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SURVEY OF SUSTAINABLE CRITERIA ON BUILDING DESIGN

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ABSTRACT. *Due to the rapid deterioration and depletion of natural resources which are utilized in the building construction industries globally, decision makers are now looking forward to the inclusion of some useful criteria's into achieving sustainable views on building designs. This stems from their increased knowledge of possible sustainable solutions to these problems from various researches or studies been carried out into innovated methodologies and technologies necessary in achieving sustainability to buildings. Building designs should account for long service life, protection of natural resources, habitat of some plant and animal species especially the endangered ones, maintaining the quality of the atmospheric air and effectively utilizing the natural sources of energy such as the sun and wind. The performance of buildings could be explained by different parameters like the environmental load, the indoor environmental quality, and the primary energy source. In sustainable building designs, it is beneficial to classify the important design indicators in order to reach various optimized design solutions or by developing a more alternative design answer. Sensitivity design and analysis makes it possible to detect the important factors in respect to performance of buildings and to concentrate design and optimization of sustainable structures like buildings. This paper will consider effective sustainable criteria in three major fields which include the: economy, society, and environment.*

Keywords: Sustainable development, building criteria, design

1. INTRODUCTION

The promotion of sustainability development (SD) concept has been a significant central point for lovers of the environment when it is to be used for engineering purpose. Asthe Brundtland reported that "sustainability development aims to meet the needs of the present generation without compromising the ability of future generations to meet their own needs" [1]

A number of sustainability development assessment methodologies exist [2]. By using the kinds of criteria in practice for evaluating the performance of key components of industries, the Global Reporting Initiative [3]. The World Business Council for Sustainable Development [4], and the standards development [5] were the key drivers for managing the sustainability in constructions. Glavic and Krajnc [6] defined and developed a standardized package of sustainability indicators for companies supporting all important aspects of sustainability development.

According to KEI [7], "Indicators and composite indicators are increasingly recognized as a useful tool for policy making and public communication in conveying information on countries performance in fields such as economy, environment, society, or technological development".

As Bebbington et al. [8] expressed "There is a widely recognized need for individuals, organizations and societies to find models, metrics and tools for articulating the extent to which, and the ways in which, current activities are unsustainable".

As stated by Ness et al. [9] "The purpose of sustainability assessment is to provide decision-makers with an evaluation of global to local integrated nature–society systems in short and long term perspectives in order to assist them to determine which actions should or should not be taken in an attempt to make society sustainable".

In the assessment of a building's sustainability the building is divided into three groups which are its design, maintenance, and rehabilitation. If the structure's design is according to specific criteria's on sustainability, in the future, there will be less reasons to worry about problems or issues which may be related to sustainability factors.

It therefore means that it will be important to have in place specific criteria's that will enable us have buildings that meet a sustainable life, but first we should be ready industrially. To design sustainably, means to have a sustainable structure and to have a sustainable idea. In this article, the design process is divided into 8 categories which are: Architectural Engineering, Interior Design, Structural Engineering, Environmental Engineering, Materials Engineering, Electrical Engineering, and Mechanical Engineering. For every category, some criteria related to that science is defined.

2. SUSTAINABLE FRAMEWORK DEFINITION

Sustainability is a very hot topic these days, as every year, several seminars and conferences in different levels are held almost all-round to find a world solution in having a green future. Pollution is one of the reasons why we as humans try to create something which would be sustainable. One of the most important developments in this field is the Pressure State Response (PSR).It is operates according to the idea of effect and cause of phenomena. The format defines the impression of social activities which apply 'pressures' on the environment and also effects in changing the quality and quantity of environmental conditions. Therefore, the society responds to these changes through sectored policies (the 'societal response'), which are economical, environmental, and for its revision [10]. The society acts like a reaction to "pressure" piece over human activities. PSR-framework of OECD [11] is given in Fig.1.

