

Adoption of Green Building Practices in Langata, Nairobi City County, Kenya

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Abstract:- The increase in greenhouse gas emissions in the atmosphere is a threat to biodiversity. This challenge is being solved by introducing green building practices such as making use of natural lighting, use of solar heating systems, using materials like bamboo which are long-lasting and renewable which aid in reducing energy, water, natural resource consumption and improving waste management in buildings which human beings spend most of their time. Although past research has established a correlation between the level of stakeholder awareness and the rate of uptake of green building technologies, this postulate had not been tested in Nairobi City County. Thus, this study focused on adoption of green building practices in Langata, Nairobi County, Kenya. The study adopted a survey research design; utilizing both quantitative and qualitative methods of data collection including semi-structured questionnaires, inspection checklist and interview schedules. The variables assessed were; the level of green building awareness of construction practitioners, regulatory measures of green building practices and the environmental sustainability indicators of green building technology. The sample size comprised of 100 samples from a total population of 13,126 comprised of construction players including quantity surveyors, construction practitioners and project managers and residential buildings built between 2010 and 2020, two floors and above were the focus of the study. The collected data was analyzed using Microsoft Excel version 13 and SPSS version 25. To test hypotheses, regression analysis was performed. The level of awareness as variables had R-Square of .106, F-calculated of 10.357 and $p \leq .002$; The Regulatory measures had R-Square of .172, F-calculated of 15.644 and $p \leq .003$ and environmental sustainability had R-Square of .241, F-calculated of 13.742 and $p \leq .002$ on adoption of green building technology in Langata Nairobi County, Kenya. The findings indicated that data was significant and alternative hypotheses were acceptable to be statistically significant. The findings depicted that majority of construction workers were not aware of green building, Kenya Green Building Society and neither were they trained on green building. Regulatory measures were implemented at a moderate extent but green building policies had not been incorporated in the current construction guidelines. The study also showed that green building practices such as

waste management, energy and water efficiency are being observed well. The conclusion is that most respondents do not clearly understand green building technology, implementation of the already set green building policies is still a challenge and there is a great change in people's attitude towards building sustainably. It is recommended that more awareness and training should be done, regulations established and enforced and government should provide incentives to encourage green building technologies. The findings of the study provide additional literature on the subject matter for further research. It also helps policy makers in formulating policies which may enhance the uptake of green building technology in the study area.

Keywords:- Contractor, Green Building, Energy Efficiency, Level of Awareness, Sustainability, Waste Management, Etc.

I. INTRODUCTION

Green buildings are structures that are designed in a way that natural resources are utilized efficiently while waste generation is being reduced. The conventional way of building has received attention from many countries because of the enormous use of energy, large amounts of waste generated in their construction and operation, and large quantities of pollutants and greenhouse gases emitted [1]. This contrasts the Paris Agreement which intends to maintain global temperatures below 20C (IEA and UNEP, 2019). Discussions on sustainable construction have led to the introduction of the idea of green building instead of conventional buildings. Guidelines on how to establish green buildings have been put in place in different regions depending on the regional characteristics and needs [2]. Unlike the conventional way of building, green building aims at providing enhanced air quality, reuse materials, use durable and long-lasting materials at the same time, save on cost as electricity and water bills reduce.

Sustainable Development, defined by Brundtland Commission-Report [3] is "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs." To ensure construction is done with minimal harm to the environment, green building practices are employed. According to the Federal Environmental Executive, a building is said to be green if it is built in a way where minimal energy is used up,

resources are utilized well and water is conserved. This is achieved through proper planning all through the building's lifecycle [4].

Research by [5], on benefits of green building affirmed that green buildings provide better health care for occupants due to indoor air quality, improves energy efficiency, enhances lives and comfort of individuals, lowers emission cost, enjoy the support of climate change protocols and reduce use of non-renewable resources, increases building life and cuts cost of water as it is used efficiently. Intergovernmental Panel on Climate Change (IPCC) projects that urgency is needed to prevent permanent effects of climate change. Yet the construction industry is a great emitter of CO₂ to the atmosphere [6]. A study done by [7] shows that green building practices reduces greenhouse gas emissions at a fast and effective way, often with net economic gain. This is an opportunity to manage global climate change, reduces dependence on expensive and non-renewable energy and decrease threats to human health [8].

According to [9], the two main challenges that face Kenya in adopting green building practices are; initial cost of green building may not be affordable to most developers and lack of enforcement of green building practices. Kenya Green Building Society (KGBS) is a council in charge of raising awareness of green building practices, accessing latest innovation on green building and certifying the best green building developments after rating using the Green SA rating tool and pushing the government to lead by example. Adopting these practices may be slow because Kenya is a developing country with poverty being a greater challenge [10].

