Using Sustainable Construction to Resolve the UK Housing Shortage

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INTRODUCTION

The building sector is one of the major contributors of greenhouse gases. It is so because of the emissions that arise from buildings. Therefore, if the building and design sector is not properly checked, there is no possibility of preventing the temperature increase, the rise in sea levels, the decreasing polar ice caps, and shifting weather patterns which are all the results of global warming. According to the secretary of the United Nations Secretariat of the international strategy for disaster reduction, Sálvano Briceño, the frequency and the magnitude of the disasters will continue to increase unless there is a control on the construction sector on aspects such as settlement, design, urban development etc. (Willison, 2008).This is just a tip of the iceberg on the responsibility of the construction sector.

There are various design considerations that need to be considered when a building is conceptualized. The energy considerations have to be in line with structural as well as the aesthetics of the building. Basically, the principles of construction, as well as the principles of design, should play a fundamental role in the workmanship of the building (Rounce, 1998).Ensuring the building is aesthetically and structurally fit is not the only way in the construction sector, there is an aspect of energy too. The energy requirements of the building are basically as per the required comfort levels and the building needs.

Buildings basically have heat gains and losses. Heat gains occur from solar radiation, energy from electrical appliances among others. Basically, there are two processes through which a building can gain heat: latent heat gains and sensible heat gains. On the other hand, losses occur through radiation, conduction, and convection from the building. Therefore, the design has to consider all these before the actual implementation. However, most building design engineers

disregard the importance of heat gains and losses in the actual design process and end up with buildings that have lower comfort levels or have higher running costs. As a matter of fact, the running costs, as well as the comfort levels of any building, determines the suitability to potential tenants and investors.

Major aspects to be considered in the heat gains and losses of a building include the structural elements and the ventilation requirements of the building. The structural aspect of construction includes determining the thermal transmittance of proposed materials prior to the actual construction. Thermal transmittance determines the rate at which the building will lose heat and as such, it is a vital piece of the construction jig-saw. Materials with very high transmittance are not suitable for building construction in the temperate regions while they may be very useful in the tropics. Therefore, the location of any proposed building determines the selection of materials. In this case, the United Kingdom is a temperate region and as such, materials with very high thermal transmittance are likely to do more harm than good, especially in the winter.

Another important factor to be considered before the actual construction is the ventilation requirements of a building. Ventilation is an important design consideration because it determines the comfort levels of the building. Basically, ventilation plays the following roles: controlling the air quality, advective as well as personal cooling and indirect cooling at night (Schlueter & Kesselring, 2009). However, the design aspect should consider the type of ventilation to be used by the building. Some ventilation methods may be very effective in removing the heat gains of a building but may prove very costly. There are basically three types of ventilation and include: natural, hybrid and mechanical. The three ventilation methods are founded on different bases with natural ventilation depending on natural forces for proper

ventilation, mechanical ventilation working on mechanics for proper ventilation while the hybrid system is an integration of the two. The hybrid ventilation is the most suited for all scenarios and the building sector in the UK basically emphasizes this type of ventilation. The system works on the suitability of the internal and external air where natural or mechanical ventilation can be used.

A final introductory is on the possibility of using on-site supplementary sources of energy to ensure that the energy requirement, as well as the running costs, are put at a minimal level. Most of the electricity generated depends on nonrenewable sources such as oil and as therefore, contribute to environmental degradation and pollution. A decrease in the usage of oil and other non-renewable resources is a major step towards green building. Some of the renewable sources of electricity and energy include biofuels, wind energy, solar energy, and oceanic energy among others (Kothari & Nagrath, 2009). The United Kingdom will have to determine the suitability of each energy source as a supplementary energy source.

Objectives of this report

The report basically focuses on the aforementioned principles of construction. However, it will be limited to the United Kingdom's building sector. In this, the report considers the location of the United Kingdom and tries to focus on the following objectives.

