

The 3G Architectural Function Bio-indicator

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ABSTRACT

Organism is an architecture entity and integrated system, Handle all the problems we are experiencing in our human architecture. All living things need to adapt in order to survive in different environments. All organisms are unique, but they are also similar in that they all carry out of the life principals and properties which gives it survival attribute in its function. Importance of the research is access to the 3G architectural function Bio-indicator which will lead us to survival Function and the defect in the building. The check list or Diagnoses Tool was reached named ((the 3G architecture Bio-indicator)). Research problem summarized in ((How can we design and evaluate our environmental architectural function efficiency with living or bio-indicators?)). Research aims to Access to 3G Bio-indicator effective strategic tool for existing building function or even function design evaluation. Creative thinkers should also be able to evaluate their ideas themselves before submitting them to decision makers. This will make the idea generation process more focused and increase the quality of ideas. The whole idea management process will become much leaner and more efficient. The research is divided according to respectively the goals mentioned earlier to two Parts, The first part Theoretical analytical approach, and the second part is The Practical approach.

1. INTRODUCTION

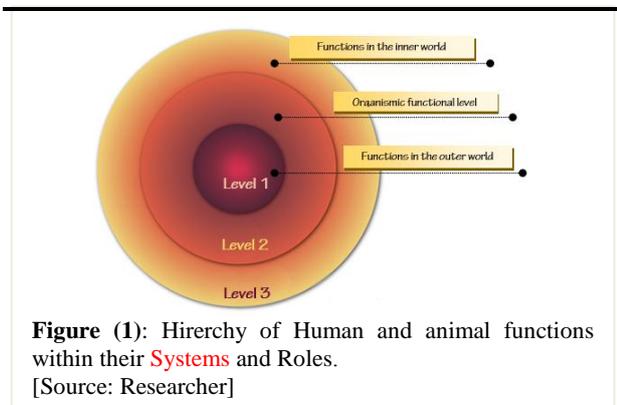
Architecture is an art of creating useful and beautiful spaces, of designing structures where the architecture based on the principles of Utility and Beauty. The unique architectures found in biology have been evolutionarily shaped to perform particular tasks, Functions help the organism survive in its particular environment, and Function should always be gave the highest priority.

Part [1]: The Theoretical analytical Approach [The Divine Architecture].

Adopted of the descriptive and the analytical comparative method, to a statement of the anatomical and philosophical relationship between architecture and the organisms function (animals and plants), through architectural description and analysis of both of them to stand on the similarities and differences.

2. HUMAN AND ANIMAL FUNCTION.

Function in biology is the special, normal or proper physiologic activity of



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an organ or part. [1] Human functioning can be described as follows: Human and animal functioning relates to the behavioral patterns of any individual in the different roles and systems that the individual forms part of within his environment. This schematic will be discussed in three levels, namely as shown in fig. (1):

2.1. Level 1: Organ system level.

The inner world of the human being for example. Anatomically, Humans has a differences, are minor compared to the internal similarity of all humans, as demonstrated by the fact that people from anywhere in the world can physically mix on the basis of reproduction, blood transfusions, and organ transplants. Humans are indeed a single species. Furthermore, as great as cultural differences between groups of people seem to be. [2]

Conclusion: Living organ system anatomically.

Anatomically, in one kind of organism, the internal systems and its function are similar.

The human body is a "machine" that has increasingly complex levels of organization progressing from cells to tissues to organs to organ systems and finally to the organism. The body's organ systems work together to try to maintain a constant internal environment called homeostasis. Many specific terms must be used to accurately describe anatomical landmarks, location of structures, and organizational relationships among body structures.

The human body: consists of many organs, each part of them has one or several functions of its own and every part of it is called an organ.

- The human body organs such as: eye, ear, tongue, heart, and others. Each group of organs cooperate and complement to form what is called (the system).
- System: a group of organs working together regularity to perform a biological function.
- Organ: part of the body of living been has one or several functions.

Conclusion: Living function Hierarchy.

In ascending order Living function Hierarchy to three level, **Organ – Organ System – Organism.** Which is corresponding in the building, **Space- Zone- Body building.**

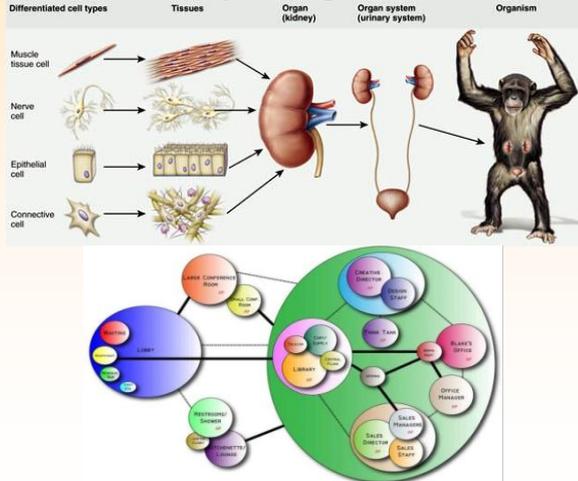


Figure (2): Human Body bubbles functional diagram. [Source: Researcher]

2.1.1. Animals and Humans Organ systems.

If we checked our body from the inside, we will find systems performing different manifestations of life as: respiratory system, digestive system, circulatory system, nervous system, muscular system and others which illustrated in previous fig. (3), these systems cooperate with each other and working regularly to keep the human body alive. Human Function happens from the inside out, not the outside in.

Conclusion:

Living Function happens from the inside out, not the outside in.

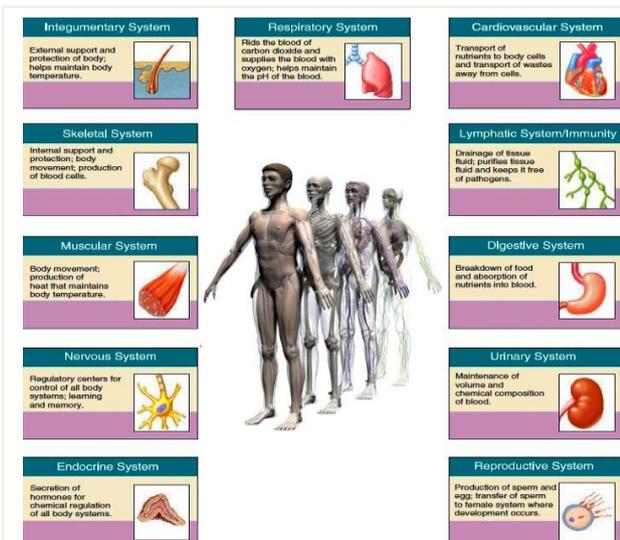


Figure (3): Human body Systems. [3], [4]

Living Systems function.

- The living systems in the human and animal can vary their means but should lead to the same function.
- Circulatory system (Communication means).
- Digestive system (Conserve energy- Conserve water).