The aim of this study was to find out the level of

awareness of green building practices by site managers, practitioners and contractors in residential buildings in Langata sub-county. The research evaluated, assessed and recommended possible sustainability and mitigation measures in adopting green building practices. The outcome is to disseminate the information with the aim of finding areas to minimize waste returning to the natural environment, utilize the energy properly, consume renewable resources and enhance indoor air [4].

II. METHODOLOGY

This study used the descriptive research design. This type of design was used because observation and measurement were done without necessarily interfering with any variable [11] and the respondents were from different organizations that regulate construction processes. Both qualitative and quantitative methods were deployed comprising interviews, semi-structured questionnaires, observation and inspection checklist. Simple random sampling was done because the population is large. According to Nairobi County Urban Planning department, Langata has approximately 13,126 residential buildings between 2009 and 2019. This research adopted Naissuma (2000) formulae with margin error of 0.05 to choose the sample size.

$$n = Nc^2 / (c^2 + (N-1)e^2) \quad n = N / (1 + N [(e)]^2)$$

where: n= sample size; N= Population; c- coefficient of variation (take 0.5); e- tolerance of desired level of confidence (take 0.05 at 95% confidence level). The population in the study comprised contractors, project managers, developers and site managers in Langata sub-county.

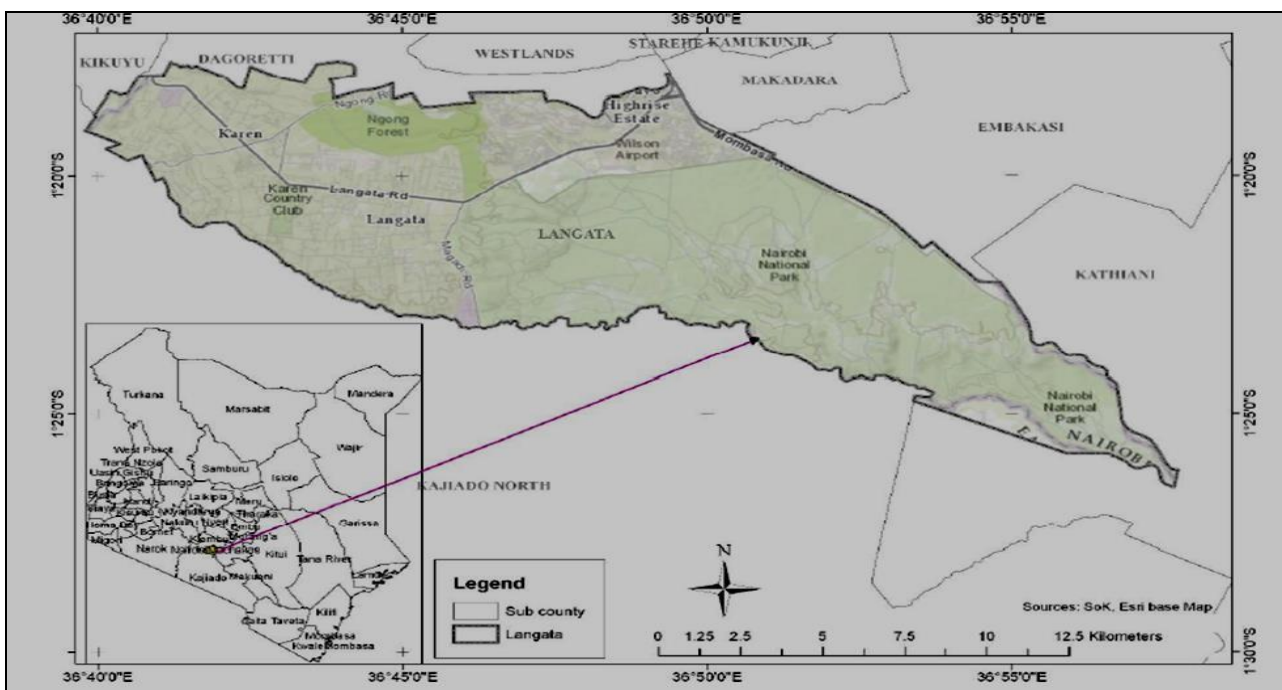


Fig. 1: Map showing location of Langata Sub- County in Nairobi City County (Source: KNBS, 2010)

III. RESULTS AND DISCUSSION

The results indicate that construction workers have adopted green building through water supply sub-meters at a mean score of 3.61, showing that majority of respondents have adopted use of water supply sub-meters to a great extent. Water metering is the tool used to monitor water usage, detect leakage, monitor demand and plan its supply to users. These results are in line with [13] that found that use of water sub-meters is being used in Nairobi to a great extent because residents are very keen on monitoring their water consumption.

A study to determine water metering strategies and how it helps improve water service provisions [14] revealed that the houses without a water meter recorded higher cost of water bill compared to those with meters. Those without a meter experienced higher rate due to malfunctioning meter, inaccurate readings and frequent outage which resulted in buying water from private suppliers that are more costly than the government suppliers. This agrees with [15] that water meters help to measure actual water consumption and identify conservation opportunities that may arise. Majority of Lang'ata residents are careful to conserve water as observed by the findings.

