The Impact of Nanomaterials on the Dynamics of Contemporary Architecture

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Abstract. In the late twentieth century, boldness was used in architectural expression associated with construction materials and used within a creative context that expresses the sense and imagination and emotion. It exhibits the behaviour of living beings, reacts to environmental conditions using sensation and arousal of emotion, achieving aesthetic in the distinctive architectural output with the help of computer software and nanomaterials to mimic the shapes and functions of living organisms, embodied in a new generation characterized by contemporary. The research tended to build a knowledge framework that includes nanomaterials, their types and characteristics, and to clarify the concept of dynamism, also included a number of previous studies to find the research problem which was identified by (the lack of theoretical propositions of the impact of nanomaterials in achieving the dynamic potential because of its characteristics, objectives and mechanisms to achieve dynamism in contemporary production) and determine the hypotheses of the research, and extracts vocabulary of the theoretical framework and applied to global projects, the most important item is the mechanisms that included (interaction, adaptation, transformation, movement, information processing using computer software) and architectural characteristics that gave diverse architectural production to achieve a dynamic contemporary architecture.

1. Introduction

The current phase of technological development is unprecedented, and it has become difficult to identify the hallmark of this era, it is the era of nanomaterials, which is the cornerstone of the technology of the present century, where all traditional science and technology failed to provide effective and sustainable solutions to many of today's problems, and hope was held on the occurrence of scientific breakthrough uses new science and techniques having the ability to face these problems and challenges. Thus sciences and nanoscience techniques emerged to face these problems and challenges and provide effective and sustainable solutions, because of its ability to understand the problems and address them early and solve them at the atomic and molecular level, that is, at the building blocks of the material (living or non-living), because of the problems in these small levels. The contemporary architecture took a new approach, changed the way of thinking and reflected the design process to start from the materials to the final form, so the buildings appeared with new forms, giant structures, irregular, complex blocks characterized by high dynamism, variable in their qualities do not have the stability affected by the surrounding environmental conditions, adapt and interact with them, characterized by intelligence of a sensory nature. The research aims to employ the concept of dynamism, including the vocabulary associated with the characteristics shown by nanomaterials to show dynamic behaviour's achieved by mechanisms, types and objectives in contemporary
architectural output.

2. The Nano-Materials in the contemporary architectural product:
The nanomaterials are defined as the distinctive category of advanced materials that can be produced so that the measurements of their dimensions or the dimensions of their internal grains range from 1 nm to 100 nm. The smallness of these materials led to behave differently from traditional materials of large size, and have distinct qualities that can't be combined in conventional materials [1], nanomaterials and their systems are concerned with transforming materials used in architecture into materials with high technological capabilities based on innovation, the production of new materials with high performance levels, and improve the efficiency and strength of the product to get benefit of characteristics of nanomaterials, gives materials with different functions at the level, structure, outer covering, paint and sensors [2], then- materials products include:-

2.1. Structural materials include:
2.1.1. Nano concrete
Silica nanoparticles are added to the cement giving improved mechanical properties [3], and a cohesive structure to obtain the required shapes is called "programmable cement" [4] and the concrete durability is increased to (10) times than the normal concrete. This makes buildings stronger and more resistant to earthquakes [5], and the addition of carbon nanotubes improves the compressive strength and durability of fracture [4], which reduces the dimensions of structural elements using quantities 10 times less, and reduces Cracks caused by shrinking [6] figure 1. The self-healing capsules are integrated into the concrete work to treat cracks if they occur [3] figure 2. Titanium dioxide is combined to gobble up the carbon dioxide that being present in the atmosphere in addition to the self-cleaning property [7] figure 3. and adding optical fiber Figure 4. to get the transparent concrete and gives a new material [8] Figure 5. it can also be converted into a self-sensitive concrete to monitor damage [9].

Figure 1. Phaneo since center in Wellsburg  Figure 2. Nano polymer  Figure 3. Jeobiel church with white

Figure 4. Nano fiber in transparent  Figure 5. Transparent concrete in Italy

2.1.2. The Nano-Iron:
Iron nanoparticles: Some additive nanomaterials are incorporated to improve its main properties. Vanadium and molybdenum are added to improve breakage problems, giving it strength and resistance to breakage problems. The addition of nano- magnesium and calcium particles gives it a high soldering capacity and minimizes cracking and nano copper particles, thus increase the safety factor and reduce the need for monitoring. Nano-paints materials are used (polymers) to protect iron from corrosion [10], and as a result of these new characteristics reduces the amount of reinforcing steel used in the concrete and gives free access to flexible and free forms, large spaces without supporting structural elements and reducing maintenance costs and CO₂ emissions [11] figure 6.
2.1.3. The Nano - Wood

It is used as a structural material for its flexibility and formability and treated with nanomaterials to improve its performance and increase the duration of its use [12]. Transparent architectural coatings of nanomaterials such as titanium dioxide particles (TiO_2 and zinc oxide ZnO_2) are used to absorb ultraviolet rays and maintain the color and structure of the existing material. Polymeric materials prevent wood from corrosion and also act as antibacterial materials [13]. Aluminum oxide prevents corrosion and scratch resistance, Fe_3O_4 triple iron oxide protection from UV rays, and silica SiO_2 gives it rigidity with resistance to corrosion, scratches, and makes it water repellent [14].

