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Managing a Green Building Architecture for Sustainable Energy Consumption by System Approach

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Abstract:

The more energy usage increases around the world the closer critical situation for supplying energy will encounter the nations. There will no way remain except optimal energy consumption moreover finding new energy resources. Renewable energies nowadays are the core concern of many researchers. Replacing fossil-based energy generation by other resources of renewable energies like wind and solar are started in the past decades.

A system approach is applied in this research to present a model to analyze how building architecture and constructions could be improved toward green energy usage. Renewable energies will increase the incentives of the environmental protection, clean supply and demand in the huge energy consumers' sectors like industries.

It is concluded that environmental issues are a matter of concern for people, they cannot tolerate the higher expenses of green energy generation. They prefer to use cheap energy resources mainly non-renewables. The model confirmed the supporting policies both to generation and consumption will dramatically improve green energy usage. The governments can support both supplying and demand sides to decrease their energy expenses and give the people some incentive to use renewable subsidized energy and also earning by selling their extra generated power to the grid.

Keywords:

Energy Management, Green Generation, Architecture, System Approach

1. Introduction:

As the world population is increasing in the last decade, there is a considerable need for doing some actions and using some strategies to gain the world's priorities: Sustainability. The building industry in each country could play an important role in getting close to this achievement, also it could be a beginning for a valuable contribution between architecture and sustainability. Sustainability is a broad and complex concept, which has grown to be one of the major issues in the building industry. The idea of sustainability involves enhancing the quality of life, thus allowing people to live in a healthy environment, with improved social, economic and environmental conditions (Akadiri, Chinyio, & Olomolaiye, 2012).

Sustainable architecture should provide a variety of needs for people who are in touch with it and of course for the environment. in conclusion: Sustainable architecture is an architecture that seeks to minimize the negative environmental impact of buildings by efficiency and moderation in the use of materials, energy, and development space and the ecosystem at large. Sustainable architecture uses a conscious approach to energy and ecological conservation in the design of the built environment(Doan et al., 2017). Therefore we should reach the optimized way to get to that "efficiency" in our design. There are several items which we should consider when we are designing an eco-friendly building and reliable sources based on new technology such as Building Research Establishment Environmental Assessment Method (BREEAM), Leadership in Energy and Environmental Design (LEED), Building for Environmental and Economic Sustainability (BEES) etc. these sources are practicing on reducing the impact of constructing a building on the environment but also using the maximum effect we could get from our environment and involve it with our building. With the helping of this source, we should be able to make a completely sustainable building with zero energy consumption and minimum impact on the environment, but we are still struggling for gaining that efficiency and that sustainable foundation we should rely on. The question is why? When the essentials knowledge for designing a sustainable building is provided, they should be suggestions for adequately using this knowledge and bring it to real life. There are some eco-friendly residential building examples such as:

1-BedZED (Beddington Zero Energy Development) London,United kingdom: The UK's largest and first carbon-neutral eco-community: the distinctive roofscape with solar panels and passive ventilation chimneys

2- The Crystal, London, United Kingdom: Siemens, one of the leading and top-most companies in the United Kingdom has built The Crystal, an urban sustainable landmark. Aside from its striking structural design, The Crystal is one of the greenest buildings ever built by mankind. This building uses natural light, that is, natural daylight is availed of entirely during the day. Another interesting feature of The Crystal is the so-called Rainwater Harvesting and Black Water Recycling. The building's roof acts as a collector of rainwater, while the sewage is treated, then recycled water is purified and converted as drinking water.

3-Pixel building, Melbourne, Australia: The first-ever building to achieve a whopping perfect Green Star score, it paved the way for the rise of sustainable infrastructure in the whole of Australia.

What makes the Pixel Building stand out is the fact that it is 100% carbon-free which means that carbon produced annually in running the building was compensated by renewable energy. The building also boasts of a systematic method called 'carbon neutrality.' This process enables to offset the carbon contained in the materials used in constructing the building(Peronato, 2019).

The buildings mentioned above are some of the good examples for actual using of sustainability in architecture knowledge, but there is still an unsolved question: when it has been proven that suitability is the key to optimize energy-wasting, why it can't be used this knowledge in building almost every residential complex all over the world? This solution can lead human beings to protect their environment from threats that can caused by them and also, the pace of global warming, animal extinctions, impacts of non-renewable energy resources on earth can be reduced. Therefore, shreds of evidence for our next generation can be accumulated.

This paper will discuss about the advantages and disadvantages of powerful collaboration between sustainability and architecture in recent decades.

2. Green architecture:

There are various forms to clarify what exactly Green architecture is. But in conclusion, Green architecture, or green design, is an approach to building that minimizes harmful effects on human health and the environment. The "green" architect or designer attempts to safeguard air, water, and earth by choosing eco-friendly building materials and construction practices (Roy,2008). So, we can assume that Green architecture and sustainability both are aiming for a common purpose: getting the most influence from the environment and causing less impairment to it.