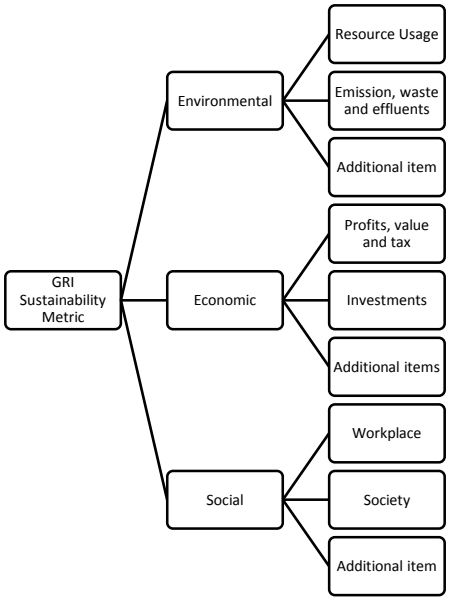

Fig-1: PSR-framework of OECD [11]

For evaluating criteria, at first, the frame work should be defined. According to Global Reporting Initiative (GRI), sustainability reporting is considered in three dimensions (Fig. 2), 1. Environmental 2. Social, and 3.Economic. Also The United Nations Commission on Sustainable Development (CSD) offered a monitoring framework that the

various sustainability parameters for performance assessment of government towards SD goals [12]. This framework has four dimensions which is included as: economic, environment, social, and institutional and it is divided again into 15 main indicators and 38 sub-indicators as given in Fig. 3

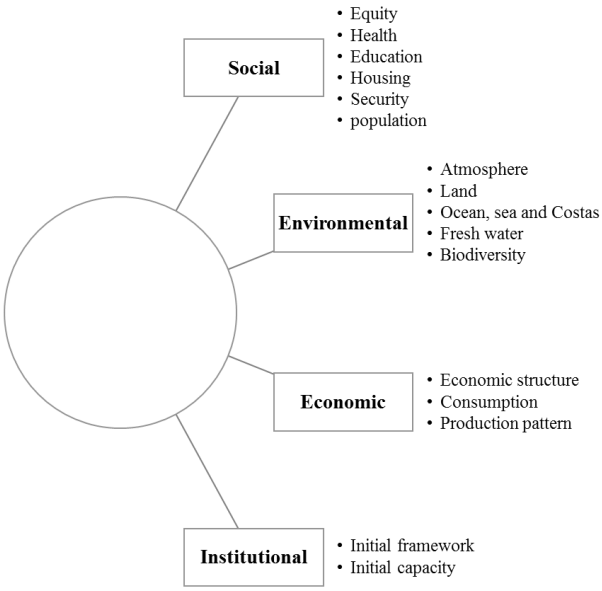

Fig-2: GRI of sustainability reporting [3]

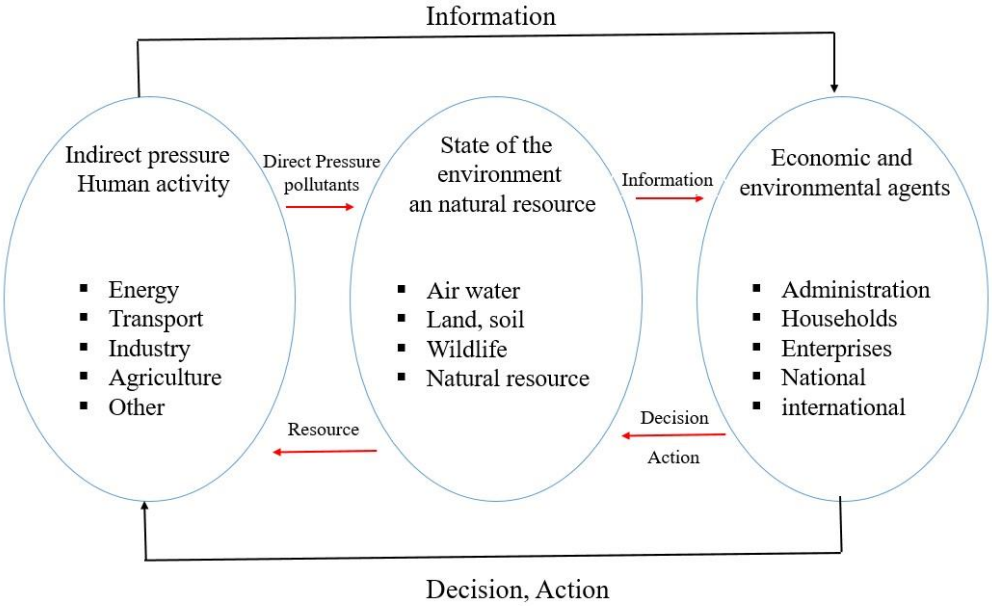

Fig-3: assessing the performance based on different sustainability indicators [12]

3. DESIGN BUILDING SUSTAINABILITY

When using sustainable criteria's in building designs, one of the most important parts of sustainable development is to have green buildings [13]. Design processes can be divided into three parts 1.Preliminary Design, 2.Execution Design and 3.Construction Completion. The Sustainable criteria should be able to make assessments at each stage of a building's design and construction, on the basis of target performance, design specification and forecast performance. Options for the consideration of improvements at each stage should also be given [14].

