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Are Intelligent Building & Sustainable Building Essentially the Same? (Is Intelligent Building Helping in Creating a Sustainable Environment?)

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Abstract: ***The advancement of technology has touched every aspect of our life, from education & work to global communication and networking, technology is shaping the modern society. In an Endeavour to provide a comfortable and reliable environment, Intelligent Buildings "Intelligence" is the ability to acquire and apply knowledge and skills. The need to construct intelligent buildings and Sustainable buildings essentially help achieve a reduction in energy consumption, use resources more efficiently and explore renewable alternatives that enable them to be financially and environmentally sustainable. The need to construct sustainable buildings was motivated by the decrease of resources caused by the increase of the globe's population. Producing resources from alternative sources, reusing and recycling materials and overall protection of the environment is possible only by constructing these sustainable buildings. With the advent of various intelligent building technologies, in the times when sustainable development is a rising concern, it was quite necessary to assess whether intelligent development is sustainable or not? The paper will discuss various concepts of intelligent building & Sustainable Building, case studies worldwide, the common grounds for intelligent building and sustainable building.***

Keywords: Technologies, Intelligent buildings, Sustainable buildings.

1. Introduction

The fast Increasing World Energy consumption levels are raising concerns over the depletion of natural resources and the increasing environmental pollution impacts like Ozone depletion, Climate change, global warming etc. The contribution from the developing countries towards energy consumption is increasing with increasing with increasing economic stability and population growth. The advancement of technology has touched every aspect of our life, from education & work to global communication and networking, technology is shaping the modern society economic stability and population growth. The concept "hierarchy of needs" (Maslow, 1943) was introduced by Maslow in the 1950s and it states that an individual has certain needs that can be ranked into a hierarchy: at the basis of this hierarchy are the physiological needs (hunger, thirst), followed closely by safety needs. In the safety needs category one can find the need for shelter, the need to have a home. In an endeavour to provide a comfortable and reliable environment, intelligent buildings and sustainable buildings essentially help achieve a reduction in energy consumption, use resources more efficiently, and explore renewable alternatives that enable them to be financially, as well as environmentally sustainable assets over time. Study and understand the intelligent buildings nowadays, their concepts and greatest Intelligent building worldwide. Study and understand the Sustainable building nowadays, their concepts and greatest Sustainable building worldwide. To assess the link between intelligent buildings and Sustainable buildings. Studying common grounds for Sustainability and Intelligent building. Identifying the perspective of Intelligent and Sustainable Building through case studies of buildings and its Ratings.

2. Review of Literature

2.1 Definition and concept of intelligent building

The term 'intelligent buildings' was first used in the 1980s and a definition was given by former Intelligent Buildings Institute in Washington as- An intelligent building is one which integrates various systems to effectively manage resources in a coordinated mode to maximize technical, performance, investment and operating cost saving, flexibility, Over the years many definitions of intelligent buildings have come up and all of them define intelligence in a building as its ability to respond to the needs of its users and use technology to perform efficiently in an economic and environmentally responsive way. An intelligent building in principle is one that uses technology to integrate its function systems and produce an efficient and healthy environment for its users. Contrary to popular belief, an intelligent building is just not a fully automated building but is the one which has intelligence applied to all its stages- from design to production to operation. An ideal intelligent building should provide a dynamic and responsive infrastructure using technology so as to optimize processes, comfort, flexibility, effectiveness, energy efficiency, costs and environmental benefits. Intelligent building and its need: Building should know what is happening inside and immediately outside .Building should decide the most efficient way of providing the convenient, comfortable and productive environment for the occupant's. Building should quickly respond quickly to occupant's request.

On the one hand we have Scientific Technological revolution that has brought us tremendous improvements in various fields and on the other we have problems such as global warming, resource depletion, deforestation, irresponsible, urbanization, etc.

It has been observed that total annual emission of CO2 have increased from 1.5 million tonnes in the 1950s to almost 6 billion tonnes in the 1990s, and it is further predicted that CO2 concentrations will double by the year 2050 unless action is taken

Sustainable development is one of the Rising issues of concern that has peaked with the advent of the 21st century. Buildings are responsible for at least 35 % of energy consumption in most countries They are resource intensive in construction and operation; they also produce enormous quantities of emissions and waste during the construction process, during their period of use and occupation, and also at the point of their eventual demolition.