2.2 Non-structural Materials include:

2.2.1. Nano- Glass:

It affects the environmental and aesthetic sides and provides internal comfort. The smart transformable glass is used to change its transparency and energy production to get more softness forms with huge areas with the possibility of controlling its softness that alters its properties and its applications [15]. This kind of glass is called a colored glass for including colors-changeable materials and exciting properties called smart materials since they respond and change its color essentially, they are either photo-chromic Figure 8 materials or thermal chromic materials or electric chromic materials [16], also these materials are used as paints giving different architectural solutions, so TiO_2 is used to get self-cleaning glass Figure 9 and reflection preventer [17]. TiO_2 and SiO_2 are used for both water preventer and light incentive to get anti-fogs surfaces [18], and adding SiO_2 between two layers of glass boards to get fire-resistance glass for more than 100' [19].

2.2.2. Nano-Polymers:

They are compounds of polyester or vinyl ester with nano carbon fibers, nano carbon tubes or natural silica tubes, characterized by high hardness, light weight, not affected by moisture, chemical stability, and high resistance to acids, alkalis and solvents and cost [20]. Reinforced polyester can be used as structural carriers used in bridges or in the manufacture of doors, windows, façades and structural systems [22].
2.2.3. Nano-Sensors:
The carbon nano tubes or metallic oxides like (SnO2, TiO2, Zno, WO3) [23] are used in the architectural systems; they are not considered as an addition, but rather they are regarded as complete parts [24]. The Nano-Sensors are used to monitor the concrete properties in earlier stages just like moisture, temperature, stages of concrete development, structure observation, cracks discovery and other physical forces during the life of structure. They are working as an early indicator to observe the structure health before failure [25] and giving dramatic effects to have the building become as a net for living components. Thus, by this way, the building could be more intelligent and everything could be defined by temperature, and color of wall based on the non-visual signals among Nano-sensors [26].

2.2.4. Nano-textiles:
They are integrated with fillers material and carbon -nano tubes (fire resistance) and carbon fiber, polymers are often used to increase the strength, solidness, resistance, friction and conduit. They are painted with Nano materials to provide some functions including Hydrophobic, self-cleaning, anti-spots, and self-sterilization. The Nano-silver articles could be used with the textile to be anti-bacteria nano textile. They could be painted with oxide titanium as a light catalyze that absorbs ultra-violate ray for self-cleaning. There are textiles specializing into generating the energy depending on light elements integrated with the textiles [27].

2.2.5. The Nano-lighting:
New lights systems use light emitting systems by using the LED technique [28], smart lights (its properties alteration or light color), the lamps could be integrated with smart materials just like polymers (for form) or could be integrated with nano-organic uncles gatherings that give huge capabilities for the functional surfaces of magnetic electric paints that affect the light reflection, these techniques could be integrated with windows to make them as light systems more efficient to improve the internal climate and energy used, it could also invested with wonderful designing methods to reflex a definite thought [29].

2.2.6. The Nano-solar energy:
The solar cells are used to transform the solar energy to the electric energy like the light silicon boards, soft membranes and polymers films or plastic solar cells with low cost depending on the Nano-particles and polymers, the soft films are characterized with flexibility in a way that could be integrated with the construction components to surmount aesthetics fears faced by the architect by using solid surface boards that could be difficult to be integrated with the building [30], also soft organic films that contain an organic color giving high light electric response [31].

2.3. The Nano-Materials Properties:
2.3.1. Architectural properties including:
1°: aesthetic form properties:
The Nano-materials could use new thoughts unknown previously and they are characterized with properties and untraditional functions; they include thoughts and future methods of Nano technology in architecture and constructions to get buildings growing from the Nano-scale into Metric (Nano to meter building) and the buildings would be self-erecting one. This method works to control and to observe the construction at the Nano-level depending on the Non-material technique and Nano-
biology, relaying on digital sample (BIM) for triple construction details [32]. The design starts from the construction into image (from bottom to top) ; the strength of these basic principles focus on new aesthetic sides with emotional effect that could be expressed as a new term and method via a modern technology that could be used as a poetic imitation not functional one, having its aesthetic, creative, sensual and imaginative role. This technology is characterized with self-organization, self-coordination as to get close to the nature and properties of the living systems requiring new materials to produce a future architecture with new scientific techniques of Nano -Technology and sciences of materials [33].

**Intellectual Changes:** The smart Nano-materials have given intellectual changes for wonderful innovations concerning with the architect and designers. This came as a result of Nano-technology development that made the architectural solutions for new projects real and future project are in progress [34].

2nd. **The Visual Properties:**

The Intelligent Nano- glass has visual properties, it is self- color change, it is of High transparency, its color get changed when exposing to the strong light, also the light- breakers polymers having the ability to move its charges by light or by exposing it to the electric domain. In this process any materials could not be carried out without being processed by Nano domain [35]. The Nano- materials emits lights and alters its color and it is one of most concerned materials represented in the technique ( LED), it includes plastic slices emitting light [36]. The Transparent concrete integrated with the nano-visual fiber known as light-emitter concrete are used for aesthetic purposes and achieving changeable visual dynamics around a day [37].