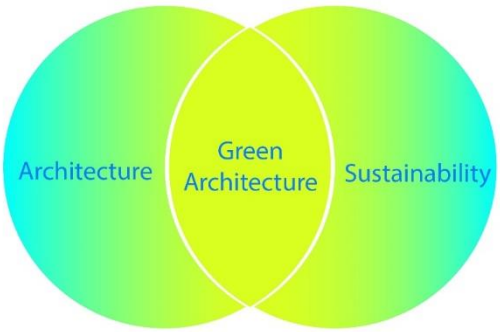

Figure 1: incorporation of architecture and sustainability

2.2. Green architecture statements:

Green architecture defines an understanding of environment-friendly architecture under all classifications, and contains some universal consent (Burcu, 2015), It may have many of these characteristics(Ragheb, El-Shimy, & Ragheb, 2016): ventilation systems designed for efficient heating and cooling, energy-efficient lighting and appliances, water-saving plumbing fixtures, landscapes planned to maximize passive solar energy, minimal harm to the natural habitat, alternate power sources such as solar power or wind power, non-synthetic, non-toxic materials, locally-obtained woods and stone, responsibly-harvested woods, adaptive reuse of older buildings, use of recycled architectural salvage and efficient use of space.
While most green buildings do not have all of these features, the highest goal of green architecture is to be fully sustainable.
Also known as: Sustainable development, eco-design, eco-friendly architecture, earth-friendly architecture, environmental architecture, natural architecture (USGBC, 2002). Few of these features are going to be explained and mainly discuss how they work and what are their benefits of using them in a building.

2.2.1. Natural Ventilation system:

Discussed above, one of the most significant concerns of sustainability is how to increase usage from our environment and lessen our impact on it. Natural Ventilation systems can be a good example of doing this task because there is no need for mechanical indoor systems, and it is designed to use passive strategies to supply outdoor air to a building's interior for ventilation and cooling. Natural ventilation has become a key component of the green building today and is required to be certified by LEED (Lechner, 2014) .
the main idea of this system is to naturally adequate ventilation from prevailing winds. There are also design elements that must be incorporated into a building to allow for free air access.
preconstruction, also the range of ambient weather variables will be determined in which the HVAC system will be turned off and natural ventilation will be used. Humidity and wind speed are also considered to provide the most comfortable and energy-efficient environment for building occupants.(Butler, 2008)

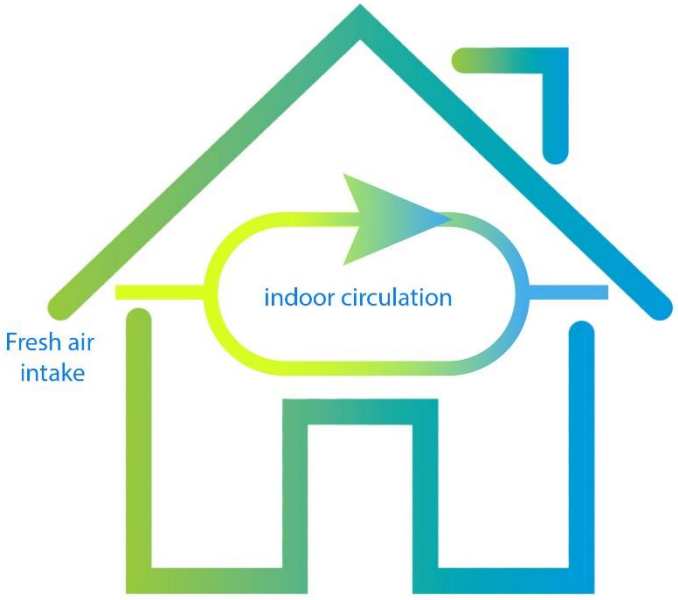

Figure 2: Natural ventilation system basis

2.2.2. Alternate power resources (solar systems and wind power):

Now a days frequently have detailed information about renewable energies and how using them has been increasing in recent years. Since human beings figured out how fast they are finishing the fossil fuel resources and there is no proper alternative instead of using these supplies. Also, as the population increases dramatically in the past years, using these resources became a necessity for the people. Because of that, they have become more inquisitive to discover an alternative system to conserve these non-renewable resources. Many factors can be counted as the benefits for solar energy systems, but the most significant ones are going to discussed below: The first one is zero energy-production costs which means the solar system product is made of 100% recyclable materials (Guy & Shove, 2014). So, if they cause any disturbance or depreciation, they could entirely be redeemed. The next one is Influencing the environment. As mentioned in previous headings, one of the purposes for sustainability is having the least impact on the environment and this system because it is a long-lasting product, also because it doesn't have any pollution based on its recyclable materials; could be a decent replacement for traditional ways of wielding electricity. The third one refers to economic reasons. It can't be denied the large amount of charges which a house may generate so that what is considered among these sorts of costs are the ones which are "sustainable". Sustainability in finance means handling some policies for utilizing materials that generate the least charges for their restoration and could induce lower expenses in the long term.

