The Role of the Surveyor in Climate Change Action

OFFICIAL MAGAZINE OF THE QUANTITY SURVEYING DIVISION
OF THE GHANA INSTITUTION OF SURVEYORS ISSUE NO. 1 2022

The Quantity Surveyor

GHANA INSTITUTION OF SURVEYORS

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Academic Programmes

UNIVERSITIES	EXISTING PROGRAMMES	UPCOMING PROGRAMMES
Kwame Nkrumah University of Science and Technology	PhD Construction Management – 3yrs min. PhD Building Technology – 3yrs min. PhD Procurement Management – 3yrs min. PhD Project Management – 3yrs min. MPhil Construction Management – 2yrs MPhil Building Technology - 2yrs MPhil Procurement Management – 2yrs MPhil Project Management – 2yrs MSc. Construction Management – 12 months MSc. Procurement Management – 12 months MSc. Project Management – 12 months BSc. Construction Technology and Management BSc. Quantity Surveying and Construction Economics	MSc. Commercial Management – 12 mo. MSc. Quantity Surveying and Construction Economics – 12 mo. MSc. Project Forensic and Auditing – 12 mo.
Kumasi Technical University	BTech. Building Technology – 4 Years MTech. Construction Technology – 2 years BTech, Building Technology (Top up) – 18 months BTech Estate Management (Top up) – 2 years HND Building Technology – 3 years HND Estate Management – 3 years CTC I, CTC II & CTC III -1 year each	
Sunyani Technical University	BTech. Construction Technology – 4 years HND Building Technology – 3 years	
Cape Coast Technical University	HND Building Technology – 3 Years Diploma in Estimation and Quantity Surveying -	
Takoradi Technical University	BTech. Building Technology (Top up) – 18 months HND Building Technology – 3 years	
Accra Technical University	HND Building Technology – 3 years BTech. Building Technology	
Tamale Technical University	HND Building Technology – 3 years	

Content

It is a refreshing time for the Quantity Surveying Division of the Ghana Institution of Surveyors to discuss, interact and recognize the opportunities available in the growing construction industry.

The theme for this annual general meeting is "The Role of the Surveyor in Climate Change Action". Climate change, digitalization and economic recession have become topical in recent times. The Quantity Surveying profession can thrive in the face of climate change, digitalization and economic recession if Quantity Surveyors adopt sustainable construction, leverage Information, Communication and Technology (ICT), and Value Management. The Quantity Surveying profession is well placed to take advantage of opportunities due to climate change.

"The Quantity Surveyor", the official magazine of the QS division, always presents interesting, educative, and innovative issues to their audience. The first issue of the 2022 magazine presents three main articles. The first article discusses the role of quantity surveyors in de-carbonising the built environment. In contrast, the second looks at the prevalence of disasters in Ghana and classifies them as human-induced and not natural. The article asserts that some disasters cannot be classified as purely natural because they may result from negligence, outright refusal to comply with required safety measures or ignorance.

The third issue deals with managing price escalation lump sum contracts. It reports on the Russia - Ukraine war's impact on the cost of inputs for the construction industry. The fourth significant section, on the other hand, concentrates on developing a comprehensive strategic plan for the Quantity Surveying Division of the Ghana Institution of Surveyors. It identifies the three most important strengths, weaknesses, opportunities and threats of the Quantity Surveying Division.

The current magazine also featured the first female quantity surveyor to hold the President of Ghana Institutions of Surveyors position.

In addition, the abstract of PhD dissertations relevant to the theme have also been published; members are encouraged to contact various authors for further discussions. The editorial team believes this will serve as a means of bridging the gap between academia and the industry.

More so, the link for the Material Prices List has also been provided, and members are to visit the site regularly for their daily quarterly updates of material prices.

Lastly, pictures of the national activities are also included in the year under review.

Once again, we strongly believe the content of this magazine will make a substantial contribution to the growth of the Quantity Surveying Division.

Long live the QS Division!!! Long live Ghana Institution of Surveyors.

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Climate change refers to long-term shifts in temperatures and weather patterns. Human activities have been the main driver of climate change, primarily due to the burning of fossil fuels, degradation of the environment through construction activities and the like. Quantity Surveyors like any Built Environment professionals owe it a duty to protect the environment for the future generation.

This bring to the fore the issue of sustainability which is fast gaining grounds through the way we undertake development projects for enhance human endeavours. The ramification of the environmental degradation through the destruction of forest for construction materials is global warming, change in rainfall and weather patterns.

Colleague Quantity Surveyors, the effects of climate change is not an elusion and as Professionals in the Built Environment, we cannot be unconcerned about the dangers our industry is inflicting on the environment without due regard to what the future generation will use for their continuous survival. It is therefore incumbent on us to practice our profession responsibly so that we can always live footprints that will ensure the continuous existence of the human race.

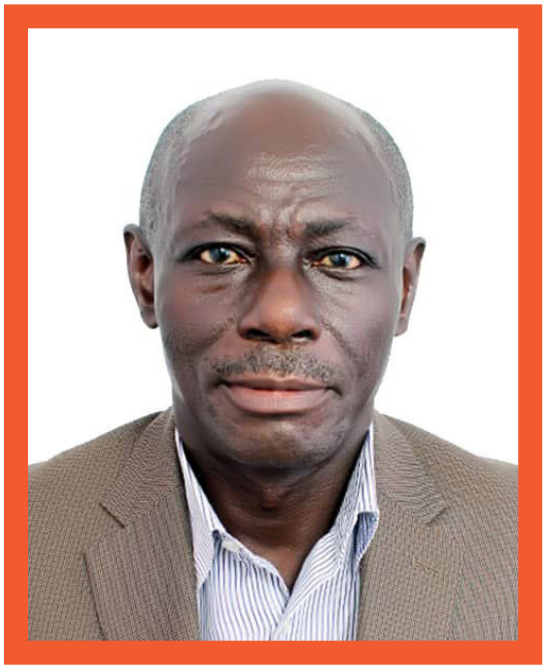
Thus, as Professionals in the Built Environment Industry, our preference for the use of construction materials should be the ones that will sustain the environment for the current and future generation.

From the foregoing, the role of the Quantity Surveyor in climate change cannot be over-emphasised. We should make conscious efforts to ensure that as project and cost managers in the construction industry, the budget we manage should always have enough resrve for use and adoption of sustainable materials and practices that will not impact negatively on the environment so that we can play our role (as Quantity Surveyors) in ensuring that we lead in the advocacy about the effects of the climate change in the Built Environment Industry.

Thus the services relating to project cost, management, procurement of materials and construction practices which is the core mandate of the Professional Quantity Surveyor should be discharged with sustainability in mind.

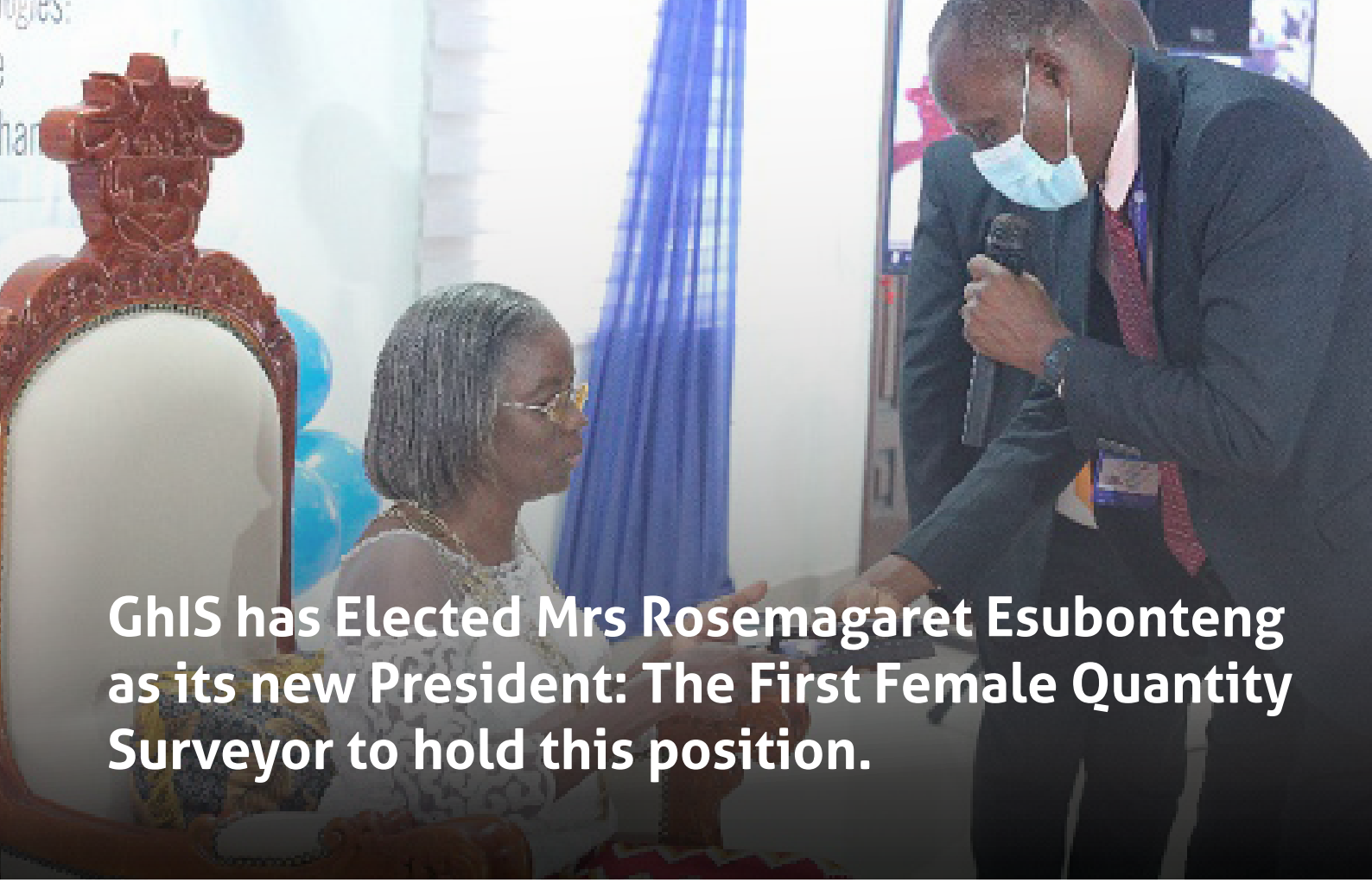
In conclusion, Quantity Surveyors have a major role to play in the application of sustainability rules that can help reduce the extent of climate change and its attendant ramifications as we practice our profession.

Thank you.



MESSAGE FROM THE QUANTITY SURVEYING DIVISION CHAIR

Surv. K. Obeng-Ayirebi, FGhIS



GhIS has Elected Mrs Rosemagaret Esubonteng as its new President: The First Female Quantity Surveyor to hold this position.

She takes over from Dr John K. Amaglo, who held the mantle for the 2019/2020 and 2020/2021 sessions. The election was held during the institution's 17th Surveyors' week celebration and 53rd Annual General Meeting in Accra. Other Executive Council members elected were Alhaji Daud Sulemana Mahama as Senior Vice-President, Dr Anthony Arno-Adjei as Vice-President, Peter Adomako Opoku as Treasurer, and Nana Nuamah Kyei-Baffour as Secretary.
Mrs Esubonteng's journey as a surveyor began in 1987 when she joined as a probationer. In 1989, she was admitted as a professional member and was elevated to the category of Fellow in 1999.
She has been serving on the Governing Council of the GhIS since 2010, and later became the Chairperson of the Quantity Surveying Division from 2013 to 2016, making her the first woman to hold that position. During the period, she led strategic moves of strengthening the quality of the Surveying Division's regional presence in the country, as well as highlighting globalisation and ICT for quantity surveyors. Mrs Esubonteng has also been a council member of the Africa Association of Quantity Surveyors since 2013, and is currently the Vice-President of the association for the Western Region of Africa.
Mrs Esubonteng thanked the members of the institution for the confidence reposed in her.
She also acknowledged her predecessors, saying she had learnt a lot from them.
"I have thoroughly enjoyed my journey in the institution which has given me some relationships I cherish. At the professional level, I have collaborated with some menes-members and benefited from knowledge acquired through participation in continuing development programmes," she said.
She noted that the institution played a very vital role in today's world, indicating that its members provided services from the beginning to the end of the construction life cycle.
Throughout its years of existence, Mrs Esubonteng said, members of the institution had chalked up successes in different areas such as contributing to national policies, holding high offices in both public agencies and private companies, as well as other allied professional institutions.
As professional surveyors, she said it was important that they became visible throughout the country by making their mark and taking leading roles in development.

She said areas of national concern such as value for money, challenges with land ownership, property development and management across the country were yearning for the output of the members.

She, therefore, urged many more surveyors to acquire skills and competencies in those areas.

Challenges

Mrs Esubonteng noted that some challenges facing private practice included remuneration for their services and attribution of professional surveyors.
That, she said, called for a current study into the factors, an investigation for possible mitigation solutions and any resulting advocacy.