Use of solar at a mean score of 3.55, shows adoption of solar energy to great extent. This contrasts which [16] that highlights that most developers in Hong Kong had not installed solar panels as most of them considered this as expensive. A study on green building design based on solar energy in China, [17] shows that use of solar energy reduces the dependence on municipal facilities which is energy efficient. In Kenya, solar panels have been positively adapted in Langata sub-county because most residential houses have the solar heating system as a way of promoting renewable energy and eventually lowering the cost of energy usage. Energy management system has been adopted in green building at a mean score of 3.46, hence showing that most respondents are adopters of energy management systems to a great extent.

The findings of this research are supported by [18] that mentioned that energy management system provided social, economic and environmental benefits to occupants. [19] argues that lighting alone consumes 4% of total energy requirement of a residential building. To even further reduce this, it is recommended to make use of smart meters and light controls. Construction practitioners have adopted use of day light at a mean score of 3.39, which shows moderate extent of adoption. [20] agrees with these findings that majority of people are using natural lighting in their homes. Natural lighting is beneficial to the health as it is believed to lessen stress, discomfort and is good for vision. A very simple way of reducing energy consumption in a building is making good use of natural light that is free and available. [21] opines that buildings have wide windows to allow enough sunlight and avoid the impact of diffused light. Even so, [22] cautions that proper planning should be done to avoid excess light, diffused light or excess heat from getting into the building through using external shading devices such as overhangs,

horizontal and vertical louvers and light shelves.

Energy conservation measures has been adopted at a mean score of 3.25, which is moderate extent. This is consistent with [13] that in Kenya, conservation is being done at moderate extent. [23] opines that natural lighting is a great way to reduce reliance on electricity which cuts on electricity bill and improves efficiency on comparing traditional and LED lighting methods, observed that LED lighting is beneficial and saves energy as compared to traditional bulbs that consume a high amount of energy and emits a lot of heat. [24] argues that LED lighting offers better brightness, contrasts and is 10 times as effective as 8 traditional bulbs. [23] also adds that light control sensors and use of smart meters go a long way in conservation. In Lang'ata, Nairobi County, energy conservation is being observed through switching off lights when not in use and making use of day light as they have large windows allowing light and ventilation in.

Artificial lighting controls have been adopted in the industry at a mean score of 2.89, which is also moderate extent of adoption. This is a system that allows for automatic switching off of lights when they are not supposed to be on. Controls can vary from dimmers, timers to even motion sensors. These findings are in line with [25] that Kenya is still new at this concept of artificial lighting controls especially in residential buildings. In his work on creating a voice sensitive lighting control to support the elderly and disabled, he suggests that this system is important as it makes work easier and saves on energy too.

Building experts have adopted water recycling in the industry at a mean score of 2.10, therefore showing low extent of adoption. This agrees with [27] that observes that only a small percentage of Nairobi occupants recycle water. A study done by [28] to examine the public trust in using reused water, found out that the public feared that reused water may have a negative impact on their health. [26] also mentioned that recycling is implemented in Kenya at a low degree but investigations found out that use of boreholes is a common means of having an alternative water source. Langata's water recycling score showed that there is low use of this technology. This could be attributed to the fact that there is little knowledge on water recycling and the technology is costly.

Water waste reduction has been adopted in the building sector at a mean score of 1.99 which means respondents have adopted at a low level. [13] also agrees that implementation of waste water reduction is at a low extent. [29] reports that most of the time, waste water is used in irrigation, cleaning and for landscaping. In Langata, observations were that most of these residential houses were in small spaces and most residents did not have sufficient land for farming. Farming would have been the best outlet for waste water used in the kitchen. For landscaping, most houses used fresh tap water instead of waste water.

Renewable energy sources have been adopted at a mean score of 1.83 which means majority of them have adopted renewable energy sources at a low extent. This is consistent with [30] that Kenya’s consumption rate of renewable energy is slower as compared to other developing countries. [31] suggests that high cost of installation is among the primary contributors to low consumption. A study done by [32] discusses that large families are reluctant in adopting as compared to those small ones because their priorities are now focused much on raising children and building family and less focus is put into sustainable building. These results portray that Lang’ata is still lagging in terms of renewable energy, though some buildings had solar heating systems and even used biogas as fuel.

The composite mean was 2.90 which implied that adoption of green building practices is being implemented at moderate extent in Nairobi County, Kenya. This agrees with [33] that found adoption of green building practices in Nigeria is moderate to good extent. [34] also reveals that adoption of green building practices in residential houses in Nairobi is average whereby some practices are being implemented well and by majority while others are not being implemented. Generally, adoption of green building in Lang’ata sub-county, Nairobi, is being moderately implemented probably because green building is still new, there is scarce knowledge of the benefits and the clear measure of saving and minimal support from government in subsidizing green building materials.