- Respiratory system (Provide and regulate Ventilation).
- Immune system (Protect and Defence).
- Skeletal system (Provide support, protection, movement and stability).
- Muscular system (Provide coverage, strength, support and control movement).
- Nervous system (a sensory function [coordinate – control], a processing and an interpretative function and a motor function).
- The Excretory System (removes excess, maintain homeostasis).

Conclusion: Living Systems Means.

- Circulatory system Horizontal and vertical communication means.
- Digestive system Supply system (Electricity, water and energy).
- Respiratory system Ventilation system.
- Immune system Defensive System.
- Skeletal System Structure System.
- Muscular system Coverage System.
- Nervous system Control system.
- The Excretory System Drainage system.

2.1.2. Animals and Humans Organs.

The animals Organs are so many, very diverse and various and different in its functions, but the constant and fixed are the senses, despite there are some senses also vary on the grades and depending to function of the organism such as the fig. (4) Illustrate some of this examples.

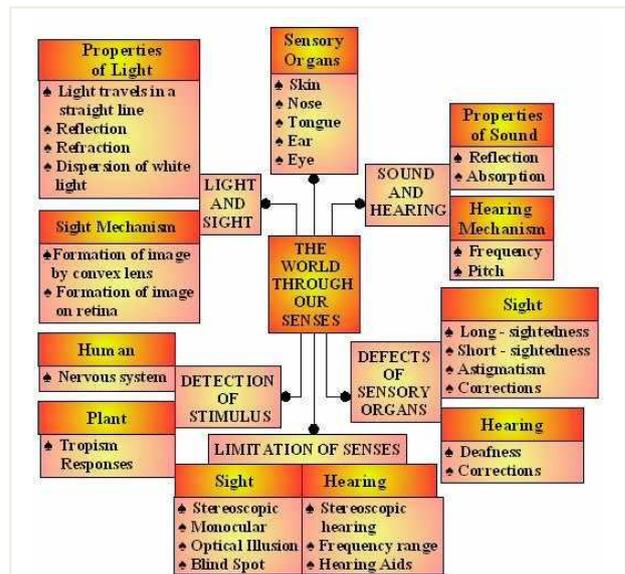


Figure (4): Some animals and Human body Sensory organs and its Functions. [5]

Sense organs allow animals to sense changes in the environment around them and in their bodies so that they can respond appropriately. The five senses are touch, taste, sight, smell, and hearing. [6]

Animals can sense a wide range of stimuli that includes, touch, pressure, pain, temperature, chemicals, light, sound, movement and position of the body. Some animals can sense electric and magnetic fields. All sense organs respond to stimuli by producing nerve impulses that travel to the brain via a sensory nerve. The impulses

are then processed and interpreted in the brain as pain, sight, sound, taste etc. [7]

Conclusion: Sensors Function.

Sensors allow to sense changes in the environment around them and in their bodies so that they can respond appropriately.

Sensory receptors take some sort of external stimulus (light, chemical molecules sound waves and pressure) and converts it into a chemical-electrical message that can be understood by the brain. [8]See fig. (5).

Conclusion: Senses receptors function.

- Inform building that something is wrong.
- Detect light of different wavelengths and the overall intensity of the light source.
- Regulate (Temperature- Vision- chemicals- Acoustics- communication).
- Awareness.
- Adaptation.

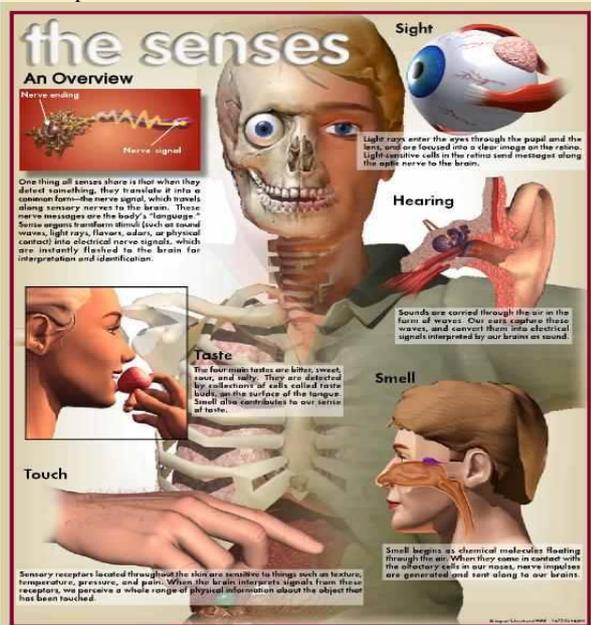


Figure (5): Humans and Animals Five Senses Functions. [9]

- **Touch:** Receptors for touch, pressure, pain and temperature are found in the skin, inform the brain of limb position.
- **Sight:** The eyes are the organs of sight. Spherical eyeballs have walls composed of 3 layers. The tough outer sclera protects and holds the shape of the

eyeball and allows light to enter the eye. The middle layer is the choroid with muscles to control the size of the pupil and hence the amount of light entering the eye. The inner layer is the retina containing the light receptor cells which illustrate color and detailed vision. The lens (with the cornea) helps focus the light rays on the retina. Muscles alter the shape of the lens to allow near and far objects to be focused.

Conclusion:

The living building vision system (eyes) are the window that overlooks the world. The organism control the amount of light entering the vision system. It closes when light is bright and opens when light is dim.

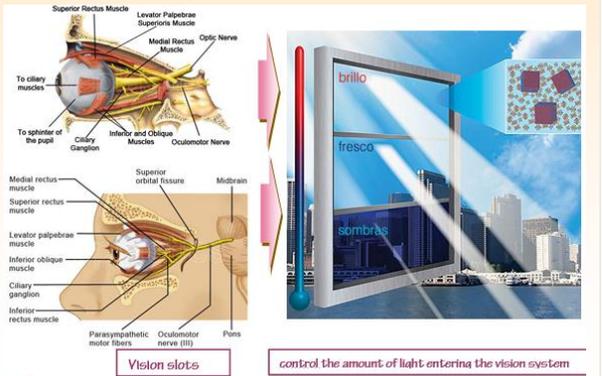


Figure (6): living building vision system. [Source: Researcher]

- **Smell:** The olfactory organ in the nose responds to chemicals in the air i.e. smell.
- **Taste:** Taste buds on the tongue respond to a limited range of chemicals dissolved in saliva.

Conclusion:

There must be a special ventilation slots other than windows and must be treated to act as an air conditioner, cleaning and humidifying the air we breathe in.

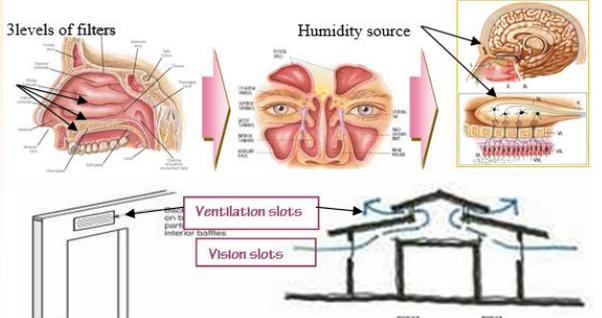


Figure (7): ventilation and vision slots. [Source: Researcher]

- **Hearing:** The ear is the organ of hearing and balance. The external pinna helps funnel sound waves into the ear and locate the direction of the sound. The sound waves travel down the external ear canal to the eardrum or tympanic membrane causing it to vibrate. Receptors in the cochlea respond by generating nerve impulses that travel to the brain via the auditory (acoustic) nerve. The Eustachian tube connects the middle ear with the pharynx to equalize air pressure on either side of the tympanic membrane.