"Indeed, being relevant in our time calls for us meeting the needs of the time and being adept at what we do," she said.
She urged the surveyors to consider how to become an institution that defined the best course of action for themselves as they entered into the future.

Rosemagaret is a Chartered Quantity Surveyor and Project Manager who has worked with both Private and Public Sector Clients; a Fellow of the Ghana Institution of Surveyors (GhIS) and a Member of the Royal Institution of Chartered Surveyors (RICS). She has worked as a built environment professional for more than thirty-seven years.

Her academic qualifications include an MBA (Construction & Real Estate) from the University of Reading, UK, a Post Graduate Diploma in Project Management awarded by the Royal Institution of Chartered Surveyors, and a BSc (Hons) Building Technology from the Kwame Nkrumah University of Science and Technology, Kumasi, Ghana. As one who believes that continuous education keeps one abreast with or ahead of the times, she has been taking a number of short courses and has been to several seminars and conferences.

She is a Proud Old Girl of Wesley Girls High School, Cape Coast in Ghana. She supports the activities and work of her Year Group. Recently, she run an interactive webinar on 'Critical Thinking' for some students her Year Group is sponsoring. She willingly assists with construction projects undertaken by other Year Groups.

The Role of the Quantity Surveyor in the De-Carbonization of the Built Environment

By: **Surv. Ing. Dr. Michael Nii Addy and Collins Eli Agar,** Department of Construction Technology and Management, KNUST

The world stage is experiencing climate change. The corollaries of climate change are here with us. What can we do to overcome this? Sustainable development has, over the years, garnered attention amongst academics, industry practitioners and various stakeholders. Mostly defined as meeting the needs of the present without jeopardizing the needs of the future, sustainability has become a topical issue. The myriad of human activities has had a negative impact on the environment. In retrospect, the activities of the 20th century have largely contributed to increased carbon emissions to the environment, the disturbance of natural habitats, the destruction of some ecosystems and the release of various pollutants into the atmosphere. Sustainable development has its roots in the Brundtland report of 1987, which sought to find solutions to the increasing human activities having a significant impact on the environment. Despite the focus initially starting from sustainable forest management, the scope of sustainable development has increased to look at economic, social and environmental issues. The UN's sustainable development goals (SDGs) have also heightened the focus on sustainable development. The SDGs are made up of 17 plans inclusive of ending world hunger (SDG 2), ensuring safe and livable communities and cities (SDG 11), developing energy efficient, reliable, sustainable and modern energy for all (SDG 7), and taking action to combat climate change and its impacts (SDG 13). In 2021, energy-related CO2 emissions increased by 6%, reaching the highest level ever (UN, 2021).

CARBON EMISSION AND GLOBAL CONCERNS

What do we mean by carbon emissions? Fossil fuels release large amounts of carbon dioxide, a greenhouse gas, into the air. These greenhouse gases trap heat within our atmosphere, which leads to global warming. It is widely known that the average global temperature has increased by 10C. Warming above 1.5oC risks extreme weather, increase in sea levels, biodiversity loss and more. Within the construction sector, Hammond and Jones (2011) aver that carbon emission is the sum of all primary energy used (carbon emitted) during direct and indirect processes connected to a good or service that take place within the framework of a cradle-to-gate process. Until the product is prepared to exit the final

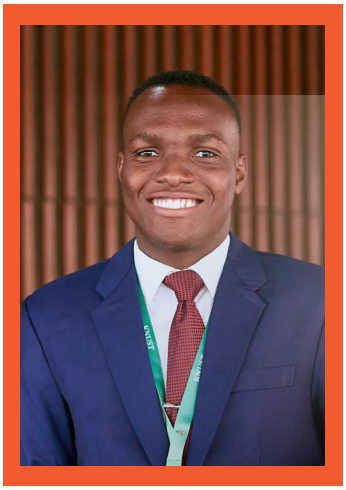


Table 1. Global warming potentials (GWP) of greenhouse gases

Greenhouse gas	GWP has over 100 years	Typical sources
Carbon dioxide (CO2)	1	Energy combustion, biochemical reactions
Methane (CH4)	25	Decomposition
Nitrous Oxide (N2O)	298	Fertilizers, car emissions, manufacturing
Sulfur hexafluoride (SF6)	22,800	Switch gears, substations
Perfluorocarbon (PFC)	7,390–12,200	Aluminium smelting
Hydrofluorocarbon (HFC)	124–14,800	Refrigerants, industrial gases

factory gate, this covers all operations such as material extraction (quarrying and mining), manufacturing, transportation, and fabrication procedures. The life cycle of a building can be divided into (I) material extraction, (II) material processing and component fabrication, (III) construction and assembly, (IV) operation and service phase, and (V) end-of-life phase. At each stage of the building's life cycle, energy is consumed (burning fossil fuels), and carbon emissions occur. Carbon emissions/CO2e emissions/CO2e equivalent/Greenhouse gas emissions generally refer to the emissions of any greenhouse gases (GHG) that affect climate change. Carbon emissions are usually expressed as CO2e (i.e., CO2 equivalent) which is a unit of measurement based on the relative impact of a given gas on global warming. The global warming potential of greenhouse gases is presented in the table below.

The world's population is estimated to double by the year 2050. Most of these will be living in cities and megacities. Between 1960 and 2010, Africa's urban population grew from 53 million to 400 million. By 2030, the number of Africans living in towns and cities will increase by 345 million. Sub-Saharan Africa's urban population will double to almost 600 million (FAO-UN, 2012). Ghana's population has increased by 1.96% from 2021, and forecasts show that by 2050, the population of Ghana will be over 50 million (United Nations-World Population Prospects, 2022). The increasing population means more demand for the scarce resources available. This means increasing demand for social amenities and physical infrastructure. The built environment has a significant impact on the environment. It is estimated that 39% of the world's carbon emission is due to the built environment.

THE ENERGY INVOLVED IN THE BUILDING LIFE CYCLE

From manufacturing to disposal, a building uses energy. The total energy used during the life cycle of the building is known as lifecycle energy. There are different types of energy and sources in the cycle, depending on which phase of the cycle. These are Embodied energy and operational energy. Embodied energy is consumed during the acquisition and processing of construction materials, energy used on site, and energy used up by demolition and waste disposal. The raw materials and manufacturing phase makes up the initial embodied energy. But as the building is in use, maintenance is necessary to keep it functioning. Some materials may have to be replaced, and some construction processes may be repeated. The embodied energy used in maintenance and renovation works is recurring embodied energy (Ramesh et al., 2010). Embodied energy also applies to the demolition and disposal phase. It includes energy used or needed for demolition and transportation of the waste materials to a disposal site or a recycling station (Ramesh et al., 2010).

Using a building requires the use of energy for different activities. Heating, ventilation, air conditioning, powering appliances and lighting

all use energy. The energy at this phase of the building life cycle, the use phase, is called operational energy (Ramesh et al., 2010). Ramesh et al. (2010) concluded that operational energy is the major determinant of the total life cycle energy of the building because it accounts for 80–90% of total energy. It should be stated that this study was based mainly in temperate regions where there is a need for both cooling and heating. Heating during the cold season accounts for a large percentage of the energy expended. As such, the embodied energy in Ghana could account for a higher percentage than stated above.

Construction-related CO2 emissions

According to the 2019 global status report for building and construction, construction processes and its services account for 39% of all carbon emissions globally, while operating emissions (from electricity used to power, cooling and light buildings) account for 28%. The rest of the 11% comes from incarnated carbon emissions, or 'upfront' carbon, associated with materials and construction processes throughout the entire construction lifecycle. Global emissions from buildings levelled by 2% for the second time in 2018 to 9.7 gigatonnes of carbon dioxide, meaning a change in the trend from 2013 to 2016, when emissions had been levelling off. This increase was caused by strong floor space and population expansions that led to a 1% increase in energy consumption to around 125 exajoules (EJ), or 36% of global energy use. Global final energy consumption in buildings in 2018 increased by 1% from 2017 and more than 8 EJ (about 7%) since 2010. While a substantial increase in the main buildings sector resulted from floor space and population expansion outpacing energy efficiency gains, floor area increase continues to disengage from energy demand, with a floor area in 2018 increasing 3% from 2017 and 23% from 2010.

From 2010 to 2018, global electricity use in buildings rose by over 6.5 EJ, or 19%. Fuel sources used for electricity generation in growing economies also rose emissions in 2018. Also, during 2010–18, renewable energy became the fastest-growing energy source for buildings, with its use increasing by 21% (up 3% during 2017–18 alone). Natural gas use rose 8 % during the same period, meeting new demand as well as displacing coal use, which dropped by almost 10% globally during 2010–18 (–2% from 2017 to 2018) (GlobalABC et al., 2019).

Construction materials

Building elements such as foundations, frames and other superstructure forms often represent the biggest contribution to embodied carbon because of their large volumes of material. Additionally, these elements often contain carbon-intensive load-bearing structural materials such as steel, concrete and masonry. Facades also contribute significantly if they utilize large amounts of aluminium and glass, both of which have carbon-intensive production processes (Matthew Adams et al., 2019).

According to global reports, cement and steel are the most important sources of material-related emissions in construction. Cement manufacture is responsible for around 7% of global carbon emissions, with steel contributing 7–9% of the worldwide total, of which around half can be attributed to buildings and construction. Both cement and steel require very high temperatures during production, making them energy intensive. In both cases, the chemical reactions during manufacture also release carbon dioxide directly. For this reason, emissions from these sectors have been considered 'hard to abate'. Other common construction materials that require high temperatures during manufacture include aluminium and glass. Globally, much of the energy for industrial heat is still supplied by fossil fuels such as oil and gas, though waste and biofuels are increasingly used in some industries and parts of the world. Recent research shows that it is feasible to decarbonize these sectors. Global cement consumption is projected to increase by 12–23% by 2050. Global steel production is forecast to grow by 30% over the same period, with recycled secondary steel growing faster than primary production. It is important to recognize the crucial role these materials have played and will continue to play in human society, even as humanity points out the need for radical decarbonisation.

Timber products and other biomaterials like bamboo have the potential to make a significant contribution to decarbonisation efforts as these materials absorb carbon from the atmosphere

during certain stages of their lifecycle. Concrete also absorbs atmospheric carbon when it is exposed to air. This process offsets some of the upfront carbon emitted during manufacture. The amount offset will depend on its application and treatment at the end of life when the exposed surface can be significantly increased by crushing.

Construction Process

The construction process is usually temporary in duration. According to Chan, building operations are known to be a significant contributor to environmental emissions, and the effects of the construction industry create unwanted remnants. This involves the degradation of non-renewable energy, the deterioration of ecosystems and the development of health and safety issues, both explicitly and indirectly relevant to the people working in this field (Chan, 2004).

Legislation on CO2 mitigation

The effects of climate change all over the world prompted some world leaders to enact the Kyoto Protocol in 2005, including Ghana (MESTI Ghana, 2013). The key goal of the Kyoto Protocol is to minimize global change by lowering greenhouse gas concentrations in the environment to the point that it will discourage harmful anthropogenic greenhouse gas pollution from impacting the climate system. Some of the laws in this Protocol concerning building regulations according to Joelson law include; designed carbon emissions must not exceed the Target Emissions Rate per year (TER), fixed design facilities should meet a fair energy efficiency level with minimal specifications set for main building fabric components; to see that there are no improper trade-offs with other building features, to ensure that this is accomplished, solar power gains should be limited, "as built" performance of the building should be consistent with the Dwelling Emission Rate (DER). Building owners are to be provided with complete information to provide for ongoing energy-efficient operation of their buildings (MESTI Ghana, 2013).

TOWARDS DE-CARBONIZATION OF THE BUILT ENVIRONMENT

To achieve national and international carbon reduction targets, buildings' embodied carbon dioxide equivalent (CO2e) must be lowered. The construction industry around the world is developing tools, databases, and methods for determining a building's CO2e emissions and recommending strategies to reduce them. As a result, it is difficult to implement effective measures to lessen embodied consequences because there are no standard methods, data sets, or laws in place to guide the process (De Wolf et al., 2017). Numerous studies have investigated various approaches to reducing a building's embodied carbon. Examples of these techniques include using low-carbon materials, material minimization and reduction techniques, material reuse and recycling techniques, local sourcing and transit-related techniques, and construction optimization techniques (Akbar Nezhad and Xiao, 2017).

Energy and carbon embodied in buildings constructed with different methods and materials is a topic of increasing attention (Monahan and Powell, 2011). Embodied carbon can be calculated with a variety of instruments and approaches. Among the most important evaluation methods are carbon footprint analysis, hybrid life-cycle analysis, and the more conventional life-cycle analysis (Kejun, 2008). It is also important to prioritize environmental impact evaluations of structures (Kumanayak and Luo, 2018). Since GHG emissions pose a serious threat to the planet's climate, we must figure out how much energy and carbon they require during their life cycle (Kumanayak and Luo, 2018).