The research sought to examine the Level of awareness on adoption of green building practices in Nairobi County, Kenya. The respondents were asked to use a Yes or No question. The results were as shown on the bar chart below.

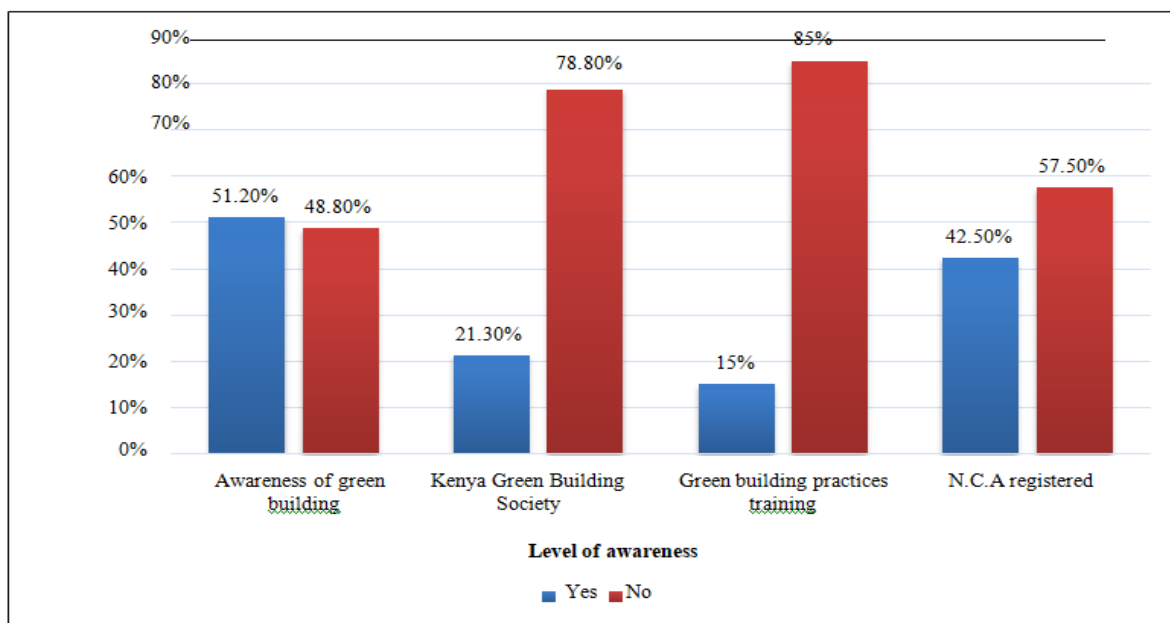


Fig. 2: Descriptive Statistics on Level of awareness on green building practices in Nairobi County, Kenya

The results illustrate the level of awareness of green building practices by construction practitioners and the respondents either agreed or disagreed that they were aware or not. 51.2% agreed that they had knowledge on green building while 48.8% said they had no idea. The findings of this study agree with [35] that most people are unaware of green building. In Lang’ata, when asked about green building, the respondents showed that their understanding was at different levels in that, some had an idea of the definition, others had a deeper understanding about the green building practices while others understood that it is the concept involved in ensuring the building is built sustainably from beginning to the end of the project and even after the project is in use. A study done by [36,37] revealed that level of awareness had a great impact in adoption of green building.

21.3% of respondents had heard about Kenya Green building society while 78.7% had not heard about it. This demonstrates that a majority of the respondents are not conversant with the body that deals in green building technology in Kenya. The Kenya Green Building Society (KGBS) is a member of World Green Building Council and its main mandate is to advocate for green building, develop rating systems in Kenya, educate and train stakeholders. In 2017, KGBS and NCA signed a Memorandum of Understanding to work together towards sustainable construction [38]. They agreed that KGBS should do green building training for NCA and also act as knowledge partner. On the other hand, NCA agreed to support through advocating on green construction, help in formulating green building policies and adoption of rating systems and standards. These results suggest that KGBS still have a long way to go in terms of training of construction workers and the outcome would eventually affect adoption of green building in Kenya.

JKA great percentage of respondents (85%) had no training on green building practices while only 15% had been trained. The few that had been trained had acquired training in workshops and seminars. This shows that few construction practitioners are equipped with this knowledge yet they are at the forefront in construction. Similarly, studies done by [39,40] explore the barriers of green building technology and they found that knowledge of green building is limited and even the little that is present has not been disseminated to the construction workers, leave alone the general public. In terms of regulations, policy makers are not knowledgeable in green building and are reluctant to utilize assets in academic institutions [41]. From the results, it can be concluded that the bodies in charge of training, including NCA and KGBS, have not played their role well as we can clearly see that most construction practitioners have limited information and know-how on green building.