An Intelligent Building provides a productive, cost effective environment through the optimization of structure, systems, services and management as well as the interrelationship between them. It integrates various systems (such as lighting, heating, air conditioning, voice and data communication and other building functions) to effectively manage resources in a coordinated mode to maximize occupant performance, investment and operating cost, savings and flexibility. They yield cost reductions over all these areas by optimizing energy use through automated control, communication and management systems during its cost post construction phase. Intelligent building design is the future of building industries. Most modern public and residential buildings are planned with the objective of decreasing expenses by reducing energy consumption.

Enhancing energy preservation strategies and using sustainable design approaches are necessary factors in developing this field. However, many definitions of 'intelligent buildings' are vague and don't mirror all the parameters. Because of the lack of practical context inclusive of the factors that regard the design of such systems, a comprehensive framework containing the convoluted criteria is demanded as a decision-making tool. There are several characteristics that describe an intelligent building, amongst which the following must be mentioned: adaptability to the inhabitants' needs, adaptability to the inhabitants' desires, incorporated technology, sustainability and health conscious on the entire life span of the building, from design to construction to post construction evaluation.

2.2 Case studies worldwide of Intelligent Buildings

Venetian Resort Hotel Casino from Las Vegas is one of the most intelligent constructions in the world. The Venetian Resort and Sands Expo received LEED Gold certification in 2010 and The Palazzo Resort received LEED Silver certification in 2008. The Venetian Congress Centre and Sands Expo also received LEED Gold recertification in 2016. Builders have incorporated into it: Sensors that detect the absence of employees in the service areas and that automatically turn off the lights, a general switch in every apartment that permits manoeuvring all the lights at once .A solar thermal system on the roof that heats the pool's and the spa's water. A management system that operates lighting, heating, cooling and ventilation of the entire building in order to optimize consumption.

Burj Khalifa, Dubai, *is* a world leader in the intelligent building movement. The Burj Khalifa already had the impressive distinction of being the world's tallest building, standing 2,716 feet tall with 160 stories. it incorporates: automatized biometric control systems, systems acting on touch, intelligent parking, voice and data networks for guests, audio-visual commands, it HighlightsWind Tunnel Testing: Over 40 wind tunnel tests were conducted on Burj Khalifa to examine the effects the wind would have on the tower and its occupants. Mechanical, Electrical & Plumbing**:** To achieve the greatest efficiencies, the mechanical, electrical and plumbing services for Burj Khalifa were developed in coordination during the design phase.

Forum mall, Bangalore: is fitted with a computerized building management system that senses where the maximum footfalls are leading and increases the cooling and ventilation in those areas. The sensors channel the information to the controllers of the HVAC (heating, ventilation, and air conditioning, Climate control) systems, which respond accordingly. Sensors and controllers thus help to optimize the consumption of energy by using networks to relay intelligent inputs detailing the attributes of the physical environment to building services systems. Improved operational efficiency of the entire system with energy savings of 8 to 10%.

Environmental system headquarters, Brookfield
Environmental Systems Inc. (ESI) is a building and facility system integrator headquartered in Brookfield, Wisconsin. Established in 1986, ESI provides solutions for control & automation, systems integration, security, life safety, energy services and building operations **KEY RESULTS:** 33% reduction in energy cost with 10,000 additional square feet, Systems continuously monitored for fault detection with alerts tied to maintenance management system, on track for LEED Platinum certification, Continuous real-time information displayed in lobby.

2.3 Definition and concept of sustainable building

100 years ago resources were more than plenty for the world's population. The explosion of population in the last century, however, led to a perilous decrease in resources. Taking this into consideration, people all over the world started being interested in protecting the few resources left.

In this respect, all industries, including construction, commenced developing products friendlier to the environment and able to recycle resources and produce them from alternative never-ending resources. This is how sustainable buildings appeared.

The term sustainability has emerged from concerns about anthropogenic changes in climate and the wasteful use of limited resources of the earth. Sustainability therefore involves the promotion of the more efficient use of natural resources, the protection of the environment and the ecosystem, and also the development of a more equitable global society. A sustainable building is a building that is capable to produce water and energy and use them at maximum of potential. It is also capable to ensure its

inhabitants' health and safety and make sure they achieve their best productivity capabilities.