2.2.3. Gray water recycling:

The great amount of water waste in the building industry cannot be ignored. That's why water conservation is becoming a frequently necessary part of conservation, and recycling building gray water is a great way to accomplish it. What is gray water? Gray water is the water that runs off from condensate from air conditioning units and other equipment that uses water. Oftentimes, this water is disposed of with wastewater. Unlike wastewater, however, gray water can be reused to fuel boilers, hydronic cooling equipment, and even irrigate plants. New sustainable design-build methods are finding ways to maximize the usage of resources, including water(Wilson, 2006).

3.Energy consumption:

The overall definition of energy consumption is the entire energy usage for an action to be done or for manufacturing a product. For example: a factory that is producing is using energies like electricity, gas, water or any other energy-based powers which will be included in energy consumption calculations.

The consumption of buildings (both residential and commercial) has steadily increased, reaching figures between 20% and 40% in developed countries. the rise of energy demand in buildings will continue shortly because of growth in population, long-term use of buildings, and increasing demand for improved building comfort levels. Therefore, the energy efficiency of buildings is of prime concern for anyone wishing to identify energy savings. (Li, Bowers, & Schnier, 2010)

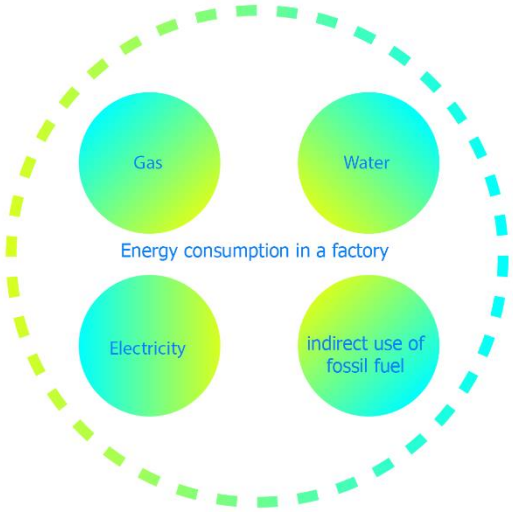

Figure 3: Some types of most frequent use of energy in a factory

3. System approach:

A system is a set of rules, an arrangement of things, or a group of related things that work toward a common goal. An example of a system is a building that all facilities inside it are working together for optimizing usages of natural resources(Duflou et al., 2012). An organization or planning to develop an organization needs to have a global approach which could be named a system. As a system is defined an assortment of features or components that are organized for a common purpose. A line of thought in the management field which stresses the interactive nature and interdependence of external and internal factors in an organization.(Rana, Ali, & Saha, 2016)

By growing energy consumption generating carbon dioxide will also increase, buildings role in energy consumption could not be ignored. These days' attentions are payed more to sustainability in building architecture. Construction sector also must change their strategy to product environment friendly building, green buildings will then take place by develop the non-energy saving building and traditional buildings to be Green! These features and elements, however, needs to have a planned relation in a system to be able move toward sustainability. A structure of this system is tried to develop here by unifying principles in an integrations of green building, architecture and renewable energies. By considering a small parts of the real world elements. It is just emphasized the approach constructive power which give to decision makers with which it is possible to monitor, construct and control interaction among elements and features.

4. The characteristics of the model:

The model have structure shown in figure 9 , it is defined by considering affection and interaction among variables and their integration; The behavior of the model, which involves from architecture and energy consumption as inputs to the model could be analyzed. the other and most important characteristic of the model is the process. It is needed to find out the interactions inside the black box and try to illustrate them(Madala, 2018). Green building , responsibility of natural resources usage , energy consumption , renewable energies and supporting policies are some example of the criterions.. Outputs of variable trends , energy saving , emission or substantial is the other characteristic; interconnectivity of the model increase the accuracy of analysis: this different portions of the model have functional as well as structural relationships between each other.

4.2. The steps of modeling by a system approach?:

There are five steps of design, develop, implement, analysis and evaluate are considered for any system approach. They may have named as Instructional Systems Design (ISD).

4.3. Clustering the variables:

In system dynamic modeling the variable are divided into three set of variable due to their affecting on the other variables:

4.3.1. State or Stock variables: These are variable that show the current state or status of the system at any time. The limitations of these investigations variables are only a function of the corresponding Rate Variables.

