmetry with pyramidal gradients on the scale side from 5 shibbabs for a small cottage to 31 shibbabs for the guests' room [30], [31].

2.3.5. Levels of scales

Repetition is the thing that pinpoints a scale but not in a relative degree to it. These scales may be doubled in scale or became larger, multiplying with the enlarging factor to give us a pyramidal listing in scales that make local symmetries but not in an exact focus on creating the fractal. Conditioned planning biology aims to meet man's needs or the human scale. Through pictures and human statues found (archeological finds) (Driton 1981 Ibid, page 148) found that the length of the human statue is (57 cm) equals to one-third of the human being's length, which is based on the tri-concept of forming the universe which consists of three levels, the sky level which is the gods level, the earth level (the human level) and the underground world. The Sumerians pay great attention to numbers; they believed that numbers have great authority over them. Numbers were used to resembling names for their special modality (Driton 1981 Ibid, p, 148). If multiplying the length of the human statues by 3, the result will be the natural length of the human body which is (171cm) the average length of the Sumerian man at that time, and this number multiply by 3, the result will be the length of the grown marsh reed. The truck without the flower at the end which 513 cm after measuring it (as shown in figure 12) if extract (e) for number 513, it is 2,7 when measured the distances between the knots of the reed, found the variable of the distances equal to 2,7 that is to say the difference is 2—3 as in table 2 and a dry reed is broken from the knots if apply stress and bend it.

Figure 10. The length of a grown reed which is = 513cm

Table 2. The way to measure the level of urban complexity in table 3
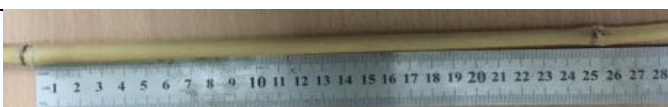
level of simplicity in villages	1.1. *	1.2. **	1.3. ***	1.4. ****	1.5. *****	1.6. level of complexity in cities
	1.7.					

Table 3. the distances between the knots of a reed.

No	The distance between two knots of the reed; the second (2nd) knot follows the first (1st) to the fifth (5th) knot.	The distance between two knots (cm)	Notes
1		25 cm	The reed measurement starts with a

#	Image	Measurement	Description
2		28.3 cm	distance of 2.7 cm between the first two knots after the end of the reed roots, but the distance decreases to half with the roots.
3		34 cm	The reed bends with a distance of 2.7 cm between the last two knots near the flower.
4		37 cm	
5		40 cm	The reed measurements in its middle reach 43 cm; this distance may be repeated in the two final knots. As in picture no 6
6		2.7 cm	

For the credibility of the scale and its rightness, select an area from the marsh approximately equal to the area of the ancient city of Ur. The selected area for a residential unit in the ancient city of Ur = (5000) m². The area selected from the marsh area almost the same as the area of the residential area of the ancient city of Ur = (5400 m²). The spaces of the city of Ur have measured the result was the largest distance is (5.13) m which equals the length of the reed, and the shortest length is (171 cm), which equals the height of a man as a length of one side of it. As for the measurements of the marsh cottages, which consists of (5 -7- 31) SHIBBABS and the width of the cottage equal to the height of two men, which is (3.42 m) which are considered the pillars of the cottage, they are parts of the man's height and the reed's length and the space between one SHIBBAB and the other =57 cm the shortest length of a cottage = 4.18 m and its width = 3.40 m (field survey).
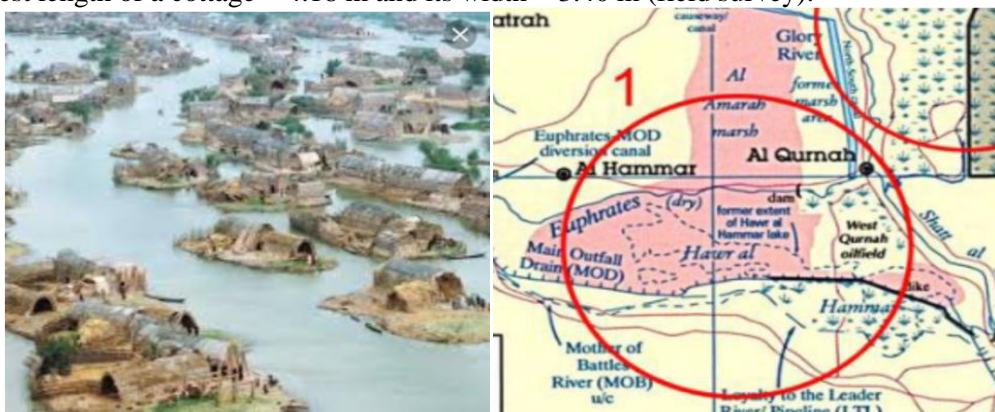