Sustainability is measured in three interdependent dimensions- environmental stewardship, economic prosperity and social responsibility. The concept of sustainability in the built environment is developed to mitigate the negative impact of human activities and their built environment. Due to global warming and resulting climate change, there has been an increase in the emission of GHGs especially CO2.

All these issues have resulted in an increase in the demand for sustainability and buildings can play an important role in it. Over the years various governments and organizations have tried to address these issues.

2.4 Case **study worldwide Sustainable building worldwide.**

The Tower at PNC Plaza, PNC has a strong history of promoting sustainable design in their corporate developments, as well as supporting and building the local community and ensuring a healthy and highly productive environment for their employees. Some specific goals for the building: Ventilate naturally at least 42% of the year, Consume 50% less energy than a typical building

Allow daylight to illuminate 90% of the building ,Recycling water should decrease annual consumption by 77%, Reduce PNC's energy costs by 30% over a 10-year period. Sustainability framework(s) utilized; e.g. LEED, Living Building Challenge, Energy Star**.**

The change initiative, Dubai, is the world's most sustainable commercial building scoring 107 out of a possible 110 on the LEED Platinum Rating for Commercial Interiors. TCI has 26 technologies, including solar panels and heat-reflective paint, on its roof that provides 40 per cent of the buildings energy requirements.

Indira Paryavaran Bhawan, **Ministry of Environment and Forest (Moef)**
Uses 70% less energy compared a conventional building. The project adopted green building concepts including conservation and optimization of water by recycling waste water from the site. Indira Paryavaran Bhawan is now India's highest green rated building. The project has received GRIHA 5 Star and LEED Platinum.

The Crystal, London: It has been designed to be one of the world's greenest buildings, achieving BREEAM Outstanding and LEED Platinum. A key requirement in the brief was to ensure the building would operate exclusively on electricity.A sustainable cities initiative by Siemens. Supporting long term cooperation with cities for infrastructure solutions.

3. Problem

The built environment affects our well-being and this in turn influences our effectiveness in the workplace. Poor environments contribute to absenteeism and to people not working as well as they might. This is an enormous cost to the nation. High-quality environmental design is an investment, as occupants are healthier, staff-retention rates are higher, productivity is higher and sustainability ideals are more likely to be met. Workplaces reflect the culture of companies and are places that are not just functional and convenient but give the occupant a wholesome experience in terms of body and spirit.

4. Methodology

As, the current trend in succeeding all of the above is possible only by constructing sustainable intelligent buildings. Therefore, **the aim is to study the state of the art of the link between the intelligent and sustainable buildings**, the way in which they aggregate, their commonalities and the way they relate and their inter-cooperation.

Intelligent buildings need to be sustainable (i.e. sustain their performance for future generations), healthy and technologically up to date; meet regulatory demands; meet the needs of the occupants; and be flexible and adaptable enough to deal with change. Buildings will contain a variety of systems devised by many people, and yet the relationship between buildings and people can only work satisfactorily if there is integration between the supply- and demand-side stakeholders as well as between the occupants, the systems and the building. Therefore, it is essential to identify and develop innovation-integrated building and energy technologies in order to advance sustainable building practices and achieve the energy efficient targets

The specific objective is to:

1) **Study and understand the intelligent buildings** nowadays, their **concepts** and greatest Intelligent building worldwide.
2) **Study and understand the Sustainable building** nowadays, their **concepts** and greatest Sustainable building worldwide.
3) To assess the **link between intelligent buildings and Sustainable buildings.**
4) Studying **common grounds for Sustainability and Intelligent building.**
5) Identifying the **perspective of Intelligent and Sustainable Building through case studies of buildings and its Ratings.**
6) **Live case study** of an existing Building in INDORE.

The following study will comprised of 5 sections. The first section is the introduction part, followed by the chapter called "Intelligent buildings nowadays", where intelligent buildings are described and exemplified.
The third chapter contains the definitions and the characteristics of sustainable buildings nowadays, along with existing examples of such buildings.

Furthermore, in the next chapter is presented the intelligent and sustainable buildings' link, and lastly, the conclusion part.

RESULT; **The Link Between Sustainable and Intelligent Building** The aim: is to understand the link between an

intelligent building and a sustainable building and to understand how building can help in creating a sustainable environment for its users. In debating the link between sustainable and intelligent buildings, whether they should merge or not, two schools of thought have formed. an intelligent The smallest of these schools of thought considers that energy can be reduced, and therefore less money spent, using natural solutions They affirm that intelligence in buildings is synonym to opulence and extravagance, and therefore opposite to sustainability.