4.3.2. Rate or flow variables: Variables whose values can be defined over a period of time and cannot be calculated at any time. These variables affect each other and the amount of state variables, and especially between them and the state variables mathematically there is a differential and integral relationship.

4.3.3. Auxiliary variables: which are inherently state or flow variables, although they are used in the model only for further explanation and have no state or rate properties.

Table1: Model variables by rate, mode and flow

Kind of variables	Model Variables
State	The amount of green building, Renewable energy generated.
Rate	Energy Consumption Long Term Economic justification Price of building's materials, Wages of work force, Suppling of housing, Demand of housing, Price of housing, investment in housing field
Auxiliary	Laws and Regulations

It is important to note that some of the variables named as rate variables may be used elsewhere as state variables. Like the energy consumption and long-term economic justification variables that are considered as the rate variable according to the research objectives and their application in the present problem. Broadly considering and in macro approach the increasing attention to sustainability is pushing the construction sector to build more sustainable buildings. In this research, several sustainable development indicators have been proposed. The worldwide diffusion of sustainability rating systems and that of their structures are considered as proxy variables for the evaluation of sustainable constructions.(Sharifi & Murayama, 2014)

5. Model Diagrams and the variable relationships:

Our research model consists of causal-circular and state-flow diagrams, the former focusing more on showing the relationship between model variables qualitatively, while the latter is a tool for understanding the differential and integral relationship between state and flow variables. It is mostly used to perform quantitative simulations. In the following sections, these charts and descriptions are shown for each

6. Causal-circular:

Causal diagram also is known as Cause and Effect Diagram (CFD), The causal relationships between variables related to Green Building Architecture which can lead us toward sustainability adoption are presented here. A

conceptual model is proposed to explain the implementation behaviors in the buildings(Kibert, 2016). This study aims to define and compare policies for the assumption Green Building Architecture.
As mentioned earlier the system dynamics (SD) approach is used. Six following aspects of deliberations which mainly could have significant impacts are considered. The model then completed through these steps: architectural relationships for green building, architectural design, architecture view for construction, energy Consumption, renewable energy, policy, supports and regulations.
Green buildings will affect both the efficient use of space and landscape, it will be affected by the Usage of resources and architecture. Use of recycled architectural salvage will affect architecture directly.

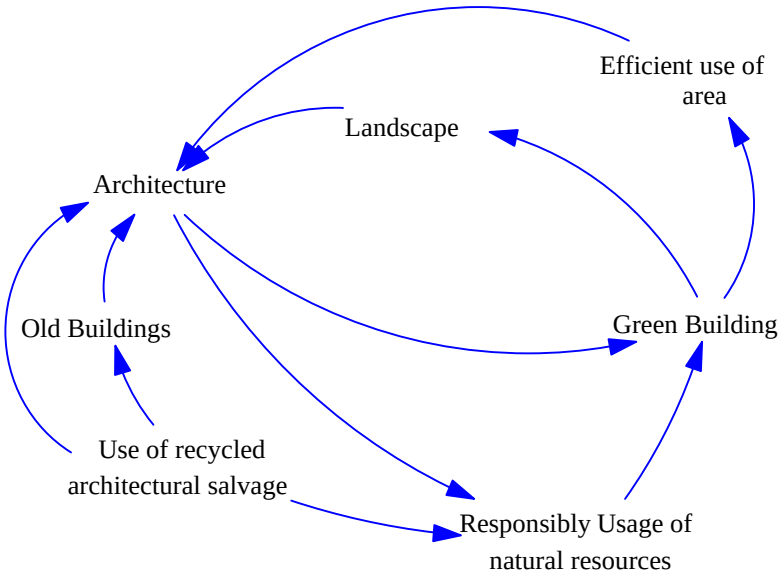

Figure 4: Architectural relationships for green building

On the other hand, one of those important factors which can have a great impact on our architecture design is how sustainable it is going to be. It is named Eco-Friendly design in our figure and in the next steps we are going to see how it is going to play a role in new buildings. Furthermore, it is shown that one of the considers factors which are going to play a role in recycling and usage of natural resources is materials that we use and as it is shown below it is going to be responsible for using natural resources.