Design building involves the collaboration of 8 kinds of sciences: which are Architectural Engineering, Interior Design, Structural Engineering, Management Engineering, Environmental Engineering, Materials Engineering, Electrical Engineering, and Mechanical Engineering, they should all have very close relation together in order to give a sustainable building. The criteria which are used in Table1, are defined according to engineering sciences.

3.1. Architecture engineering

This is one of the most important aspects in building designs as it is connected to architecture [15]. It involves getting ideas from the owner and using ones creativity to design a sustainable building which would maximize the utilization of resources. Table 1 shows the parameters which can help to design a sustainable building.

Table-1: Architecture Survey

No	Criteria	Remarks
1.1	Day Lighting	Design according the use of daylight (efficient use of natural light) to achieve minimum day lighting standards
1.2	Well Plan	Preventive of useless place
1.3	Drying space	Provision of adequate drying space – based on the number of bedrooms within the dwelling
1.4	Home Office	Provision of a compliant home office space
1.5	Flexibility	Evaluate ease of movement and comfort such as: floor area per occupant, ceiling height, adaptation to IT equipment, and availability of refreshment space.

3.2. Interior design

Interior design is the next step after the architectural design and it should involve the design of a building according to sustainable criteria. In this part of design, the interior Designer should use from available sustainable materials or resources to home furnish the building with minimum cost. Lighting is also one of the important things in interior design, suitable distribution of lighting can be useful for sustainability, also using suitable colors can be effective to a number of parts in a house [16,22]. Table-2 illustrates these effective parameters.

Table- 2: Interior Design

No	Criteria	Remarks
2.1	Lighting	Internal lighting that does not exceed the maximum average wattage across the total floor area - 9 watts/m2
2.2	Furnishing	Using Sustainable furnishing
2.3	Suitable Coloring	Design according Mental Society needs

3.3. Structural engineer

Structural engineers are connected with the safety and resistance of buildings against the effects of natural and unnatural loads for examples earthquakes, landslides and a missile attack on a structure [17]. It is important that the structural engineer designs buildings with maximum efficiency and friendliness with the environment, table 3 shows the effective criteria in building design.

Table-3: Structure engineering survey

No	Criteria	Remarks
3.1	Reliability	Interruption of building functions in the event of a disaster or an accident is taken into consideration as a functionality issue. Design according to functionality level retained by each building equipment type during an emergency situation under Reliability.

3.2	Natural Event Resistance	Design according Potential threats to human life such as building collapse during a disaster and compromised occupant comfort during strong winds or flood or earth quake is taken into consideration as environmental factors for the space within hypothetical boundaries.

3.4. Material engineer

Material science is very important in sustainability [18], because there are a lot of effective parameters in the design of buildings by using materials which do not pollute the environment and can be renewable in the future. Also, the material designer should pay enough attention in providing materials which act as good insulators to thermal and sound parameters. Table-4 shows the related criteria to material engineering to have sustainable design.

Table-4: Materials engineering survey

No	Criteria	Remarks
4.1	Environment Impact of materials	Using re-recycled materials for as: roofs, external walls, internal walls, windows and upper and ground floors.
4.2	Avoiding the use of Materials with pollutant Content	To reduce the environmental load associated with use of resources, it is important to reduce the amount of the resources used, and also to reduce the use of materials that include pollutants. This Criterion evaluates performance in reducing the emission of pollutants associated with the use of resources.
4.3	Responsible Sourcing of Materials	Design according the responsible sourcing tier levels of the applicable new materials.
4.4	Reducing Usage of Non-renewable Resources	Regard depletion of non-renewable resources as an environmental problem beyond the hypothetical closed space, and evaluate efforts to reduce consumption of such resources. Specifically, evaluate reduction in the resource usage volume itself.
4.5	Sound Insulation	Using sound insulated materials to prevent noise from reaching interiors, and sound absorption to stop reverberation of sound that penetrates the room.
4.6	Thermal Insulation	Using Thermal insulation in external walls, ground floors, roofs and building services is assessed as a minimum requirement.