Figure 11. The marshes scheme in the triangular area between NASREYAH, EMARAH, and AL BASRAH in the south illustrates the cottages built on the GIBBSHATS.
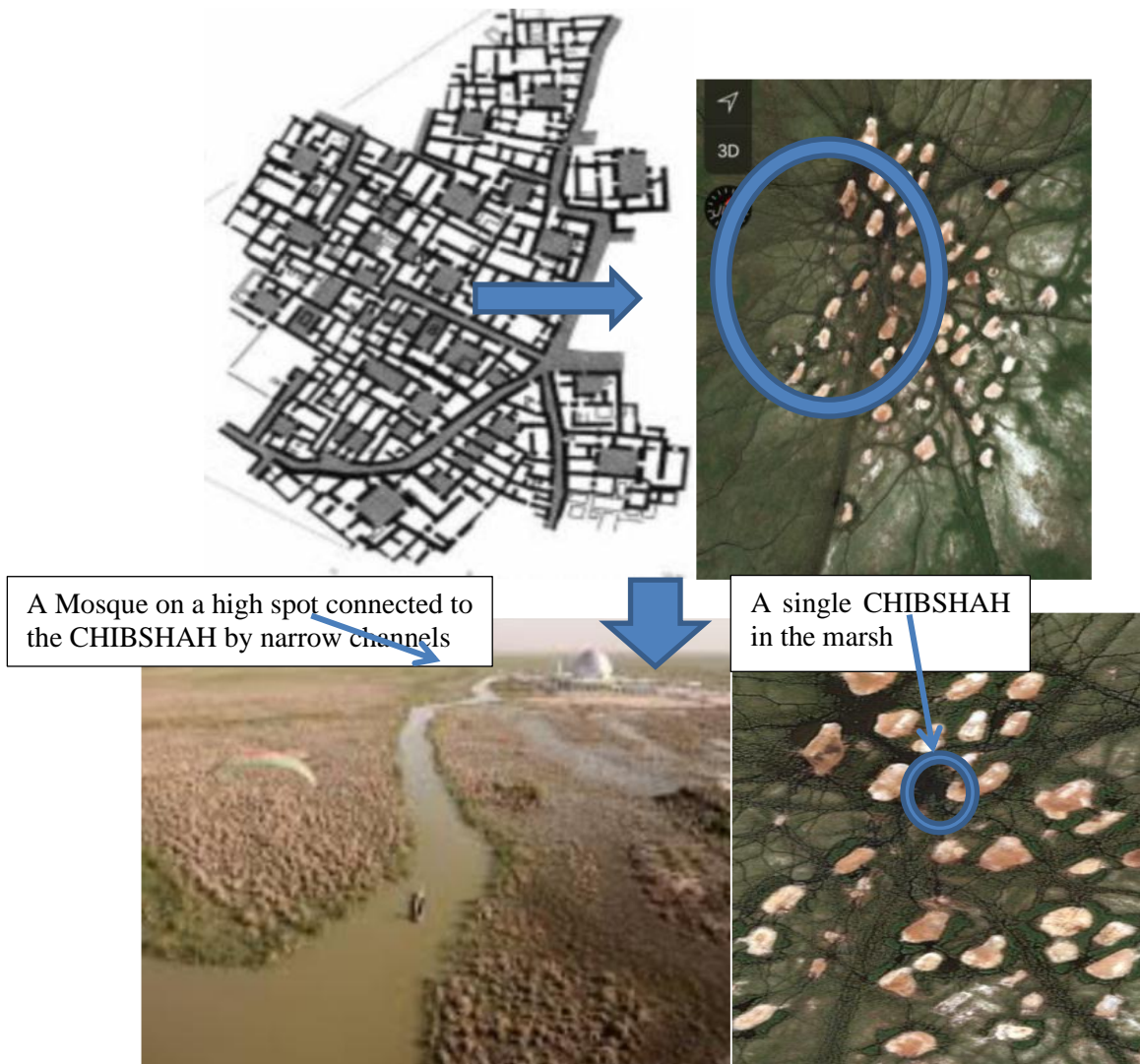
Figure 12. clarifies a comparison between a sample of 45 CHIBSHAH inhabited in the middle of the marsh (maps- G.I.S), the horizontal area of the place = 5400 m^2, and the residential area in the ancient city of Ur

3. Research methodology

In this research, two ways of the study were depended upon. The first is the biological field study, and the other is analyses study for the historical documents and comparing them to find, measure and select the basic characteristics to the level of complexity in the urban style and the amount of connection and closeness between the basic types and the types selected from them. A scale was put to measure the level of complexity in the shape of stars. The highest level of complexity = (*****) five stars and the lowest is (*) one star as in the following table.