Life Cycle Analysis

Life cycle assessment refers to the method used to estimate how a product might affect the environment throughout its useful life. Originally published in 1997 as ISO 14,040, the standard guideline for conducting a life cycle assessment was revised in 2006 and 2020 before being republished as ISO 14,044 in 2017. As Mohebbi et al. (2017), the field of life cycle assessment (LCA) is rapidly growing in significance in the fields of environmental policy and business (Ayres,1995). Four phases comprise a product's life cycle: manufacturing, building, use, and disposal (Gibbons and Orr, 2020). Any of these points may be included in a Life Cycle

Analysis. There are two stages to the process of determining a building's embodied carbon: the cradle phase and the grave phase.
The method of life cycle analysis includes taking a life cycle inventory. According to ISO 14040 (ISO, 1997), to conduct an inventory analysis, one must gather information and carry out mathematical operations to ascertain the precise quantities of all pertinent inputs and outputs. The life cycle inventory considers the labour, materials, and energy required for construction, the trash produced, and the carbon emissions produced. Designs, bills of materials, technical specifications, and reports from regulatory agencies all feed into the process. Professionals in the field of building help make reasonable assumptions when there isn't enough information to go on. Estimates for the most important parts of the structure were made with great care. When converting from a basic material quantity (m3, m2, or m) to mass, appropriate standards and manufacturer specifications are considered. Work units are broken down into simpler material units when possible. However, this isn't always the case, depending on the nature of the task (Kumanayak and Luo, 2018).
Analysis of the data is the next stage after the life cycle inventory is complete. In this stage, you will combine the results from the inventory analysis and the impact assessment to make your final judgments and provide recommendations for the future within the parameters and goals of your study (Kumanayak and Luo, 2018).

The Cradle-to-Gate Life Cycle Assessment

The environmental impacts of modular and conventional building construction can be compared and contrasted using a cradle-to-gate life cycle assessment. By using this assessment technique early in the design phase, decision-makers may assess the environmental effects of various building materials and choose the greenest options. The raw materials, transportation of materials and labour, and energy resources are gathered for a cradle-to-gate life cycle review. Environmental impact metrics, such as the possibility of global warming, are also gathered (Kumanayak and Luo, 2018).

The Cradle-to-Cradle Life Cycle Assessment

A growing trend is using a Cradle Life Cycle Assessment to ensure products are created in a way that minimizes their negative impact on the environment (Kumanayak and Luo, 2018). Buildings have a significant effect on the environment. They account for more than one-third of global greenhouse gas (GHG) emissions, and in the majority of countries, they constitute the sole source of GHG output (UNEP, 2009). To create a more sustainable world, the cradle-to-cradle concept proposes a new paradigm for designing good products and services for the economy, society, and the environment. It shows a positive future vision when products are drastically improved to help people and the planet. For the built environment, the end goal of the cradle-to-cradle approach is to encourage ecologically responsible designs that work in harmony with nature (Tamoor et al., 2022).

Hybrid Life-Cycle Analysis

The environmental effects of items and processes can be evaluated with life cycle evaluations (LCAs). Life cycle analysis can be used to assess the environmental impact of construction projects by analyzing the pollution caused by the creation of construction materials. Traditional life cycle analysis data is generally reliable but lacks validity because numerous precursor activities are not included. Though comprehensive on a systemic level, input-output analysis suffers from inaccuracies when applied to the life cycle study of individual goods. When compared to conventional life cycle statistics, the information gleaned through an input-output life cycle analysis model can help you make better decisions. On the other hand, hybrid LCA data completes what is lacking in the more standard form of LCA data. Treloar et al. (2010) With a hybrid LCA, we hope to reap the advantages of both methods.

Carbon Footprint Analysis

The term "carbon footprint" refers to the total amount of carbon dioxide emissions exclusively attributable to human production or consumption activities and are both

relevant to climate change. Carbon footprint is a measurement of the direct and indirect emissions of carbon dioxide that are cumulative over a product's lifecycle (Wiedmann and Minx, 2008). The largest portion of society's total carbon footprint comprises carbon emissions related to the built environment (Fenner et at, 2018). Carbon footprint analysis, as defined by Franchetti and Apul (2013), is the process of measuring the amount, content, and origin of processes that release greenhouse gases. One of the most well-liked subjects in sustainability research is still analyzing carbon emissions from buildings. The World Resources Institute (WRI), the World Business Council for Sustainable Development (WBCSD), and the Greenhouse Gas Protocol (GHG Protocol) were accepted and adopted globally despite the fact that the majority of carbon footprint studies addressing buildings have different system boundaries, scopes, greenhouse gas emissions, and methodology (Onat et al., 2014). Carbon footprint analysis is regularly carried out as part of an audit or assessment process. This entails the monitoring and quantification of data as well as, if appropriate, a potential facility walk-through. Energy and carbon footprint reduction is the process of lowering energy use and greenhouse gas emissions by modifying processes, equipment, and resource allocation. The following is often covered by the energy and carbon footprint audit in construction:

- investigating the energy consumption and greenhouse gas emissions connected with the construction process.
- creating suggestions to increase process effectiveness while reducing energy use, greenhouse gas emissions, and energy expenditures.
- supplying a thorough list of construction material suppliers that complement the suggestions to construction enterprises (Franchetti and Apul,2013).

Circular Economy Concept

In a circular economy, things are made and consumed to minimise our use of the world's resources, cut waste, and reduce carbon emissions. Products are kept in use for as long as possible. This is achieved through repairing, recycling and redesigning. This makes sure that they can be used over and over again. At the end of the product's life, the materials used to make it are kept in the economy and reused wherever possible. The circular economy is an alternative to traditional linear economies, where we take resources, make things, consume them and throw them away. This way of living uses finite raw materials and produces vast waste. Recycling seems to be akin to the circular economy. However, waste materials are converted into new materials and objects in recycling. This process itself consumes energy, creates emissions and contributes to global warming. In an ideal circular economy, products are redesigned to last through several life cycles rather than being immediately recycled. In the construction context, one of the ways this can be achieved is through refurbishing. While there is still a significant gap in knowing and applying the circular economy principles, especially within the Ghanaian context, the concept proves to be a major game changer in fighting climate change and carbon emission reduction.

OPPORTUNITIES AND CHALLENGES

The quantity surveyor is a specialist with knowledge of managing a construction project's financial aspects throughout its stages (RICS 2015). Because of the importance of their work, their high level of knowledge in construction management, and the pride that comes with their professionalism, these individuals are highly regarded in the construction business. Quantity surveyors have renowned construction competencies and are widely involved in construction projects. They possess essential skills to fulfil consumers' growing and transforming requirements, particularly in the global construction industry. The QS collaborate with other construction industry experts, including architects and engineers, as well as with owners, governmental bodies, insurance providers, contractors, and sometimes subcontractors. Due to the emergence of new construction technology, large-scale building projects are becoming more sophisticated and utilizing a variety of construction experts. Additionally, the demands of customers and stakeholders are becoming more complex,

including the need for sustainable design and construction to address global warming. Construction experts are expected to fulfil a variety of tasks to satisfy evolving demands and expectations due to various technological advancements, competition, and the industry's dynamism.

Sustainable construction has emerged as a viable approach for addressing the construction industry's myriad social, economic, and environmental challenges. Construction professionals worldwide are beginning to recognize the importance of sustainability and the benefits of sustainable structures (Abidin 2010). Because quantity surveyors play such an essential role in construction, cooperation in sustainable construction has become crucial. Ashworth et al. (2013) believe that reducing greenhouse emissions and developing efficiency in the building sector are prominent and diverse quantity surveying techniques. The RICS (2013) has emphasized the need to encourage quantity surveyors to improve their carbon management abilities, which will become progressively important in building projects as time goes on. Sustainability performance assessment, zero carbon and property value, and sustainability value achievement in construction procurement were described as the three roles a quantity surveyor can play to ensure sustainability in the construction sector (Emmanuel, 2011).

A quantity surveyor with a strong understanding of technology and innovation is a crucial consultant at all phases of a project's life cycle. Quantity surveyors may offer trustworthy advice on construction costs and recommend a suitable construction technique or building materials to achieve the target green building rating by studying the building materials and their specifications. Green costing, carbon footprint, life cycle costing, property performance reporting (PPR), green building ratings, and building information modelling (BIM) have all been related to the development of quantity surveyors' abilities for sustainable construction Seah (2009). Considering the paradigm change toward sustainability, the present scope of the quantity surveying profession will not be enough to keep up with the competition. This new trend allows quantity surveyors to engage in the current innovation application, green cost consultation, cost-effective, sustainable strategies, building material solutions, life cycle cost analysis, and property performance evaluation.

In sub-Saharan Africa and Ghana, to be precise, there are many impediments to the work of a QS in carbon emission reduction. One key drawback is the lack of databases. As quantity surveyors, identifying the equivalent GhG emissions in a building will serve as a premise to advise clients, engineers and other stakeholders of the impact of design decisions. The lack of a complete codified database on the embodied energy embodied carbon, and carbon emissions of the various building processes and materials that make up the structure hinders quantity surveyors working in Ghana. It must be stated that there are a number of international databases, such as the Ecoinvent Database. However, such database excludes local materials and construction processes and, more importantly, are not open to all. Consequently, this impedes the computation of carbon emissions.

Another major issue facing the field of quantity surveying is a lack of knowledge and technical capacity about sustainable construction and carbon emission computations. Quantity surveying is becoming more dynamic and adaptable due to Construction Industry 4.0 and digitization. As a result, increasing awareness of the need for sustainable building in pedagogy and customer requirements has become an issue. Other issues that also tend to act as stumbling blocks include the lack of general awareness, poor regulations of the construction industry in Ghana, procurement challenges, poor citizen science, lack of interest in environmental issues etc.

CONCLUSION

The fight against climate change is inextricably related to sustainable development resulting from well-designed, constructed, and maintained built environments. As a result, to be sustainable, current quantity surveyors must further develop their abilities and core competencies across the board. By including all issues related to sustainability in their line of work, sustainability may begin its path of integration into the construction business. The contemporary quantity surveyor can also

use building information modelling to achieve sustainability successfully. The management approaches for sustainable designs may be made by employing BIM early in the design and preconstruction phases. Current quantity surveyors must adapt to the quick changes and growing demand for low-carbon buildings to provide better and more comprehensive services to the market. Investigating environmental impact assessments of all feasible building solutions will result in efficiencies by monitoring and analysing pre- and post-construction impacts with different criteria that have a direct or indirect effect on the environment. As it is said, we do not inherit the Earth from our ancestors, and we borrow it from our children.

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Prevalent Disasters in Ghana should be classified as Human-Induced and not Natural

By: **Surv. Dr. Jemima Antwiwaa Ottou,** MGhIS, MCIOB

Natural disasters may be defined as the abnormal intensity of a natural agent which causes damage because the usual measure to curb their negative effects on the environment were either not taken or insufficient. They take various forms like volcanic eruptions, landslides, hurricanes, tornadoes, wildfires, earthquakes, and floods. All over the world, these disasters have destroyed millions of lives and properties. This has led to diverse strategies to reduce the negative effects of the so called natural disasters.

Some disasters cannot be classified as purely natural because they may be a result of negligence, outright refusal to comply with required safety measures or ignorance. Such is becoming the trend in Ghana as even the so called natural disaster are human induced. Ghana has experienced disasters that can be classified as historical due to the scale of destruction and magnitude of the effects after the disaster. Other disasters can be classified based on the location such as markets as the disaster agent eg. Fire is the same. Further, a seasonal classification also emerges as some disasters are triggered by seasonal rains eg. Floods.

Table 1 presents information on some major disasters that can be classified under the three categories in Ghana (historical, location, and seasonal).

