The Sustainable Design Technologies in Babylonian Architecture

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Abstract. The sustainability as a concept does not require a change in the quality of life as much as it requires a change in ideas and rationality towards ways of living that are less consumed and continuous for the longest possible period, which has made sustainability the most prominent evidence of sustainability in real terms. In it as a concept it has successfully implemented and in its various functional patterns (houses - temples and ziggurat - palaces, castles and forts), the study's goal is Distinguishing sustainability indicators in Babylonian architecture to reveal their operational indicators that made them continue successfully For centuries, archaeological discoveries have also confirmed. To achieve the goal, the research developed a methodology that was adopted clarifying the implementation indicators for sustainability in Babylonian architecture, which has emerged at the level of the environmental context to confront the environment and interact with it and preserve its resources. It singled out a vocabulary group that represented operational indicators that the ancient Babylonians worked and continued to develop, through selected models were analysed after the historical analytical survey of Babylonian architecture and its various functional patterns, research concluded that implementation of sustainability has been linked to several stages, starting from the planning to the smallest details, which have always produced positive results and as little as possible from the failures that are negligible compared to the gains obtained from them environmentally, economically and socially. Research determined detail indicators to build theoretical framework of Babylonian architecture sustainability for developed recommendations to improve the application of Sustainable concept in contemporary architecture.

1. Introduction
Babylon era considered the era of lights in the structure of Mesopotamia civilization and asymptotically for the era of lights that European thought witnessed in the eighteenth century AD. Babylonians main concern was to tame the pressures of their natural environment, so they achieved irrigation projects, digging canals, and the success of the agricultural and harvest campaigns and their archaeological and architectural waste that reflected high engineering experience and advanced art in the field of architecture and construction, so the effects of their civilization extended beyond the neighbouring countries to the Valley of India, the Nile Valley, Anatolia, Crete, Aegean and Europe (Sahib, 2011, p.91).

Babylon  had become the public cultural capital of the East, with its spacious and beautifully organized urban streets and its important residential neighborhoods (Sahib, 2011, p.20), and described as the largest and wisest city in the ancient East fortified by a wall spanning about 20 km, as Herodotus described it as the possibility of a vehicle that is pulled by Four animals to walk above it and the abundance of defensive towers in it from (Kretion, 1982, p.33). Babylon was overflown with a life of originality, capability and creativity. The proudest amongst the cities of the ancient world due to its high and greatness, especially the splendor of its artistic buildings and the diversity of its designs.
Its walls, gates, and other impregnable fortifications Its greatness and splendor are always associated with the eternal name of Babylon (Kretion, 1982, p. 5), and expeditions have estimated the durability of Babylonian houses for more than (300 years) thanks to their thick and durable walls and courtyards facing southward and tiled with good bricks all the way to its fine details (Royters, 1985, p. 69-p.71).

According to the foregoing, the Babylonians became aware of the sustainability inputs and the methods of their implementation; so that their results were confirmed in the construction of the famous city of Babylon and it endured for centuries of time even its simple houses.

The problem of research: "the absence of a comprehensive perception of the sustainable indicators of Babylonian architecture, which it applied to confirm its endurance for centuries,". The aim of the research : "the necessity of re-reading the indicators of the permanence of Babylonian architecture that made them last for centuries as indicators that achieve their sustainability."

2. Research Methodology
The research adopted the analytical approach to the description presented by the historical excavations and historical discoveries of the Babylonian civilization in its different eras to arrive at the key vocabulary of sustainability & its techniques, then analytical in detailed some samples of Babylonian houses, temples & palaces , to arrive at the detailed and accurate indicators implemented by the Babylonian hands with what achieved sustainability Their architecture, especially its centuries-old.