Table 3. the levels of urban complexity to the marsh cottages' clusters and the ancient city of Ur.

Characteristic of complexity.	A measure of the selected characteristic.	The city of Ur	Level of complexity in urban style	Clusters of marsh cottages	Level of complexity in urban style
Strong centres	Functional grading	Scale grading comes from moving blocks and spaces according to function.	*****	Scale grading comes from elements and relations in the natural environment.	**

Characteristic of complexity.	A measure of the selected characteristic.	The city of Ur	Level of complexity in urban style	Clusters of marsh cottages	Level of complexity in urban style
Gradients	Functional grading	Complex functional grading political, religious, residential, and economic	*****	Simple, functional grading residential and economic	**
Levels of scales	Scale grading	Fractal triangle and zigzag through phibonatchi (e=2.7) spaces graded according to a triangle and zigzag grades.	*****	Fractal triangle and zigzag through phibonatchi (e=2.7) the measurements of CHIBSHAH are graded if the grading is found.	*****
Boundaries	The contrast between the space and the boundaries results from grading in height.	The contrast between the space and the boundaries results from grading in height.	***	Fractal grading between the edges of water and land from one side and the colonies of reed and water	***
Alternating repetition	Alternating in the existence and vanishing of specific elements	Alternating in the existence of blocks and their vanishing within the residential fabric	***	Alternating between the existence of the cottages on the CHIBSHAH and the marsh water	*****
Positive space	The contrast between the surrounding area and the void height resulted from the relation between grading with heights.	Void grading gives importance to the internal space making it a live space.	*****	Contrast and Void grading (land and water surface)	***
Good shape	Repeated relations and elements within facades and plans	Repeated relations and elements within facades and plans for the space of similar functions	***	Repeated relations and elements within facades and plans	*****
Local symmetries	Scale grading	Scale grading	****	Pyramidal symmetry on the scale	**
Deep interlock and ambiguity	Number and kind of interlocks between shapes	Number and kind of interlocks in the residential fabric	*****	Environmental interlock	*****
Contrast	Similarities and differences in shape and scale	Similarities and differences in shape and scale	*****		
Roughness	Number of broses in shape and the frequencies of shade and light	Number of broses in shape and the frequencies of shade and light	*****	Number of broses in shape and the frequencies of shade and light	***
Echoes	Scale grading	Scale grading	*****	Repetition in form and scale	*****

Characteristic of complexity.	A measure of the selected characteristic.	The city of Ur	Level of complexity in urban style	Clusters of marsh cottages	Level of complexity in urban style
The void	Scale grading	Grading balance according to urban function	***	Balance with the environment	*****
Simplicity and inner calm	Less number of shapes and elements	No (20)result from complex interlock between the houses makes a complex sequence from general to private.	*****	No(4) interchange between water and land represented by CHIBSHAH resulted in the form's clearness.	*****
Non - separateness	The similarity in grading and repetition in elements and relations between shape and surrounding	Scheme 9 kinds of measures from the longest side= (5,13 m) to the shortest (1,71m) the relation between man and reed which lead to change in measure from reed to man	*****	Scheme 5 from (31-7-5) Shibbab distance of length (23.94 to 4.18m) and width of (3.42m) with a simple difference in the fractures of numbers according to the kind of reed. Nature made the cottage.	*****

Level of simplicity in villages, *=lowest, *****= highest

4. Results and discussion

The presence of evident environmental cohesion in the marsh cottages area is elevated to formal cohesion to produce the complex pattern language in the urban residential site of Ur's ancient city. Drought may be the cause or the activities to bury the area to make new houses until it became a residential urban fabric. The analysis method came for many reasons; one of them is the city kept the same form of the water narrow paths the canoe moves through, but in the residential area, it turns to a narrow path among the houses the second is the difference in the design of the central nucleus are designed differently from the design of its residential fabric with exaggerations of its measures and surrounding it with a high wall. As for the designing of the houses, it is evident to find a similarity between them and the cottages in the rectangular space of the cottage and the use of the marsh reed in measuring them though the building material was not the same in the cottage of the marsh and the area of the ancient city of Ur., the two materials are taken from the same area. The length of the courtyard after measuring it is equal to the length of the reed, and the other measurements came equal to the parts of the reed as the distance between a knot and the other from hearing came the fractal interlock between a house and the other that made the length of the reed and the distance between its knots the basic style used in all measurements in the civilization of Sumerian Ur.