The vestibular organ of the inner ear is concerned with maintaining balance and posture. It consists of the semicircular canals and the otolith organs.

Conclusion:

The living building sound system (Ear) designed in a way we can hear the sounds without any difficulty, as it avoided hearing the nagging voices.

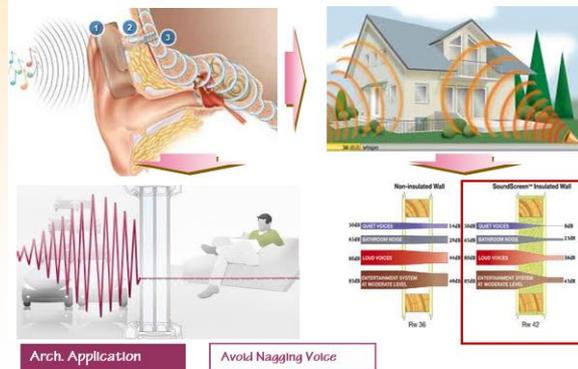


Figure (8): The living building sound system. [Source: Researcher]

2.1.3. Communication between organs and organ systems.

Communication between organs and organ systems is vital. Communication allows the body to adjust the function of each organ according to the needs of the whole body. The heart must know when the body is resting so that it can slow down and when organs need more blood so that it can speed up. The kidneys must know when the body has too much fluid, so that they can produce more dilute urine, and when the body is dehydrated, so that they can conserve water. [8] Communications Means are Vessels. Types of vessels are arteries, capillaries, and veins. See fig. (9). [10] Vessels function to:

- Transport blood and its contents.
- Carry out gas exchange.
- Regulate blood pressure.
- Direct blood flow.

Conclusion: Communication flexibility.

Flexibility of Communication between organs and organ systems is vital according to the n

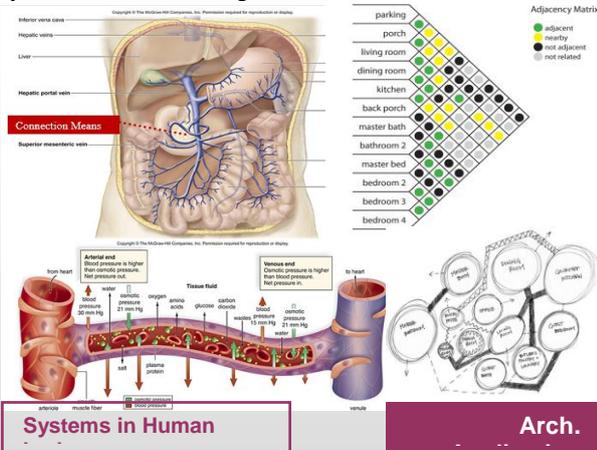


Figure (9): Veins and vessels in Human body. [Source: Researcher]

Conclusion: Communication function.

Communication allows the body to adjust the function of each organ according to the needs of the whole body.

Conclusion: Living Communication means provide multi- function:

Communication means provide Transportation- Carry out and exchange- Regulate- Direct flow.

- Veins and Venules transports blood to almost all of the body's organs and systems. [11]

Conclusion: "Let us begin from the heart"

This is the solution of The Architecture question **Function or Form first??**

In the living, we can't forcing the different architectural functions into one general form, without reference to the inner distribution.

2.2. Level 2: Organismic functional level.

Human in relation to his fellow human, its relation to nature, a person for example works as engineer, employer, teacher, economist, etc. and each time that a person steps into interaction with any of these systems, his functioning changes with reference to the role which he performs at that stage. In animals world also every kind in animals has different a function, also every organism in the same kind has a function.

Conclusion: Level 2 Living Function.

Each Living building including its Organs and its own systems Prepare him to a specific function or several functions.

2.3. Level 3: Population level.

The outer world of the human being. Each human functions within specific systems and then interprets a specific role within each system. Firstly the individual is seen as a system which is in interaction with all the other systems it comes in contact with. Active mutual affects occurs between all these systems. Every human being forms part of a system which consists of various parts that function in harmony to achieve a certain goal, for example family, political system, school, work environment, etc. And the role each individual plays in every system which relates to his place in the system, for example parent, child, manager, employee, etc. Even in animals some other species organize themselves socially mainly by taking on different specialized functions, such as defense, food collection, or reproduction but they follow relatively fixed patterns that are limited by their genetic inheritance. [12]

Conclusion: Level 3 Living Function.

Has a Community and Social function.

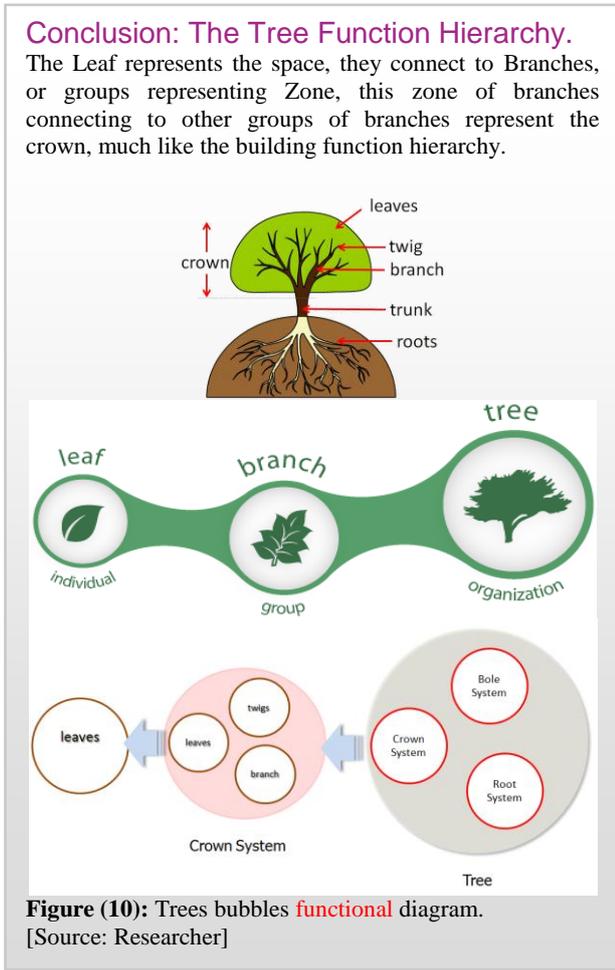
3. PLANT FUNCTION

A tree is a dynamic living organism. All of the various parts and functions of a tree are interdependent. The trunk, crown and roots function together as a balanced system in a vigorous tree. [13]

3.1. Level 1: Organ system level.

Plants have a basic structure made up of three parts that work together to help the plant function. Almost all plants have these three parts: roots, stems, leaves.