3. The concept of sustainability
Sustainability has been defined as meeting the needs of the present without compromising the capability of future generations to meet their own needs (Subramanian, 2012, p.39). Sustainability also means “retention” or “support from below.” This aspect, in turn, refers to the society’s ability, the ecosystem, or anything to continue as a system and to continue future work away from the need to reduce or deplete key and core resources (Ghani ,, 2012, p. 21). Accordingly, sustainability in architecture goes beyond environmental aspects in its narrow sense, to the urban environment with its broader concept of economic and social dimensions (Kibert, 2013, p.8)

4. Principles of sustainability according to (UIA) Union Internationale des Architectes
According to the (UIA- International Union of Architects) World Sustainability Union, sustainability is linked to (resources with energy efficiency) and (building health with materials), and thus the concept emphasizes dealing in an environmentally, socially and aesthetically sensitive way. (UIA, 1993), and the concept of sustainability is also linked to environmental challenges and resources and how to invest them, where the philosophy of sustainability is directed towards maximizing the built environment, as opposed to reducing or eliminating negative impacts on nature (Mclennan, 2004, p.4), as well, sustainability is linked to alternative energy resources and the continuous and complete recycling of ecosystems over and over again, which leads to the conservation of resources and energy sources, as the concept calls for the adoption of renewable energy sources in nature because it provides a limited set of basic resources for life that have been tested over the time of the earth by selection processes Natural, and Next, any change and manipulation of it results in negative consequences for the life system, so sustainability is not actually achieved by adopting manufactured resources and technology, and this relates to the principle of managing resources in order to preserve them in the distant future, as sustainability emphasizes good management of resources and achieved by dealing with available capabilities that are not produced for future environmental costs and this requires a surplus reduction (CABLE, 2012, p. 198-200).

5. An extrapolation of the operational indicators of sustainability in Babylonian architecture
The Babylonian’s natural environment is described as a "giving full of resources and good things", but with aggressive behaviour due to the floods (Jacobsen, 1980, p. 147). The most prominent characteristic of Babylonian architecture was determined by its "natural environmental medium’s hosting it" property, as Babylonian architecture embraced its natural environment, its religious and worldly functions and the self-vision of Babylonian architects who enriched Mesopotamian architecture with renewal and aesthetic additions. (Sahib, 2011, p.44-p.45), and employed resources and techniques for man to achieve an architecture described as the art of shaping life in the monuments and cities (Al-Bayati, 2006, p. 15). By looking at a set of considerations, a positive relationship (cause and effect) has woven between the building and its surrounding environment to provide comfort for occupants on the one hand and respect for nature on the other hand, represented by:
5.1 Coherence with the context:
The people of Mesopotamia took their precautions starting from the planning stage at the site, as it shows the coherence of the plan with the site and its topography, as indicated by excavation work, and found filling and burial works for the majority of buildings, especially temples of sand and pure clay materials, as it was noticed that the unequal declines resulted from a difference in soil quantities and their organization were observed. Between the low and high stages, at the walls. It was found that the gradual rise was in line with the natural height of the surrounding area (Coldfi, 1985, p. 44), and the building units were interconnected and attached to each other and the walls were welded together under the surface of the earth depending on the palms veins that were tied together strongly and tightly, as well as the adhesion of structural units to the earth to the degree that they made contour of planning underground and the adaption of available materials within the site to avoid the burden transferring materials from distant places (Coldfi& Friedrich, 1981, p.15)

5.2 The potential of space configuration of the plan and its architectural elements to face the environment:
The organization of building plans and their masses in houses, palaces, and temples depended on the presence of the open courtyard, so the principle of openness towards the interior was a basis for the ideal shape of the buildings, as the spaces are distributed on two or three sides of the courtyard itself (Coldfi1, 1985, p. 35). In dry environments, the sun is strong and the hours of day are hot, but the nights are cold and have cool breezes, so the courtyard acts as a regulator of heat exchange between the interior and exterior, storing heat at times to be transmitted at times (Hamandi, 1991, p. 86), in addition to the presence of refractive vestibular spaces that control the movement of air and provide privacy to its users. The interstitial space is represented by the portico as a transverse space around the central unit "central courtyard" and is usually directed southward (Mortortes, 1975, p. 239)

