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THE APPLICATION OF "GREEN TECHNOLOGY" IN THE MODERN DAY CONSTRUCTION PROJECTS-A REVIEW

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Abstract

Green technology has become an integral part of sustainable construction projects when observing the vast impact made on the built environment. Its values are influential and all-inclusive, contributing noteworthy gains when used in innovative facilities as well as current structures. The purpose of this paper is to indicate the value of shift from conventional technology to green technology towards achieving sustainable modern construction projects, identify values and challenges of green technology adoption in construction. This paper utilizes a well-organized review of various literature to expose the drifts of green technology applications from first solving conceptual sustainable design problems such as diminishing returns, unstable investment, waste prevention, etc. using sustainable design principle with a well-grounded understanding of the technology life cycle. From every indication, the standpoint of this paper show that solving sustainable designs problems is very pivotal in construction, and the possibility of improved energy efficiency through elimination of unnecessary energy use and saving as much as 30% of costs on energy is made possible through the implementation of green technology in construction. Most developed countries like USA, China, and the UK are quickly utilizing the vista and opportunities in green technology implementation which other developing countries like South Africa are imitating. In the wake of the 21st century, most attention is drawn towards sustainable development, and for any built environment in any country to achieve its sustainable goals, it is approved that adoption of green technology in their construction projects is key.

Keywords

Construction Projects, Green Technology, Sustainable Design, Sustainable Principle, Technological Life-cycle.

1. Introduction

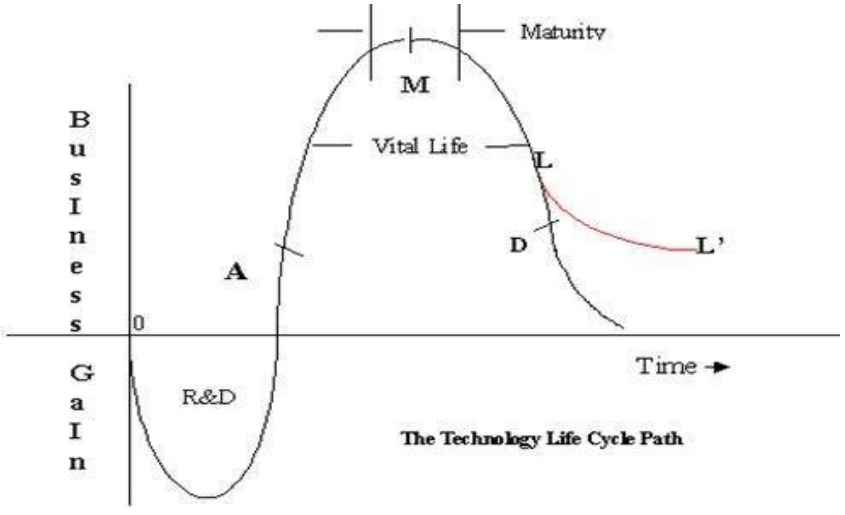
The realm of green technology is fast improving and trendy solution in the construction industry today. Since early 1990's a lot of importance is being placed on green technology, and in modern day construction; there is a serious shift to an efficient construction design implementation driven by eco-friendly activities that make sustainable technology possible. Green technology, otherwise known as sustainable technology, is one that has a "green" driven-insight geared towards sustainability strongly applicable to construction in our modern era. Of a truth, when we talk of "Green" it's referring to nature. But green technology, in general, is one that takes into account the temporary or lasting impact of innovation on the environment (Arslan, 2016). Green technology in construction encompasses the construction of innovative buildings that integrate one with extra aspects of eco-friendly solutions in construction projects. According to US daily newsletter on green technology (2016 edition), green products are eco- friendly discoveries that often consist of efficient energy, recycling, health safety concerns, and resources which are renewable, etc. In the construction of environmentally friendly buildings, the highest goals are; firstly: safeguarding natural resources conservation, eliminating the negative impact of construction activities on environmental safety by producing materials that are reusable or recyclable, and also causing an alteration in production pattern to reduce waste and pollutants. Secondly, finding an alternative to undesirable practices which affects the environment and is challenging to humans' existence. When an appropriate design is used and a good setting for the construction is obtained, then an improvement in the energy efficiency of the building is inevitably achievable.