42.5% were registered by National Construction Authority while 57.5% were not registered. This shows that majority of construction practitioners were not accredited by the National Construction Authority. The importance of accrediting workers is to certify that they are professionals in the industry and have adequate skills for construction. A study done by [42] reveals that poor workmanship is the greatest cause of building collapsing. Yet these results prove that very few construction practitioners are registered and known by the relevant authorities compromising construction activities and meaning that green building education is limited. Green building training and awareness is a key factor even as countries evolve towards sustainability and one of the greatest importance for construction workers is the fact that those who demonstrate expertise in this field attract more clients, especially those that are environmentally conscious [42].

[43] reveals that the level of green building awareness in Kenya is at 50% which is average and agrees with the findings on Figure 4.1. These results show that green building knowledge is still low, many people are not aware about the knowledge and practices and therefore explains why adoption is still slow in Kenya. This is consistent with

[44] that found out that awareness of green buildings and practices level in Sri Lanka. Therefore, a lot needs to be done to disseminate the available information on green building through social media, workshops, seminars, television stations and radio stations.

To test null hypothesis, **H0**: There is no statistically significance relationship between the levels of awareness on green building and adoption of green building practices in residential buildings in Nairobi County, Kenya regression analysis was performed. The results were statistically significant since $p=0.002$ which is less than 0.05; hence, null hypothesis that there is no statistical significance influence between the levels of awareness on building and adoption of green building practices in residential buildings in Nairobi County, Kenya, was rejected.

The research sought to examine the regulatory measures of green building practices in Nairobi County, Kenya. The respondents were asked to use a Likert scale of 1 to 5, where 1=no extent to 5=very great extent. The five-point Likert scale is considered an interval scale. The mean is therefore very significant. From 1 to 1.8, means no extent. From 1.8 to 2.60, means low extent. From 2.61 to 3.40, means moderate extent, 3.41 to 4.20, means great extent while 4.21 to 5.0, means very great extent.

The respondents agreed to a great extent that they adhered to green building practices as illustrated by a mean score of 3.57. This shows that adherence of green building is at a great extent in Nairobi County. This is in agreement with [45] that Kenya shows a positive attitude in terms of building green as seen by the practices and behaviors that are being done. First, water conservation is observed where use of low flush or aerated taps and showerheads, and use waterless toilets and urinals. Also, it is observed that most buildings have plumbing system where wet areas are close together to reduce cost of plumbing. Additionally, grey water is used in irrigation and toilet flushing and moves by gravity to avoid use of energy to pump water. The results were as shown on Table 1.

Table 1: Descriptive Statistics for Regulatory measures on green building practices in Nairobi County, Kenya

	N	Mean	Std. Deviation
NCA Construction permits	80	2.90	1.143
Nairobi City permits	80	3.00	1.147
NEMA Clearance certificates	80	3.01	1.073
KGBS Clearance certificates	80	3.31	1.279
Adhere to green building practices	80	3.57	.792
Periodic check-up by NCA	80	1.23	.420
Disposing waste materials	80	1.24	.428
Composite Mean		2.61	.897

In maintenance, it is seen that occupants are learning importance of water and energy conservation, there are smoke-free signs in buildings to enable breathing in fresh air and only using designated areas for smoking, also presence of green housekeeping practices is observed as seen by use of mild detergents that have mild scents to accommodate those

with allergies. Regular inspection of buildings to check leaks, drainage issues, insufficient ventilation and damaged windows is a practice that most buildings do and all these are ways to increase durability of a building.

Secondly, experts in the industry acquired KGBS Clearance certificates at a mean score of 3.31, showing moderate extent. [42] supports green construction in Kenya. This is seen by supporting use of locally available materials including mangrove timbers and coral stones which reduces the need to import and Kenyans are able to appreciate the sustainable use of natural resources. Secondly, energy efficiency is being promoted as seen by use of daylight, proper ventilation to avoid use of air conditioners and generally maximizing energy through switching off when not in use. Businesses too are striving to go green because of the long-term gains involved [46].

In Kenya, Strathmore Business Schools, Pope Paul VI Learning Centre in Catholic University, Sandawood Waterfront and UNEP building just to mention a few, are some of the green buildings that have led by example [47]. The results of this study show moderate extent. This could be attributed to the fact that for a building to be constructed, one needs NEMA clearance, NCC clearance and architectural designs to start. Green Building clearance, however, is not mandatory as it has not been established as a mandatory requirement. This reduces the urgency to be rated green by the Kenya Green Building Society as developers become reluctant due to poor enforcement. NEMA clearance certificates are acquired at a mean score of 3.01, meaning that adherence is at moderate extent.