2.3.2. **The functional Properties:**

1st: **Structural properties:**

Using intelligent materials with the cement improve the mechanical and physical properties (solidness, stiffness, control in water ratios and the methods of mixture and solidness) to get the best appearance for the concrete, with high ability of bending (curve) having unique properties (strength, flexibility, stiffness, aesthetic design); besides, it carries self- healing properties, especially parts that are located near the natural level of earth or the earth that being watered with water [38]. In respect to the Nano-iron, it is characterized with properties in respect to the strength (3 times stronger than the usual iron), corrosion resistance, welding ability, low cost, high performance to get designs of light weight and solid at the same time [39].

2nd. **Non-Structural Properties:**

The surfaces become self- cleaning, maintenance easiness, water and scratches resistance, less exposing to dirties accumulation, anti-fog surfaces, anti - reflection surfaces to protect from ultraviolet ray by adding nano materials and materials characterized with sound isolation and anti-writing surfaces and anti-thumbs surfaces, while the anti-bacteria surfaces would be either paints or added materials and fire resistance materials [40].

3. **Concept of Dynamics:**

3.1. In the Foreign dictionaries:

The word (Dynamometer -Dynomo- Dynam) refers to a strength and the term (Dynamic) refers to (Dynamics or dynamical) having relation with the strength or the natural energy, the term (Dynamical) refers to a thing characterized with continuous activity or continuous alteration. In general, Dynamics is a branch of Physics searching for strength in the movable and immovable bodies' altogether. The motion strength is natural either be moral or intellectual [41].

Dynamics: means an energy, strength, a huge activity, the dynamics ensues from two sources (physical and Biological) passing through anthropological fields, as it came in the encyclopedia of philosophical. Land: Dynamics opposite to quietness not include movements connected according to
the laws, but it also includes an active, motion and dynamic strength [42]. Dynamic is characterized with continuous activity - motion - teemed with vitality.

3.2. In Arabic Dictionaries:
Dynamic is mentioned through synonymous like (the movement, growth, development, continuity, transformation, alteration, sustainability) they are interpreted into (Dynamic or dynamical) the al-Mujd dictionary indicated the concept of dynamic by stating: Dynamo (movement): it is a machine that converts the mechanical energy into electric energy, dynamic: strength, actively motivated.

Dynamical: it is a state of dynamic (a philosophical doctrine does not acknowledge physical elements, but with strengths that identify its work as well as bodies and its aspects; philosophy of Aristotle was dynamic and known as objective philosophy in Arabic[43].

3.3. In the different cognitive fields:
3.3.1. Literature:
For each literary work has its own dynamic, it could not be understood unless by studying its former development and its internal structure looking for future. It is a dynamic work having its own past and moving toward future, it could be understood unless studying its own structure. This field is doubled processes that aim to destroy old structure and building a new structure [44].

3.3.2. The philosophy- dynamics:
It is a philosophical doctrine in relation to mechanicals or machinery and it is called as a doctrine (Libintz) that interprets all physical phenomenon with force unrelated to quantity and motion; it is a dynamic doctrine that indicates the existence moving by its own self [45]. It is a theory indicating to be there an intent strength in the substance as that mentioned in the dictionary of meanings.

3.3.3. The art:
The Dynamics appears in the artistic work by using curve lines, waving forms and element of light. With these essential elements taken from the universal movement, making everything in the universal moving and changing in a continued form and the movement is compared with the light working on destroying the forms to uncover what is behind them and they are in state of integration [46]. It used the dynamic formation that sends the motion in a full space it includes and it does not succeed unless the motion of every detail is consistent logically with the total movement [47]. The dynamic formation is used many of sloping lines and they are worried and that lead to feel with the movement, energy and excitation [48].

3.3.4. Physics:
The concept of dynamics is taken from physics and it means the motion and development, the development does not mean unidirectional movement, but it means the slope, on other word, transferring or transforming from a state into other either be in a periodical or linear or forwarding or back warding. This necessitated a space it moves therein and time where this transform could be achieved [49]. The dynamic loadings affect behavior of establishments in way that is not less important than the static loadings where changes are carried out slowly. The loadings include persons, wind, earthquakes, and explosions; establishments exposing to these loadings are studied thus the dynamic load is the load that changes its stiffness or its direction or its point of application as a speed with the time [50].

3.3.5. Mathematics and Algorithms:
In architecture methods for establishing designs are appeared led by technology and computer by using algorithms. The algorithms design specifies establishing architectural designs through computation description. The architect builds the program on which the digital sample depends, the process of Algorithms design is described as (producing architectural samples from written programs by the architect). The process of design produces parametric samples through mixture of geometric figures to illustrate the thoughts [51].
3.3.6. Biology:
The developing biological theory is considered as a basic source for dynamics [52] and contributing with the concept of self-organization which is an ideal state between the solid system unmov-
ing, idle to change without being destroyed from one side and between continuous renewal without any stability occurred for chaos, changes permit to appear new aspects. These aspects could be a structure or a new behavior [53], the development changes lead to happening adjustment with the environment [54], the adjustment is the main organizational principle or the unique one for life [55].

3.3.7. The dynamic system:
It is a tool or motion machinery, by this concept, the elements and existences are thus described in the world. Every element in the universal and the world is a tool or machinery or interfered dynamic system working by depending on each one. The dynamic systems or movement mechanisms are not only visual, but there are indirect included systems. The dynamic systems (moving) are unstable since they are not ideal, but they suffer from lacking; the system tries to compensate that and it is the cause of its motion and of its interaction with other elements existing in its environment. Any biological or physical system could not be stable owing to shortage in its design and its state and this makes the system in state of motion and it does as a role to defend the motion by minimizing this shortage relatively [56].