This illustration shows the three main parts of a tree. See fig. (10):

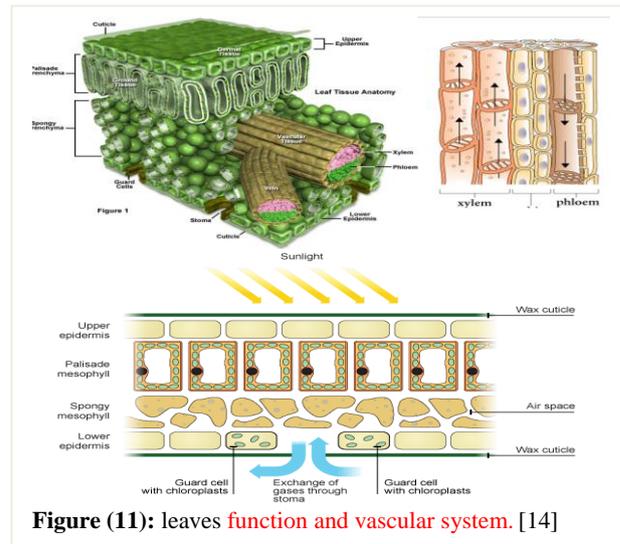


■ **The crown (canopy):** includes the branches and leaves at the top of the tree. The crown shades the roots, collects energy from the sun (photosynthesis) and allows the tree to remove extra water to keep it cool, the crowns of trees come in many shapes and sizes.

■ **The leaves:** The function of a leaf is photosynthesis – to absorb light and carbon dioxide to produce carbohydrates. As shows in fig. (11) The equation for photosynthesis is:

Carbon dioxide and water → glucose and oxygen.

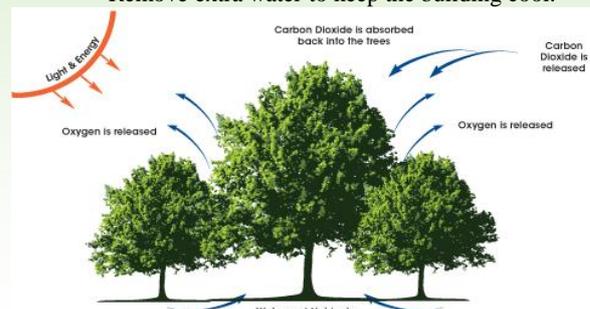
- Leaves are the source of all of food on the planet.
- Leaves recycle carbon dioxide in the air.
- Leaves contain the world's most abundant enzyme.
- Reproduction.
- Storage.
- Transport.
- Hormone production.



■ **The trunk:** is the tree's woody stem. Food and water flow up and down inside the trunk (transportation and Transpiration). [14]

Conclusion: Organ system level provide:

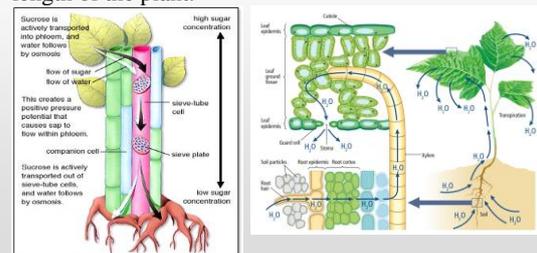
- The source of energy to surrounding.
- Recycle the air.
- Reproduction.
- Storage and Collects energy from the sun.
- Remove extra water to keep the building cool.



Transportation, There are two different transportation vessels. Xylem moves water and solutes from the roots to the leaves–phloem moves food substances from leaves to the rest of the plant. Both of these systems are rows of cells that make continuous tubes running the full length of the plant.

Conclusion: Transportation and communication.

There are two different transportation vessels vertical and horizontal that make continuous tubes running the full length of the plant.



Transpiration explains how water moves up the plant against gravity in tubes without the use of a pump. More water is drawn out of the xylem cells inside the leaf to replace what's lost. As the xylem cells make a continuous tube from the leaf, down the stem to the roots, this acts like a drinking straw, producing a flow of water and dissolved minerals from roots to leaves.

Conclusion: Transpiration.

Transpiration provide water to move up against gravity without the use of a pump.

Table (1) Factors that affect transpiration rate. [14]

Factor	Description	Explanation
Light	In bright light transpiration increases.	The stomata (openings) open wider to allow more carbon dioxide into the leaf for photosynthesis.
Temperature	Transpiration is faster in higher temperatures.	Evaporation and diffusion are faster at higher temperatures.
Wind	Transpiration is faster in windy conditions.	Water vapor is removed by air movement, speeding up diffusion of more water vapor.
Humidity	Transpiration is slower in humid conditions.	Diffusion of water vapor out of the leaf slows down if the leaf is already surrounded by moist air.

- **Roots:** help support the tree in the ground and absorb water and minerals the tree needs to make food. [18]

3.2. Level 2: Organismic functional level.

The tree is plant to perform one or more function as: A forest trees, a shade tree, fruit tree, ornamental trees, deciduous trees, evergreen trees, or act as a windbreak or screen.

An ornamental tree: provides beautiful flowers, and Decorating gardens of vegetative, syphilis and beauty elements.

- **Screen trees:** for Blocking unwanted scenes.
- **Shade trees:** is used for protection from the sun, Shading and decorate the streets and farm roads and places that are meant shadowed.
- **Forest trees:** Extracted from wood, paper, charcoal, many useful rubbery materials, some pigment, oils and others.
- **Evergreens with dense:** persistent leaves can be used to provide a windbreak or a screen for privacy.
- **Deciduous trees:** A tree that drops its leaves in the fall allows the sun to warm a house in the winter.
- **Fruit trees:** A tree or shrub that produces fruit can provide food for the owner and/or attract birds and wildlife into your home landscape. [19]

Conclusion: Level 2 Living Function.

The plant in this level also perform one or more function to benefit its surrounding such as provides shade tree, food, ornamental or act as a windbreak or screen.