3.5. Environmental engineering

This branch of engineering considers building designs on the environment as detailed as possible. The environment is divided into sub details like the marine environment (water), the soil environment (land), and atmospheric environment (air). The designer should spot all of the design result on environment [14,21], these criteria is available as table-5

Table- 5: Environment engineering survey

No	Criteria	Remarks
5.2	Natural Energy Using	Design according direct use of natural energy (light, Solar, water heater, and ventilation etc.)
5.3	Water Recourses	Regard water shortage due to rapid use of large volumes of mains water as an environmental problem beyond the hypothetical closed space, referring to whether or not there are efforts for saving water, using rainwater, and reusing greywater.
5.4	Consideration of Global Warming	Design according to the direct use of natural energy (light, Solar, water heater, and ventilation etc.)
5.5	Consideration of local Environment	Regard water shortage due to rapid use of large volumes of mains water as an environmental problem beyond the hypothetical closed space, referring to whether or not there are efforts for saving water, using rainwater, and reusing rain water.
5.6	Consideration	Evaluate the following CO2 reduction initiatives using the quantitative LCCO2

	of Surrounding Environment	indicators: [1] Efforts to reduce operating energy affecting climate change [2] Use of existing structural frames and recycled construction materials, which contribute to the reduction of embodied CO2 related to the manufacture of construction materials [3] Efforts to extend building lifespan that contribute to LCCO2 reduction Assessment is performed based on the emissions rate (%) relative to LCCO2 (kg CO2/year-m2) of a reference building with level 3 performance in all assessment categories except this item(excluding LR1 Energy) and equivalent to the evaluation standard for building owners as referred to in the Energy Conservation Law.
5.7	Using Renewable Technologies	Consider the reduction of atmospheric pollutants emitted from buildings or from within the property. This includes measures such as the control of pollutants from the operation of building equipments and pollutants removal by plants. Considering efforts that contribute to mitigation of the heat island effect of surrounding areas. This includes enhanced airflow leaving the site, greening of the building, and reductions in solar absorption and artificial heat discharge.
5.8	Consideration of Emission Pollutions	Consider noise, vibration and odor generated during the operation of the building. Noise and vibration generated during the operation of the equipment are evaluated according to whether measures for source elimination and propagation control have been established. Assessment of odor is based on reduction measures for odors generated from chemical substances designated under the Offensive Odor Control Law and from organic waste. Buildings that are vulnerable to damage from wind hazards (e.g. large structure buildings) should be carefully considered during the design stage.
5.9	Safety	Design and use of renewable versus old technology

3.6. Electrical engineering

Electricity is one of the most important but expensive energy sources in the world [19], according to the design criteria below in table-6 we will be closer in having a sustainable building in the field of electricity.

Table- 6: Electrical engineering survey

No	Criteria	Remarks
6.1	Setting Lighting	Implementation lighting that does not exceed the maximum average wattage across the total floor area according standards
6.2	Safety	Energy efficient external space and security lighting
6.3	Display Energy devices	Design according to Energy display device displays both electricity and primary heating fuel consumption data Exemplary credit –energy display device that is able to record consumption data.
6.4	Lighting Controllability	That is able to record consumption data lighting control (systems managing brightness and lighting positions).
6.5	Control of Illuminance	Illumination should be flexible to increase or decrease of brightness

3.7. Mechanical engineering

Mechanical engineering is the last one in this category, this deals with room temperature control, humidity control and type of air conditioning system. Table-7 shows these criteria in mechanical engineering [20]:

Table- 7: Mechanical engineering survey

No	Criteria	Remarks
7.1	Room Temperature Control	Design according the setting, control and maintenance management systems for interior temperature,
7.2	Humidity Control	Design according humidity and air conditioning, and the related equipment.
7.3	Type of Air Conditioning System	Design according low cost and friendly with environment
7.4	Ventilation	Design to have good system to ventilate of building

4. CONCLUSION

A good design is the strong base for the production or manufacturing of a service or goods irrespective of location, economy or the society at large. If the construction which the owner wants to build is to be sustainable, therefore the design criteria should be sustainable. In this article, building design is divided into 8 categories: Architectural Engineering, Interior Design, Structural Engineering, Management Engineering, Environmental Engineering, Materials Engineering, Electrical Engineering, and Mechanical Engineering. For every category, a definition and a brief explanation on some of the criteria in making a sustainable building is given. With more consideration in the future we can define more criteria in having a sustainable future for our posterity.

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