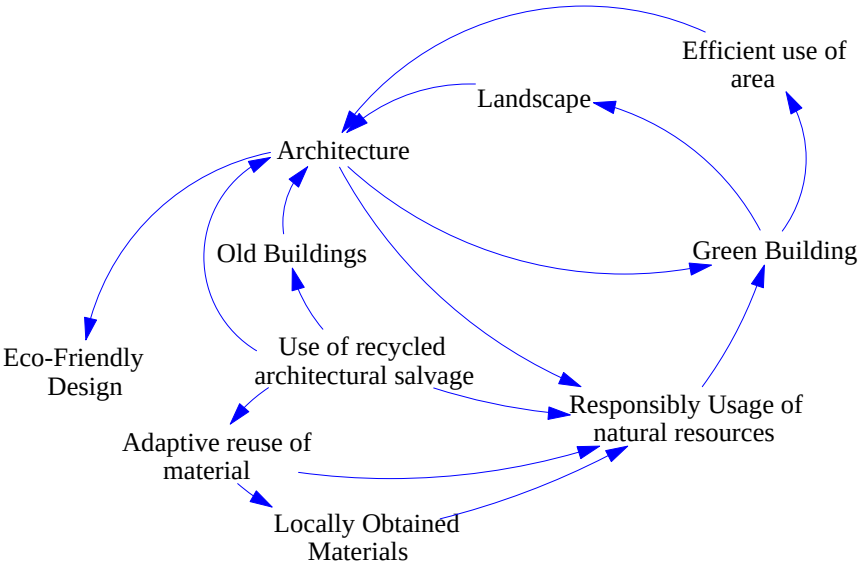

Figure 5: Architectural design

In the next step, different types of materials are mentioned and how they are going to impact designing new buildings architecture. Two types of sustainable materials are defined with "Non-toxic materials" and "Non-synthetic materials". The variety of materials that are used in architecture is countless but if architects consider how their designed building is going to be sustainable, they would not have the freedom they used to.
Sustainable materials are mostly known as natural ones which can be easily found and seen in our environment. The most important thing for designers is how using these kinds of materials and still being concerned about our environment. So that they came up to create some of these materials like concrete. Therefore, it is mentioned as Non-toxic materials below.

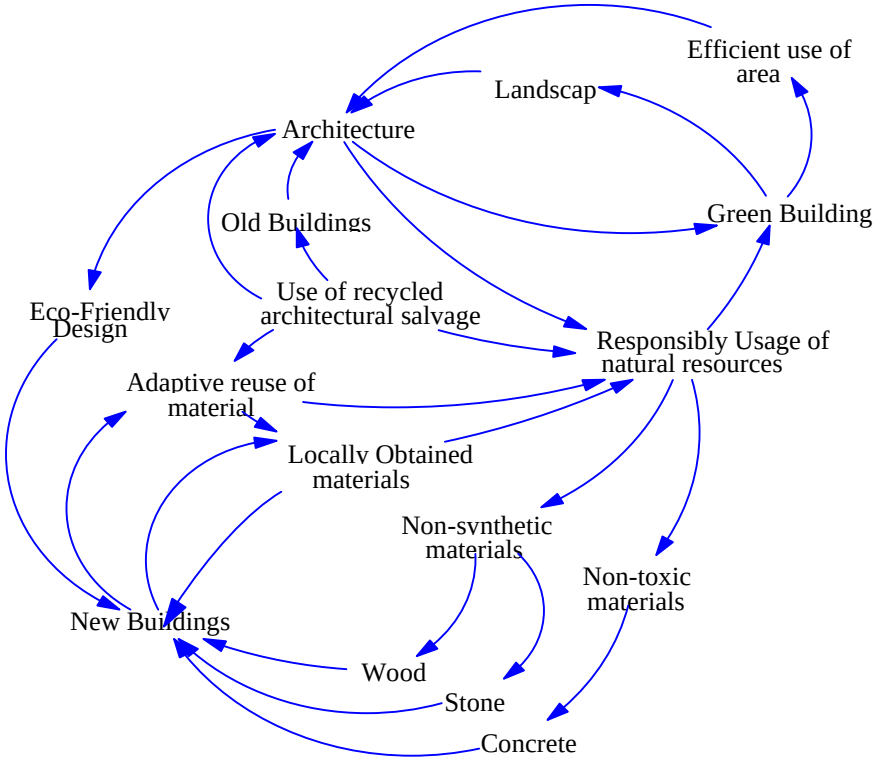

Figure 6: Architecture view for construction

The next factor which should be involved is kinds of efficiency which mostly known as efficient lightening and ventilation system in architecture. Also, it is shown that how they are going to impact energy consumption.