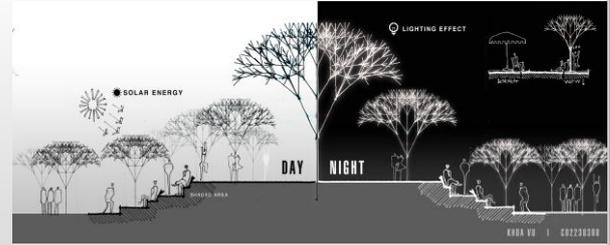


Figure (14): The living building benefits to surrounding. [Source: Researcher]

3.3. Level 3: Population level.

The trees in this level have furnished surrounding with two of life's essentials, food and oxygen. As we evolved, they provided additional necessities such as shelter, medicine, and tools. See fig. (15). Then had increased the functions in population level to include:

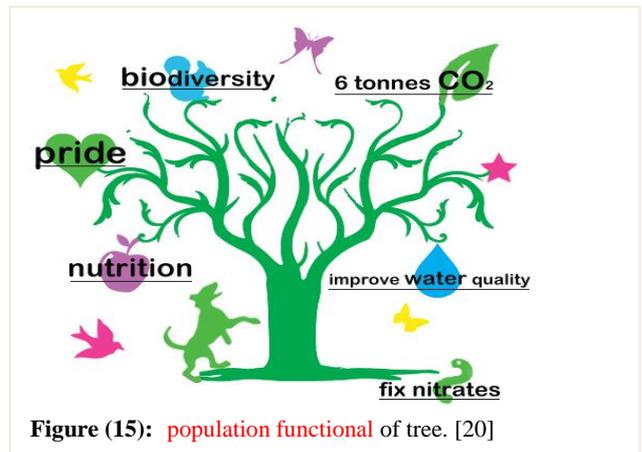


Figure (15): population functional of tree. [20]

■ **Economic function.**

Direct economic benefits come from a savings in energy costs. Cooling costs are reduced in a tree-shaded home, and heating costs lowered when a tree serves as a windbreak."Trees properly placed around buildings can reduce air conditioning needs by 30% and save 20-50 percent in energy used for heating." [21]

■ **Community and Social function.**

The streets, parks, playgrounds and backyards are lined with trees that create a peaceful, aesthetically environment. humans gather under the cool shade they provide during outdoor activities. Using trees in cities to deflect the sunlight reduces the heat island effect.

■ **Ecological and Environmental function.**

Trees contribute to their environment by improving air quality, climate amelioration, conserving water and preserving soil. In addition to influencing wind speed and direction, they shield us from the downfall of rain. Trees also reduce the air temperature and the heat intensity of the greenhouse effect by maintaining low levels of carbon dioxide. Trees absorb and store rainwater which reduce runoff and sediment deposit after storms. This helps the ground water supply recharge, prevents the transport of chemicals into streams and

prevents flooding. Fallen leaves make excellent compost that enriches soil. [21]

■ **Personal and Spiritual function.**

Most of us react to the presence of trees with a pleasant, relaxed, comfortable feeling. In fact, many people plant trees as living memorials of life-changing events. The sentimental value, We often make an emotional connection with trees we plant.

■ **Practical and Commercial function.**

Trees have supported and sustained life throughout our existence. Wood was the very first fuel. Trees provide timber, construction, furniture manufacture, tools, sporting equipment, and thousands of household items. Wood pulp is used to make paper. the bark of some trees can be made into cork and is a source of chemicals and medicines, Quinine and aspirin are both made from bark extracts, [22]

Conclusion: Level 3 Living Function.

in all level of function the plants provide benefits to its surrounding, in the population level the functions increase to include one or more function of the following (Economic function, Community and Social function, Ecological and Environmental function, Personal and Spiritual function and Practical and Commercial function).

Part [2]: The Practical Approach [The 3G Architectural Function Bio-indicator].

This part is to set a List of biological guiding principles criteria by which was abstracted and predicted from animals and plants for the first level of mimicry (the organismic level) and the (function) sub-levels.

4. THE 3G ARCHITECTURAL FUNCTION BIO-INDICATOR

4.1. The 3G Architecture Function Bio-Indicator concept.

In this study the analysis and comparison of organisms functions from an architectural view that create three region, some functional indicators common between humans, animals and plants have been expressed in gray color, and there are indicators a private to plants only been expressed in green color, and indicators a private to the animal only been expressed in golden color.

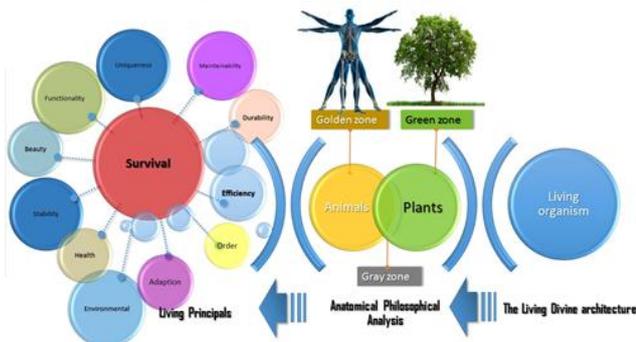


Figure (16): The 3G Architectural Function Bio-indicator Concept.

[Source: Researcher]

4.2. Effective biological Evaluation Criteria.

The 3G architectural function Bio-indicators are a rules and principles of survival architectural function based on biological indicators. This indicator depend on brainstorming session. Having generated a lot of criteria. Then narrow this list down by combining sister criteria and deleting weaker. Then we put the ratios accorging to indicaors importance.

Table (2): Checklist to evaluate living [survival] function

[Source: Researcher]

4.3. Define the Evaluation Process.

After finalized the list of criteria and weight them, the following formula is used to calculate the total idea rating:

A-The G-indicator overall of function percent =

$$\frac{\text{Number of achieved indicators}}{\text{Total number of indicators}} * \text{Impotence weight of G-indicator}$$

B- Function efficiency (AE) =

$$\frac{\text{Sum of [The G-indicator overall of aspect percent]}}{\text{Impotence weight of Aspect}}$$

Generally, scores of 80% or higher indicate the idea is very valuable and worth taking further.

5. EXAMPELS OF BUILDINGS FUNCTION (ADAPTATION FOR SURVIVAL):

5.1. NYC Skyscraper project

5.1.1. Project Basic Information.

Table (3): Project Basic Information. [23]

NYC Skyscraper Project.	
Architect	Ahmed Elseyofi- by IAMZ Design Studio.
Location	New York City.
Climate	A humid subtropical climate.
Project Area	10,000 square foot.
Function	Include residential, commercial, administrative, hotel, and entertainment spaces.
Designed Year	2012

For this project, and as discussed and analyzed in this chapter, the architecture had mimicked the **Photosynthesis in plants.**

5.1.2. Project Living challenge and Bio-analysis. The level of mimicry

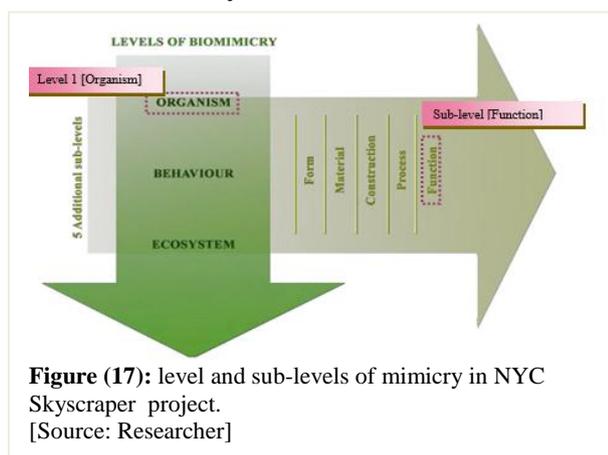


Figure (17): level and sub-levels of mimicry in NYC Skyscraper project. [Source: Researcher]