The first objective of the report is to investigate the thermal properties of materials which have been used extensively in the construction of various buildings in the United Kingdom. This will basically focus on the relative and percentage usage of materials in the construction sector. The country is located in the temperate regions of the world and as such, will provide a platform to investigate the probable heat losses and heat gains throughout the year.

The second objective is to focus on the average running costs of buildings within selected portions of the United Kingdom. The running costs of buildings mainly consider the usage of electricity on appliances, heating of the rooms etc. Running costs indicate the necessity for the implementation of a supplementary power option. Some of the supplementary power sources have been indicated in the introductory part.

The final objective is to determine the most appropriate and commonly used ventilation system. Heat losses and gains determine the comfort levels and as such, an appropriate ventilation system is necessary for any building design. Ventilation systems vary from country to country and as such, will indicate the predominant type in temperate regions.

LITERATURE REVIEW

Housing and construction is one of the fastest growing industries in the world. The need for proper housing coupled with the increase in population are some of the major factors that contribute significantly to this growth. That stated, a building has been described to be as good as its structural strength.The statement basically means that any building that does not have the capability of withstanding natural forces does not fall into this category. However, this should also consider that some buildings are constructed in regions that are prone to disasters such as the Philippines and as such, various additional measures have to be taken (Willison, 2008).

In the recent past, numerous discussions have been held with the main focus the building sector and particular emphasis on green building technology. The green building technology focuses on the minimization of emissions from buildings and more so from the human settlement. An increase in the emissions has been described as a scourge that might lead to unprecedented disasters.However, designers and engineers alike have come up with various methodologies in building design and construction that ensure that the emissions are cut down.

The design of a building basically encompasses various structural as well as aesthetic principles (Willison, 2008). A building is first conceptualized before it is designed by an architecture or any other competent body. In this stage, the designer outlines the various layouts of the building. The basic conceptualization stage involves imagining the various rooms and the floors that a building is to have. This stage will, later on, be put to the drawing where the engineer is to determine the structural elements that are to provide a cover for all these conceptualized ideas. However, if the engineer observes that the building may not conform to the principles of construction and, the

loop goes back to the designer whereby he comes up with alternative designs. The structural elements present in a building include the slabs, walls, roofs, and columns etc. which provide a frame for all the other elements to be built upon. The engineer's part, to a large extent, plays the pivotal role of ensuring that the building does not collapse during operation. This part requires extensive research and detailing.in accordance to the principles of construction. Later on, the workmanship ensures that the building has been transferred from paper to a visible and tangible structure.

There are various aspects of building design that need to be discussed in this report because they are basically the building blocks of sustainable and green housing. The basic ones include the ventilation requirements, the heating requirements, and the supplementary power sources among others. All these provide a rudimentary aspect of building construction.

Ventilation

Ventilation is a basic requirement in building construction because it ensures that there is a continuous supply of fresh air. Furthermore, this part of the design is responsible for the removal of pollutants and the dirty contaminated air. There are three basic types of ventilation mechanisms and they are: mechanical, hybrid and natural. These three types of ventilation are founded on the principle of air exchange rates and airflows.

To begin with, the natural ventilation system is founded on the natural flow of air (Per kvols, 2000). In this, air moves into the building through leakages and openings while it moves from the building into the surrounding through leakages, openings, roof outlets among others. However, the main function of this ventilation system, like any other, is to serve the following

purposes: control the quality of air, advective cooling, direct personal cooling and night time cooling (Allard, 1998).

Many people may assume that natural ventilation system basically depends on the natural driving forces for ventilation and cooling but there has been tremendous research pertaining this form of ventilation. The research has focused on the different configurations necessary to ensure that there are proper design and sufficient mechanisms to ensure that the airflow pattern is as effective as possible. Because natural ventilation depends on buoyancy and pressure difference for operation, there are three configurations that have been proposed: wind-driven cross ventilation, buoyancy-driven ventilation and single sided ventilation (Allard, 1998).Al, these forms of natural ventilation are very effective in heat removal and proper air flows both in tall buildings and residential apartments.