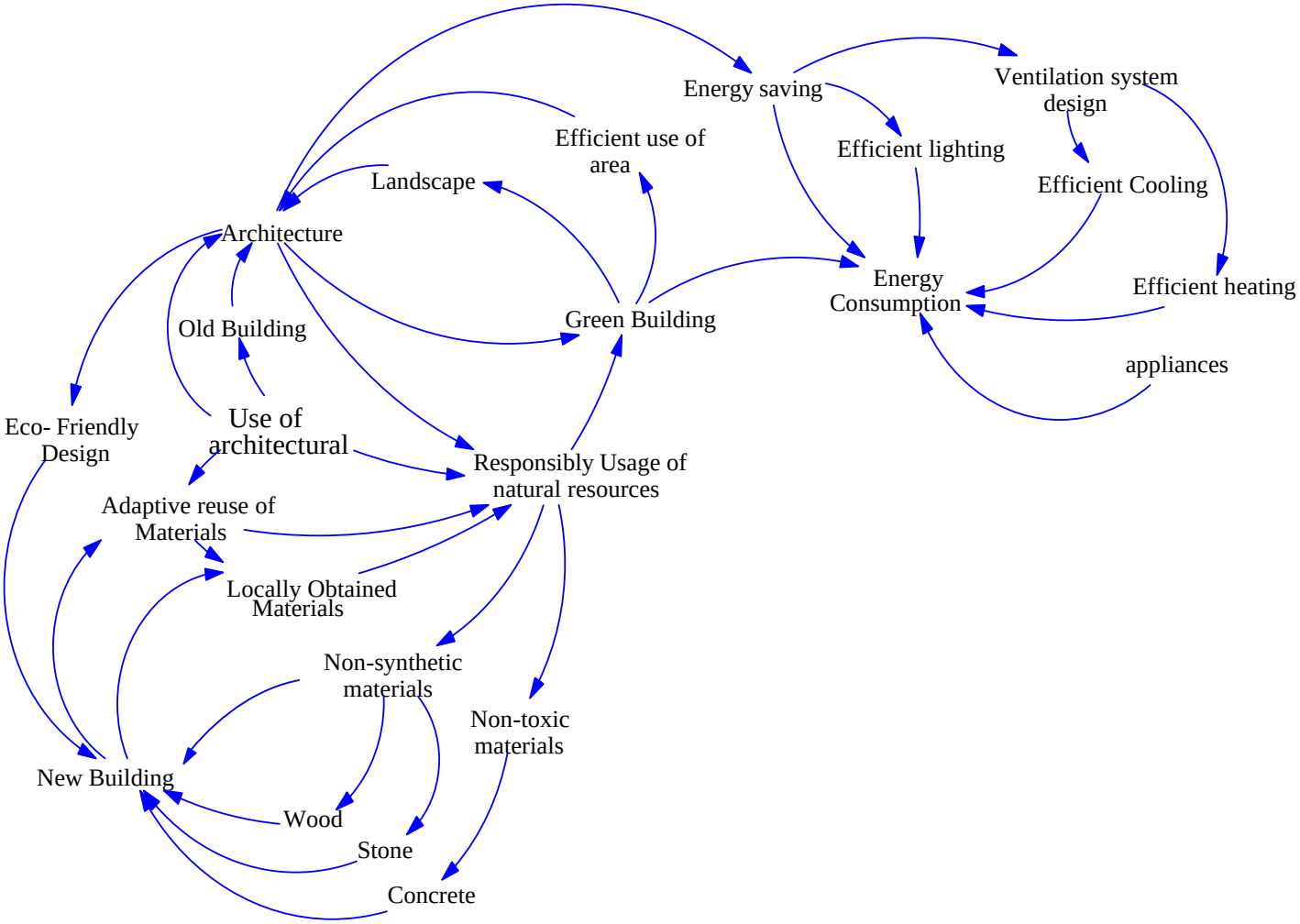

Figure 7: Energy Consumption

It is noticeable that for reaching to the energy consumption some renewable resources need to be contained. As it mentioned above, using renewable resources is one of the most proper ways to build a sustainable architecture.
Some of these renewable resources are biomass, geothermal, wind and solar power. Renewable resources can be counted as alternate power resources which they are environmentally friendly resources. And they are the base of renewable resources.
The other impactors of friendly resources are fossil energy which can cause pollution and may influence our usage of natural resources.
It can't be denied that policies and financial supports are influencing this circulation. So that they are involved, and we can see their impact in green building and how decreasing harm to the nature can have impact on policies.