1. Complexity in an urban and natural environment results from connecting many characteristics, including the scale and symmetries in it (repetition, gradients, and symmetry) was borrowed from the natural environment and used in an urban environment. The length of the marsh reed, its length reaches (513) equal to three times the length of a Sumerian man was used. The Sumerian believed humans are built of three parts (heavenly, earthen, and underground) where three grades are found. Then the Sumerian hexagon appeared (two opposite triangles), and a grade on the scale was found to give us smaller measures as shown in figure 13. In general, the tiny fractal part equal to (5.65) close to (2.7) or close to (3, 2), which is the smallest measure unit. From the measure of this unit's grades, the part and the whole measure of the ancient city of Ur and the marsh cottages from the details of openings to the buildings' final measurements.

2. Similarity in scale due to repetition, gradients, and symmetry, appear in two areas; the first has a village pattern representing the marsh cottages, and the second is the residential area in the ancient city of Ur.
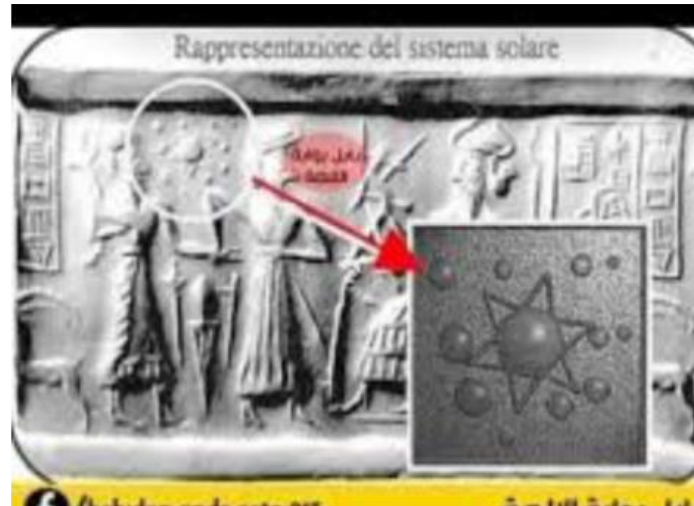
Figure 13. The hexagon in the Sumerian civilization

The marsh cottages, the main material used in building the cottages is reed (the bunch of reed, columns, or SHIBBABS are with a diameter of (19-38 cm), and the distance between one Shabbat and the other covered with reed mats from (57–76 cm) all of them are the multiplications of number (19 cm) which is also a multiplication of number (2.7 mm) that provides to an environmental pattern language. It is number (19) its parts and multiplications.

The second area (the residential area in the ancient city of Ur): it can be noticed that the measurements of the courtyard and the spaces around it are from the biggest, which is (5.13 m) equals the length of the matured reed to the lowest which is (1.71 m) equals to the length of a matured Sumerian man with fractal interlocks between a house and the other that starts from the height of a man to (57 cm) one-third of the height of the Sumerian man that provided a stylish formal language that is from its parts and multiplications. As for the buildings of (temples, mansions, and ziggurats), their lengths are multiples of the reed's length and parts. The connection resulted from the similarity between the spaces shapes of the residential house in Ur and the space in the marsh cottage from the ratio of measure in the length and width of the spaces using the same measuring tools of the two areas despite the difference of the building materials. The two provide the characteristics of roughness and cohesion with the surrounding environment, which gave the climate conditioning with the environment. This means that the environmental cohesion creates a complex environmental pattern language as in the cottages or creates a formal cohesion that creates a formal complex pattern language as in the residential fabric of the ancient city of Ur as in scheme 2.
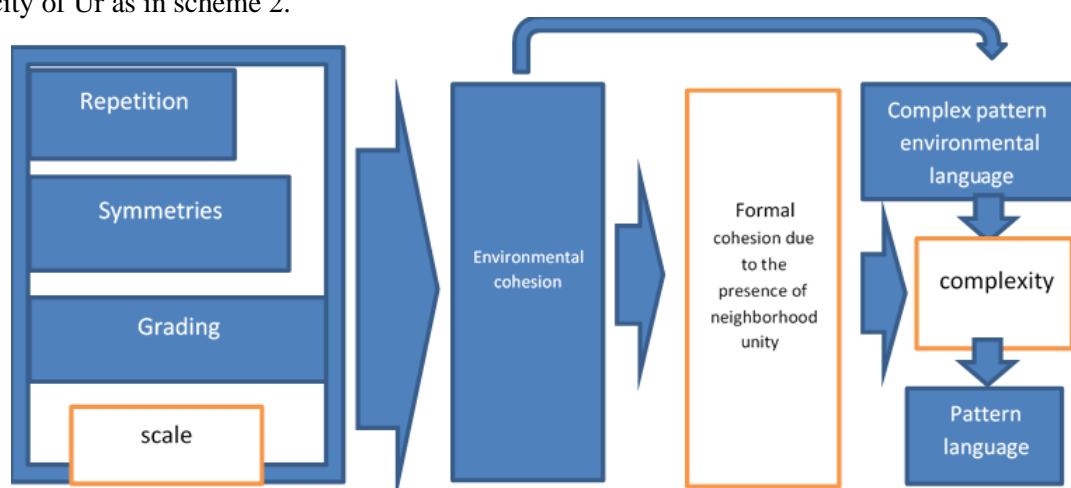