Table 1: Information on Some Major Disasters in Ghana

Date of incident	Incident Location	Disaster description	Disaster Agent and classification	Negative effects	Graphical representation
Historical Disasters in Ghana (2001-2022)					
January 2022	Apeate	A gold mine at Bogoso bound truck carrying explosives exploded when a motorcycle crushed into the truck.	Human-induced (explosion)	17 people died, some 59 people were injured, 500 buildings were destroyed and approximately 1500 people were made homeless.	
November 2021	Keta, Volta Region	Tidal waves displaces residents of Keta	Natural (tidal waves)	Over 3,000 people were rendered homeless	

March 2019	Kintampo	Two buses from oppo-site directions crashed head-on and caught fire.	Human-induced (V e h i c u l a r accident)	At least 60 people died and several others injured	
March 2017	Kintampo	A large tree fell on tourist at the waterfalls following a storm.	Natural (Storm)	28 people died and several injured	
June 2015	Accra	Fuel station burnt with people and vehicles in the vicinity.	Human-induced (flood and explosions)	Over 200 people feared dead and property lost	
May 2001	Accra Sports stadium	The police fired tear gas into the crowd in the stadium with locked gates	Human-induced (Stampede and panic)	126 people died and property damaged	
Human-induced Percentage:67%				**Natural Percentage: 33%**	
Location induced: Major Market Disasters in Ghana (2020-2021)					
July 2021	Makola, Accra	Three storey building burnt	Human-induced (fire)	Over 500 shops including goods worth millions of cedis damaged	
April 2021	Central Market, Kumasi	Shops of sandals sellers burnt down	Human-induced (fire)	Over 40 shops including goods worth thousands of cedis damaged	
May 2021	Timber market, Accra	Shops and timber burnt	Human-induced (fire)	Loads of wood and shops lost	

April 2021	Techiman Market, Techiman	Two storey building burnt	Human-induced (fire)	Properties damaged	
April 2021 and May 2021		Market burnt twice in the space of two months	Human-induced (fire)	20 metal containers and 5 cold store lost	
February 2020	Dagomba line	Dagomba line burnt	Human-induced (fire)	200 head porters displaced	
December 2020	Kaneshie market, Accra	Shops in Kaneshie market burn	Human-induced (fire)	9 shops destroyed	
December 2020		Several shops in the market burnt	Human-induced (fire)	Over 1000 shops destroyed	
July 2020	Koforidua market, Eastern Region	Shops in the market burnt	Human-induced (fire)	Property destroyed	
April 2022	Tema Timber Market, Accra	Shops in the market burnt	Human-induced (fire)	About 300 people lost their dwelling places and property worth millions destroyed	

	Dome market, Accra	Shops in the market burnt	Human-induced (fire)	Property destroyed	
November, 2020	Odawna market, Accra	Shops in the market burnt	Human-induced (fire)	Over 500 shops destroyed affecting over 3000 traders	
Human-induced Percentage:100%					**Natural Percentage: 0%**
Disasters in Ghana (2022)					
May 2022	Dagomba -Line Kumasi	A 10-bedroom rented apartment on the third floor of a three storey building housing some police officers at was burnt. Electrical fluctuation was suspected to have triggered the fire.	Manmade (fire)	Occupants of the third floor were displaced and properties were lost	
June 2022	Cape Coast-Elmina Highway	I officer drowns as 30 prison officers from the Ankaful prison were detailed to rescue residents who had been inundated with flood water.	Natural (flood)	1 person died, some personal belongings of flood victims were lost	
June & July 2022	Alajo, Accra	Svere flood leaving roads shredded and dozens of buildings submerged	Natural, flood	Infrastructure and houses destroyed displacing several people	
July 2022	Achimota, Accra.	Wooden structures and metal containers used for commercial purposes were burnt by fire.	Human-induced (fire)	Traders were displaced and properties were lost (30 wooden structures and 50 metal containers)	

May 2022	Tolon Nothern Region	The top floor of the girls' dormitory occupied by over 600 students of Tolon Senior High School has been burnt.	Human-induced (fire)	Over 600 students displace and their properties lost. The structure was also damaged	
Human-induced Percentage:60%				**Natural Percentage: 40%**	

From **Table 1,** it can be deduced that majority of the severe disasters are human -induced in comparison with the so called natural one. Hence, these disasters can be avoided if humans ensure that safety procedures and guidelines inform their decisions and actions. The quantity surveyor can assist in reducing the risk of disasters by incorporating health and safety measures in the bills of quantities as these guides the contractors in construction. For instance, quantity surveyors can consider including fire resistant components in their item descriptions for market projects; fire extinguishers; smoke detectors; fire alarms etc.

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Jemima Antwiwaa Ottou holds a PhD in Construction Management from the Kwame Nkrumah University of Science and Technology, Ghana; MSc. in Engineering and Management from the Coventry University, UK; and a Bachelor of Science Degree in Building Technology from the Kwame Nkrumah University of Science and Technology, Ghana. Her research interests include Total Quality Management and Procurement in Construction Project Delivery. She is a Member of the Ghana Institution of Surveyors and a Member of the Chartered Institute of Building. Jemima Antwiwaa Ottou has over 20 years functional experience as a Quantity Surveyor, Procurement Professional and a Contract Administrator. She has performed duties related to Pre-Contract and Post Contract activities for major construction projects in both Building and Civil Engineering Works. She has worked for Contractors and Consultancy Services in Ghana for both Public and Private Institutions. She has managed several donor funded government construction projects. In the past 7 years she has acquired experience in teaching and thesis supervision in contract management, procurement, total quality management, and project management at both the undergraduate and post graduate levels. She currently the programme coordinator for Project Management post graduate level at the GIMPA Business School. Her passion for helping the deprived and vulnerable is seen in the selfless consultancy services she provides to organisations in need.

My Opinion Piece - Managing Price Escalation on Lump Sum Contracts With the Impact Of the Russia – Ukraine War on the Cost of Inputs.

By: **Albert Y. Latsu,** MGhIS, MACostE, GCInstCES

Lump sum contracts are contracts that the sum is known from the onset. In other words, there is much price certainty. Lump sum contracts have the contract amount predetermined, making the price fixed with little or no variations.

Most people say that there cannot be variations on lump sum contracts but I do not agree with this assertion. There can be variations on lump sum contracts in situations where some elements change, for instance the client may decide that he no longer requires the use of 150mm solid concrete blocks but would rather prefer the contractor use 125mm solid concrete blocks which would amount to a variation in cost. Some items which are no longer manufactured may also account for variation if alternatives are to be used. Unlike re-measurable contracts, quantities in the lump sum contracts are not subject to re-measurement, which means the quantities do not have a bearing on payments. Payment maybe made in stages in accordance with a payment schedule submitted by the contractor.

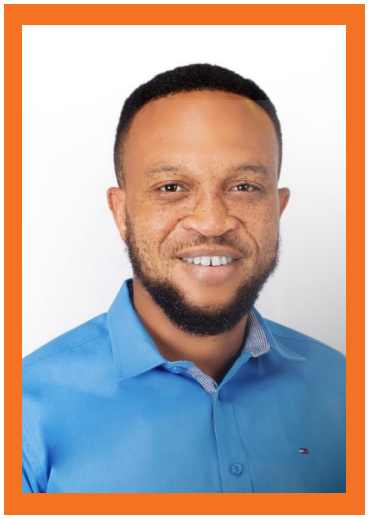
Lump sum contracts are mostly used where the clients require certainty on the final price and completion date is of extreme importance. They are sometimes used for projects with smaller scopes.

The contractor assumes responsibility for a wider range of risks when lump sum contract is the go-to or preferred option unlike most contracts where risk sharing is balanced between the client and the contractor.

The go to standard forms for this type of contract may be the FIDIC Silver Book for EPC (Engineer, Procure, Construct)/Turnkey -1999 version and upwards or sometimes the FIDIC Red Book 1999 version and upwards provided that certain clauses in the particular conditions are modified to suit lump sum.

The impact of the recent Russia-Ukraine war has affected many economies and industries across the world as the prices of goods and services have sky rocketed these past few months in an unprecedented manner. Sadly, the construction industry has taken its share of the blow.

Many contractors and subcontractors have started dusting their contracts from off the shelves to see if there is a price escalation clause that they can activate especially those who have signed lump sum contracts. Prior TO the Russia-Ukraine war, prices were quite stable and most lump sum contracts or subcontracts I have come across, mostly bespoke, didn't have price escalation clauses.



From a personal

point of view, I don't see the need for an inflation clause in a lump sum contract because contractors are permitted to price risk in this type of contract. Thus, it makes sense to assume that the contractor has catered for this in his pricing.
Long before the Russia–Ukraine war, prices were relatively stable. Most private developers saw lump sum contracts as a perfect go–to procurement route because there is much price certainty and there is no burden of extra cost.
This opinion piece seeks to attempt to advise how contractors and clients who already have a lump sum contract agreement without inflation provisions in the contract can manage the contract jointly in order that the project is not abandoned. It also seeks to attempt to advise parties who want to enter into lump sum contracts with the current happenings.

Managing Price Escalations

Certain matured client–contractor conversations must be made in order to ensure that the contractor is able to deliver the project. It is prudent that these conversations are made earlier in order to prevent disputes. The approach is for both parties to come to terms and accept that this is the current happenings.
Prices of goods and services are surging in an inconsistent manner if not checked would affect the contractors' ability to complete the project, hence the need for some flexibility in the contract.
An opportunity should be given to the contractor to do value engineering to enable the contractor meet the client's requirement using alternatives which would still achieve the same objective but keeping within the agreed amount.
Also, the client can opt to go for less expensive options in order to reduce the cost burden on the contractor. For instance, if the price of a particular wall cladding has sky rocketed unprecedentedly, alternatives can be looked at.
The client and the contractor as another way can agree to modify the design. Example, the area of curtain wall can be reduced.
Generally speaking, it is needful that the client together with the contractor makes a checklist of major items within the bills of quantities which it is possible to modify without tempering with the contractors priced risks within those items.
Another way to manage lump sum contracts during these times is for the client to request from the contractor to reduce profit margins in order to get the project delivered.
The above are proposed options available to parties who have an existing lump sum contract agreement where inflation clauses weren't considered in the contract whether as an oversight or deliberate omission.

The options available for parties now going in for lump sum contract is to have an early discussion of the current happenings before going into the contract.
The contractor can introduce a price validity period as part of his price clarification to the client beyond which rates would be revised.
Another option is for parties to go in for a cost reimbursement contract where the client would be responsible for the prime cost of labour, plant and materials and a margin be paid the contractor separately for supervision and management.
The next option is for parties to introduce a clause in the contract for rise and fall of cost of labour, goods and other inputs. The FIDIC Silver Book Sub–Clause 13.8 makes a provision for this.

Conclusion

To conclude, in a scenario where there is greater price stability and much predictability, lump sum contract would be a preferred option if not cost reimbursement contract would be the next option that way, the client knows exactly what he's paying for.

Pharmacotherapy of Hypertension

By: **Dr. Peter Yamoah** (Lecturer and pharmacovigilance consultant at the Department of Pharmacy Practice, University of Health and Allied Sciences, Ghana)

BACKGROUND

Hypertension is defined as elevated systolic pressure ≥140 mmHg and diastolic blood pressure ≥ 90 mmHg. Globally, hypertension remains the leading cause of death. An estimated 1.28 billion of the global population aged 30–79 years have hypertension out of which two–thirds reside in low and middle income countries.

The major symptoms of hypertension are chest pain, shortness of breath, palpitations, claudication, peripheral oedema, headaches, blurred vision, getting up to urinate in the middle of sleep at night (nocturia), blood in urine and blurred vision.

Aside from lifestyle modifications, antihypertensive medicines are beneficial in managing hypertension.

ANTIHYPERTENSIVE MEDICINES

The major primary antihypertensives used in the management of hypertension include thiazide diuretics, calcium channel, angiotensin converting enzyme inhibitors and angiotensin receptor blockers. In some cases, primary anti–hypertensive medicines may not reduce blood pressure sufficiently and as such, secondary antihypertensives are added. The secondary antihypertensives include beta blockers, centrally acting alpha–2 agonists, alpha blockers, direct vasodilators, loop diuretics and aldosterone antagonists.

THIAZIDE DIURETICS

They act at the distal convoluted tubule of the kidney to inhibit the reabsorption of sodium. In so doing, salt and water are lost through urine, leading to a reduction in heart load and blood pressure. Examples of thiazide diuretics include bendrofluazide, hydrochlorothiazide, indapamide and chlorthalidone. The side effects of this class of antihypertensive medicines include hyperglycaemia, hyperuricaemia, hypokalaemia, hyponatraemia, erectile dysfunction in men, dizziness, headache and weakness.

CALCIUM CHANNEL BLOCKERS

The calcium channel blockers act by preventing calcium from entering the cells of the heart and arteries. Calcium causes the heart and arteries to contract to raise blood pressure. By blocking calcium, these medicines allow blood vessels to relax and open and relax the heart as well leading to a reduction in blood pressure. Examples of calcium channel blockers include nifedipine, amlodipine, felodipine, nicardipine, verapamil and diltiazem. Side effects of calcium channel blockers include constipation, dizziness, fatigue, palpitations, headache, swelling

of the feet and legs, nausea and vomiting.

ANGIOTENSIN CONVERTING ENZYME INHIBITORS (ACEIs)

These medicines relax veins and arteries as well as a decrease in blood volume which leads to a lower blood pressure and decreased oxygen demand from the heart. Examples include lisinopril, ramipril, captopril, benazepril, etc. The side effects of ACEIs include dry cough, increased potassium levels in blood (hyperkalaemia), fatigue, dizziness, headache and loss of taste.

ANGIOTENSIN RECEPTOR BLOCKERS (ARBs)

These medicines dilate blood vessels by blocking the action of a natural chemical in the body which causes blood vessels to constrict called angiotensin II. This leads to a reduction in blood pressure. Examples of ARBs include losartan, valsartan and candesartan. Side effects of these medicines are similar to those of ACEIs.

BETA BLOCKERS

Beta blockers act by blocking the effects of the hormone adrenaline resulting in slowing the heart beat and with less force which lowers blood pressure. Examples of beta blockers are atenolol, bisoprolol, propranolol, metoprolol and sotalol. The side effects of beta blockers include tiredness, dizziness, lightheadedness, insomnia, nightmares and lack of concentration.