Architecture Living Function bio-indicators			
Architecture Living Function Gray Indicators (mandatory requirement)	1	Level 1: Has a hierarchy in function space (Space-Zone- Body Building).	From Function Rate = 80%
	2	Level 2: Its internal environment Prepare it to a specific function.	
	3	Level 3: Has a Population level.	
	4	Form fits Function.	
	5	Function strongly influences its design and construction.	
	6	All building living systems are coordinated concurrently Provide Equal Access.	
	7	The Main Systems and Functions.	
		■ Supply system (Conserve energy- Conserve water).	
		■ Ventilation system (Provide and regulate Ventilation).	
		■ Defensive System (Protect and Defence).	
		■ Structure System (Provide support, protection, movement and stability).	
		■ Coverage System (Provide coverage, strength, support and control).	
		■ Control system (A sensory function [coordinate –control], a processing and an interpretative function and a motor function).	
		■ Drainage system (removes excess, maintain homeostasis).	
		■ Circulatory system (Communication means).	
	8	The systems Sensors respond appropriately.	
9	Communication means provide Transportation, exchange, Regulate Direct flow.		
10	Flexibility of Communication between spaces and Zones according to the needs.		
11	Security and healthy systems. Consequently Occupants and Assets.		
12	All systems Provide and Enhance Indoor Environmental Quality.		
13	Assure Reliable Systems and Spaces.		
14	Optimize Operational and Maintenance Practices.		
15	Provide Function and use flexibility		
16	The building has a network of systems with closed cycles and self-sufficient.		
Architecture Living Function	17	Has immune system (sophisticated defense system to protect the building).	From Function Rate = 20%
	18	Sound system provide Acoustics regulation and avoid the nagging voices.	
	19	Has special treated ventilation slots other than windows.	
	20	Has a controlled light vision system, controlled the intensity of the light source.	
	21	Sun louvers flexible and sensitive to control the amount of light.	
	22	Has Internal temperature regulator.	
Architecture Living Function Green	23	Level 1 ■ Storage and produce the energy to surrounding. ■ Recycle the air. ■ Reproduction. ■ Cool and heat the building body.	From Function Rate = 20%
	24	Level 2 provide: accessibility, aesthetics, productive, secure and survival.	
	25	Level 2. Provide: a useful function to the fellow organism.	
	26	Level 3: Has a Community and Social function.	

And this building has a Green living Function

Total function efficiency= 76.5+20=96.5%

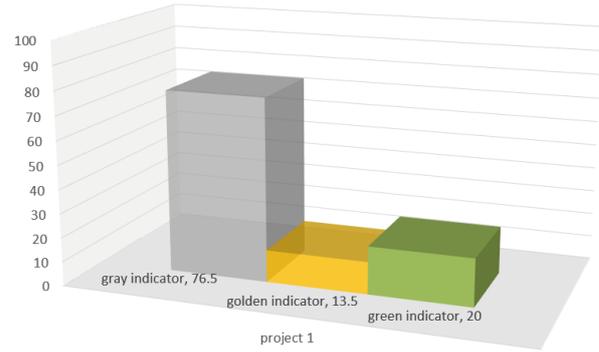


Figure (19): Project Result of evaluation with 3G arch. Bio-indicator (function Ratios).

[Source: Researcher]

5.2. Qatar cacti Project.

5.2.1. Project Basic Information.

Table (4): Project Basic Information. [24]

Qatar cacti Project.		
Architect	Bangkok-based firm Architects GO Group.	Aesthetics
Location	Qatar.	
Climate	Qatar is fairly barren, covered by sand, and receives an average annual rainfall of 8.13 centimeters.	
Project Area	2,500-square meters.	
Function	The office building of Municipal Affairs & Agriculture Minister.	
Designed Year	2009.	

The architects borrowing an idea from the cactus stomata function, the "pores" that the plants breathe through: To cope with the arid, hot desert environment, cacti usually open these only at night when it's cooler. Hence the MMAA's new building in Doha will have a sequence of smart shutters over its entire bulbous exterior, and these will open and close automatically to keep the interior of the building within comfortable temperature levels. The building will even have an attached "bio-dome" structure. This will be packed with plants, each busily converting CO2 into oxygen and adding to the overall "green" aesthetic.

Identify: The challenge: Function

How to convert carbon dioxide into energy?

Define: World of Chlorophyll, a skyscraper that is associated with its photosynthetic function.

Discover and Biologize: The nature model: Leaves arrangement and photosynthesis. As illustrate in fig. (5).

Abstract: Imitates the 'branch and leaf' structure that is associated with its photosynthetic function.

Emulate nature strategies: The Strategy: [23]

Make an Environmentally friendly functions by include natural unit ventilation, direct sunlight exposure, and the creation of indirect lighting. The units take the form of leaves, stemming mainly from the columns.



Figure (18): level and sub-levels of mimicry in NYC Skyscraper project. [Source: Researcher]

5.1.3. Project Result of evaluation with 3G arch. Bio-indicator.

This project concept is to mimic one of plants functions (photosynthesis), how plants convert carbon dioxide into energy. So we were insert the project on a functional standard ruler for survival (**3G arch. Bio- indicator**). **The results were as following:**

The mandatory indicator of function= 76.5%

[The mandatory indicator of function] efficiency =95.6%

The Golden indicator of function=13.5%

[The Golden indicator of function] efficiency= 65 %

The Green indicator of function=20%

[The Green indicator of function] efficiency= 100 %

This is mean that this building has a survival function

5.2.2. Project Living challenge and Bio-analysis.
The level of mimicry

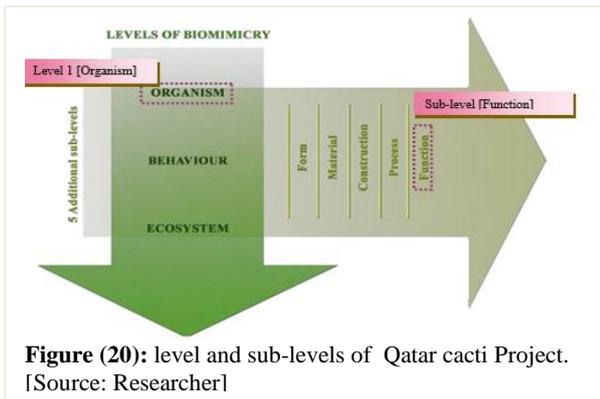


Figure (20): level and sub-levels of Qatar cacti Project. [Source: Researcher]

Identify: The challenge: Living Function.

Define: Building bears and coexist with harsh desert climate.

Discover and Biologize: The nature model: This building taking inspiration from the cactus stomata function and cactus form, from the way these plants deal with the scorching desert climate and successfully survive in hot, dry environments.

Abstract: Building is designed in order to be very energy efficient and utilizes sun shades on its windows. Depending on the intensity of the sun during the day, the sun shades can open or close to keep out the heat when it is too much. This is similar to how a cactus chooses to perform transpiration at night rather during the day in order to retain water. [24]

Emulate nature strategies: The Strategy: Make an Environmentally friendly function by:

- Very efficient energy.
- Utilizes sun shades.
- Efficient shape.