The basic configuration of wind-driven cross ventilation is that of an inlet and outlet at different ends of a building. However, the operation of this configuration is as effective as the pressure difference and the internal resistance to the flow of air permit. A high-pressure difference is likely to have more ventilation effects than lower differences. Furthermore, an increase in the internal resistance to flow of air results into lesser ventilation effect. The second configuration of buoyancy-driven stack ventilation depends on the difference in density of cool external air and the warm internal air. Typically, the warm internal air is at a much lower density than the external air and as such the outlet openings are located at a higher level than the inlet openings. A major aspect of consideration in this configuration is that of the design of a chimney. Chimneys tend to create a more efficient removal mechanism by inducing buoyancy on the warm internal air. However, the wind effects of any region affect the ventilation mechanism in this

type of configuration at much higher degree than the buoyancy effects. Finally, the single-sided ventilation, unlike the two stated, serves a single room or one hall. In this, there are windows or openings located on one side of the structure and the main mechanisms of ventilation are room-scale buoyancy effects, small differences in envelope wind pressures, and/or turbulence (Allard, 1998).

However, the natural form of ventilation is limited by the natural forces such as wind and as such, may not be effective throughout the year. Regardless of that, the system may be combined with a fully mechanized system to form a hybrid ventilation system. A hybrid system is one which combines both natural forces with a mechanized system for effective ventilation. However, this system uses the two features at different times because of various aspects such as energy saving etc. Therefore, the system combines the features of natural ventilation as well as the features of mechanical ventilation at their appropriate moments. As a matter of fact, technology has given rise to an automatic hybrid system where there are temperature and environmental monitors that have the capability of switching between natural and mechanical modes.

The hybrid ventilation system, just like the other two, has been found on principles that guide its operation and efficiency. The first principle is that of shifting between natural ventilation and mechanical ventilation. By basically operating between two periods that may require either natural or mechanical ventilation, the system optimizes energy saving measures. The two periods may include midsummer and midwinter or during periods when the working space is occupied and periods when the space is not occupied. Cooling at night may require natural ventilation while the day may necessitate the use of mechanical ventilation. The second principle is based on

the natural system but there is a fan to assist in the circulation of air and air removal. The principle is based on the fact that sometimes the demand for ventilation may exceed the natural forces or there may be times when there is not sufficient natural driving force. Finally, there is the principle that lies on the support of stack difference and wind forces. The stack pressure in any building system lies on the density of the air in the building and as such, the system ensures that there is proper ventilation through the driving natural forces.

The three systems of ventilation have varying applications and as such, the design engineer should consider each option before resting on one. However, the most appropriate system, considering both the energy requirements as well as the environment, is the hybrid system that predominantly uses the natural mechanism of ventilation. In the United Kingdom, the use of the natural system is mainly advocated for because it tends to reduce the energy costs, carbon emissions and cooling energy consumptions, all in comparison with the fan system of ventilation (Stephen, et al., 2001). There has been a comparison of naturally ventilated and mechanically ventilated offices in the United Kingdom whereby it has been estimated that the natural systems tend to save the annual energy requirements of office buildings from 0.77 £/m2to 2.05 £/m2 (BRECSU, 2000)