Nairobi City permits at a mean score of 3.00, meaning moderate extent. The role of NCC in construction is to provide services, such as waste management and water services to the residents of Nairobi County. This body provides building permits before starting the project and the developer is expected to show evidence of architectural drawings, land title and copy of architect's license [48]. Nairobi County had the privilege of hosting the Africa Climate Summit after the Governor, Johnson Sakaja had his office assessed by Excellence in Design for Greater Efficiencies (EDGE) to check for areas to improve and be the first IFC EDGE green government office in East Africa [49]. This is good leadership where government offices should be the first to adopt green building. During Africa Climate Summit, it was discussed that only few years are left to 2030 Sustainable Development Goals yet 600 million Africans still lack electricity while 970 million lack access to clean cooking [50]. It was also noted that despite Africa's ability to provide 40% renewable energy, only a fraction (2%) of total renewable investment on renewable energy has been submitted towards the same. There was a commitment to implement policies and regulations aimed at attracting investments for green growth and finally, made a declaration to promote investments in urban infrastructure to establish climate resilient housing.

NCA Construction permits at a mean score of 2.90 which represents moderate extent of adoption. Periodic check-up by NCA as well, were well conducted at a mean score of 2.23 which means it is at a low extent. NCA is the major construction authority in charge of overseeing all construction activities, compliance, accrediting construction workers and checking for site safety and proper construction

activities. Studies done, however, show the downfall of this authority that most construction developers wait too long for licenses which demotivates their activity [53]. Being the authority in charge of construction, it is expected that NCA should be at the forefront of supporting sustainability. Nevertheless, reports indicate that Kenya lacks sufficient guidelines on how to build sustainably as this gap is left for EIA experts who write the report and the developer's eco-friendly consciousness and goodwill [51].

In a study to investigate the effectiveness of National Construction Authority, [54] discusses that the greatest challenge this body faces is poor workmanship which is the most likely reason for buildings collapsing, poor choice of materials and developers using quack contractors probably because they are cheaper compared to the those with licenses. In Langata, it is observed that most buildings had license from NCA and even agreed that the authority came by to do checks periodically. As much as the authority is keen on compliance and construction workers, there is still much work to be done in terms of advising developers on importance of green building practices.

Majority of the respondents agreed that waste materials are properly disposed at a mean score of 2.24 which means that waste disposal is at low extent. In Langata, the high-income earners are able to comfortably pay for waste disposal, have bins and well-organized system of garbage collection. However, there are those in the middle and low-income category who do not prioritize paying for garbage collection and therefore use other ways like illegal dumping along the streets or river. Waste management is not a solitary activity as it requires efforts by government, estates and individuals [55]. Waste management gets even more complicated when it comes to construction waste disposal. The findings of this study indicate that waste disposal is low in construction. Majority of the developers agreed to a great extent that they have limited ideas on how to reuse or recycle these waste materials.

Further, in a study to investigate construction waste management in Kenya, [56] mentions that management of waste was seen to be different depending on the waste. That means, some kind of waste is easy to manage and affordable as compared to others. These findings could be attributed to the limited know-how of construction waste disposal and the lack of urgency to clean up after building. This negligence could be because of low enforcement from authorities and poor leadership in sites.

The results demonstrate that regulatory measures are being adhered to at a moderate level as demonstrated by mean score of 2.61. A study by [13] is in line with these findings that enforcement of laws is at a moderate extent in Kenya. Respondents reported that besides poor guidelines and regulations on green building, there was also lack of motivation and demand by clients as there are no incentives for green building technologies. This is consistent with previous studies done by [18,39] that policies such as financial incentives, development priorities, publicity and legislation have not been given first priority resulting in the

slow adoption of green building. Moreover, a study done by [12] emphasizes on the importance of legislation as a key driver of green building adoption.

[18] opines that establishment of laws and regulations are vital but without enforcement to implement, then they cease to be of use. [18] [56] notes that when building codes and regulations are not well developed, there result in poor implementation of green building practices. The importance of regulatory systems in adoption of green building practices cannot be assumed and as it is a key indicator of the measure of adoption in a country. [35,57,58] recommend that governments should enforce regulatory measures that are in place, promote green product rating, increase subsidy on green building technology, provide loans and incentives in a bid to at least promote green building technology.

In terms of influence of regulations on adoption of green building practices, Kenya is slowly adopting to green building as indicated by mean score of 2.61, which means moderate extent, especially where there is enforcement of construction industry key players.[41] suggests that governments are willing to create regulations but the challenge is that there is limited know-how of green building. [31] mentions that low-income countries priority is to see how sustainable buildings will be of importance in their economies and some neglect this agenda because sustainable buildings are long-term goals and the gains may not be seen immediately.

This therefore becomes irrelevant to their national development short-term plans. It is important to note that Kenya's building code has not clearly emphasized the importance of green building and additionally, there has not been any clear guidelines, laws and regulations on building sustainably.