Dynamics appeared with many synonymous in all life fields and its bases, taken from biology being characterized with the, it is a system dealing with the forces causing the motion as an opposite to motionlessness. motion impression, the movement affecting the bodies are either intent forces or outer effective forces, the forces are organized to produce the dynamic action through specific behaviors represented in (growth, continuity, interaction, development, Adaptation) owing to the feeling of shortage to get to the ideal state, it is appeared a developed state different from the former state with preservation of type and symmetry among the system components it is considered as an adjustment development and it is one of the essential systems laws.

3.4. Dynamic mechanism:
The Dynamics is a system that could be fulfilled by a number of behaviors (mechanisms) to transfer from one state to other interfered, working by depending on each other [57] depending on mechanisms taken from behaviors of living creatures [58]. The environment where human lives could be dynamic and requires developed techniques based on its execution concept [59] achieved by the nano-materials having the ability to create dynamic systems through mechanisms and as follows:

a- The Adaptation as a means for response for different functions and uses many thoughts are linked to it, including direction (known as it is the growth and motional transformation of living creature (often be a plant) as a response of environmental incentive to the light or to the sun ray.

b- Transformation: it is changes in the form, size, formation or appearance.

c- Interaction in and outside the building [60].

d- The change: it is a developed process that affects the structure of creatures and its functions and its behaviors and it is the cause of adjustment development [61], it is continued renewal without any stability and there is not to expect any new details, and it allows reaction to unexpected disturbances resulted from unexpected [62].

e- The movement: it could be either a movement affected with outer forces or a movement within the structure of substance (nucleus level) [63].

f- Information processing: by using computer on level of design and implementation (Johanson, 2002).

3.5. Types of Dynamics:
The dynamics is embodied in architectural production with multi-types including the motion dynamics its importance appears by reflecting the aesthetic, psychological and environmental effects that could be expressed about new visions achieved by the technological progress; it is classified into intellectual motion (intent dynamics), the motionless motion is non-physical movement represented in the expressional form of the movement or the objective dynamic movement (visual field), it means dynamics of alteration in "the time" represented with the 4th dimension in the design. It could alter
the building by the movement of some elements constantly or inconsistently. The movement comes from dynamic human awareness of the form and making the building moving by integrating information technology and digital environment with the physical environment [64]. The visual awareness could be also affected by the surfaces and discrepancies in the light and the effectiveness of time changes on the physical field. The artificial and natural lightings add depth to the geometric figures, the light of the day penetrating into the internal space transforms constantly into formations of light and shadow to produce visual effects, the effect either be dramatic or dispersed with time passing [65]. The dynamics of non-similarity that could be achieved by surmounting what is traditional as an experience touching the aesthetic parts of fun by adding symbolism to the building and radically getting away from what is familiar or it might appear a state of integration between what is familiar and what is new as a source for delight [66].

3.6. Dynamic goals:
The architectural movements are depended on the creative design to take into consideration characteristics of materials and its properties to appear them in outstanding form [67], directing toward the nature, using waving forms, flowing lines and changeable rhythm [68] to be as a source for fulfilling dynamics. The digital techniques have affected on many life fields, especially the artistic and intellectual creation; it is not only considered as a form transformation, but it becomes represented one of the contemporary intellectual system structure elements for having new visions for the human thinking [69]. This helps integration between the science and Nano-materials technology to get non-linear and complex buildings [70] characterized with aesthetic values and different forms connected with the nature [71] and its functional systems. The aesthetics and the function are connected each other non-separated [72] and the pure aesthetics appear on the Nano-surfaces to achieve different functions that reflect on the building [73]. Through the light weight and little thickness grant it a visual appearance that helps to establish coherent architectural components [74]. The sustainability is taken to fulfill the aesthetic side and as a system interacting with the environment, thus environmental processes have been used to get benefit of the natural energies [75].

It has appeared frontals having the ability to move to change its form or change its coverage for the building, giving dynamic visual effects. High technique glass has been used having the ability to control its softness and its color; its activity might be increased by granting it the ability to move and motion [76].

The Dynamic goals lie in getting buildings of multi-complex structures, carrying in its formations ability to perform vital activities for living creatures, originally taken from biological field and being achieved with multi-levels including intellectual, form, aesthetic and functional level and by help of nano-materials that being described as an intelligent one.

4- Former studies:
4.1. Study of (Harba and Murhaj-2017) (The Architecture under the technique of Nano)
The study is concerned over the Nano-architecture that changes methodology of architectural design to start from the materials firstly that became the indicator to the designing thought, created new forms depending on the biological activities characterized with flexibility, vitality and dynamics as well as artificial intelligence, changeable, could be controlled, fulfilled the intelligence by integration between nano-materials integrated within the structure of the building and its different elements with the technique of central computer system controlling the management of the building and reinforcing the internal environment and increasing the actual performance of the building toward the natural environment reaching to the expressional architectural formations seemed to be impossible to be achieved, and providing huge capabilities in designing the architectural formation, flexible blocks organized or complex spread horizontally or extended to high heights unfamiliar previously. The nano-materials contribute into improving the performance of the construction materials and pavement and increasing its environmental and formational efficacy and granting them additional functions like the self-cleaning frontals and controlling the process of entering sunlight and minimizing temperature inside spaces and producing energy. Thus, the cover of the building become interacting with different levels of intelligence with weather variants and transforming into a motional dynamic system adjusting.
with the needs of building and users, taking into consideration the environmental aspects to diminish the energy, to improve the internal and external environment and to remove pollution from the natural environment (sustainable architectural) and materials used either be structural materials like concrete, iron, wood or finishing materials like glass, polymers, paints and ceramics.