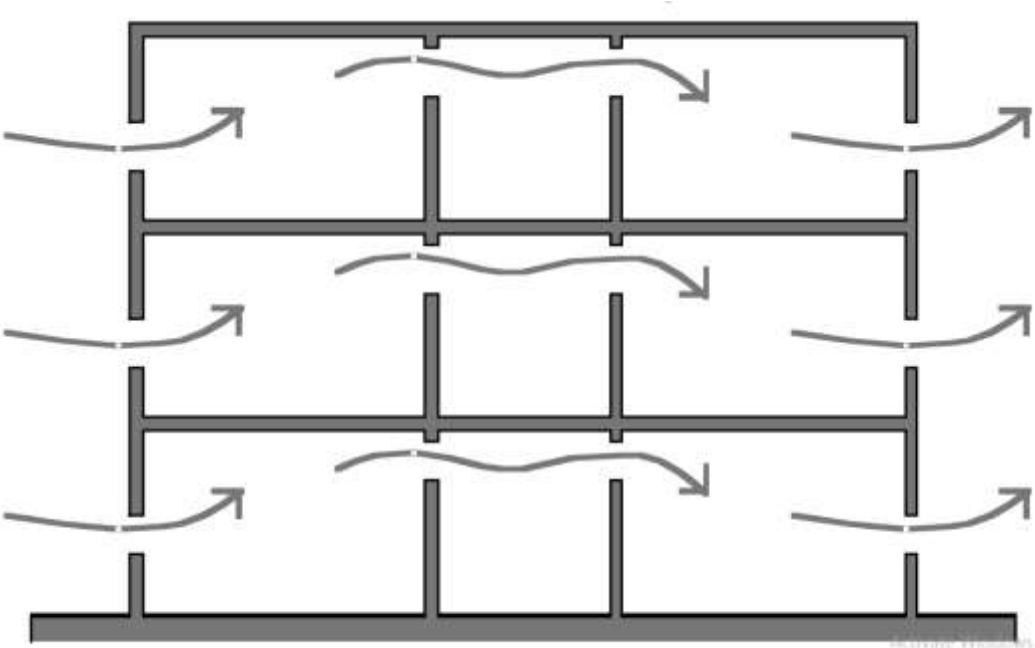

Figure 1: wind driven cross ventilation

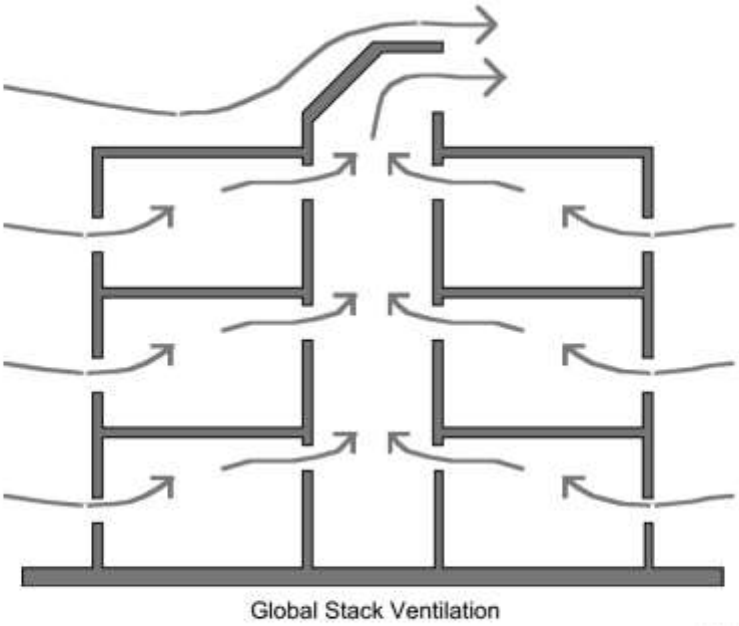

Figure 2 Buoyancy-driven stack ventilation

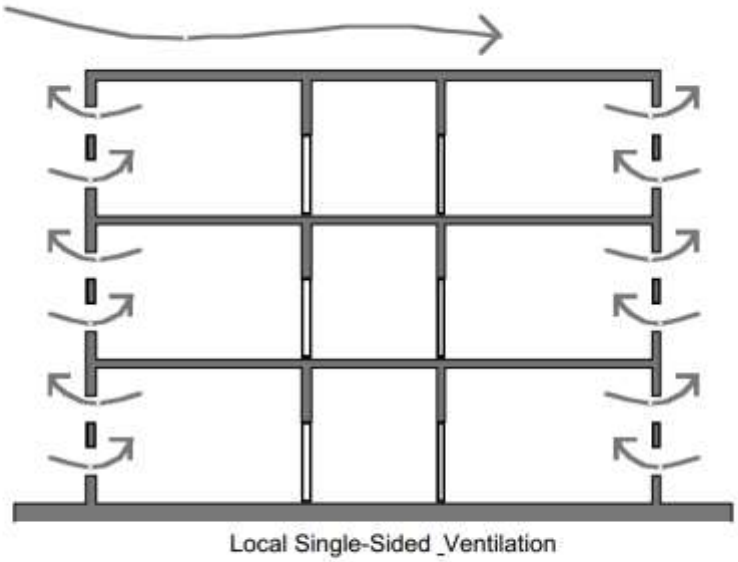

Figure 3 Schematic of single-sided ventilation

The heat losses and gains of buildings

Heat losses and gains prevent a major problem for buildings designers. Basically, the comfort levels of buildings are determined by the heat and energy levels. Furthermore, these heat gains and losses increase the running costs because of the need for mechanical systems for removing heat as well as the need for other systems to raise the heat levels in the building. Some of the systems that may be employed to increase the temperature of buildings include radiators, heaters etc. all which consume enormous amounts of energy consequently increasing the running costs of these buildings

Heat losses

During cold weather, roof and wall elements constitute the largest percentage of the heat losing elements. (Merritt & Ricketts, 2001)Basically, these are the two largest elements of building and as such, their design is of considerable importance. Basically, calculation of the heat losses through these elements is based on the temperature difference between the inside and the outside, with the thermal transmittance determining the extent to which the element can lose heat. In the design considerations, the overall coefficient of thermal transmittance should be established to ensure that the elements do not transmit enormous amounts.Furthermore, the height, as well as the thickness of these elements, determine the level of heat losses to be expected.In the United Kingdom, it is expected that the thermal transmittance of these elements are at a minimal to ensure that the heat losses are within range to avoid costly heating requirements.Buildings are required to maintain the heat levels during winter and this can only be possible if the elements do not lose heat as much.

Other elements that basically lose heat include the basement floors, walls set on grade and basement walls. Considering the walls that are set on grade, it is really difficult to establish the heat lost when a floor structure lies directly on the ground and as such, the most common method is to determine the heat losses from the exposed edges. On the other hand, calculation of heat losses through basement floors and walls is based on the temperature of the groundwater, since the direct methods are not available.

Heat gains

The only difference between heat gains and heat losses is the fact that heat gains move into the building while heat losses move away from the building. However, both play a vital role in the comfort levels associated with any building. However, the heat gains are not limited to any season or day of the year since they occur as a result of the lighting system, the moisture from people, solar radiation etc. There are two forms of heat gains to a building: sensible heat gain and latent heat gain (Yildiz & Gungor, 2009).

Sensible heat gain is responsible for raising the temperature of buildings and occurs through basic processes and functions such as insolation from the sun, electrical appliances, warm air into the building etc. On the other had latent heat gains occur through basic human activities such as exhalation etc. and involve the movement of moisture. However, the two processes need to be properly established to ensure that all the heat gains are accounted for so as to ensure proper ventilation measures.