5.3 The potential of Facade composition and its architectural elements
Babylonian facades relied on the implementation of distinct sunken formations as aesthetic aspects to deepen the feeling of the mass and its dominance (Strommnger, Eva p423) by adopting cob material and sometimes bricks through the use of vertical elements in the form of (towers that were processed with streaks in the form of vertical outlets and entrances) and Mesopotamian architecture in the Babylonian period was characterized by a new treatment with bricks that represents the use of sculpture in architecture and that is if it had the appearance of sculpting (Baroo, 1978, p. 375) and the external facades were completely empty of windows, which indicates that the Babylonian was dealing with the climate when constructing his house, as he left outlets and we were not windows in the known sense to provide permanent air movement in the summer, and in the winter depends on blocking them with a few bricks or with a stack of firewood, to ward off the harsh north winds (Royters, 198 5, p.69- p.50) and appeared for the first time in Babylon the phenomenon of inlets and outlets in the walls and was facing northward to be considered an architectural feature inherent to Babylon even though it has a great resemblance to the ventilation holes in the art of modern Persian architecture known as the Badicere, and as it is used today to ventilate the rooms Widely used in those regions. These openings are built to a height that exceeds the roofs of buildings and ends there with a small peak that picks up air and pushes it down through the slit opening. The peaks of the air vents in today's buildings are among the most impressive achievements of architecture (Coldfi& Friedrich, 1981.p. 76-78)

5.4 The potential of physical composition based on natural resources
GRC materials are the same as the environment provided basic natural materials for the creation and formation of architectural structural systems, and the evolution of the use of building materials to sometimes reach a high degree of innovation thanks to the diversity of building materials and their formation methods (Saeed, 1985,p.97).Architectural development was based on interaction (primary material - environment resources - nature of the climate) (Al-Jader, 1985,p.77) , as the soil was transformed into architectural patterns with the possibilities of materialization and physical formation within the site through the formation of building materials that achieved the structural elements of the walls and ceilings and were of heat-resisting properties and imposed the use of Heavy and thick clay brick walls (Hamandi, 1991, p. 86) and were represented by (brick, cob, or puddled bricks, non-puddled bricks or bricks, stone, but it did not replace cob as a basic material, but only for packaging and for building foundations, columns, gates and wood), so the plaster of coating asphalt or bitumen
for its resistance to moisture, as well as its viscosity and elasticity to block pores, preserved the buildings from erosion (Al-Adhami, 1990, p. 46)

5.5 The potential of implementation and building and construction techniques

Industries employed in construction such as pottery, seals, cob, clay, bitumen, asphalt, reeds, papyrus, wood, etc. The Babylonians relied on various techniques to work with the materials available in their environment, including the "keso" technique adopted in building walls that reached a thickness of 2 m by adopting the bricks and stones available at the site, and the pile was made and mixed with clay as it is painted with bitumen with a layer of clay or straw to prevent the sticking layers from sticking together to give a future opportunity to benefit from it in the construction of a new building )the same waste is often reused after leaving the buildings to build new ones (Coldfi, 1985, p. 34), and when constructing the walls The technology of layers of bricks and thick limestone layers that were established over the thicker clay layers with the bitumen were adopted for protection and the permanence of the building for the longest possible period, as was adopted by the so-called "framing system" (Zargensystem) and these are made of thick boards of palm trees intertwined with each other and on top of each other and in a form Especially in the corners and angles, the purpose of which is to preserve the wall and protect it from cracking and collapsing, and to ensure the endurance of the building (Coldfi, 1985, p.14).

5.6 The possibilities of preserving the recycling of natural resources

The ancient civilization of the ancient Mesopotamia was famous for its high temples and it was called the Zuqurat, and it is only that the old temple was turned into crumbling ruins then it is rebuilt in the same place and with the same bricks as well, and thus quickly rises above the surrounding city building, (Woolley, 1939, p.), And the houses were built with materials available in the area Surrounding the building site so that its cement color is brown to red or its color is more black as there are kind of coating in the form of several layers on top of each to prevent the walls from being damaged by time and this was evident that it was made from the waste of houses mixed with mud and these materials compose the hills in the whole area (Royters, 1985, p.50)

5.7 Finishing implementing

The finishing of the floors depended on the presence of two layers of bricks to be built with tar as well as their coating with it when finishing the walls (Coldfi, 1985, p.15), the floors were often composed of clay cladding and in rare cases of cob, and in exceptional cases of brick stones (Royters, 1985, p. 50). Two types of floor finishing were found: the untouched and unpuddled clay tablets ditched on the muddy ground and even “neglected” and they were stacked here to be pounded , crushed and washed to purify them from any impurities to prepare a new writing-fit material (Royters, 1985, p. 67). Babylonian murals were also executed on Walls of cob after adjusting its specifications by filling the grooves between the rows of cob with a special type of pure clay and settling the indentations on its surfaces, and then covered with a light mortar of fine and bright white plaster as a suitable ground for receiving colors, in order to achieve accuracy in completing the drawings, the wall surface is divided into a number of Interlocking engineering squares .. It was known as the squared nets, using a number of ropes, after being dipped in color, set and rounded to the point of contact with the architectural surface. This technique is useful in implementation to control the system of relations between the elements of formation, including proportions and sizes of shapes and areas of negative and positive spaces on the optical surface (Sahib, 2011, p. 107)