Figure (21): level and sub-levels of Qatar cacti Project. [Source: Researcher]

Analysis of living function:

Level 1: The project has a hierarchy in function space (Space- Zone- Body Building). As see in fig. (22).

Level 2: Its internal environment Prepare it to do (residential, commercial, administrative, hotel, and entertainment) function.

Level 3: The project has a Population level, this is represented in environmentally friendly functions as the plant photosynthesis which is through this Process convert carbon dioxide into energy.

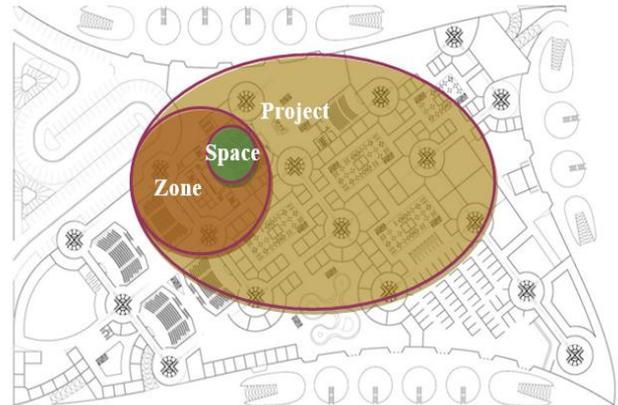


Figure (22): NYC Skyscraper project function hierarchy. [24]

5.2.3. Project Result of evaluation with 3G arch. Bio-indicator.

This project concept is to mimic the cactus function, from the way these plants function deal with the scorching desert climate and successfully survive in hot, dry environments. So we were insert the project on a function standard ruler for survival (**3G arch. Bio-indicator**). **The results were as following:**

The mandatory indicator of function= 69.5%

[The mandatory indicator of function] efficiency =87%

The Golden indicator of function=13.5%

[The Golden indicator of function] efficiency= 67 %

The Green indicator of function=17%

[The Green indicator of function] efficiency= 86 %

This is mean that this building has a survival function And this building has a Green& Golden living Function

Total function efficiency= 69.5+17=86.5%

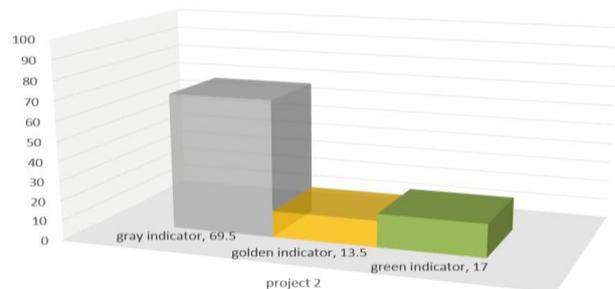


Figure (23): Project Result of evaluation with 3G arch. Bio-indicator (function Ratios).

[Source: Researcher]

5.3. Water Wise Freeway Corridor and Biomimicry

5.3.1. Project Basic Information.

Table (5): Project Basic Information. [25]

Water Wise Freeway Corridor Project.	
Architect	Mike Knowlton and Stephen Cornelius
Location	San Diego
Climate	semi-arid climate
Function	Water usage and collection management.
Designed Year	2013
Architect	Mike Knowlton and Stephen Cornelius

For this project, and as discussed and analyzed in this chapter, the architecture had mimicked **the System function.**

5.3.2. Project Living challenge and Bio-analysis. The level of mimicry.

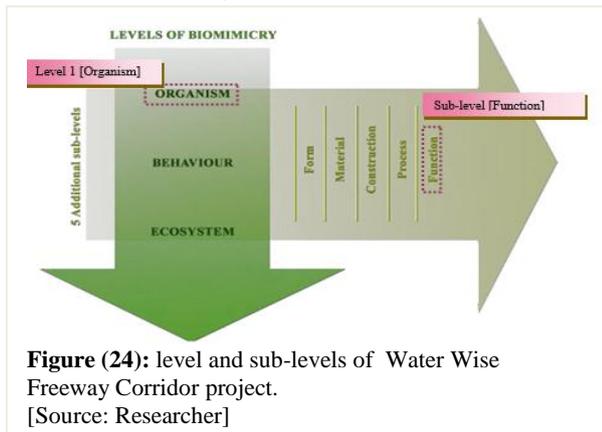


Figure (24): level and sub-levels of Water Wise Freeway Corridor project. [Source: Researcher]

Identify: The challenge: systems function.

80% of San Diego's water supply is imported from northern California, it was crucial to implement a system to collect water runoff and distribute water back to its urban environment.

Define: The goal is to create a sustainable system to access, manage, and distribute water in urban areas around the world with high density and a lack of open spaces.

Discover and Biologize: The nature model: Trees Circulatory and excretory system Function.

Abstract: The system mimics the closed-loop sustainable model of a trees and introduces that model into an urban environment.

Emulate nature strategies: Making the water purification and structural tree system into pre-fabricated modular units allows for efficient global implementation. After being adapted to its local setting, the system begins to remove waste and runoff from the surrounding

environment; it then uses the waste and runoff to give back to the local community in the form of urban agricultural distribution, water recirculation, and community involvement.

They created an integrated system that acts to access, store, and distribute water and energy. [25]

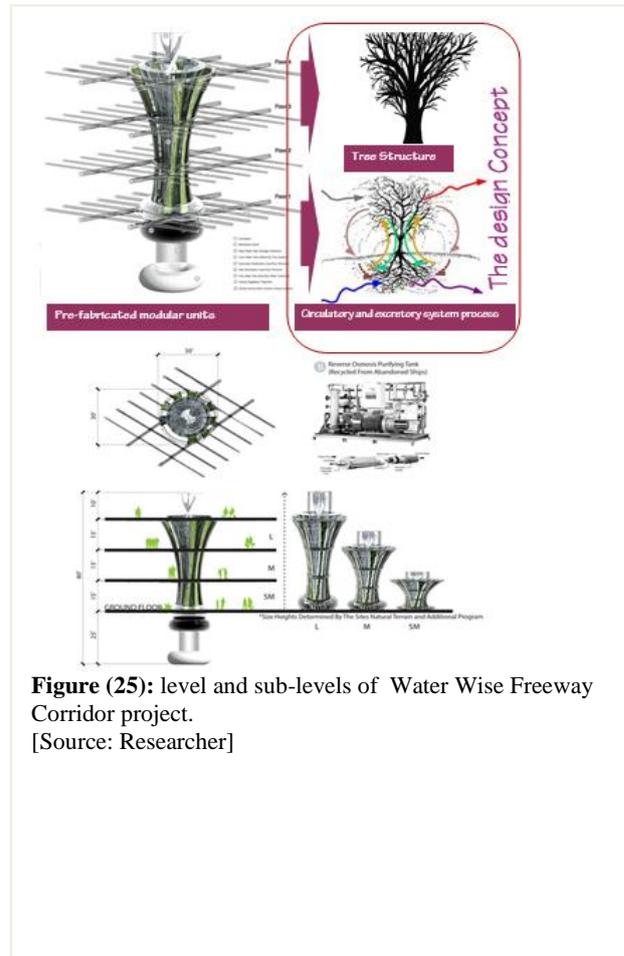


Figure (25): level and sub-levels of Water Wise Freeway Corridor project. [Source: Researcher]