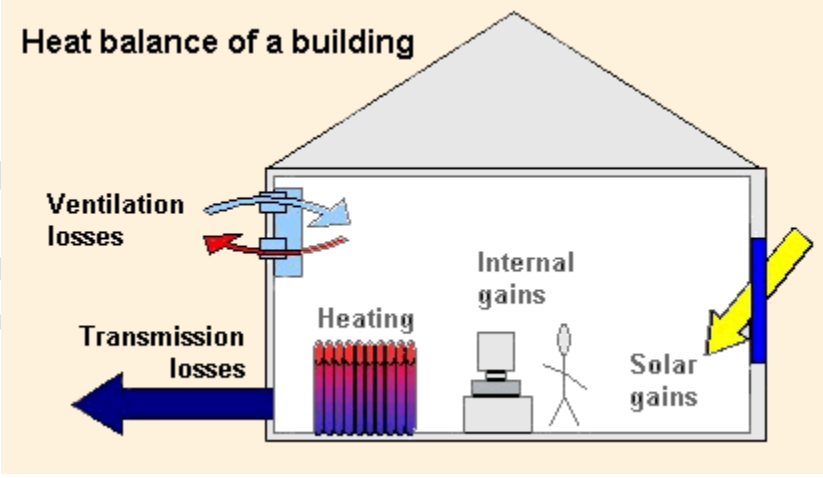

Fig 4: Heat losses and gains

On-site supplementary power options

On-site power supplementary options are necessary to reduce the running costs of buildings. The electricity consumed by buildings can be supplemented by other power options such as solar energy, biomass, and wind energy among others. Some of these have quite a number of advantages and the basic include pollution free, non-exhaustibility, cheapness among others. However, their production capacity is still rudimentary and more and more studies need to be conducted.

Fig 5: On site power generation by means of wind energy

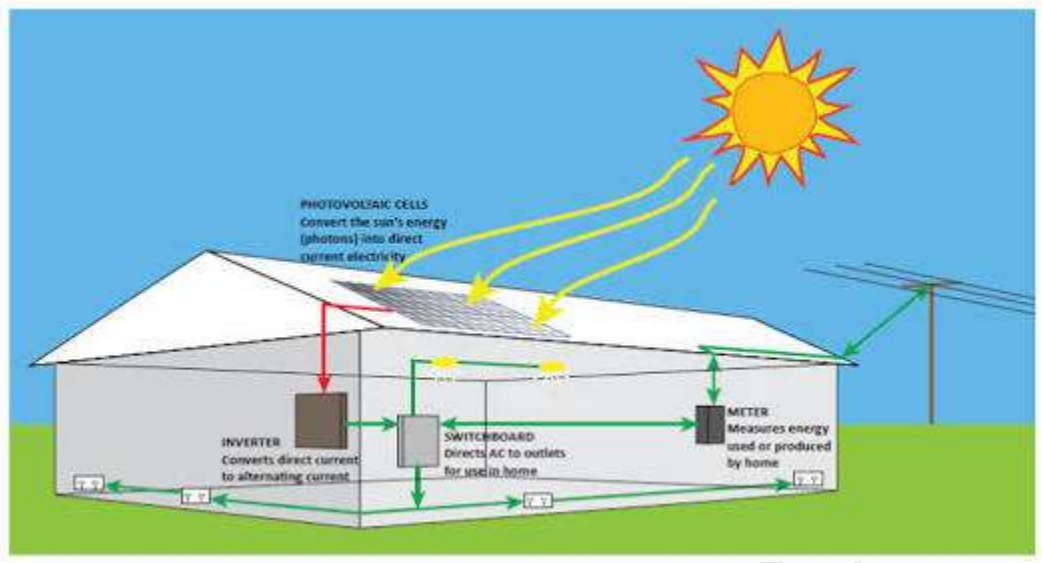

Fig 6: on site power generation by means of solar panels

METHODOLOGY

The building sector covers an important aspect of our daily lives and as such, the research methodology may be based on a review of relevant literature, surveys, and questionnaires. Basically, all will be around localities to be determined prior to the actual research. Therefore, this research will incorporate the actual fieldwork, various literature and research and mathematical models to come up with appropriate conclusions and recommendations

To begin with, the literature will focus primarily on the building codes of the United Kingdom. The building codes entail the design aspect of the building, aesthetics and the practices that are to be done prior to the actual construction. The code of practice, as stated before, is an important aspect of the building sector because it basically acts as a guide to the design and construction. The literature will also be limited to the year 2010 because the last five years have seen remarkable development in the building and construction sector. The aspect of green technology has been highly emphasized as of the recent past which just limits the research to the past couple of years.