Figure 14. The results of table 3

3. From the above tables and the scheme resulted from them, two factors affect the general shape of the two areas' final look. They are social and environmental factors. (The nature of the area) They are as follows:

   A- **The social factor**: the social factor affected the urban form of the residential area in the ancient city of Ur and evident from the general, sub-general, and special grading of spaces, which creates

a solid urban fabric. The general spaces are considered as the nucleus of the city and represent the religious and political centre for the people of the city; on the other side, the gathering area near the outside walls and the sub-general are the main roads that lead to the narrow roads and internal gatherings (the neighbourhood) as for the special areas they are the houses and their courtyards.

B- **The environmental factor** (the nature of the area and its topography) affected the places of building the residential cottages built on the GIBSHATS where no urban fabric or neighbourhood found and the boarders of the special space is water surrounding the GIBSHAT. The cohesion came from the natural environment's unlimited complexity and the simplicity of the cottage's shape (floating reed carrying reed). The function related to them. these pictures from the air cannot illustrate cottages because they appear unclear due to the building materials. As a result, cannot take clear pictures for them as shown in figure (12) unless they take a close picture due to the insolation made by the colonies of reed from the eyes of strangers (privacy made by nature). There are no paths for canoes that connect land to the cottages. It is only from the snaky paths of canoes among the colonies of reed and papyrus.

4. As for the climate environment and its effect on the designing characteristics of the ancient city of Ur and the marsh cottages, it is as follow;

A- THE ANCIENT CITY OF UR; Experimental imitation of the environment contributed to consolidating climate protection for the residential fabric. The snaky narrow paths that sometimes are narrow and others are wide to increase the speed of air to get rid of high heat and humidity in addition to the broken axes of the buildings which lessen the high wind-loaded by dust to prevent it from reaching the courtyard and the spaces opened on it. The courtyard is considered a lung to the building where the light went through to the spaces around it, and also the heat exchange occurred between the building and the outer space. This is from the side of characteristics and design concepts, as for the design elements as the thickness and the finishing of walls plastering the walls and their shapes, the roughness of finishing the wall and the small fractal prisms and losses that make spots of shadow and light which accelerate heat exchange between the wall and the outside space to cool the building.

B- The marsh cottages built with a reed in the marshes; after making a sample of a cottage measuring (1 /20) and take the temperature in the extreme times (high temperature), the results are less than the normal or higher by five degrees which provide a kind of heat balance inside the cottage due to the wood material of reed empty from inside as a high insulating material with the insulating made by the air void in addition to the insulation mad by the double side reed walls the thickness of the void is approximately equal to the diameter of the SHIBBAB in addition to covering the opening with the reed mats as a screen to filter lighting and lesson the speed of the air currents and allow the breeze to enter the cottage.

5. If a close look at the urban planning of the ancient city of Ur, a great similarity between the planning of the residential fabric and the distribution of GIBSHATS and the movement axis in them and their turnings, this will explain the phenomena two possibilities: -

C- First: The symmetry in planning and distributing marsh villages was used in the residential fabric of the ancient city of Ur.

D- Second: The residential fabric was originally bigshots and spots of the marsh. The drought that the area faces from time to time resulted in burring the area and turning it into an urban fabric after filling the spaces between the bigshots with houses to complete the residential fabric, keeping the movement and transportation axis as they were.

5. Conclusions

The area's civilization was named after reed due to this plant's evident impact on old and new domestic life. Therefore, the research recommends paying special efforts to use this material in the insolating process for walls and roofs in a new and modern way and strengthening the building material.

On the side of measure, the researchers recommend using the same parts of the reed plant to create spaces close to the marsh cottages and the ancient city of Ur that carry the characteristics of the local area and its surrounding, to provide services for tourists and to enhance the industry of tourism by building new places that carry the same characteristics of the local environment and can attract tourists from all over the world making the place (Venice of the east).

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