According to the above , it was found that the Babylonian architecture that lasted for centuries was implemented based on the employment of the environment represented by its climatic factors and the sufficiency of its latent and available resources and the development of working techniques in it, to the extent that it reached the absence of foundations for its buildings, except rarely because it is self-sufficient with the accumulated disintegrated piles from the buildings, sustainability is implemented through cohesion with Location and integration with the natural environment to create the appropriate internal environment and to face climate conditions, confirmed its efficiency (environmentally), and preserve the lowest cost resources and recycle them at the lowest costs in terms of construction and
maintenance, confirmed their efficiency (economically) according to the seven paragraphs discussed above.

6. The analysis of implementation

The research proceeds with the second procedural step through analysis application on Babylon samples of various functional types (houses - temples - palaces and castles) To explore the detailed indicators for the seven major sustainability indicators:

6.1 The analysis of Babylonian houses

The Babylonians were keen that their homes had beautiful appearances, with their white appearance shining in the sunlight and their floors were covered with layered brick, from the reed wall the brick was born and from the idea of the brick the cob wall was born and with the engineering of the mud the buildings increased in strength and regularity as seen in (fig. 1), and the structure of the engineering system of the houses maintained its form to the present time (Sahib, 2011, p. 53)

- Babylonian House No. 1

The core of the rectangular house plan was the square courtyard surrounded by rooms and the effect represented the center of gravity of the entire building as well as two other effects: the first is the pattern of the walls being connected to each other as they never intersect but only meet each other and the second phenomenon is thick wall blocks compared to the built area and occupy about half of the built area. The house was constructed with air-dried cob, mortar, and stuffing from reeds. The house’s foundation is from stacked soil extracted from the foundations pits, and since the Babylonian, in all of his architectural thinking, always come from the use of square piece of brick, he transferred the solution to the outside and came up with those inlets which are considered like a structural architectural element without breaking the brick as seen in (fig. 1,a) because that means a great loss in that material and in working hours. House tiling depended on the technique of the layers on top of each other and separated from them by very thick layers of dirt as a filling and were coated with bitumen or mortar, and for rainwater drainage from the roof of the house, Cob grooves were adopted (Royters, 1985, p. 86-p.90)

- Babylonian House No. 2 independent two parts

The shape of the expanded plot of land has divided the house into two separate parts, i.e. the double-planned house is independent of each other and the two houses had a common secondary courtyard between them, this house lasted for a very long time according to the excavation, the main plan in northern part is based on the courtyard surrounded by rooms, its floor from The tiles are coated with a bitumen and tilted towards a drain hole leading to a duct consisting of clay rings. As for the walls of the house, there was no continuity and were zigzagged because the path of the plot deviate a lot from its axis facing northward to southward as seen in (fig. 1,b) These zigzags subsequently join with the zigzags of the western wall of the adjacent house to ensure that they are joined together. (Royters, 1985, p. 96-p.97)

- Babylonian House No. 3

Is called The big house as it contains a large courtyard facing south as center and source of air and light as well as two isolated secondary western courtyards, constructed like other homes with cob and brick mortar with layers of stipe tenacissima and wooden foundations, and floors with bricks as usual, and the drainage channel for the drainage of rain water from The roof of the house, also constructed with brick, in the southern wall. Exposed to the facades of the house are the gears that are familiar with their wonderful system and beautiful composition. The architect, when choosing the general direction of the interior walls, did not pay any attention to any of the three street paths, but rather sought to use the North-South direction as seen in (fig. 1,c) . Thus, the biggest deviation (more than 10 °) occurred between the north-south axis of the house and its eastern extension line, so this difference in direction appeared on the external facade in the form of very heavy gears, for the purpose of balancing the contrast of directions as well, and the building materials for the walls were clay covered with a layer of mortar as well. On the lower part is covered with a sublayer of clay and straw, on top of which is a smooth, thick layer of pure clay, and the floor of the courtyards is made of tiles. The solutions were filled with gypsum. On top of that layer was a layer of regular brick, due to the presence of the filling represented by a soil layer (Royters, 1985, p.100-p.105)
The basic plan differs due to the extension of the plot of land of the house to its maximum length along the (middle road) towards the north - south. Its walls were of cob, the southern part includes a main room without back rooms, standing on the south side of the courtyard whose shape is almost square as seen in (fig. 1,d). On both sides of the courtyard in the east and west are some rooms, but it is generally tiled with two layers of bricks, while the northern side of the rooms is empty and there is a wall separating between it and the northern part, and the work of the corridors was adopted in many turns. The walls and the floor of the courtyard were coated with mud and the excavations revealed large amounts of ash beneath it. (Royters, 1985, p. 108)