Mclennan, (2004) indicated in a study that sustainable design in construction is very dynamic and as well important; recognizing that the human problem is not pollution but sustainable design. But, sustainable design cannot be developed if practical steps are not taken through well guided sustainable principles towards ensuring ecological sustainability. There is, therefore, a connection between both, and it makes decisions relating to design to be made with the intention of impacting sustainable development in the built-environment. Although in total, green technologies bid will be a valuable investment for any corporation demanding an improvement in its operations, boost its corporate intellectual, and decrease expenditures. Although the costs of certain green technologies may be extra high initially when implemented, in the end, the established profits might exceed the makeshift benefits for any construction industry. However, prime important attention is given to the technological life-cycle of the products to identify its efficiency and economic advantages it produces.

1.1 Technological Life-cycle

Technological life-cycle relatively differs from product life-cycle. The former deals with product performance at the market sphere while technological life-cycle emphases are focused on various phases of technological growth in production and operation of technology toward industrial progressions (Hitesh, 2019). This defines the commercial advantage resulting from products or construction materials at the cost of investigation and through the developmental phase and the economic profits at its dynamic life. Technological life-cycle principally is concerned with the time and cost of developing the technology. Regaining cost time limits, sophisticated processes which makes the technology yield a profit is proportional to the costs and risks involved. Hitesh in his study goes further to clarify that the technological life-cycle can be seen as comprising of four (4) phases. The research and development phases: This sometimes is called the "flow or bleed verge" profits generated from the input are negative and the prospect of failure is likely to be very high. The gradient phase: In this phase expenditure-cost had been recovered and the technology is reinforced by moving forward beyond some point A on the technological life-cycle, also refers to as the "principal verge". Maturity phase: On the technological life-cycle path in figure 1 below, maturity is marked by M. In this phase, the profits are anticipated to be high and stable until it goes into satiety. The decline phase: This is as well-known as the "falloff phase". At this phase, there is a decline in future resulting in a drop in utility. Figure [1] below shows a representation of the life-cycle in industrial development with production system progress from the stages of its initial commencement to its conclusion as either a technique or procedure of common practice or to its demise.

In Figure [1]- Y-axis illustrates indications that commercial profit is reached shown to the owner of the technology as the "business gain" while X-axis hints on the generation per time



Source: http://en.wikipedia.org/wiki/file:Technology_life_cycle.png.

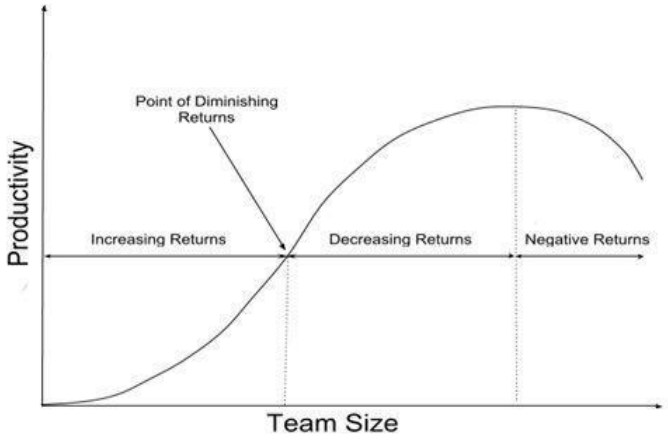
1.2 Conceptual Sustainable Design Problems in Construction

Sustainable design is a fundamental point in sustainable construction projects. It involves the practice of design physical structure, facilities, and services to act in accordance with the principle of ecological sustainability considering most importantly socio-economic factors. The target is eradicating negative environmental impact utterly through skilled, and profound design. Sustainable design is obvious in renewable resource, minimization of negative environment effect of waste, and interaction of people with its natural environment.