Furthermore, the literature will focus on the thermal transmittance of various materials. The thermal transmittance of materials plays a huge role in the heat loss and gains of a building and as such, is a very crucial piece of information in relation to this project. Different materials with different properties are used in the construction industry and therefore, the literature will provide an extensive view of the material. However, because not all materials are used in construction in the United Kingdom, the main focus will be materials that can be used in the United Kingdom construction sector.

The methodologies used in the construction sector in the United Kingdom are to some aspect different to those applied in other countries and as such, the construction aspect has to be investigated. The spacing between the windows, walls, and wall thickness are all major aspects of construction and as such, are invaluable to this project. All these are investigated alongside the codes of practice and construction

An aspect to be looked into are the mathematical models that are used in the calculation of heat losses and gains to a building. Various mathematical models are used in the calculation of heat gains and losses to a building and as such, are used by the design engineers to establish the necessary ventilation measures as well as the heat retaining measures of buildings. The project will look into these models.

Finally, the literature review will focus on the relevant energy renewable sources that have the potential for growth in the United Kingdom.However, because the united kingdom is made up of suburbyun, urban and rural areas, there are numerous renewable energy sources that can be used. This aspect of research is very useful on finding the necessary recommendations to the energy problem that most households and buildings face

The second aspect of the methodology is the actual field visit. Field visits will entail going to the actual buildings and making relevant conclusions and observations. The design aspect of the buildings has to be properly observed with the building layout, wall sizing and all the heat reducing and gaining measures elements of observation. However, this will be done in conjunction with the actual design plans of the building and with the cooperation of the different parties involved in the construction and design of the chosen building. By engaging the parties in the survey, the various building patterns and methodologies can be easily explained.

Finally, there is the aspect of questionnaires. In particular, the questionnaires should be such that they give the respondent sufficient room for explanation. As such, there is the need for open-ended questionnaires. The basic questions will include the materials used in the construction and the design principles that have been employed. However, the questionnaires will be to a large extent given to the design engineers because of the pivotal role they play in the establishment of the buildings. The next group of people to be handed the questionnaires are the contractors and subcontractors who basically see the houses through to completion. The aspect of qualitative data will be obtained through the Likert scale where the respondents will answer questions that may indicate opinion. To some extent, the questionnaires may be mailed to the address of the contractors and subcontractors who may have vital information regarding the building design. Other aspects of questionnaires include e-mailing. However, the two will be limited to extreme cases.

The building inclusion criteria

The project is based on trying to understand the development aspect of the building sector and as such, the buildings involved will vary in size as well as the age. Older buildings provide significant insight into the original building plans of the country while newer buildings(less than 5 years old) indicate the progress and strides in the building sector.As a matter of fact, some of the materials that have been used in the fabrication of older buildings tend to be outdated and underused in the current building era. Therefore, this inclusion criteria tries to investigate and compare the material properties of buildings built at different times. Furthermore, this criterion will provide the basis for investigating the different design aspects of the ventilation as well as the heating requirements of the building.

Limitations to the study

Basically, an extensive construction research project has various limitations. To begin with, there is a likely limitation of the literature available for the new buildings. As indicated in the inclusion criteria, new buildings will basically include those that are less than five years of age. Numerous buildings are available but the literature may be somehow backward and therefore present a significant challenge to this research in building construction.

The second challenge will be the availability of the respondents at the site. The respondents will include the engineers but they may not be present and as such, the data will be obtained from secondary respondents such as foremen etc. The Secondary respondents may not present the data as accurately as possible and this will lead to erroneous calculations.

Finally, questionnaires may contain wrong information. Respondents sometimes do not answer as accurately as possible and therefore provide wrong bases for conclusions. Interviews are the most preferred but there is no way to clarify the response.

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