6.2 The analysis of Babylonian temples
The temples were characterized by regular geometrical forms with clear details, which are often rectangular shapes, surrounded by huge walls to isolate them from worldly worlds, their ribs are facing towards the four sides, and are provided with a coordinated number of dimensions and incomes, their function is to support the walls architecturally, and to decorate their external surfaces with flashes of light and shade. They made sure to coat it from the outside with a layer of pure white plaster, which was constantly renewed, so they were able to give their sacred buildings an amazing luster: the act of their aesthetic brilliance, and worked to strengthen them against the effects of natural factors (Sahib, 2011, p.50)

-Babylonian Temple 1 (Ninmach) -
The temple is located next to the southern palace of the ruins of the palace (Kasr) and the Ischtar - Tor gate through which the procession street of Murdoch passes, and it consists of three layers of land surface at one door, one above the other, all in good condition, the lower part of the brick (Barnstelne) coated with bitumen, As for the second or middle layer, two layers of bricks, then comes the upper ground layer, which is made of bricks (Coldfi, 1985, p.18), and the plan of the temple include (open courtyard, gate with groove towers, vestibule, rooms) as seen in (fig. 2,a). The courtyard represents the center of its plan and is surrounded by rooms, its outer walls were built using Queso techniques and are made of 2 m thick brick and its walls were made with bricks and limestone placed upon the thickest mud layers with bitumen, for protection, and the framing system was adopted in its corners with thick interlocking palm panels. As for the floor of the yard and the floor of the rooms, it consisted of two layers of brick coated with bitumen and built in it as well, and pedals were made of straw as they were placed in the clay cracks to protect the wall from vertical cracks, and each of the walls was finished with lime layers to protect the walls, while the floors were made of two layers of bricks coated with bitumen (Coldfi, 1985, p.14-15)

-Babylonian Temple 2 (Z) -
It consists of layers: the middle layer is normal and underneath it is another layer consisting of double pieces of brick beneath a filling of mixture of sand and clay, the plan is surrounded by walls constructed of cob (Lehmziegel) and using Queso technique that surrounds the building from its four
sides with burnt brick built according to the requirements and conditions of the temple, and its plan is coherent to the site and its topography, as the filling and burial works that reached a depth of 4.75 m in the temple were found through filling the unequal soil quantities and organizing them as seen in (fig. 2,b) (Coldfi, 1985, p. 36-38). The material used in the process of filling and raising the level of the earth’s surface inside the temple consisted of sand and pure clay, in particular, without the need to perform procedures to raise the level of the “arbido”. The reason for carrying out the procedures to raise of the surface of the temple’s land is due to the desire of the Babylonians to keep pace with the natural height of the area Surrounding the City (Coldfi, 1985, p. 44)

**- Babylonian Temple 3 Ipatutella “Ninep”**

It consists of a group of rooms surrounding the courtyard, which is characterized by the transverse axis facing south as seen in (fig. 2,c) the building with towers with double grooves in the temple’s facade, and the inside is made of brick. As for the cracks, they were filled with limestone coating and the outer surface is coated with bitumen, the outer walls are made of bricks with grooves running through them and a thick layer of straw placed in opposite directions and fastened together horizontally and vertically and in turns for durability purposes. As for the finishing, it is made with burnt brick pieces. Its courtyard is paved with brick stones and its floor was raised three times which is nearly 75 cm in each process of raising the water element so it was like a lunge in the plan to provide a comfortable environment (Coldfi, 1985, p. 49-51)