Micheal and William (2013) in his book stated that human being does not have any problem of pollution; but a problem of obtaining and utilizing sustainable design. If humans were to invent products, tools, plants, but more intelligently from the on-set, there would not have to be requisite to think in terms of waste, pollution, and dearth. Sustainable design can tolerate plenty of boundless reuse, and create a pleasant environment. Day-to-day, a decision relating to design are taken based on impacting sustainable development. In a construction project, there are numerous problems limiting efficient sustainable design. The problem primary demands a critical solution, and practical principles ought to be monitored to tackle the problems. Some of the problems are as follows.

Bauer and Papp (2009) in a study stated that common management practice initiates diminishing marginal returns problems in all direction of effort indicating diminishing prospect. Therefore, there is a possibility of fast-track decline and indication to pursue better opportunities elsewhere. According to Tainter (2014), when diminishing marginal returns begin to occur as a result of attaining natural limits, the consequences are inevitable. Diminishing returns in construction projects is disturbed with concern given to materials used on sites and employees output. An increase in the productivity process is not necessary directly proportional to the increasing number of employees because another additional employee might be harmful to the organizational team framework-team size (Lucas, 2017). The demand for extra workers may incur the problem of diminishing returns when an added worker is introduced, firstly the input will increase and returns on investment will be reached i.e. increasing returns. But the input decreases as more workers are added i.e. decreasing returns. Finally, saturation occurs when an extra addition to the workforce makes everyone compete for the tasks and resulting in a decline in the input i.e. negative returns.

Figure [2] below illustrates the relationship between productivity and team size (Lucas, 2017).



Source: Lucas, (2017)

The problem of a decline in investment upturn is caused by a gradual dropping of resources, and this has been investigated amidst others by scholars. Tainter (2014) in a study, explains that this problem appears when the limits of resources are hard to perceive, therefore turn over investment and struggle to combat diminishing returns problem created led to an irresponsible investment. Although, it would seem cost-effective at an early stage but might end up in failure. This normal error in investment policy contributes greatly to the failure and get rid of over-stressed resources necessitate decreasing stress on them, not continually increasing it whether it's more efficient or not (Buzz, 1973, cited in http://howlingpixel.com/i-en/sustainable_design, 2019)

Furthermore, studies have indicated no absolutely best waste prevention method because most waste removal practices are considered to have an adverse influence on the environment, human wellbeing, and the economy. Therefore, environmental damage from waste can ultimately be avoided by preventing its generation. According to Anastas and Zimmerman (2003), prevention of waste is integral in sustainable design as waste prevention measure should be critically considered to prevent the waste generated on construction sites. So, strategic planning for facilities and design strategies is necessary. Waste prevention strategies can be applied although it can be carried out through diverse approaches such as, utilizing products that minimizes waste and are non-toxic, composting or anaerobically breaking down of biodegradable wastes into useful products, reusing materials on site or collection of proper materials for off-site recycling, and consuming fewer capitals requires creating less waste, thereby reducing its damaging influence on the environment.

Globally, climate change is proving to be a challenge that research efforts are concentrated on. Possibly, there is a most apparent and overwhelming prerequisite for an eco-friendly sensible sustainable design which can lessen the adverse effects of global warming and climatic change in the environment. And this can be credited to some faults such as an improper design that certainly don't consider the environmental implications (Nadia El-Hage *et al*, 2010).

Jurrian (2014), in a study, highlighted a significant, and mostly irretrievable loss in the biodiversity of life on earth, statistics revealing that *10-30 percent* of living species are endangered and probably will be in extinction because of human activities like construction activities. But lack of sustainable design contributes significantly to the biodiversity of the environment, and also the influences of construction actions generate pollutants from wastes which result in the production of the negative, direct or indirect effect that alters the flow of energy, the chemical and physical composition of the environment and abundance of living species (Jenny, 2017).