5.3.3. Project Result of evaluation with 3G arch. Bio-indicator.

This project concept is to mimic Trees Circulatory and excretory system Function. The system begins to remove waste and runoff from the surrounding environment; it then uses the waste and runoff to give back to the local community in the form of urban agricultural distribution, water recirculation, and community involvement. They created an integrated system that acts to access, store, and distribute water and energy. So we were insert the project on a function standard ruler for survival (3G arch. Bio- indicator). The results were as following:

The mandatory indicator of function= 73%

[The mandatory indicator of function] efficiency =91.5%

The Golden indicator of function=6.5%

[The Golden indicator of function] efficiency=33.5%

The Green indicator of function=17%

[The Green indicator of function] efficiency= 86 %

This is mean that this building has a survival function And this building has a Green living Function

Total function efficiency= 73+17=90%

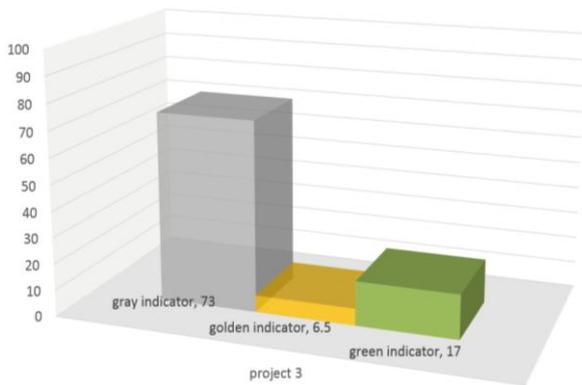


Figure (26): Project Result of evaluation with 3G arch. Bio-indicator (function Ratios).
[Source: Researcher]

5.4. The Over all of Projects Evaluation Results.

- The following chart shows the percentage of indicators of each project achieved in its problem.
- Most of project achieved the mandatory indicators of (Gray indicators) to survival function.

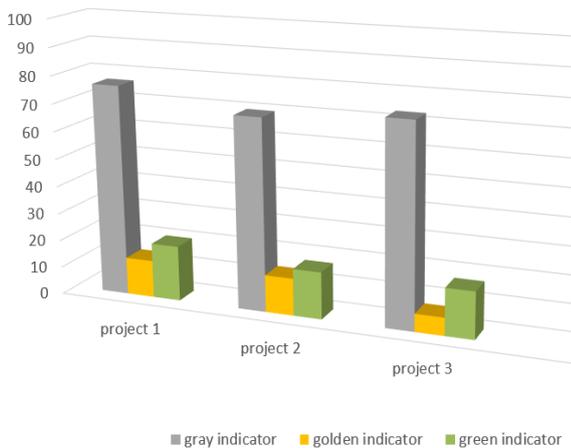


Figure (27): The overall result of evaluation.
[Source: Researcher]

6. RESULTS AND DISCUSSIONS

- The Divine architectural function represented in Organisms have the ability to survive in their environments, this organisms teach us a lot of lessons in architectural function design. The 3G architectural function bio-indicator is an architecture living indicator led us to survival function.
- Diagnoses of 3G architecture bio-indicator is an important stage in our architecture design to reach a survival design.
- The 3G architectural function bio-indicator not only the principals and indicators to guide the architects in their designs or to solve function problems, but also it

can be a tool of diagnose and evaluate an idea or constructed project.

- All of project achieved the mandatory indicators (Gray indicators) to survival, and this is itself sufficient to judge that idea or the building has a successful function design.
- Whenever the percentage increased in green or gold or the two colours this is means that the building is the nearest to perfection in solving all problems.

7. CONCLUSION

- This research is the result of the analysis and comparison of Humans, animals and plants function from architectural view.
- This analytical comparison generate a List of biological guiding principles criteria by which was abstracted and predicted from animals and plants for the first level of mimicry (the organismic level) and the sub-levels (function).
- Research draw architectural biological function basics Common between organisms that is represent the survival indicators towards a living building function. This indicator is expressed by gray colour.
- This indicators orient the building function to be green (closer to the plant), or gold (closer to human and animal).
- This indicators is a guide to design a survival building function.
- The 3G architectural function Bio-indicator is rules and principles of survival architectural function based on biological indicators. This indicator depend on brainstorming session. Having generated a lot of criteria. Then narrow this list down by combining sister criteria and deleting weaker.

8. REFERENCES

- [1] <http://www.biology-online.org/dictionary/Function>
- [2] <http://www.project2061.org/publications/sfaa/online/chap6.htm>
- [3] http://encyclopedia.lubopitko-bg.com/Human_Systems_Work_Together.html
- [4] http://nikolai.lazarov.pro/lectures/2014/medicine/cell_biology/01_Introduction_to_Anatomy.pdf
- [5] <http://www.scorea.com.my/eng/examhall/enotes/AF21511.html>
- [6] <http://www.factmonster.com/ipka/A0776199.html>
- [7] Jillyn Smith, John Wiley & Sons, Senses & Sensibilities, New York, 1989.
- [8] http://www.answers.com/Q/How_do_sensory_receptors_make_it_possible_for_you_to_perceive_external_stimuli
- [9] <http://www.humananatomyposters.com/five%20senses.html>
- [10] <http://classes.midlandstech.com/carterp/Courses/bio110/chap12/chap12.htm>
- [11] <http://www.innerbody.com/image/cardov.html>
- [12] <http://www.project2061.org/publications/sfaa/online/chap6.htm>
- [13] <http://www.aucklandcity.govt.nz/council/documents/hgidecision/hgiapp15.asp>
- [14] http://www.bbc.co.uk/schools/gcsebitsize/science/add_edexcel/organism_energy/photosynthesisrev1.shtml
- [15] <http://www.metrofires.co.nz/why-metro/why-choose-metro>

- [16] http://www.mhhe.com/biosci/esp/2001_gbio/folder_structure/pl/m4/s3/index.htm
- [17] <http://www.leavingcertbiology.net/chapter-25-nutrition-in-the-flowering-plant.html>
- [18] <http://www.insideoutsidenature.com/?p=2244>
- [19] <http://www.fourseasonstreecare.com/default.asp?PID=48>
- [20] http://hoosiergardener.comwww.treesaregood.com/treecare/resources/benefits_trees.pdf
- [21] <http://www.savatree.com/whytrees.html>
- [22] <http://www.mymodernmet.com/profiles/blogs/iamz-design-studio-world-of-chlorophyll>
- [23] <http://inhabitat.com/qatar-cactus-office-building/cactus-building-2/?extend=1>
- [24] <http://www.library.utoronto.ca/see/SEED/Vol4-1/McNeil.htm>