4.2. Study of (Parthenopoulou and Malindretosa-2016)
(The use of innovative materials in innovative architectural applications)
The study has shown the role of the nano-materials to provide new capabilities that affect the design and architectural applications to establish high buildings, using self-gathering specialty; it is of intelligent materials achieved by new techniques to create intelligent systems for the external structures to perform multi-functions. Carbon materials are used with structure materials to grant it more strength 100 times more than iron, achieving strong structures with light weights and self-improvement buildings and improving the traditional materials resistance to corrosion, water technique, operating devices that depend on body temperature or through the motion, energy production, air technique; these materials are characterized with an ability to transform based on the external climate conditions. The internal climate forms aesthetic dynamics via colors change and softness replacement using the nano-paints and either be soft layer on the glass surfaces or tissues surfaces to protect from the solar rays or layers from the Nano-articles that connect with the basic material to provide properties (isolation, spots resistance, pollution, scratch, self-cleaning, germs countering, corrosion, water leakage prevention), or using nano-sensors that could be integrated with the construction materials to observe the biological and chemical effects and to interact with the control sensors to provide information to the observation system. The Nano-robots are considered as a means to uncles geometric products having abilities special capabilities (intelligence, cooperative behavior, self-collection, reiteration, and information processing, programming and discrepancy surface), of its applications are the valves emitting light and solar cells. The development of biological researches and nano-researches contributes into collecting and developing systems imitating the nature in field of architecture.

The nano-materials give buildings high performance on the structural level and granting the architectural components additional functions taken from means of nature work.

4.3. Study of (Schodek, Ferriar, Ashby -2009)
(Nano materials, Nano technologies and design an introduction for engineers and architects)
The study divided nanomaterials according to their uses, namely:-

1\textsuperscript{st} functional nanomaterials: which are related to surface behaviors, because of the importance of surface properties such as self-cleaning and can either make the surfaces either hydrophilic or hydrophobic or through photocatalysis which makes concrete surfaces, glass, paint, tiles, self-cleaning textiles and anti-pollution or anti-bacterial materials using Paint, nanoparticles, nano sealants, nano adhesives, nano porous materials, nanotextiles.

2\textsuperscript{nd} Intelligent nanomaterials: that are associated with properties, Variable properties use a range of sensory techniques that have the ability to respond to one or more optical, electrical, magnetic, mechanical or chemical reactions that show beneficial effects when external stimuli are present and possess a range of sensors and operating devices. Intelligent behavior (smart materials) is a visible change in some properties of the material, is the behavior of the dynamic material that is linked to the properties of different material. At the level of structural material Silica improves the link between the constituents of concrete, and silica with iron oxides nanoparticles gives it strength. The addition of mineral fibers and polymeric materials to obtain a self-healing or self-repairing structure used as capsules get hardened when stimulated, active synthetic systems have the ability to report phenomena occurring by the environment, distortions, deviations, cracks, vibrations generated by winds and earthquakes. They are intelligent materials that provide information on the location and type of damage, and there are systems that provide a response through damping systems. The compound systems either be integrated (nano sensors) or control systems depending on computer. There are many of control, observation and communication systems, lighting and environmental systems.
The study included nanomaterials and techniques in order to deepen knowledge for design purposes and their applications in architecture, and is either making small functional devices or improve the performance of architectural components by taking advantage of distinct characteristics, which appear when exposed to different types of external influences. Architecture has changed from static to dynamic and has given life to buildings to meet functional, environmental and aesthetic requirements.

All architectural studies mentioned above did not address the uses of nanomaterials in achieving the concept of dynamism, but tried to employ the concept according to a perspective is not inclusive of all the vocabulary contained in it. The contemporary architecture is achieved by using mechanisms, types and objectives of the dynamic not referred to studies. The problem of research has emerged (the lack of theoretical and local studies of the impact of nanomaterials in achieving the dynamic potential of the characteristics, objectives and mechanisms to achieve in contemporary architecture).

To solve the research problem, the research assumes the following:
- The main hypothesis: The nano materials achieve form, structural, performance and environmental properties through mechanisms that fulfill dynamics in the contemporary architectural product.
- The 1st secondary hypothesis: The Nano materials achieve unfamiliar form properties to ensure a type of natural and vital dynamics through mechanisms of transformation and alteration.
- The 2nd secondary hypothesis: The Nano materials achieve properties granting the construction structures components more strength and more lighter weight via mechanisms of the adaptation and motion.

5. Conclusion of Theoretical frame vocabularies:
It is explained that the type of nano-materials and its properties has a huge effectiveness on achieving mechanisms, types and goals of the contemporary architectural dynamics.