Table 1: Summary of previous literature on sustainable design problems in construction

Conceptual Sustainable Design Problems	Authors
Problem of diminishing marginal returns	Bauer and Papp (2009), Tainter (2014), Lucas (2017)
Lack of responsible investment	Tainter (2014)
Proper prevention of waste	Buzz (1973), Anastas and Zimmerman (2003)
Global warming and climatic change	Nadal El-hage et al (2010)
Biodiversity loss in the ecosystem	Jurian (2014), Jenny (2017)

2. Sustainable Design Principles in Construction

Combating sustainable design problems in construction projects involves sustainable principles which must be used in standard project design guides and must be firmly adhered to by either government, private organization or individual. In John Todd ecological principles as detailed by Vold and Buffett (2008), species must be preserved to conserve genetic diversity, therefore habitat must be maintained. Climate influence must be checked to ensure a balance ecosystem. This principle was also supported by Sim van der and stuart (2007), which explain the ecological design principles as effective in making natural system the basis of design thereby creating an efficient, healthier, less toxic, and more sustainable buildings, landscapes and technology.

In Hannover principles by Michael and William (2013), the human rights and nature co-exist, therefore interdependence must be recognized. Responsibility must be taken for any design decisions, and design must create safety and lasting value, eliminating waste, but limitations of design must be recognized. Mclennan (2004) in a study clarifies that non-recyclable materials used in construction consumes large capitals to

produce, applied and generate waste when the structure is wrecked. These waste materials create landfills, huge incinerator demand which is not cost-effective. Consequently, choosing low impact, non-toxic sustainably formed or recycled materials involving less energy procedure is very decisive in construction work.

Additionally, in construction, the use of energy-efficient industrial materials which are products with less energy demand can help to reduce the greenhouse effect by decreasing greenhouse gas emissions. Such are of high necessity in construction projects and can only prioritize to achieve sustainable construction. According to the (United State National Construction report, 2016) energy efficient materials is vital not only to the handler but the environment because non-renewable energy sources are not only costly but contaminate the environment. It is discovered that material that can be reused and recycled is best used in construction. Therefore, materials, methods, and system should be designed to ensure market values for secondary materials from construction waste. Also, durability should be the highest design quality in materials. Material diversity should be minimized in multicomponent material to encourage disassembly and value retention. In a report by Philip (2017), understanding how both reusable and recyclable materials can be utilized is key to comprehending how to make the earth more sustainable.

Table 2: Summary of previous literatures on sustainable design principles used to solve design problems in construction or any building projects.

Design principles in construction	Authors
● John Todd Ecological design principles 1. Design should follow the law of life, not the opposite. 2. Biological equity must be considered in design. 3. Using renewable energy sources. 4. Limitation of design should be well understood. 5. Design must reveal bioregionalism 6. Climate effect must be checked.	Mclennan, J. (2004), Sim Van der and stuart (2007), Vold and Buffett (2008), Nadal El-hage et al (2010), John (2019)
● The Hannover Principles 1. Using low impact or non-toxic materials. 2. Using energy-efficient materials. 3. Eliminating waste should be key in the design. 4. Dependant on natural energy flows. 5. Acceptance of responsibility for any consequences of design decisions.	USA National construction report (2016), Mclennan, (2004), Michael and William (2013)
● Other Principles 1. Using reusable and recyclable materials. 2. Materials should be designed to ensure market values for secondary materials. 3. Durability should be highest design quality	Philip (2017)

3. Methodology

This paper utilizes an organized review of various literature which sources are from renowned conference papers, journal articles and government reports to expose the drifts of green technology applications from first

solving conceptual sustainable design problems such as diminishing returns, unstable investment, waste prevention, etc. using sustainable design principle with a well-grounded understanding of the technology life cycle. And also to identify the value and challenges of green technology application in construction project.

4. Discussion and Findings

Green technology is premium and of great necessity in order to stimulate the sustainable principles outlined in this study. More so, the value obtained from "green technology" application in construct work can be significant and broad, offering noteworthy advantages when used in new facilities as well as current structures. Engineers and structure owners take various phases to make a building "green". These appropriate approaches as stated by Elizabeth (2019), include correctly locating the structure to take gain of normal conditions together with solar alignment, making use of recycled or eco-friendly building materials, and reducing housing sprawl with considerations to other sustainable principles appropriate in solving design problems. Apparently, any kind of construction is naturally harmful to the environment. Nevertheless, with sustainable design; it is likely to lessen or eliminate any damaging effect. There are numerous values derived from applying green technology in the construction industry which some studies has revealed. Elizabeth (2019) also stated that although the purchase and costs of installing green building materials might be somewhat costlier initially, long-standing profits are much realistic. These technologies are intended precisely to efficiently maximize resources, which in return, causes a reduction in overall costs. According to Elizabeth (2019), workable sustainable features in designing procedures and construction of a building can moderate environment influence, conserve expenses and create value that lasts.