**- Babylonian Temple 4 Izakila (Marduk)**

The temple is a four-shaped building constructed from brick and is believed to be a relic of the Babel Tower surrounded by a double wall in more than one side with a series of rooms that form fortifications of the plan as a whole, and it seems as if there is another double wall that reveals a part of it on the western side and it is located between the exterior wall and ziggurat, the temple have a large inner courtyard and small open courtyards, and there are grooved towers that adorn the inner and outer wall (Coldfi, 1985, p. 81). The building style of the temple is the method of using columns, where the towers represent the column used, and the organization of its plan depends on courtyards (Coldfi, 1985, p. 84) and is characterized by six layers, two layers are attached to each other so that they appear as three layers as seen in (fig. 2,d) in each time the previous used layer is coated with a new layer of sand and much, then the coating layer separating between the earth’s surfaces are not left for long and another till anew layer come from the earth and be placed above it and in each process of raising the earth’s surface to be in level with the house’s roof’s new level, and between all the layers a brick or dust or a space of broken burnt bricks is placed, most of these capsules were empty or contained some dust (between the layers there was either broken bricks or dust places as a filling or is left empty), it was also noted that there was a thin layer of fine red dust above the ground layer that dates back to the time of Nebuchadnezzar and directly above this particular layer we find a strange gradual layer consist of piles of discarded, smashed and burned materials with different broken glass fractures. (Coldfi, 1985, p. 88-90)
6.3 Third : The analysis of Babylonian palaces and castles and their attachment

The status of the Babylonian Palace is like a museum, which includes a large library in it. It has been transformed from a system of royal military forts into cultural and administrative centers of a special kind. The palace (in its core) consists of an open central courtyard surrounded by a number of rooms. The architectural unit is in a unique and consistent system and the architectural proportions several times (sahib, 2011, p. 51).

- **Babylonian Palace 1 (Nebuchadnezzar the South)**
  The construction of the Nebuchadnezzar Palace achieved the highest uniformity in its formation, especially at the intersections and the edges as well as the strong degree of coalescence between the outer wall of the balcony and its thickness is 4.60 meters, and consists of the main royal castle in the central part and the eastern courtyard hall and the western courtyard hall surrounded by a wall, and the rows of rooms and corridors extending around it as seen in (fig. 3) (Abdul Kassar, 2014, pp. 333-334), and All halls and courtyards were reinforced with walls of broken brick and lime mortar and in the same style as the balcony walls, which prepared the solid base necessary for any new wall or for the part extending in front of it and at any required height (Coldfi and Fredrisch, 1981, P15-16) , and the architectural plan of the Southern Palace is distinguished by an irregular rectangular shape, and it consists of five open courtyards, one of which opens to the other (sahib, 2011, p.178)), all building materials from cut bricks and mortar were previously provided as well as the continuous and regular import of building materials that are adapted To deal with the conditions, the lime mortar material is very pure, white in color and extremely hard and was used in the middle and upper sections of the wall. In the lower parts, it is rather gray, and on the edges of the wall, a strip of reddish lime straw is formed, acquiring hydraulic features by adding the red brick powder to it prevents moisture from escaping to the walls and as it found here and there are layers of papyrus over the mortar, and the presence of asphalt in the cracks was limited to the facades of the walls of the rims in the north. Asphalt was used in construction after raising its temperature so high that it always adheres not only to the lower bricks of the lower rocks, but also to the top, adherence is strong, and it is so strong that we cannot even today separate a stone from a stone without breaking the two stones (Coldfi and Fredrich,1981, P18-19)

- **Babylonian Palace 2 Hanging Gardens of Babylon in the Palace of Nebuchadnezzar (Babel Tower)**
  It represents a rectangular building consisting of 14 sheds on top of it is a thick layer of soil and includes vestibule for storing alcohol and in one of its rooms is a well for watering trees and roses as seen in (fig. 4) It was explained that the water was raised from them by a wheel, and excavators have interpreted this building that it may be the hanging gardens that the city of Babylon was famous for and built by Nebuchadnezzar to please his A median wife (Amits), (Finkel,2008,P.23)  The shape is square and its arched sheds bear trees and has balconies, stairs and a spiral to raise the water of the Euphrates (Strabo, 2011, P.XVI).