The other group, the largest of them, considers intelligence to be at the basis of sustainability, taking into consideration the fact that intelligence supports several technologies that help reduce the use of resources as water, energy, wood etc.

Outcomes	Environmental	Economic	Social
Advantages of Intelligent Buildings	• Energy efficiency • Automatic response to change in energy loads • Reduction in GHG and CO2 emissions	• Decrease in building operation, maintenance and energy costs • Increase in employee productivity • Increase in rental incomes, investments and occupancy rates • Immediate return on investment • Reduced payback period	• Increase in occupant comfort and well-being • Increase in employee productivity • Increased sense of safety and security • Helps overcome loneliness, isolation and depression
Disadvantages	Passive sustainable solutions reported better energy savings as opposed to intelligent buildings in a handful cases studied	None	• Lack of privacy • Inconvenience due to devices • Feeling a sense of loss of control over surroundings

Case study was done of six buildings
Herman Miller International Headquarters, UK ,The U.S. Green Building Council (USGBC) Headquarters, USA, Genzyme Centre, USA , Asia Square Tower 1, Singapore , Taipei 101 Tower, Taiwa.

Live case study of Design Cell, office of and designed by Manish Kumat sir: The office serves as a living lab and demonstrates through its sophisticated and advanced green building design and technology use as a Sustainable Intelligent building with: Day – lighting Design, Solar passive techniques, Rain water harvesting, pipes system, Water Metering, Water conservation, Efficient water fixtures, HVAC system, and local material. **Active Design**; Installation of SKN 154 & 144 DGUs, VRV-III, Under Deck Insulation, LED lighting, Daylight & Occupancy Sensors, HRW system and 10kwp Solar-PV installation •51.5%energy savings over ASHRAE &ECBC 2008. •Energy metering to monitor energy consumption.

These buildings were chosen due to the use of intelligent technologies and their high sustainability ratings.
It can be observed that the intelligent building technologies used in the above case studies can be categorized functionally in broader groups namely Integrated Building Automation, Lighting, HVAC, Water management, Security, Fire safety and IT. It can be reported through the study of literature and case studies that intelligent buildings provide various benefits on the environmental, economic and social front. They have the potential to promote high efficiency spaces and low-energy consumption, which can be the answer to a multitude of environmental concerns. They can also reduce water usage as well as the release of harmful green house gases into the atmosphere. As is evident intelligent buildings and sustainable buildings are striving towards common goals.

5. Conclusion

It can be observed that the benefits of intelligent buildings contribute to the 'triple bottom line' of sustainable development i.e. the environmental, economic and social aspects. By conducting this review of existing literature, theoretical concepts and case studies the research aspires to provide an optimized solution of sustainability and intelligence. The study started with a review of existing intelligent building and sustainable building .It was followed by an analysis of case studies from around the world to showcase the role of intelligent building systems in achieving total sustainability, understand the link between an intelligent building and a sustainable building and to understand how building can help in creating a sustainable environment for its users.

Intelligent buildings are smarter, better connected, self-monitoring spaces providing safer, comfortable, secure, efficient environments capable of self-managing utilities; and maximising occupant performance, investment and operating cost, savings and flexibility. The aforementioned characteristics bear resemblance to the common objectives of sustainable buildings that are designed to reduce the overall impact of the built environment on the natural environment, human health and economy by: ·Efficiently using energy, water, and other resources ·Protecting occupant health and improving employee productivity · Reducing waste, pollution and environmental degradation. As is evident intelligent buildings and sustainable buildings are striving towards common goals.

6. Future Scope

The overall objective of a research is to explore the state of the art of the link between intelligent and sustainable

building. The study and analysis will be restricted to the overview of case studies only. Constructing intelligent sustainable buildings is now a growing concern for the developers in the construction industry... Building these kinds of buildings has numerous perks: 1) the number of resources used will decrease; 2) the environment will be protected; 3) inhabitants will have safer and more secure homes; 4) the interior ambient will be healthier; 5) the exterior ambient will be safer and healthier; 6) the level of comfort will increase dramatically. The study can be taken further carried in terms of Materials and Technologies.

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