CENTRALLY ACTING ALPHA-2 AGONISTS

These medicines activate alpha-2 receptors in the central nervous system to reduce blood pressure. Examples of medicines in this class are methyldopa and clonidine. Side effects of this class include headache, muscle weakness, swollen ankles or feet, stomach upset, vomiting, diarrhoea and dry mouth.

ALPHA BLOCKERS

These medicines lower blood pressure by preventing a hormone called noradrenaline from tightening the muscles in the walls of smaller arteries and veins. As a result, the blood vessels remain open and relaxed leading improvement in blood flow and reduction in blood pressure. Examples include doxazosin, prazosin and terazosin. Side effects of alpha blockers include dizziness, faintness, headache, nasal stuffiness, peripheral oedema, decreased ejaculation and tachycardia (heart rate over 100 beats per minute).

DIRECT VASODILATORS

These medicines relax the smooth muscles in veins to reduce blood pressure. An example is hydralazine. Side effects of direct vasodilators are flushing, headache, stomach upset, vomiting, loss of appetite, diarrhoea, constipation stuffy nose, rash and eye tearing.

LOOP DIURETICS

Loop diuretics reduce sodium reabsorption in the thick ascending limb of the loop of Henle of the kidney. In so doing, salt and water are lost, leading to a reduction in heart load and blood pressure. Examples of loop diuretics are furosemide, bumetanide and torsemide. The side effects of loop diuretics are similar to those of thiazide diuretics.

ALDOSTERONE ANTAGONISTS

These medicines decrease the effect of aldosterone, a hormone responsible for salt and water retention in the body. This leads to higher levels of potassium and low levels of sodium in the blood. Examples include spirinolactone and finerenone. Their side effects include hyperkalaemia, hyperchloraemic metabolic acidosis, acute renal failure, gynaecomastia and kidney stones.

CONCLUSION

There are potent anti-hypertensive medicines currently available on the market. However, their use requires a thorough patient assessment by a qualified physician. Different patient populations require specific management plans to enhance good treatment outcomes. It is therefore imperative to visit the clinic for early assessment and treatment rather than to resort to self-medication.

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Development of a Comprehensive Strategic Plan for Quantity Surveying Division of the Ghana Institution of Surveyors (QSD-GhIS): a Stakeholder Engagement Swot Analysis

By: Surv. Prof Adjei-Kumi Theophilus, Surv. Enoch Odame, Surv. Osei-Agyemang Badu, Surv Baah Yamoah and Surv Eva Akrofi

The QSD-GhIS has been operating without any clear and documented high-level path to a desired position. In the corporate world, this high-level path is documented in a Strategic Plan which then becomes the guide to the achievement of the desired goals. In this regard, the QSD-GhIS sought to draft a strategic plan for the division for the period 2023 to 2033 which includes the following:

The Strengths

Strengths focus on internal factors which are the positive things about the QSD like corporate relationship with membership, good membership attitudes, huge share in the market, high integrity, capital, research capabilities, and other positive qualities.

The Weaknesses

Weaknesses focus on internal negative factors. Weaknesses such as the areas that the QSD lacks, limited productivity, limited resources, and other things.

The Opportunities

Opportunities refers to the external factors and circumstances that will likely give the QSD a chance to flourish. These can lead to market growth that would hugely benefit the QSD, or there is new information from the market and environment that will surely give the QSD huge opportunities.

The Threats

Threats are external and negative factors surrounding the QSD. These threats can be your contemporary or possible competitors in the future, aspects that are out of the control of the QSD that can lead the QSD into grave danger, new products or technologies in the market from any competitors that can potentially lead the QSD into poor performance, changes in the attitudes of Clients that can lower their patronage of the services of QSs.

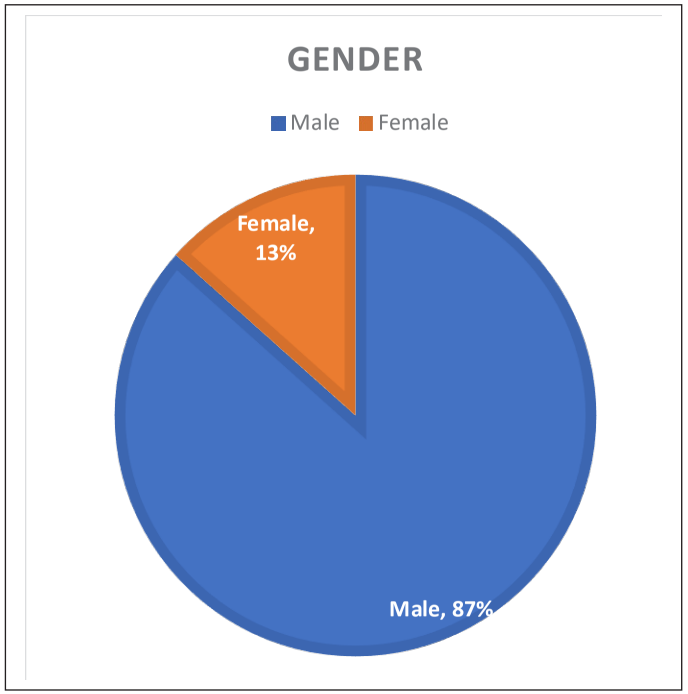
SWOT ANALYSIS

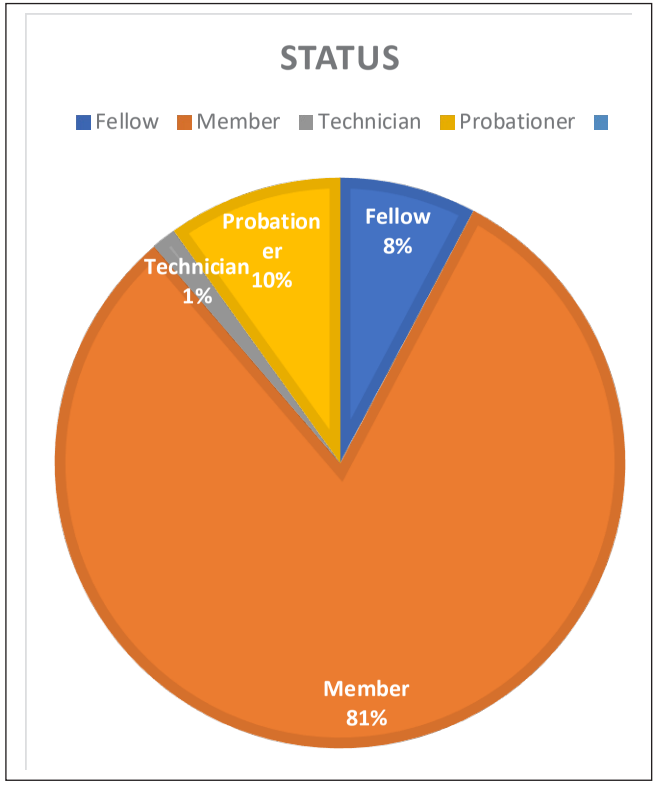
A SWOT analysis was conducted using data collected from 142 QSD-GHIS members using a structured questionnaire. This report presents the results of the data analysis as part of the development of a strategic plan for QSD-GHIS. The data analysis and presentation begun with the background of the respondents. Subsequently, the results of the numerical data analysis were presented. The analysis focused on answering the questions;

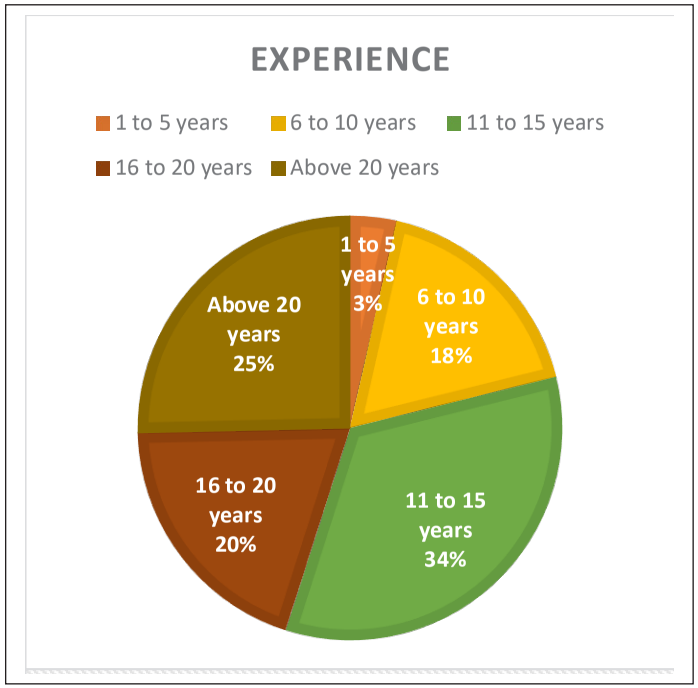
1. What are the top three most important Strengths/ Weaknesses/opportunities/threats?
2. Which of the Strengths/Weaknesses/ opportunities/threats and statistically significant?

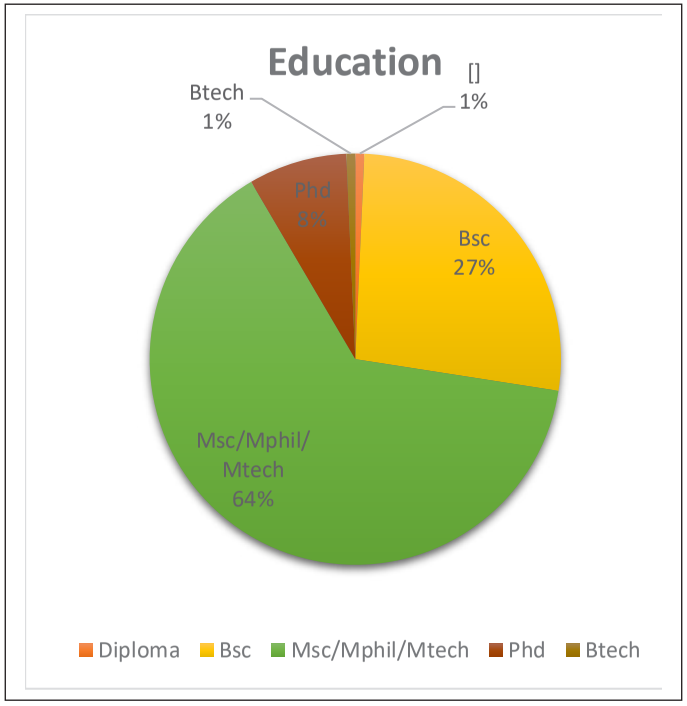
Background of the respondents

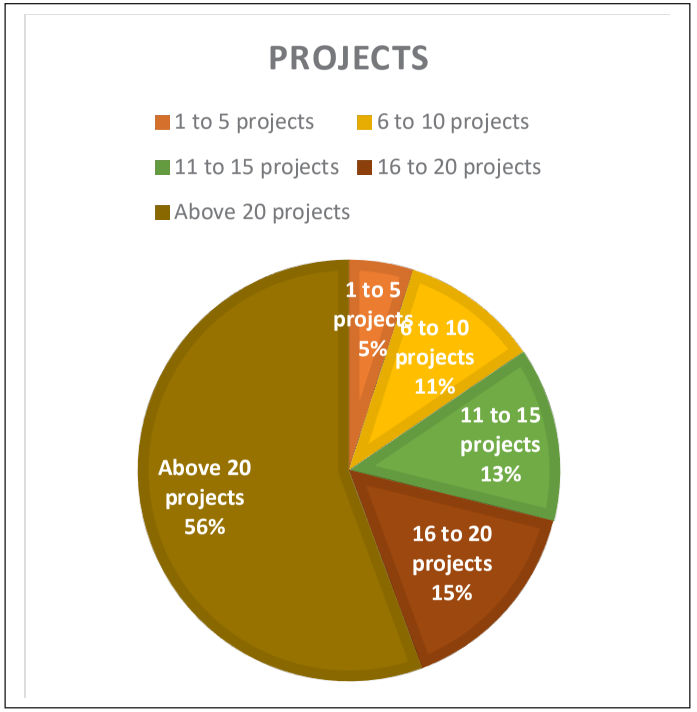
The data collected had 87% male responses and 13% female responses. In addition, 8% of the responses were from Fellows whiles 81% were from Members. 10% were Probationers and only 1% were Technicians. Furthermore 8% of the responses came from PhD holders whiles 64% came from Msc/Mphil/ Mtech. 27% had BSc degree and only 1% each came from Btech and Diploma holders. Over 50% of the respondents had above 10 years of experience and has been involved in over 20 projects


GENDER
Male
Female
Female, 13%
Male, 87%


STATUS
Fellow
Member
Technician
Probationer
Fellow 8%
Probation er 10%
Technician 1%
Member 81%


EXPERIENCE
1 to 5 years
6 to 10 years
11 to 15 years
16 to 20 years
Above 20 years
1 to 5 years 3%
6 to 10 years 18%
11 to 15 years 34%
16 to 20 years 20%
Above 20 years 25%


Education
[]
Btech 1%
1%
Phd 8%
Bsc 27%
Msc/Mphil/ Mtech 64%
Diploma
Bsc
Msc/Mphil/Mtech
Phd
Btech


PROJECTS
1 to 5 projects
6 to 10 projects
11 to 15 projects
16 to 20 projects
Above 20 projects
1 to 5 projects 5%
6 to 10 projects 11%
11 to 15 projects 13%
16 to 20 projects 15%
Above 20 projects 56%

Strengths of QSD-GHIS

Table 1 presents the results of the analysis. Based on the analysis, the top three most important strengths were;
1ST – Linkages with regional and international professional groups.
2ND – Significant level of national recognition.
3RD – Possession of unique Industry cost management knowledge.