The Hanging gardens are considered the most famous work done during the era of Nebuchadnezzar and in the history of ancient Iraq, so that they became the title of the Mesopotamia civilization and are considered as one of the Seven Wonders of the World, and they were in the form of surfaces standing on top of each other and each one of these surfaces is later than what was beneath it even as the trees on it were more like Green hillocks with wonderful lawns and lustrous gardens, as there were artificial roads similar to mountainous roads to ascend from them to the top of the gardens, and one of the columns was hollow and inside the machines pushed the water from the river and poured it into the orchards and the ceilings on which the soil and trees were built were built furnished with plates made of cane, coated with two rows of bricks and sheets of lead that prevent the water from penetrating under it if the trees above it are watered as seen in (fig. 5). On top of the lead is the dirt planted with trees (Sosaa, 1986, p. 157)
Figure 3. plan of Nebuchadnezzar the South (Abdul Kassar, 2014, p. 333)

Figure 4. Hanging gardens according to the Heisekrik concept (Coldfi, 1985, p. 134)

Figure 5. The default visualization of hanging gardens demonstrates the technique of raising water up (Dalley, 1995, p. 45)

7. The results
After a descriptive analysis of the samples of the selected Babylonian architecture, research determined a theoretical framework of detail sustainability as well as main indicators were extracted and organized as seen as (table 1).

Table 1. framework of Executive indicators of sustainability in Babylonian architecture (researcher)

| Main indicators | Sub-indicators | Detailed |
|-----------------|----------------|----------|
| Coherence with context | Planning stage | Consistent with site topography | Landfill and burial works for settlement of the site material |
|                 |                | Regulating soil quantities according to the natural height within the region |
| Planner Cohesion | Joining with 3 side | Relationship of the walls |
| Joining with earth | In full | Confluence |
|                  | Part of it | Cross |
| Construction stage | Landfill plan underground | Placement work | In full plan | Part of plan |
|--------------------|--------------------------|----------------|-------------|--------------|
| Material selection | included in site          |                |             |              |
|                    | Off site                  |                |             |              |

**The potential of space configuration of the plan & its elements**

| Spaces planning | open Courtyard | Just one | More than one |
|-----------------|----------------|----------|---------------|
|                 | Courtyard location in plan | center | Off center |
|                 | Courtyard shape | Square | rectangle |
|                 | Courtyard Long axis orientation | south | other |

| Organized Spaces around the courtyard | From all its sides to be the center of gravity of plan | Some of its sides |
|--------------------------------------|------------------------------------------------------|------------------|
| The presence of vestibular and refractory spaces | Intra-spaces such as galleries | Surrounding the plan as a wall |
| harden and sculptures | |

**The potential of Facade composition and its architectural elements**

| Deep Treatments | Items Support and backup | Towers |
|-----------------|--------------------------|--------|
| Shading elements | Inputs | Protrusions |
| Providing air moving elements | Narrow ports that control opening and closing | Oriented the elements to north |

| The nature of the material | From site | Recycling | Off site |
|---------------------------|-----------|-----------|---------|

**The potential of physical composition based on natural resources**

| Nature materials represent the building material | composition | Soil and environment | Clay raft |
|--------------------------------------------------|-------------|----------------------|----------|
| Structural systems | Load-bearing walls | Ceilings | Flat Tribalism |
| Finishing materials | Mortar or milk | Calcine | Stone |

| Properties | Thermal insulation properties | High resistance |
|------------|--------------------------------|-----------------|
|           | Durability properties | Self-bonding |
|           | Economic characteristics | Low cost |
|           | Available in abundance | Does not require transfer |
|           | Formations and customization | Ease of adaptation |
|           | Economic characteristics | Difficulty forming |
| Implementation capabilities and building and construction techniques | Industr y employment | One industry
More (pottery, seals, milk, clay, bitumen, asphalt, reeds, papyrus, wood) |
|---|---|---|
| Availability of technologies | Kisou Layer interconnectedness Wall | Rain water drainage technology |
| The possibilities of preserving the recycling of natural resources | Turning rubble into a new building | Use of household waste |
| | | Use of hills in the area and represent the ruin of overcrowded houses |
| Implement terminations | Adoption of multiple layers | Clay Milk Run Not proud number Proud number |
| | painted Bitumen |