The main and sub- Items with its values from the theoretical frame have been concluded as in table no.1:-

| Item no. | main Item | Secondary Item | Possible values                          |
|---------|-----------|----------------|-----------------------------------------|
| 1       | Types of Nano Materials | Structural materials | Concrete               |
|         |           |                | More durability                   |
|         |           |                | Preventing trophy & fail            |
|         |           |                | Self-repair                         |
|         |           |                | Preventing penetration of water      |
|         |           |                | Report about problems               |
|         |           |                | High strength                        |
|         |           |                | iron                                 |
|         |           |                | high strength                        |
|         |           |                | More efficiency                     |
|         |           |                | Resistant corrosion                  |
|         |           |                | Glass                                |
|         |           |                | Light and heat control               |
|         |           |                | Self-cleaning                        |
|         |           |                | Fire resistance                      |
|         |           |                | paint                                |
|         |           |                | Self-cleaning                        |
|         |           |                | Anti-reflect                         |
|         |           |                | Self-repairing                       |
|         |           |                | Strength and hardness                |
|         |           |                | Films and polymers                   |
|         |           |                | Regulate lighting                    |
|         |           |                | Thermal insulation                   |
|         |           |                | Sound insulation                     |
|         |           |                | Improve electrical conductivity       |
|         |           |                | Aesthetic Shapes and                 |
|         |           |                | Developing buildings                 |
|         |           |                | creativity                            |
| 2 | Architectural Properties of nano materials | feature | Intellectual change | Non-realistic projects |
|---|---|---|---|---|
| | | | Visual changes | Future projects |
| | | | Changes in Transparency | Half |
| | | | | Transparent |
| | | | | Transparent |
| | | | Synthetic lighting | Light materials |
| | | | | Glowing screen |
| | | | | Using shadow and light |
| | | | Pressure and stress resistance | Light weight |
| | | | | Thermal insulation |
| | | | | Elasticity in the formation |
| | | | | High performance |
| | | Functional properties | Self-cleaning |
| | | | Self-repairing |
| | | | Resistant corrosion |
| | | | Thermal insulation |
| | | | Fire resistance |

| 3 | Mechanism of dynamics | Transformation | Shape |
|---|---|---|---|
| | Movement | Volume |
| | | Color |
| | Movement | Movement effected by external forces |
| | | Movement in molecular level |
| | Adaptive | Orientation |
| | | Movement |
| | The change | Evolutionary |
| | | Adaptive |
| | | Predictive |
| | | Probabilistic |
| | Information processing | Design |
| | | Implementation |

| 4 | Kinds of dynamics | Mental movement |
|---|---|---|
| | dynamic Movement | Objective movement |
| | | | folding |
| | | | sliding |
| | | | Zoom in |
| | | | Zoom out |
| | | | Transformation |
| | Structural movement | Effected by external forces |
| | | Adapt the structure with external elements |
| Natural lighting dynamics | Dramatic effects | Direct          |
|--------------------------|-----------------|----------------|
|                          |                 | Indirect       |
| Non similar dynamics     | Using non-linear areas | Combination between systems and random |

5. Dynamic objective

| Mental and artists creativity | Wavy shapes | Flow lines | Changing rhythm | Orientation towards nature |
|------------------------------|-------------|------------|------------------|----------------------------|
| Access to aesthetic values   |             |            |                  |                            |
| Access to functional values  |             |            |                  |                            |
| sustainability               | Keeping nature | Interaction with nature |                  |                            |

6. The 2nd axis

6.1. The Practical study:
The theoretical frame items will be applied to a number of projects selected and that includes application of different Nano-materials including the implementation projects and future imaginative projects.

6.1.1. The trusted measurement method:
The analytical descriptive method and its application to the selected projects has been depended on.

6.1.2. Applying the scale to variables:
Specifying values of measurement for variables between zero-unfulfilled value, while 1= the fulfilled value. The statistic mean rates for all values will be depended on for the purpose of measurement and the projects will be inserted based on its arrangement from 1-3 and as that will come later.

1st. Italy Pavilion Milan Expo-2015. (The Italian architect / designer: Nemesi and Partners)
Geometry of the outer covering is unique and represents a rich texture of unplanned branches, which sheds natural light on the sculpted forms to be a building inside a building [77]. It consists of active concrete panels that have photocatalytic properties when they come into contact with light that capture pollutants from the air and turn them into salts. It reduces smog, they are self-cleaning materials and the concrete contains pieces of white marble type Carrara gives stronger gloss than white cement, it is a very dynamic material helps in the design of streamlined forms similar to the complex forms in the paintings in the Italian palaces each it has its own design. The active concrete also has been used in the middle space, the dynamic is obtained from the internal surfaces rising upward to complement the aesthetic impression of the external facade and the continuity of the concept of urban forest, the upper roof represents an innovative sail to form an umbrella outside the glass ceiling [78] with flat geometric curved square steel containing photoelectric glass Figure 13.
The reflection of night lighting from and on the outside dispute gives the building high dynamism and expressive power. Photoelectric glass in the upper ceiling of the middle space and dynamic verification of natural lighting and solar energy gain. The dynamism formed by the outer shell in oblique formations and flowing entanglement in various forms and its aesthetics as a product of the use of active concrete.