However, from the statistical significance test analysis, only "Sole body for QS" was deemed statistically insignificant.

Table 1: Ranking of the strengths of QSD-GHIS and statistical differences based on gender and status

Strengths of QSD-GHIS	Mean	SD	t-value (t>1.96) @ 4.00	Rank
Linkages with regional and international professional groups	4.61	0.673	10.719	1ST
Significant level of national recognition	4.57	0.728	9.333	2ND
Possession of unique Industry cost management knowledge	4.42	0.708	7.113	3RD
Quality practice comparable to that in other international jurisdictions	4.37	0.786	5.655	4TH
Increasing CPDs for members	4.35	0.744	5.525	5TH
Uniform basic training of members	4.31	0.844	4.376	6TH
Significant partner in the GhIS fraternity	4.30	0.840	4.194	7TH
Fiduciary duty to the Members regarding ethics of QSs practices	4.29	0.804	4.279	8TH
Diversity in service delivery by members i.e. Project Management, Insurance, Adjudication etc.	4.23	0.670	4.132	9TH
Increasing Membership over the years	4.21	0.761	3.308	10TH
Sole body for QSs	3.97	1.197	(0.281)	11TH

Source: Field survey, (2022).

Weaknesses of QSD-GHIS

Table 2 presents the results of the analysis. Based on the analysis, the top three most important weaknesses were:
1ST – Lack of support services to membership i.e., support services like databases on cost and prices, cost indices etc.
2ND – Poor visibility and marketability of the QS profession.
3RD – Low level use of QS-related software in the industry.

However, from the statistical significance test analysis, only the first ten (10) weakness were deemed statistically significant.

Table 2: Ranking of the weaknesses of QSD-GHIS and statistical differences based on gender and status

Weaknesses of QSD-GHIS	Mean	SD	t-value (t>1.96) @ 4.00	Rank
Lack of support services to membership i.e., support services like databases on cost and prices, cost indices etc.	4.54	0.721	8.965	1ST
Poor visibility and marketability of the QS profession.	4.40	0.764	6.171	2ND
Low level use of QS-related software in the industry	4.34	0.835	4.840	3RD
Lack of regulatory power	4.31	0.916	4.030	4TH
Poor PR work in the various media i.e. public mainly unaware of QS	4.30	0.832	4.237	5TH
Low level of representation on statutory bodies in public institutions	4.29	0.815	4.235	6TH
Poor membership benefits to enhance job opportunities	4.23	0.897	3.003	7TH
Weak linkages with MDAs, MMDAs, CSO, NGOs etc.	4.23	0.829	3.241	8TH
Inadequate standardization in service delivery	4.22	0.852	3.055	9TH
Unregulated rates for fees and charges for some common services	4.21	0.930	2.627	10TH
Weak firm-to-firm collaboration	4.13	0.849	1.778	11TH
Inability to deal with high number of unqualified practitioners	4.12	0.945	1.515	12TH
Weak linkages with regional and international bodies	4.12	0.863	1.653	13TH
Disinterest in the practice challenges of members	4.10	0.902	1.303	14TH
Weak linkages with professional bodies e.g., GhIE, GIA etc.	4.08	0.911	1.106	15TH
Poor linkages with Training and Research Institutions	4.02	0.918	0.274	16TH
Low level consideration for R & D	4.01	0.812	0.103	17TH
Lack of evidence-based research work	4.01	0.821	0.102	18TH
Lack of impetus towards branding	3.99	0.945	(0.178)	19TH
Weak linkages with relevant student bodies in educational institutions	3.96	0.981	(0.429)	20TH
Difficulty in progression to membership in parent bodies like RICS	3.96	1.058	(0.398)	21ST

Poor financial standing	3.96	0.890	(0.5660	22ND
Low leverage on matured technology	3.95	0.921	(0.640)	23RD
Lack of systems for membership renewal/activation of class status	3.95	0.873	(0.675)	24TH
Unclear requirements for progression in the professional class	3.89	1.049	(1.284)	25TH
Lack of logistics	3.86	0.986	(1.702)	26TH
Lack of special arrangements for dissatisfied clients	3.83	0.891	(2.260)	27TH
Low level of membership	3.82	0.994	(2.196)	28TH
Lack of dedicated staff for QSD	3.75	0.954	(3.078)	29TH
Low level of proactivity to involve the old and experienced	3.74	0.937	(3.237)	30TH
Apathy towards divisional programmes	3.67	0.931	(4.252)	31ST
Significant numbers of inexperienced members	3.55	0.996	(5.410)	32ND
Difficult route to membership	3.26	1.056	(8.341)	33RD
Active internal party-political divisions	3.14	1.138	(8.958)	34TH

Source: Field survey, (2022).

Opportunities of QSD-GHIS

Based on the results in Table, 3, the top three most important opportunities were;

1ST – Explore the possibility of making the Division the body of choice for MMDAs and MDAs in the empaneling of ETC and TEP.
2ND – Provide leadership in VfM, Risk Management in infrastructure development in Ghana.
3RD – Embrace fully digitization and digitalization of information, procedures and processes.

Nevertheless, the statistical significance test analysis showed that all the opportunities identified were significant.

Table 3: Ranking of the opportunities of QSD-GHIS and statistical differences based on gender and status

Opportunities of QSD-GHIS	Mean	SD	t-value (t>1.96) @ 4.00	Rank
Explore the possibility of making the Division the body of choice for MMDAs and MDAs in the empaneling of ETC and TEP.	4.56	0.649	10.158	1ST
Provide leadership in VfM, Risk Management etc. in infrastructure development in Ghana	4.54	0.651	9.744	2ND
Embrace fully digitization and digitalization of information, procedures and processes	4.52	0.734	8.403	3RD
Explore collaborations with Ministries, state institutions, MMDAs and MDAs	4.51	0.673	8.914	4TH
Explore high-level collaboration with training and research institutions	4.51	0.581	10.320	5TH
Explore the use of matured technologies	4.48	0.704	8.041	6TH
Possible inclusion of related disciplines like Construction Project Management, Procurement Management, Cost Engineering, Value Management, Industrial Research, Contract Management etc.	4.48	0.724	7.817	7TH
Explore high-level collaborations with professional groups	4.44	0.732	7.155	8TH
Making services widely available to public and private clients	4.44	0.732	7.046	9TH
Exploring business growth and expansion for members	4.44	0.702	7.348	10TH
Establishment of more consortiums where QS firms form Principal Consultants	4.44	0.712	7.243	11TH
Provide leadership in Sustainability, Project Management, 4th Industrial Revolution etc. in infrastructure development in Ghana	4.43	0.648	7.831	12TH
Changing perception youthful QSs to join the QSD	4.43	0.680	7.457	13TH
Exploring technological & innovational collaboration among industrial players	4.40	0.666	7.110	14TH
Explore high-level collaboration with sub-regional, regional and international organizations	4.39	0.652	6.995	15TH
Explore and take advantage of the national drive in Technical and Vocational Education and Training (TVET)	4.34	0.736	5.400	16TH
Explore and take advantage of the African Continental Free Trade Agreement (AfCFTA)	4.34	0.745	5.329	17TH
Explore and take advantage of the national drive towards Skills Development in Ghana	4.31	0.750	4.959	18TH
Explore the use of social media to tap from the ever-increasing gains in the sector	4.31	0.709	5.129	19TH
Explore new markets such as environmental restoration and infrastructure decommissioning in the mining industry	4.29	0.725	4.782	20TH

Source: Field survey, (2022).

Threats of QSD-GHIS

Table 4 presents the results of the analysis. Based on the analysis, the top three most important threats were;
1ST – Lack of investments in technology both by the institution and individual members of the institutions.
2ND – Unhealthy/unethical practices of members affecting the image of the Division
3RD – Professional skill gaps

However, from the statistical significance test analysis, only the first three (3) threats were deemed statistically significant.

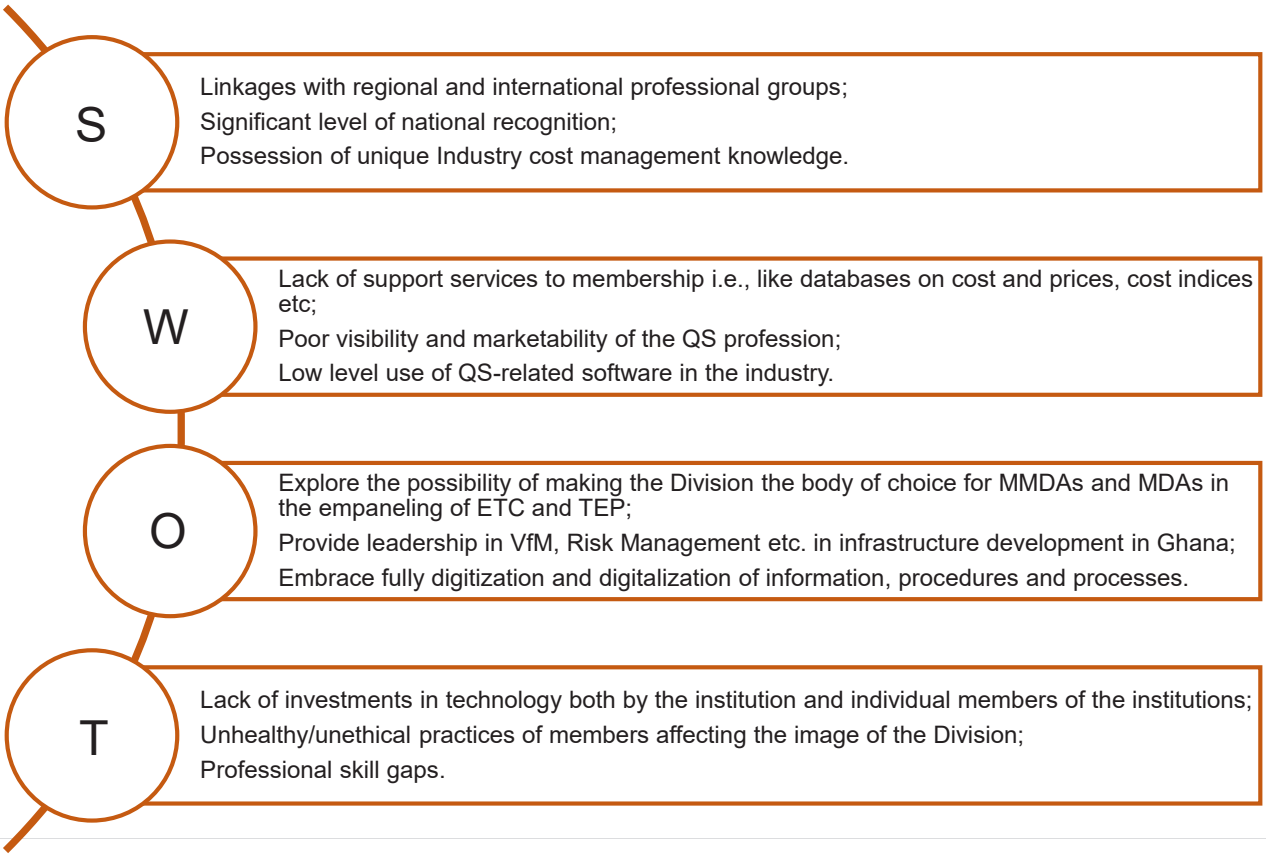
Table 4: Ranking of the threats of QSD-GHIS and statistical differences based on gender and status

Threats of QSD-GHIS	Mean	SD	t-value (t>1.96) @ 4.00	Rank
Lack of investments in technology both by the institution and individual members of the institutions.	4.27	0.748	4.296	1ST
Unhealthy/unethical practices of members affecting the image of the Division	4.26	0.764	4.091	2ND
Professional skill gaps	4.21	0.835	2.934	3RD
Economic conditions/downturn promoting intense competition	4.06	0.829	0.816	4TH
Government policies on for example, interest payments on public projects etc.	4.03	0.952	0.355	5TH
Rapid technological advancement	3.99	0.941	(0.090)	6TH
Increasing number of non-members	3.99	1.106	(0.153)	7TH
Preference for expatriate professionals by foreign companies	3.98	1.014	(0.250)	8TH
Emergency and competitiveness of strong One- stop Consulting firms out performing traditional QS firms.	3.86	0.976	(1.645)	9TH
Migration of expatriate professionals offering QS related services	3.81	1.043	(2.107)	10TH
Influx of various software for productivity enhancement	3.77	1.027	(2.633)	11TH
Political party influences	3.72	1.368	(2.409)	12TH
Emergence of related industry bodies e.g., Ghana Chamber of Construction Industry (GCCI), Ghana Institute of Construction (GIOC) etc.	3.63	1.055	(4.166)	13TH
Current changes in Pre-university curricula	3.59	1.017	(4.736)	14TH
Influx of related offshore services due to African Continental Free Trade Agreement (AfCFTA) World Trade Organisation (WTO) etc.	3.45	1.075	(6.053)	15TH

Source: Field survey, (2022).