Possibly the particular most significant value of buildings applying green solutions is the environmental influence of waste it minimizes. Orthodox technologies, for instance, petrol generators, can result in a wide devastating effect on the environment, making it indispensable for companies to decide on using green technologies. Particularly, green technology aid in reducing industrial carbon footprint production minimizes waste generation, preserves water consumption, decrease energy usage as related to old technologies (Zhiwei Yi, 2014). Since the stir of the 21st century construction industry is towards sustainable development which is obviously towards the reduction of negative impact, utilization of green solutions will be paramount and appropriate. More so, the 'green' energy sector in an economy is accountable for numerous job prospects in today's market sphere. There is a need for sufficient proficiency in workable solution in the business of building structures. "Green energy" sector is perhaps an emerging market niche which now remains more than a few generations to come. Consequently, various employment choices are available for the public, some of which include; health engineers, solar utility specialists, and proficient illumination professionals in addition, etc.

Structures which have suitable green solutions on ground, whether housing or commercial, are qualified for duty rewards of which many government policies would support. Normally, the infrastructure shall be initially evaluated based on employing green solutions, for instance, photovoltaic cells, solar heaters, geothermal power or even small wind systems. Then the government would provide motivations to lure co-industries to adopt such or similar green solutions in their day-to-day operations. No doubt about this, industries are constantly considering substitute solutions that can help to cut expenditures. To be specific, industries will earn profits in maximizing green energy solutions in several ways. Innumerable scholars had shown a persuasive necessity to implement green technologies in construction projects. The key theory being that green building is not just about the maintenance of the environment, but also solutions that are sustainable which make sincere sense for a construction corporation to embrace green technology. Consequently, opinion tells that industries implementing green solutions are more likely to entice clients than their contemporaries (source: www.constructionworld.org. 2018)

This specific kind of benefits transmits from the corporate societal responsibility of the given corporation where its motivated to contribute in return to the general public in one means or the other. Besides, a construction corporation which has satisfactory sustainable solutions on the ground have minimized energy consumption and operational costs which can be cut down to about 30%. For instance, utilizing solar generated power like using solar inverter in place of electricity can help cut service charges by virtually 30 percent. Additionally, industries that apply green technology are eligible to enjoy motivations through government encouragement. The additional capital earned in the process can be invested in another area of operations in the corporate, thus

improving general service provision. According to Siemens building technology, numerous studies have acknowledged cases of the “sick syndrome” that can create an unhealthy working environment in commercial buildings, particularly older buildings and those situated in hotter climates where ventilation issues are a concern are related to waste generated from construction actions that cause pollution which can be prevented by the sustainable application of green solutions. A survey, carried out by the Building Engineering Service Association (BESA, 2016) stated that nearly 70% of office workers supposed poor air quality in their place of work was having an adverse effect on their daily output and well-being. Absolutely, the green solution applied in construction projects would help to ensure a healthier working environment.

5. Best Green Technology in New and Existing Construction

Green technology in construction is an effective way of using resources that can provide energy efficiency, waste reduction, and sustainable systemic evolution. There are a large variety of renewable construction technologies available today that can make a direct impact on how well building functions. For example, cool roofs are specifically intended to offer improved sun reflectance by reducing emits from the thermal source. In another way, its reflect more of the sun’s rays than any regular roof made up of shingle. This prevents any air inside either warm or cool to abscond in the topmost of the edifice. In the summer period, beneath the penetrating hotness of the sun, dark shingle roofs can increase to the temperature of about 65.5 degrees Celsius. The reflectance of a cool roof can reduce this temperature by more than 50 degrees Celsius. Dropping the roof temperature itself is an advantage, certainly, although the real savings is the interiors. A cool roof will enhance the reduction in the interior temperature of the building, either by reflecting penetrating heat or trapping the air inside. This diminishes stress on the air conditioning systems, thus decreasing the emissions that come from driving the heating and cooling process. Cool roofs are manufactured from several materials, with quality reflective paint and cool roof-shingles and tiles. Without no further look, there is a high conservative reason to believe and accept the effectiveness of the cool roof. Their reflectance definitely aids in lowering the heat mass influencing urban and suburban areas, which causes intensely higher temperature with severe sun effect in contracts to neighboring rural areas.