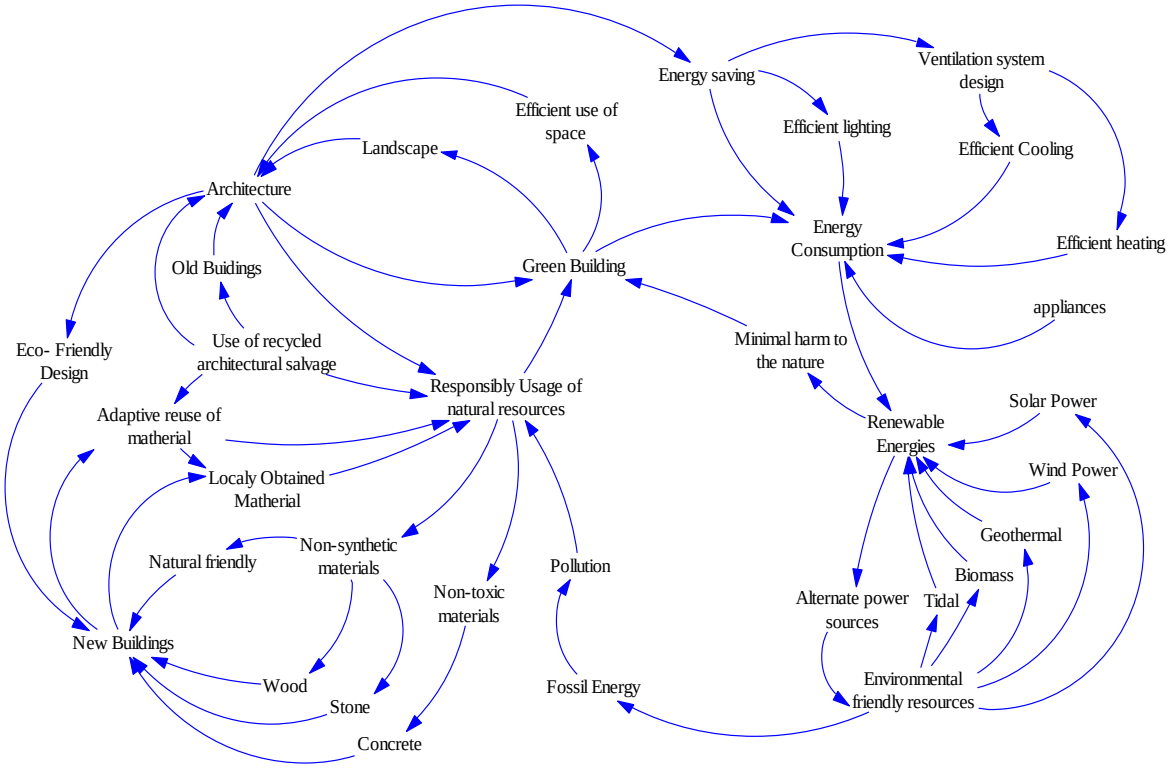

Figure 8: Renewable energy involved

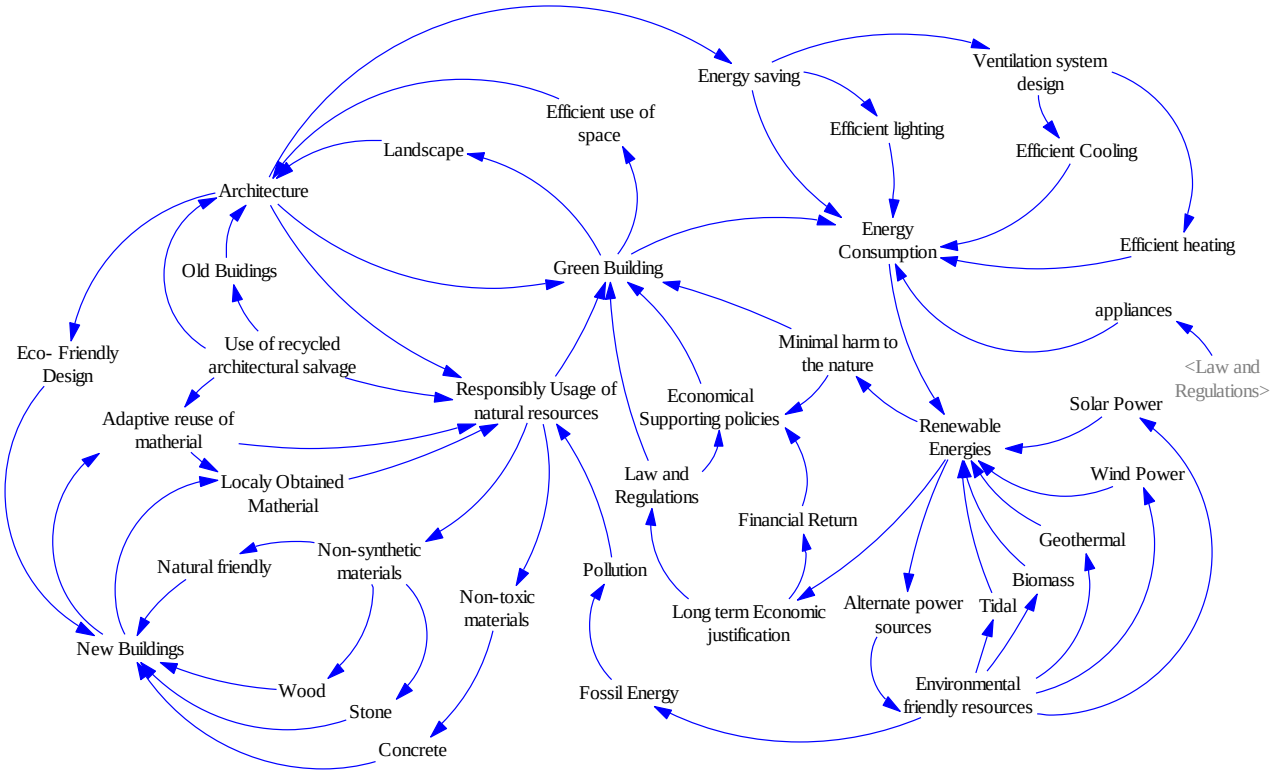

Figure 9: Policy, supports and regulations

The objective of the evaluations was to improve our understanding of the dynamics between energy efficient buildings and their users. The focus of the case studies has mainly been on the use, operation, indoor environmental comfort, and the social and cultural context of the buildings. Which user actions and attitudes may influence building performance and how are the users' actions and attitudes influenced by the buildings? (Thomsen et al., 2011) they are introducing some following factors for manage and controlling energy consumption in the building. It is tried to consider them in the study.

Management	Environmental impact	Cultural heritage
Green Building	Architecture	Law and regulations
Planning	Land use and ecology	Financial return
Energy consumption	climate	Building
fossil energy	Healthcare	Green building
Renewable energy	surpluses	Building costs
Pollution	Society	Building benefits

Available rating systems span from energy consumption evaluation systems to life cycle analysis and total quality assessment systems. The description of assessment results from a sample of buildings provides data to discuss construction characteristics that, currently, aim at being defined as sustainable. The study shows that building energy performance is considered the most important criterion in sustainability rating systems, and the least achieved one in sustainability assessments. (Cassells & Lewis, 2011).

7. Conclusion:

This study figures out some important factors affecting energy consumption. Architectural consideration of a building to decrease energy wastes and improve energy saving to have a sustainable energy management are the other concern of the conceptual proposed model. The main variables are divided to Stock, Rate and Auxiliary and the model improved step by step by increasing a variable. Causal relations are defined and 3 loops are developed. consumers positive and negative attitudes towards timber frame house and discussion the solutions. In order to improve the acceptance degree of timber Renewable energy generated, Energy Consumption and Long-Term Economic justification are crucial, which also need the cooperation of several fields, such as government, investment in housing, Law and Regulations and so on. The study confirms these attitudes of green buildings making policy and market promotion strategy by government and building developers. There are some limitations of the study, for the architectural and demographic factors including locations, incomes and age choice, and also for their energy consumption. It is better to figure out the criteria for the future data collection. Future