Figure 13

2nd/ The Bach Multidisciplinary Research Institute in Los Angeles-2011
(The designer / Joseph A. Sarivan)

It is a collection of symmetrical shapes generated by genetic algorithms as if they grow in similarity in different locations that create corridors. As a result of loads, the main and secondary parts of the structure are represented by a group of aluminum-coated pipes. The building acts as an organism that interacts with its environment and controls its porosity. The facade consists of a grid of hierarchical openings in shape, controlling the transmission of sound, light and air individually or all at once, so that the building merges with its environment and acts as a test instrument in addition to the function of space surrounds, sound effects are treated as spaces need different levels of acoustic insulation opens and closes automatically. The double outer covering is a carbon nanofiber sheet containing a perforated glass shell structure consisting of two layers of soft glass sheets with a transparent insulating membrane of aerogel characterized by acoustic and thermal insulation. The shell is controlled by a single system each part has an algorithm that is site-controlled and contributes to the movement of the entire matrix, and works in an integrated way to get close the vital architecture and modern technology.

Figure 14

3rd/ Taiwan Tree Tower (the designer / architect Stevan Dorwin).
The structure of the building consists of eight nanoscale concrete towers connected to the central supporting part and together by steel supports and shock inhibitors. The exterior parts are adjustable photovoltaic panels. The museum, which is located above the ground level, has a fiber optic dome to illuminate the basements below the ground level. The elevators are of light nanoparticle polymer material used in aerospace industries filled with helium filled up and down (a new generation of materials). The tower is designed to generate electrical energy from photovoltaic panels to the exterior surfaces of the building structure and floating balloon surfaces. The vertical center part contains wind turbines of nanomaterials that respond to environmental influences. The basement of the building collects rainwater from floating observatories and recycles it.

Figure 15
6.1.3. Results of scientific study application:
Applying the results to the main hypothesis: Formalities properties achieved (74%), and then item structural features achieved (81%), while functional characteristics (non-structural) achieved (72%), shows the impact of nanomaterials on the structural structure in the first place and reflect on the aesthetic sides. The performance features (non-structural) come second in its influence on the dynamism of contemporary architecture. We conclude from the above that nanomaterials achieve the aesthetic aspects in the first place and the features of the function comes in second place and this gives the impression that contemporary architecture invested the characteristics of nanomaterials to achieve aesthetic and functional impression, forms appeared unfamiliar as previously became doing the additional functions.
Applying the results to the first secondary-hypothesis: The results showed that nanomaterials influenced the dynamism of contemporary architecture through the mechanism of transformation which achieved the highest percentage (78%) characteristic of dynamism as all objects are transformed as a result of visual changes shown on shape, size or color. The orientation mechanism achieved (67%) and is considered a complex mechanism.
Applying the results to the second secondary hypothesis: The nanomaterials achieve attributes of the structural structure that give it strength, durability and light weight, using the two mechanisms of movement, achieving a ratio of (83%) and adaptation achieved (67%).

The first project achieved 74%, the second 87% and the third 85% for the key vocabulary values as shown in the table no.2