Conclusion

A SWOT analysis has been conducted towards the development of a QSD–GHIS strategic plan. This was based on the collated responses from QSD–GHIS members focusing on the top three factors and the statistically significant factors in each category of the SWOT. Figure 1 presents a summary of the results



Abstract of PhDs

A FRAMEWORK FOR THE UPTAKE OF GREEN BUILDING CONCEPTS IN THE GHANA CONSTRUCTION INDUSTRY

By: Dr. Lee Felix Anzagira KNUST 2020

Activities of the construction industry has gained publicity for their environmental impacts and the consumption of natural resources. These impacts have far reaching effects, yet theneed for construction is increasing hence, the degradation, exploitati on of the resources, generation of waste and the abstinence of clinching to conventional building practices by the construction industry (CI) persists. Awareness and knowledge of these impacts as well as efforts to miti gate them has increased. Green building (GB) is globally acclaimed as the most fo rmidable answer to the adve rse effects brought upon the climate and environment by buildings and construction activ ities for which reason Governments and stakeholders in developed co untries have developed codes, policies and frameworks to encourage and enforce the uptake of green building concepts (GBCs) in their CIs to achieve sustainable development. In contrast. current evidence suggests that uptake of GB in developing countri es or Sub-Saharan Africa (SSA) is at a snail pace and characterized by the absence 01· GB codes and fram ewo rk s. In Ghana. the uptake of G BCs is at a slow pace. immature and at an infancy with on ly 8 ce rtified GBs. Th is study therefore was motivated by the inadequacy of frameworks and too ls to address the slow pace of GB uptake in the Ghana const ructi on industry (GC I). This research aimed to develop an uptake framework for the successful adoption and im plementation of Green Building Concepts and Technologies (GBCs and Ts) in the GCI.

An exploratory method of investigation invol ving both quantitative and qualitative methodology was used to achieve the objectives of thi s study. A literature review and questionnaire survey was conducted among stakeholders in the GCI. The survey yie lded 292 valid responses. Data collected from the survey were analysed using various quantitative analysis techniques. On awareness of GBCs, the results indicated that the level of awareness is high in Ghana but does not correspond with low, level of implementation of GBCs. It also revealed many stakeholders know GB as being environmentally friendly. There are 8 certified GBs in Ghana. Many stakeholders have not heard about the Ghana Green Building Council. On the behavior antecedents influencing GB adoption, there is significant influence of perceived behavioural control on GB adoption. It also found a significant influence of perceived innovation characteristics on the attitude to adopt GBs. On the extent of application of GBCs and Ts in Ghana, the results showed that the five most applied Green Building Technologies (GBTs) are Optimizing site planning, building orientation, and configuration. Use of natural ventilation, Integrative use of natural lighting with electric lighting systems. Application of energy-efficient lighting systems, and Use of Permeable paving: low -traffic areas. Majority of these belong to the energy-efficiency technologies category of GBTs.

The results also indicated there is need for buildings in Ghana to he greener and GBTs adoption shou ld be mandatory by government and current state of GB in Ghana is immature. On the drivers for GB adoption in Ghana, greater energy-efficiency of buildings, enhancement or occupant's health and comfort and satisfaction, greater wate-efficiency of buildings, better indoor environmental quality, and thermal comfort -better indoor temperature were the top live drivers. The factor analys is indicated that the underlying drivers for the significant drivers were Environment and Health-associated, Socio-economic, Project and Property-level, Company image associated, and Occupancy associated drivers'. Regarding the barriers to GB adoption, the results indicated the top five most critical barriers as lack of government incentives/supports for implementing GBTs, lack of knowledge and awareness of GBTs and their benetits. Lack of GBTs databases and information, Lack of GB expertise/ skilled labour and Higher costs of GBTs. The factor analysis grouped the 27 critical barriers into 4 government and knowledge associated, technology and training, cost and time, and stake holders' attitude barriers. On the stimulation measures for in creased GB up take in Ghana,

educational programs for developers, contractors, and policy maker related to GBT , mandatory GB codes and regulations, availability of better information on cost and benefits of GBTs, public environmental awareness creation through workshops, seminars, and conferences, and better enforcement or existing standard by local government, Metropolitan Municipal and District Assemblies (MMDAs) etc. were revealed as the top five measures. The factor analysis grouped the 17 stimulation measures into 5; government regulations and policies, commitment and GB research, education and publicity, and incentives and support.

Furthemore, the Partial Least Square-Structural Equation Modelling (PLS-SEM) results revealed that GB awareness, Perceived behavioral control, Company-image associated drivers have a significant positive influence on GB adoption, and Education and publicity Stimulation measures all have a signilicant positive influence on GB adoption whilst Stakeholders attitudes barriers and cost and time associated barriers have a significant negative influence on GB adoption. The study developed quantitative models showing the influences of awareness, behavior decisions, drivers, barriers and strategies on GB adoption based on which the uptake framework is developed to promote the widespread adoption of GBCs and Ts. The framework is validated by means of semi-structured qualitative interviews by both industry practitioners and academia in Ghana and the findings suggest that the framework is valuable and suitable for use in practice.

The study poses practical, theoretical, and methodological significance for GB adoption in the GCI. The developed framework serves as a tool for policy makers, developers, academia, and investors who are desirous of implementing GB in the construction industry. It has advanced the understanding about GB development and has contributed to the GB body of knowledge especially the developing country context and will be beneficial to the GCI's contribution to meeting the United Nations Sustainable Development Goals (UN SDGs).

CAPACITY BUILDING OF SMALL AND MEDIUM BUILDING CONTRACTORS FOR LEAN CONSTRUCTION UPTAKE

By: **Dr. Emmanuel Nsiah Ankomah** **KNUST** 2020

In every country, the composition of the construction industry is pyramidal in form with a few large firms at the top. In Ghana, Small and Medium Building Contractors (SMBCs) constitute about 95% of contractors, over 90% of the job market, and nearly 80% of all short-term employment. Notwithstanding the significant contributions of SMBCs, they face fundamental problems which lead to widespread underperformance within this sector. Lean construction (LC) is a production delivery system with the potential to deliver exceptional performance improvement for any organization and a possible solution to the many problems of SMBCs. Therefore, LC is an important area to examine, especially as there is a lower up-take of LC by SMBCs. SMBCs lack capacity to adopt LC principles. This problem is more profound in developing countries as majority of indigenous construction firms lack capacity and are unable to innovate and adapt to new ways of working. Therefore, the aim of the study was to develop a framework for capacity building of SMBCs for the uptake of LC principles. The "4P Model" of the Toyota Way was adopted as a comprehensive model for LC adoption. Four theories; Absorptive Capacity Theory, Human Capital Theory, El 's Conditions of Change Theory and Social Network Theory were adopted to facilitate understanding of the complexities surrounding capacity building of SMBCs. The contextual nature of the research was best served using a case study. In order to obtain a better understanding of the phenomenon under study, three (3) exploratory case studies were purposively selected for the research. This was done to reflect the reasonable replication logic for the conduct of case study research. Across the three (3) cases, twelve (12) face-to-face structured interviews were undertaken. Data gathered in th form of observations and interviews were analyzed using thematic analysis technique. Across the cases, it was realized that there

is a low level application of LC principle, among SMBCs. The capacity needs of the firms were found to be management's commitment and involvement, resources (financial and human), organizational change (culture and structure), education and training, change in mindset, stakeholders involvement and legislative instrument. The results highlight the need to establish strategies to assist SMBCs in the adoption of LC concepts. Accordingly, this study developed a framework for building the capacity of SMBCs to adopt LC principles. The workability of the framework was demonstrated through interviews and focus groups discussions with original study participants as well as others who were not originally part of the study. The work adds to the current body of literature, among other things, by focusing attention on capacity building of SMBCs for the adoption of LC principles. Future research can look at building the capacity of other stakeholders (subcintractors, clients, suppliers) for the uptake of LC principles.

CONTRACTORS' ADAPTATION TO ENVIRONMENTALLY SUSTAINABLE CONSTRUCTION PROCESSES

By: Surv. Engr. Prof. Sarfo Mensah KNUST 2016

Environmental sustainability is foundational to achieving the global goals of sustainable development. The construction industry has a significant role to play in pursuance of environmental sustainability. However, stakeholders in the industry lack capability and understanding to adapt to environmental sustainability practices in construction. There are lack of guidelines for understanding and promoting sustainable construction, especially in developing countries. Therefore, the aim of this research was to develop a framework that will provide guidelines for contractors to build capacity for Environmentally Sustainable Construction (ESC) processes. Four theories; the Resilience, Ecological Modernization, Institutional and Social Network theories have been adopted to facilitate understanding of the complexities surrounding adaptation to ESC. Through face-to-face semi-structured interviews, qualitative data have been collected from large scale contractors in the country. The data have been analysed using data matrix and template thematic analysis techniques. Adopting an abductive approach, a back and forth iteration between findings and the theories have been applied to facilitate development of the framework. Contractors act within socialecological system of the construction industry. The inability of these system actors to adapt to ESC is attributed to legislative, socio-cultural and other barriers. Improving knowledge of clients and other stakeholders in ESC processes would enable ESC adaptation. Formation of social network of contractors and collaboration with 'noncontractor' stakeholders are also primary to creation of drivers and enablers of ESC. Other frameworks developed for sustainable construction in developing and emerging economies do not provide stakeholder-specific guidelines for developing the needed capability to achieve sustainable construction. The framework developed in this research zeroes in on providing guidelines and strategies for contractors, as construction industry stakeholders , to achieve capability for adapting to ESC processes. The contribution o f this research is that studies directed towards achieving sustainability in construction industry have been advanced through application of relevant multidisciplin ary theories. The significance of this study is that. in line with the 'Agenda 21 for Sustainable Construction m Developing Countries' recommendation, guidelines for contractors to attain capability for sustainable construction have been provided. For successful implementation of the framework, it is recommended that the guidelines provided are to be integrated into a contractor's organisational policy. 'Establishing and enforcing ' governmental regulations on ESC is a key driver for bringing contractors' adaptation to ESC into reality.

DEVELOPMENT OF A BUILDING ENERGY EFFICIENCY ASSESSMENT TOOL FOR OFFICE BUILDINGS IN GHANA

By: Surv. Ing. Dr. Michael Nii Addy KNUST 2016

The built environment 1s responsible for some of the most serious global and local environmental changes. This is exacerbated by increasing energy demands and decreasing resource availability. Building energy remains a critical criterion amongst both developed and developing nations and its availability cannot be overemphasized . In Ghana, more focus has been placed on the supply side, with measures taken to overcome the current supply deficit. Inspite of the importance of improving the supply side, the demand side cannot also be overlooked . Interestingly, studies show that electricity demand is fast increasing, hence a need to retook at the strategy to curb this growing problem. In this thesis, the focus has been placed on demand side management. The thesis sought to answer one key question : how can one determine whether a building is energy efficient or not? A basic question, yet a critical starting point for energy efficiency studies in Ghana. Consequently, the overarching aim of the study was the development of a building energy assessment tool to be used in determining the energy efficiency of office buildings in Ghana. To achieve this aim, four main research objectives were formulat ed and a mixed methodology approach adopted. A combination of four different methods were used in this research: review of pertinent literature, Delphi survey, Delphic Hierarchy Process (DHP) and Simulation study. The first objective sought to examine methods used in building energy performance assessment towards the development of a conceptual framework. From the review of literature a conceptual framework was developed. The second objective sought to identify applicable criteria to form the dimensions of the building energy assessment method. A Delphi survey was conducted in two successive rounds follo win g the literature review. Expert opinion from fields of academia, industry and government were assessed and consensus established showed that the international assessment methods are not fully applicable to the Ghanaian built environment. Five main blocks were established: the energy performance indices; calculation of energy performance; assessment of energy performance; setting of energy efficiency limit and energy performance labelling. Following this, the Delphic hierarchy process was used in achieving the third objective. This involved, the development of a customised weighting system for the Ghanaian environment. The resultant weighting system had building design having the highest weight followed by energy efficiency of building facilities. Use of renewable energy had the lowest weight. The findings reflect t he current d evelopm ent of building e nergy data studies. It was noted that despite the huge role that renewable energy can play in reducing energy efficiency, current economic issues present an impediment to its investment and subsequent development. To achieve objective four, a simulation study was undertaken to test and validate the developed weighting systems and further propose a grading system . Building energy data studies provided the required framework to properly develop the tool. It is important to state that the outstanding contribution of the study lies in the final tool developed for determining the energy efficiency of office buildings at the design stage . The development of a building energy assessment tool amongst many would contribute to energy security and economic stability . Such a tool can be adopted by energy planners, policy developers, building scientists, facility managers and designers in the planning, design and implementation of energy efficient building. Almost all well-known building assessment methods are updated and revised either annually or biannually. Therefore, it is recommended that the tool be subject to regular review which will inform required development and updating . Further developments should incorporate the developments of guidelines needed whilst using the tool. It is recommended that future studies explore building optimisation studies. This is necessitated by the dearth of study in this field in Ghana and a need for more direction to undergird the full utilisation of the developed tool. Also the interplay between cost and building energy efficiency is worthy of investigation in further research.