Also, insulation is roughly considered the worst paraphernalia in construction, as anyone who’s gotten fiberglass shards in their skin can confirm this. The paraphernalia doesn’t necessitate any attractiveness or loveliness because it’s fundamentally wall pitch. Fundamentally, why not make insulation out of any old rubbish if the in-built practice is considered? This is basics in green insulation installation. Cellulose insulation, for instance, takes a similar product and recycles it. Recycled paper insulation grown is common in numerous varieties, but most popular in blow-in cellulose. This can be sprayed in walls or garrets instead of being laid out in sheets. Although, fiberglass insulation can be made from recycled glass, there’s a difficulty: Melting the glass and making fiberglass insulation from paper. Cellulose insulation regularly contains 75-85 percent recycled material, in comparison with fiberglass’ which is 30-40 percent. Cellulose is even more superior in avoiding airflow compare to fiberglass, therefore it is considered better when referring to green insulation neither does it cause any discomfort or health concern in fiberglass usage.

Wesley (2019) in a study concludes that since erecting a new structure is about building something new, occasionally we do overlook another side of the coin; when demolishing or disposing of building materials as waste. Biodegradable materials can be changed through processes transforming it into something more environmentally profitable. As an alternative to a huge mass of waste generated and harmful chemicals produced, there can be a status quo resulting in a production that naturally degrades and will not contaminate the soil. An excellent example is biodegradable paint. This is an effective method of preventing wearing of the walls and reduction of waste.

An olden construction practice which involves using a mixture of earth and hard substances such as clay or gravel combined with a stabilizing element like concrete and beaten to form compacted hard walls known as “rammed earth bricks” is desirable. After forming, rammed earth must cure for months or with the proviso of at least two to three years in a tropical climate to completely cure and toughen. The compactness of rammed earth makes it one of the best materials for controlling building temperature. It makes building remain cool in the summer and warm in the winter season. Fabricating rammed earth bricks generate a smaller amount of

emissions compared to the usual building method of manufacturing bricks. Systematically, rammed earth bricks are evidently proving to be a better green material to be used in building construction.

In rural settlements, runoff waters from heavy rains and snowfall can carve out huge strips of plot and cause damage to the life of a plant when wearing away occurs; which is a seriously damaging phenomenon. The influence caused by stormwater from the major municipal area is equally hazardous; overflowing culvert systems can flood highways creating hazardous driving conditions and destroy buildings bringing great damages to lots of properties. That's where managing this stormwater is indispensable; it involves remodeling and planning systems for property management of huge volumes of water. Therefore, the US Environmental Protection Agency introduces "green infrastructures" which offer an inclusive series of value and potentials. Through the encouragement of growing greenery in the municipal area. Infrastructure built will help lower cold effect created by heat-absorbing pavement and metals, reducing sewer overflow by absorbing the water, and simultaneously reducing the pollutants from stormwater as it flows within plants and soil. Increased production of green coverage-plants reduces overall runoff, and air quality improvement occurs when carbon dioxide is absorbed by the plants. In many developed countries, effective management of stormwater is practiced in highways structures. Instead of managing stormwater a new process is now used by utilizing the life of the plant to control water.