research will have focused on evaluating the factors that lead to formation of particular attitudes and how to further enhance of green buildings. Regarding the sustainable schemes, green building may be considered as an alternative for managing the energy use in developing countries. Investigating green factors in the other systems, was to propose a new set of comprehensive factors named Price of building's materials, Suppling of housing, Demand of housing, Price of housing, investment in housing field, Law and Regulations. Also, comparing performance sensitivity to the five representative green building rating systems confirmed the reliability of the suggested tool based on measuring the criteria deviations. The outcomes provide a valuable reference to the policy makers and also could be a considerable suggestion to the future studies.

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Fatima Sadat Ghaderi is a student at School of Architecture, College of Fine arts, University of Tehran She has been accepted among nearly 600000 applicants in the entrance exam. She finished her high school with honor in Roshangar which is among the first ranking high schools in Iran. She is interested in Green Building Architecture and has done some researches. She is very well familiar with the art and science of designing buildings, and the design and method of construction. When she finished her courses she has a creativity thorough understanding and appreciation of the structures in which we live today, and also look to the future of design and found how ideas can be made real and implemented. She made project design work and its associated exercises. Many of the practical modules are assessed by her course work alone.

Seyed Farid Ghaderi is a Professor of Industrial Engineering in the College of Engineering at University of Tehran, Iran, where he was also the Deputy Dean of the department. He earned his BSc in Electrical Engineering from University of Ferdowsi at Mashad Iran, Master in Industrial Engineering from Tehran Amir Kabir University in Iran and PhD in Industrial Engineering from Tokyo Institute of Technology (TIT) in Japan. He also served as a member of Iran Power Market Regulatory Boards from 2008 to 2010. He is the Founder and CEO of the Research Institute of Energy Planning and Management from 2003 to 2007. He was also the Vice President of the ICS Triplex in Iran (1999) and Head of the Standards Department Planning Bureau of the Iran Ministry of Energy from 1989 to 1995. His research interests include energy management, energy planning, energy modelling, electrical energy technologies, electrical energy demand and supply, energy economics, energy pricing and energy efficiency. He has also published more than 50 papers in many reputable journals.