To test the null hypothesis H₀: There is no statistically significant relationship between regulatory measures on building and the adoption of green building practices in residential buildings in Nairobi County, Kenya, regression analysis was performed. The results were that the F-calculated is 15.644 and it is greater than the F-critical (4.001) and $p \leq 0.03$ which is ≤ 0.05 . Therefore, the null hypothesis that there is no statistical significance influence between regulatory measures on building and the adoption of green building practices in residential buildings in Nairobi County, Kenya was rejected.

The research sought to examine the economic factors in the green building practices in Nairobi County, Kenya. The respondents were asked to use a Likert scale of 1 to 5, where 1=no extent to 5=very great extent. The five-point Likert scale is considered an interval scale. The mean is therefore very significant. From 1 to 1.8, means no extent. From 1.8 to 2.60, means low extent. From 2.61 to 3.40, means moderate extent, 3.41 to 4.20, means great extent while 4.21 to 5.0, means very great extent. The results are presented on Table 2.

Table 2: Descriptive Statistics on environmental sustainability in green building practices in Nairobi County, Kenya

	N	Mean	Std. Deviation
Energy efficiency	80	3.04	1.096
Water efficiency	80	3.06	1.083
Waste management	80	3.10	1.086
Availability of disposal methods	80	2.95	1.054
Availability of waste disposal plan	80	3.10	1.086
Availability of maintenance services	80	3.03	1.006
Composite Mean		3.05	1.069

The findings depict that waste management is conducted as a green building practice as per a mean score of 3.10, meaning that residents use municipal county waste management plan to a great extent. This is in line with [59] that residents with middle and high income tend to prioritize waste management because they can afford to pay private and municipal county waste collectors. The bodies in charge of waste management in Kenya include Nairobi City County, private sector, community-based organizations and non-governmental organizations. A review of fee charged by these bodies shows that community-based organizations are affordable compared to the rest of the collectors [60]. This means that those with low-income can dispose waste at affordable prices.

A review of municipal waste disposal of African countries done by Japan International Cooperation Agency (JICA) reveals that most countries dispose solid waste in landfills but even those landfills are not well maintained. However, there are countries that are constantly improving their landfills including Angola whose landfills are covered

with soil to prevent bad odors and flies and South Africa that convert waste to biogas which is useful renewable source of energy. Nevertheless, most countries reported open landfills, common fires caused by pickers, no conservation facilities like leachate collection pipes and storage ponds [61]. Perhaps solid waste management is well organized in Lang'ata estates because residents have money to pay for the service.

Construction workers sited availability of waste disposal plan at a mean score of 3.10, also meaning that Nairobi County has prioritized waste management at moderate extent. In terms of waste disposal, Lang'ata is willing to pay for collection services, segregate their waste accordingly, reuse some packaging items such as carrier bags and plastics and minimal waste dumped on the road side is observed. In a study to compare low income and high-income households waste management practices, [62] reveals that majority lack regular garbage collection services. However, high-income residents prefer to pay for waste collection, have dustbins in their households, rarely burn

waste and do not dump openly in streets or roads. From our findings, we can say that as much as Lang'ata observes waste disposal through collection and dumping in landfills, it still has a lot of work to do in terms of waste management techniques like recycling, reusing and reducing.

Energy efficiency at a mean score of 3.04, depicted that energy conservation is being observed at a moderate level. [57] points out that most large constructions made use of natural lighting through using large windows. Most green buildings in Langata had large windows for ventilation and use of day light for energy efficiency. Another way is through using solar panels as renewable energy source which supports sustainability. A study done by [63] supports that energy efficiency is a major aspect in determining a green building even though there is a high initial cost due to high energy prices and carbon trade cost. Nevertheless, this cost is offset during the operation and maintenance stage of construction.

In the findings at a mean score of 3.03 indicates availability of maintenance services in the building industry as a green practice meaning that implementation of this practice is at moderate extent. Maintenance of buildings helps to repair, prevent hazards and make it more durable. When buildings are carefully built with consideration of sustainability from initial stage to final stage, maintenance becomes simpler and easier [64]. The goal of sustainable construction is to minimize maintenance [65].

The results therefore demonstrate that majority of residential buildings in Lang'ata, Nairobi County are adopting green building because of the way buildings are being maintained. It was notable that some buildings were built long ago, but due to regular maintenance, they still look good. It is important to note that some developers preferred incorporating green building practices into their old buildings as a way to save on water and energy.

In terms of water efficiency and management, the findings show that Lang'ata conserves water to a moderate extent. Similarly, [66] reported that the overall average of water consumed in green building is approximately 49.05% showing that they are water efficient. Green building aims to acquire water efficiency through harvesting rainwater, proper storage of water, using low-flow flushing systems such as dual flush toilets and storm water captured for use [65].

A study evaluating household water efficiency in Taiwan [66] revealed that water used in flushing and bathing amounts of 50% of total household consumption. However, [67] notes that even with efforts to try water conservation in green building, water consumption is entirely dependent on individual usage whereby some use more as compared to others. It is important to note that majority of the buildings in Lang'ata had improved in water management through use of low-flow flushing systems, harvesting rain water, using waste water for irrigation and proper storage of water.