Furthermore, geothermal heating can be used in connecting to natural energy from the earth to generate power like wind or solar power. Geothermal is a proficient renewable energy resource that's far more environmentally friendly than coal-powered electricity or natural gas. Even though this method of technological implementation does have its shortcomings like burrowing earth space to place the energy and assemblage of shrill which is largely heavy duty, yet it's a noble reason to make use of it. Also dynamic solar systems noticeably offer supplementary heat compare to passive solar design. Solar panels, for instance, it absorbs the sun's radiation and makes use of the heat to warm air or water, reducing consumption of gas and electricity along the process. The more dependency on solar energy, fewer greenhouse gases produced from using non-renewable energy source. Although, the efficiency of solar panels varies depending on the dimension of the system and the local climate. However, giving perfect situations, a solar system usually covers up and insure the direct costs of connection over the old systems with existences of unrestricted energy.

Also, smart glass, or electrochromic glass, use an insignificant surge of electricity of ionically charged materials on a window sheet changing the quantity of light it reflects. Although, low-emittance window disturbs radiation from the sun which already occurs. But smart glass has the ability to indicate the quantity of light to obstruct. This kind of glasses is recently manufactured and finished for use commercially, expecting more of this glass in the future as competing manufacturers bring these smart energy-saving inventions to the market for sale. Producers of Innovative machines are also integrating recent technology commonly used such as smart systems which fast-track the building processes. For example, in agriculture, a robotic plough is now being used instead of the normal crude machine operated manually. Some of this machine are programmed to even indicate the start and finishing time for the work of the project. Many construction projects contractors meet the deadline when smart systems are effectively utilized in the construction processes. Nowadays, a lot of high-rise buildings are built in much less time due to the successful implementation of this new technology. Also, "Zero energy" structures, or 'zero net energy' structures, can be constructed effectively to function self-sufficiently with a precise electric grid. In any way, they generate their own control from a renewable source. "Zero" is a word which denotes both energy consumption and carbon emissions. Annually, a "zero energy" structure consumes zero net energy and will never generate carbon emissions because it depends on renewable energy power supplies like solar or wind power source.

6. Challenges to Green Technology Adoption in Construction

In general, it can be deduced that green technology is costlier in comparison with any other technology its substitute since it accounts for most green costs that can be uttered in many conventional invention developments. Although green technology is relatively new and recent, the dynamism in progression, and with implementation, costs can make it even more costly in comparison to olden technology. Though, supposed benefits also reliance on other factors such as supportive infrastructure, technological enthusiasm, human

resources capacities, and geographical components. Adopting and application of green technology have some constraints caused by a number of other barriers which may be either customary, such as the lack of an appropriate regulatory framework; or technical, economic, political, cultural, and legal in nature. More so, from a corporation's viewpoint, these barriers in adopting green technology include; input, performance impacts uncertainties, insufficient funds, and skilled personnel. But, overcoming these barriers is a difficult task. Supporting 'green' growth then requires identifying and removing these barriers that hinder the large-scale distribution of green technology into most developing countries like South Africa.

CONCLUSIONS AND RECOMMENDATION

In modern day construction projects, green technology is applied to offer an increasing demand and higher market values for their facilities. Even most infrastructure owners benefit from having the lower ongoing cost of operation, improved rates of occupant retaining their space, and higher building values. Most of these green technologies are used in buildings to integrate regulatory systems implanted in many structures. By efficiently managing infrastructure processes, construction industries can generate better production while maintaining a high-performance system of operations, and also reduce operational costs, as highlighted before in this study.

From every indication, the standpoint of this paper shows the possibility of improved energy efficiency through elimination of unnecessary energy use and saving as much as 30% of costs on energy which makes green technology of utmost importance. Although, most developed countries like USA, China, and the UK are quickly utilizing the vista and opportunities in green technology implementation. But, most developing countries of the world like South Africa are still struggling to adopt these green technologies in their construction industries and probably object is the cost of its implementation. But this study indicate that prospective resources conservation and sustainable construction can only be achieved in such developing countries like South Africa when green technology is applied sustainably in construction projects. Further research should be geared towards knowing the perception of various stakeholders in the successive implementation of green technology. As a final point, in the wake of the 21st century, most attention is drawn towards sustainable development, and for any built environment in any country to achieve its sustainable goals, it is approved that adoption of green technology in their construction projects is key.

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