8. General Conclusions
In the context of extrapolating the sustainable indicators of Babylonian architecture in its different eras (ancient, medieval and modern), the following can be confirmed:
- The Babylonians implemented sustainability in Babylonian architecture as it lasted for centuries with clear applicable dimensions and was not a bright concept as we find it today, based on their knowledge and experience with climate data and employing it in setting guidelines for planning, designing and implementing their buildings, as well as using their knowledge of natural resources in their environment and their characteristics to develop technologies Industry and directing it towards practice and implementation, sustainability in Babylonian architecture is a de facto innovation before anything else. The Babylonians continued to develop, achieving their great architecture.
- The Babylonians used the environment to achieve a successful relationship (building-perimeter), so they determined the best approach to their buildings, controlling their location, space organization and their outer cover to face climatic factors on one hand, as well as using only their inherent resources to build buildings that achieves quality and performance to meet the environmental conditions and at the lowest possible costs in which the architecture has always been Re-use of building waste and its ruins instead of permanent consumption of environmental resources, despite its abundance and ease of availability within the construction site, to reduce costs and reduce transport costs on one hand and preserve the right of future generations.
- The problems that the Babylonians faced, foremost of which is confronting the environmental and climatic conditions, were a basic pillar for their adoption of structural, executive treatments that balance their problems at the time, despite their simplicity, but they are at the heart of the problem, not complicated without success, so they crystallized and matured solutions that confirmed their quality in our time today, especially the consequences that glorified ancient Babylonian architecture.
- Babylonian architecture focused on harnessing the resources of its natural environment at the lowest possible cost and did not constitute an economic burden on its people, and a burden on its environment, as its buildings coalesced in its natural context and efficiently, as evidenced by its centuries-old endurance and development rather than retreating from the goals as a result of failure in certain sustainable aspects.
- Babylonian architecture and at all stages confirmed the endurance of its implementation solutions for centuries represented in (the stage of planning - building and construction - recycling finishing up to the maintenance stage as Babylonian architecture did not incur significant costs despite its time limits).

9. Detailed conclusions
With regard to conducting an analytical survey of operational sustainability indicators adopted by the Babylonians to construct the architecture with its various functional patterns (houses - temples - palaces - castles and forts) and compare them, the study concludes the following:
1. Despite the simplicity of the appearance of Babylonian architecture and its endurance without complication, it also includes the complexity in its essence at the level of finding solutions to adapt the architecture to face the effects of the natural environment in the Mesopotamia with the least physical burden and the longest period of time, and this continuity and time limit (throughout the Babylonian ages starting from the ancient era until the present era) is a sure indication of its efficiency.
2. Babylonian architecture was constructed, completed, then sustained and maintained with materials available in nature or previously used materials or that produced by the minds of the Babylonians from its soil, or from what has degraded or damaged as a result of circumstances and wars, as the Babylonians dealt with resources with high wisdom in their respect and respect for the implementation of the concept of sustainability.
3. The implementation of sustainability has been linked to several stages, starting from the planning to the smallest details, which have always produced positive results and as little as possible from the failures that are negligible compared to the gains obtained from them environmentally, economically and socially.
4. The Babylonian buildings affirmed their cohesion with the context of their environment in line with its topography through the work of filling and burying with the same materials of the site and stuck to the land to the point where they were partially or completely underground or their ruins have been used as a foundation on which they were built, and they were organized schematically by connecting all of its sides together except the entry side to reduce the solar exposure.
5. Babylonian architecture focused on defining a method for the formation of its spaces within the plan. Openness to the interior was adopted by adopting the presence of a courtyard that represented the lung of the plan in exchange for fencing the entire plan with thick walls and using it as supporting walls on the one hand and for delaying thermal conductivity during the day as well as including vestibular and interstitial spaces that controlled the air movement to provide a comfortable interior environment.
6. Babylonian architecture handled the exterior walls with high sculptures and hardness, using the environment materials that it developed from the brick to the puddled brick using the Babylonian industries and simple and effective techniques, most notably those related to providing thermal insulation, so it prohibited the making of openings except those that are open to the courtyard and only provided shading elements like frames and extensions that emphasized both aesthetic and functional formation potential.
7. Babylonian architecture adopted flat roofs that are easy to make and achieve the least sun exposure and heat-resistant materials that do not cost transportation costs.

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