| Item no. | main Items | Secondary Items | Possible values | Project no. | Average of Possible values per. (%) | average of Main single per. (%) |
|---------|------------|-----------------|-----------------|-------------|------------------------------------|-------------------------------|
| 1       | Types of nano Mate | Concrete Structural materials | More durability | 1 1 1 | 78% | 84% |
|         |             |                 | Preventing trophy & fail | 1 1 1 |               | 84%+ 72%=78% |
|         |             |                 | Self- repair | 1 1 1 |               | 84%+ 72%=78% |
|         |             |                 | Preventing penetration of water | 0 0 1 |               | 84%+ 72%=78% |
|         |             |                 | Report about problems | 0 0 1 |               | 84%+ 72%=78% |
|         |             |                 | High strength | 1 1 1 |               | 84%+ 72%=78% |
|         |             |                 | High strength | 1 1 1 |               | 84%+ 72%=78% |
|         |             |                 | More efficiency | 1 1 1 |               | 84%+ 72%=78% |
|         |             |                 | Resistant corrosion | 0 1 1 |               | 84%+ 72%=78% |
| rials | Glass | Non Structural materials | Paint | Films and polymers | Architectural Properties | Change of shapes | Visual changes | Synthetic lighting | Structural properties | Functional properties | Non Structural properties | Movement | Transformation | Movement affected by external forces |
|-------|-------|--------------------------|-------|-------------------|--------------------------|---------------------|-----------------|--------------------|-----------------------|------------------------|------------------------|-----------|----------------|----------------------------------|
| Light and heat control | 1 | 1 | 1 | 67% | | | | | | | | | | |
| Self-cleaning | 1 | 1 | 1 | | | | | | | | | | | |
| Fire resistance | 0 | 0 | 0 | | | | | | | | | | | |
| Self-cleaning | 1 | 1 | 1 | | | | | | | | | | | |
| Anti-reflect | 0 | 0 | 0 | | | | | | | | | | | |
| Self-repairing | 1 | 1 | 1 | | | | | | | | | | | |
| Strength and hardness | 1 | 1 | 1 | | | | | | | | | | | |
| Regulate lighting | 1 | 1 | 1 | | | | | | | | | | | |
| Thermal insulation | 1 | 0 | 1 | | | | | | | | | | | |
| Sound insulation | 0 | 1 | 0 | | | | | | | | | | | |
| Improve electrical conductivity | 1 | 1 | 1 | | | | | | | | | | | |
| Developing buildings | 0 | 1 | 1 | | | | | | | | | | | |
| Self-cleaning | | | | | | | | | | | | | | |
| Fire resistance | | | | | | | | | | | | | | |
| Self-repairing | | | | | | | | | | | | | | |
| Strength and hardness | | | | | | | | | | | | | | |
| Regulate lighting | | | | | | | | | | | | | | |
| Thermal insulation | | | | | | | | | | | | | | |
| Sound insulation | | | | | | | | | | | | | | |
| Improve electrical conductivity | | | | | | | | | | | | | | |
| Non-realistic projects | 1 | 0 | 1 | | | | | | | | | | | |
| Future projects | 0 | 1 | 0 | | | | | | | | | | | |
| Transparent | | | | | | | | | | | | | | |
| Half Transparent | | | | | | | | | | | | | | |
| Non transparent | 1 | 1 | 1 | | | | | | | | | | | |
| Light materials | 1 | 1 | 1 | | | | | | | | | | | |
| Glowing screen | 0 | 1 | 0 | 3% | | | | | | | | | | |
| Using shadow and light | 0 | 1 | 1 | | | | | | | | | | | |
| Pressure and stress resistance | 1 | 1 | 1 | | | | | | | | | | | 81% | 81% | Average = 77%
| Light weight | 1 | 1 | 1 | | | | | | | | | | | |
| Thermal insulation | 0 | 1 | 1 | | | | | | | | | | | |
| Elasticity in the formation | 1 | 1 | 0 | | | | | | | | | | | |
| High performance | 0 | 1 | 1 | | | | | | | | | | | |
| Self-cleaning | 1 | 1 | 0 | | | | | | | | | | | 70% |
| Self-repairing | 1 | 1 | 1 | | | | | | | | | | | |
| Resistant corrosion | 1 | 0 | 0 | | | | | | | | | | | |
| Thermal insulation | 1 | 1 | 1 | | | | | | | | | | | |
| Fire resistance | 0 | 1 | 1 | | | | | | | | | | | |
| Shape | 0 | 1 | 1 | | | | | | | | | | | 78% |
| Volume | 0 | 1 | 1 | | | | | | | | | | | |
| Color | 1 | 1 | 1 | | | | | | | | | | | |
| Movement | Movement affected by external forces | 0 | 1 | 1 | | | | | | | | | | | | 83% | Average |
| Hanis m of dyna mics | Movement in molecular level | = 84% |
|---------------------|-----------------------------|-------|
| Adapтив e           | Orientation                 | 1     | 1   | 1   | 67% |
| Movement            | 1                           | 1     | 0   | 0   |
| The change          | Evolutionary                | 1     | 1   | 1   | 78% |
| Adapti ve           | Predictive                  | 1     | 1   | 1   |
| Probabilistic       | 0                           | 1     | 0   |
| Simulation          | Building natural structure  | 1     | 1   | 1   | 100%|
| Perform function    | 1                           | 1     | 1   |
| Information process ing | Design                   | 1     | 1   | 1   | 100%|
| Implementation      | 1                           | 1     | 1   |

| Kind s of dyna mics | Movement dynamics | Mental movement | = 51% | 78% average = |
|---------------------|-------------------|-----------------|-------|---------------|
| Adapтив e           | Objective movement| Folding         | 0     | 1   | 1   | 33% |
|                      |                   | Sliding         | 0     | 0   | 1   |
| Zoom in             |                   | 0               | 1     | 0   |
| Zoom out            |                   | 0               | 1     | 0   |
| Structural movement | Effected by external forces | 0 | 1 | 1 | 67% |
|                      | Adapt the structure with external elements | 0 | 1 | 1 |
| Natural lighting dynamics | Dramatic effects | Direct | 1 | 1 | 0 | 83% |
|                      |                   | Indirect        | 1     | 1   | 1   |
| Non similar dynamics | Using non-linear areas | 1 | 1 | 1 | 100%|
| Combination between systems and random | 1 | 1 | 1 |

| Dynamic goals | Mental and artist's creativity | Wavy shapes | 1 | 1 | 1 |
|---------------|--------------------------------|-------------|---|---|---|
|               | Flow lines                      | 1           | 1   | 1   |
|               | Changing rhythms                | 1           | 1   | 0   |
|               | Orientation towards nature      | 1           | 1   | 1   |

| Sustainability | Access to aesthetic values | 1 | 1 | 1 | 100% |
|                | Access to functional values   | 1 | 1 | 1 | 100% |
| Keeping nature | Interaction with nature        | 1 | 1 | 1 | 100% |

Average of each project | 74% | 87% | 85% |
Conclusions

1. We conclude from the practical study the impact of the type of nanomaterials used for their distinctive and diverse characteristics that give architecture different behaviors achieved by mechanisms of these materials that appear in the form of applications that give different types of dynamics used to achieve a specific goal, and it emerged that the mechanisms play a major role in achieving the dynamism of contemporary architecture.

2. The use of nanotechnology in architecture starts from the early stages of construction to the final architectural form, by choosing the appropriate and sustainable materials that helped in the production of complex buildings and in cooperation with different disciplines.

3. Nanomaterials enabled the architecture to perform multiple functions, including self-cleaning and self-repair and control of bacteria and power generation. It is an architecture oriented towards living and harmony with nature.

4. The results of the study showed the impact of nanomaterials on the structural structure first, which affected the aesthetic nature by the emergence of forms of unfamiliar structures characterized with strength, agility and light weight, inspired by natural.

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