Waste management is at moderate level. Green building encourages reduction of waste, solid waste being produced to either be converted to biogas if degradable or recycled if non-biodegradable, toilet waste converted to biogas and waste water from washrooms be treated and used to water the garden or grass [65]. From the findings, most of the residential buildings let the municipal waste to manage their solid waste. Very few owners had a proper disposal plan for specific wastes and also lacked more than one way of disposing. This means that Nairobi County has potential to even increase their chances of being sustainable through practicing proper and various waste disposal techniques.

Generally, the average score is 3.05 which means that environmental sustainability is at moderate extent in Nairobi City County, Kenya. This agrees with a study done by [12] in Malaysia that environmental sustainability was at a moderate level and a great driver towards green building. The study further explores that lack of knowledge is the main hindrance to environmental sustainability. Nevertheless, the study revealed that high education level of construction practitioners influenced environmental sustainability.

On testing hypothesis, regression analysis was employed. The results of the null hypothesis H_0 : There is no statistical significance relationship between environmental sustainability on building and the adoption of green building practices in residential buildings in Nairobi County, Kenya are significant since $p \leq 0.002$ is less than 0.05; hence, null hypothesis presumed that there was statistically significant relationship between environmental sustainability and adoption of green building practices in residential buildings in Nairobi County, Kenya, was rejected.

IV. CONCLUSION

Based on the above findings, the study concludes that level of awareness on building has affirmative influence in adoption of green building practices in Langata Nairobi County, Kenya. This is in spite of challenges such as lack of access to green building practices, poor literacy on green building among construction workers, lack of training of construction workers and insufficient awareness platforms. In this respect, level of awareness is a keystone in adoption of green building practices in residential buildings.

The study further concludes that establishing and implementing regulatory measures on green building technology is vital in adoption of green building practices in Langata Nairobi County, Kenya. This creates an avenue for construction workers are regulated to showcase their talents and skills through technology transfer in green building. The regulatory measurer's faces hurdles such as inadequate capacity building on green building standards and poor enforcement and implementation of already established guidelines thus affecting adoption of green building practices in residential buildings in Nairobi County, Kenya.

Finally, the study concludes that environmental sustainability significantly influences adoption of green building practices in Nairobi County, Kenya. The increase environmental consciousness of both developers and construction workers is the first step in implementation of green building. It is easy to train green building and actually practice it if the attitudes, perceptions and behaviors towards sustainability is positive. The environmental sustainability has faced the challenges such as poor green building, technology skills, inadequate use of available research information on green building technologies and high Cost of green building technology limiting green construction Nairobi County, Kenya.

V. RECOMMENDATIONS

From the findings and conclusion drawn from the study, the following are the recommendations.

The study recommends that Kenya Green Building Society and Ministry of Environment, Climate Change and Forestry should increase awareness through different media and platforms as well as increase training of green building technologies to the construction practitioners and the public.

The study recommends that Nairobi County government, National Environmental Management Authority and National Construction Authority should establish robust regulations for green building, emphasize on the implementation of already set guidelines and enforce green building laws.

The study recommends that the government through Ministry of Environment, Climate Change and Forestry, National Construction Authority and Nairobi City County, should provide incentives for green building materials, financially support research in green building and use the available research in green building implementation and share the importance of green building to the public.

A literature review depicted that there were few studies on adoption of green building practices in Nairobi County, Kenya. Consequently, the findings from this study serve as the base for further studies on this area of study.

The study restricted its focus on levels or awareness, Regulatory measures and Environmental sustainability. As connotation, analogous study should be conducted to determine whether the findings could also apply to other green building practices in the Country other than Nairobi County. This would help in shaping whether its findings could be indiscriminate to other parts of the country. In accumulation, there would be the need to conduct further studies especially on other factors that were not evaluated in the current study.

As such, equivalent study, but with a different spotlight can also be carried out within Nairobi County. This would be critical in evaluating other factors that influence adoption of green building practices within the Country.

AUTHORS' CONTRIBUTIONS

Mercy Chebet: Conceptualization, Methodology, Results, Discussion and Conclusion. Original draft preparation, reviewing and editing. Joseph Gweyi, Esther Kitur: Supervision:

CONFLICT OF INTEREST

The authors declare that they have no competing interests.

DATA AVAILABILITY

The authors declare that the data supporting the findings of this study are available within the paper. Should any raw data files be needed in another format they are available from the corresponding author upon reasonable request. Source data are provided with this paper.

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ABBREVIATIONS AND ACRONYMS

- **GB** – Green Building
- **KGBS** – Kenya Green Building Society
- **NCA** – National Construction Authority
- **GHGS** – Greenhouse gases
- **SDG** – Sustainable Development Goals
- **NEMA** – National Environmental Management Authority

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