SHEAR STRENGTH PROPERTIES OF STRUCTURAL LIGHTWEIGHT REINFORCED CONCRETE BEAMS AND TWO-WAY SLABS USING PALM KERNEL SHELL COARSE AGGREGATES

By: Surv. Dr. Alex Acheampong KNUST 2015

In the last three decades, the use of Palm Kernel Shells (PKS) as coarse aggregate in concrete has continuously received increasing attention among researchers, especially in Africa. This is primarily due to its environmental and economic benefits. However, while considerable amount of research has been carried out to assist in understanding its concrete mix designs and associated mechanical properties, a limited amount of works have been carried out to assist in the current understanding with respect to its shear resistance. The main objective of this study was to investigate the shear strength properties of structural lightweight reinforced concrete shallow beams and two-way slabs using PKS coarse aggregates. A comparison between properties of PKS concrete and normal weight concrete (NWC) was made. The effect of types of cement on the mechanical properties of both PKS and NWC were also investigated. The materials phase of this research evaluated fresh concrete properties such as slump, and the key mechanical properties of hardened concrete, that is, compressive, flexural tensile strengths and density. The study employed a series of trial mixes, which resulted in casting and testing 216 cubes and 180 modulus of rupture beams at 7, 14, 21, 28, 56, and 90-days of curing, to obtain an optimum mix design. The third phase of the study consisted of testing 46 reinforced concrete beams to evaluate the flexural response of the reinforced PKS concrete and NWC beams, with and without shear reinforcement. The 46 beams consisted of 19 beams without shear reinforcement (15 PKS concrete and 4 NW) and 27 beams with shear reinforcement (21 beams were cast with PKS and 6 beams were cast with granite aggregates). The variables of the third phase w re the overall depth of the beams, longitudinal reinforcement, shear reinforcement, shear span-to-depth ratio and modes or loading. The fourth phase of the study investigated the flexural response of eight two-way slabs (four slabs were cast with PKS and four were cast with granite aggregates). The main variables were concrete strength and the modes of loading. The study revealed that the physical and mechanical properties of the PKS aggregate are satisfactory for producing structural lightweight aggregate concrete. The 28-day air-dry density of PK concrete was within the range for structural LWAC. The 28-day compressive trength of the concrete produced in this study was found to satisfy the minimum strength requirements of a structural concrete based on BS 8110-1 and ASTM C330. It was found that PKS concrete beams with and without shear reinforcement behaved in a similar manner to those of NWC beams based on the range of parameters tested, including the cracking modes. PKSC two-way slabs mostly failed as a result of punching shear. The study further revealed that the design equations of the British Standards Institute, American Concrete Institute and Eurocode 2 can be used to safely predict the shear capacity of PKS concrete beams with and without shear reinforcement. It is further concluded that PKS aggregates can be used in the production of LWC for structural applications in Ghana.

SIMULATION - BASED EXPLORATION OF THE THERMAL PERFORMANCE OF SELECTED MULTI- STOREY OFFICE BUILDINGS IN ACCRA, GHANA

By: Arc. Dr. Simons Barbara KNUST 2015

The lack of empirical data and practical advice on thennal performance and efficient use of energy in buildings are gradually becoming a burden to the country. Amidst the recent advancement in the usage of cmiain walls for office buildings, high consumption of energy and poor thermal comfort issues have become dominant. Given the warm-humid climatic characteristics of Ghana, energy needs for cooling of office buildings represent an increasing burden on the environment and the economy. In many instances, the building design is not supported by a detailed analysis and evaluation of thermally relevant features as well as options related to orientation, envelope, glazing ratio, shading devices, and thermal mass. Thus, design decision making is not sufficiently informed by relevant expertise pertaining to energy efficient building design methods and technologies.

By adopting subjective thermal comfort models, building performance simulation and experimental approaches, this research aimed at advancing knowledge on how thermal comfort conditions could be enhanced and energy-use reduced in Ghanaian office buildings. In this context, the research had the following objectives:

- To assess occupants view of their indoor thermal comfort conditions within the selected buildings.
- To determine the thermal comfort conditions of the indoor environment of the selected buildings.
- To identify energy reduction strategies for the indoor conditions of the selected buildings based on validated models.
- To identify overheating reduction strategies (passive case-no air conditioners) of the selected buildings.

Adopting a case study research strategy, a number of data collection methods were employed. Both quantitative and qualitative data were collected and analysed in line with a framework designed to examine and extract relevant materials in relation to the research questions. The research database included 4 multi-storey office buildings (Ridge Towers [R.T.], World Trade Centre [W.T.C.], Premier Towers [P.T.], and Heritage Towers [H.T.]) and 195 occupants' questionnaires.

From May, 2012 to April, 2013, indoor and outdoor climatic conditions (mainly temperature and relative humidity) were monitored, using data loggers. To evaluate the existing indoor climatic conditions, measured air temperature and relative humidity values were plotted in the psychrometric and bioclimatic charts. A survey (questionnaire) of 195 occupants was conducted to record their views on indoor environment, installed systems and energy use.

At a general level, the study provided insight into the character of occupants within the buildings, their general views and concerns regarding energy use and them1al comfort. It provided evidence of how the buildings could be made comfortable by means of the psychrometric and bioclimatic charts. Significantly, the study showed how building cooling loads could be reduced to the minimum whiles providing comfortable indoors passively. On the psychrometric chart, the monthly hourly temperature and relative humidity values for R.T. and P.T. were within the comfort zone. All the values for W.T.C. were outside the comfort zone whiles H.T. had the montJ1s of January, May, June and July inside the comfort zone.

This suggests that R.T. and P.T. could operate passively all year round while H.T. could do that within certain months of the year. W.T.C. was found to be very uncomfortable all year round. Plotting both W.T.C. and H.T. values on the bioclimatic charts,

7 months were within the comfort zone of Olgyay's chart in the H.T. building. This gave an indication of five uncomfortable months for the same building. Givoni's chart suggests that W.T.C. could be made comfortable by means of comfort ventilation, conventional dehumidication and air-conditioning for the various months. Olgyay's chart suggested that air velocity of between 0.1 mis to I mis could improve the comfort conditions of the spaces within the W.T.C. In the H.T., Givoni's chart recommends high thermal mass and comfort ventilation whiles Olgyay's chart proposes air velocity of 0.1 mis to get the other 6 months within the comfort zone.

Additionally, the analysed data from the questionnaire among others showed that the three most important parameters for occupants' satisfaction in the office spaces studied were air quality, thermal comfort and fire safety. Again, the respondents (occupants) were interested in receiving training on the effective and efficient operation of building systems, which could help increase satisfaction, comfort and reduce energy performance of buildings.

The calibrated simulation results suggested that measures regarding building fabric and controls could improve buildings' energy performance. Pa11icularly, careful combinations of improvement measures (such as efficient glazing, thermal mass, faCrade insulation, night ventilation, efficient electrical lighting, form and orientation) have a significant potential to reduce buildings' cooling loads (31 % – 49%) in the climatic context of Accra.

When the buildings operated passively, the alternative improvement scenarios considerably reduced the mean overheating in the offices up to about 2.9K, depending on the reference overheating temperature assumption. Though not exactly identical, there is a clear correspondence between the ranking of the scenarios in view of lower cooling demands (active building mode) and lower overheating tendency (passive operation mode).

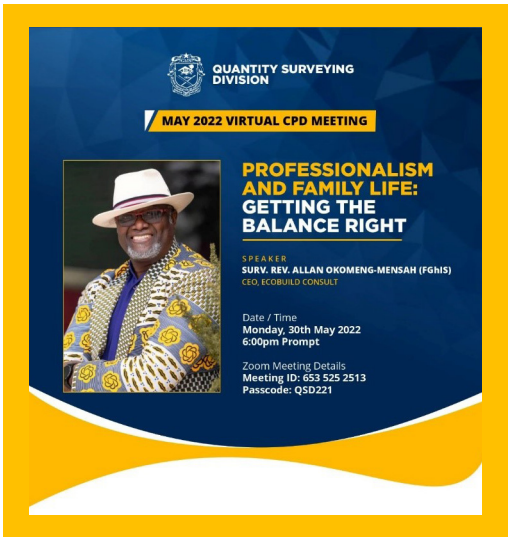
A significant contribution of this research to the body of knowledge is the prov1s1on of empirical evidence with respect to improvement of thermal performance in multi-storey office buildings in Accra, Ghana. Until the current research, the above assertion had not been supported by any empirical study within the localized climate of the capital city of Ghana. Another significant contribution of this research to the body of knowledge is the provision of sufficient evidence to confirm that the procedure for the determination of the comfort zone on the psychrometric chart could be adjusted for tropical climates where people are generally adapted to higher relative humidity and moderate temperatures. Validated simulation models are used in retrofit analysis for improvement in the thermal performance of buildings. Therefore another significant contribution of this research is the achievement of validated simulation models for energy assessment in multi-storey office buildings in Ghana. This provides a reference point for future validated simulation studies involving multi storey office buildings with curtain walls in Ghana. Moreover, this study is the first of its kind in the climatic context of Accra, Ghana.

PHOTOVOLTAIC ADOPTION IN THE GHANAIAN BUILDING INDUSTRY: PERCEPTIONS AND RELATIONAL DYNAMICS OF INNOVATION ADOPTION DECISION FACTOR

By: Surv. Dr. Naa Adjeley Ashiboe-Mensah KNUST 2012

In Ghana, where there is a need to decrease demand on the national grid and also increase the renewable component of the nation's energy mix, photovoltaics1 seem like a plausible means of achieving both goals simultaneously especially by incorporating them in new buildings in urban areas. However, experiences with solar energy technology adoption and diffusion globally reveal that adoption and diffusion are influenced by a wide variety of factors that may be social, cultural, economic, technical and institutional; and an appreciation of the factors that play a role in a given context within which the technologies are to be adopted is essential to their successful adoption and diffusion. Consequently, an understanding of the innovation behaviour of potential adopters of this technology is relevant so as to manage the innovation diffusion process adequately. For this reason, this research identifies and evaluates the potential factors that may influence photovoltaic adoption in the Ghanaian building industry. Guided by Rogers' (1995) diffusion of innovation theory and a framework by Hartmann et. al., (2006), the research employed both quantitative and qualitative research methods to achieve the research aim which is to describe and understand the potential factors that may influence photovoltaic adoption in the Ghanaian building industry. The quantitative aspect involved the use of a cross-sectional survey of clients, architects, electrical and mechanical engineers in the Ghanaian building industry. A total of one hundred and thirty-two valid responses were obtained and the data obtained were analysed using Relative Importance Indices, Pearson chi-square, Fisher's exact test, Cramer's V and Mann-Whitney U statistical tests. In the qualitative aspect of the study, a holistic multiple case study research design was employed. The study focussed on three products in the Ghanaian building industry: prestressed beams and blocks for floor construction, pozzolana cement and asphaltic shingles. Data was collected using semi-structured interviews. In all, twelve individuals (clients, consultants and supplier representatives) were interviewed and thematic analysis was used as the tool for data analysis. In the survey, the worldwide web was identified as the most prevalently used communication channel and information from consultants/other building participants was rated as the most reliable channel. The certainty of an innovations future performance was rated as the most important factor in a decision to adopt or reject it. Seventy-five percent (75%) of respondents knew about photovoltaics technology and although there was a generally favourable perception of the technology, actual adoption was approximately twenty-three percent (23%). The case study revealed that although the innovation attributes had an important influence on the adoption or rejection on the cases studied, the extent of influence is dependent on the other factors which relate to the context and the communication channels used, hence, the context is most relevant in view of the modulations of the other adoption factors. The major contribution of the study to academia is that it tests and extends the innovation diffusion theory by applying it within a new context- the Ghanaian building industry. Furthermore, Hartmann et. al.'s (2006) framework is tested within a different country and among private rather than public clients thereby focussing on a social system different from that of Hartmann and his colleagues. Practically, the results of the study can be used to guide change agents' promotional efforts through the formulation of principles discerned from the patterns in the data collected that could guide future action.

2022 QUANTITY SURVEYING DIVISIONAL CPDs



MAY 2022

Professionalism and Family Life: Getting the Balance Right

By: **Surv. Rev. Allan Okomeng-Mensah** (FGhIS)
CEO, Ecobuild Consult

Highlights

As a professional working in a fast-paced and financially demanding world, pause and ask yourself, "Which is better? Time with your family or making money to provide for your family?" Or "Is it even possible to have a balance of the two?" This session sought to help Quantity Surveyors get the answers to these all-important life questions.

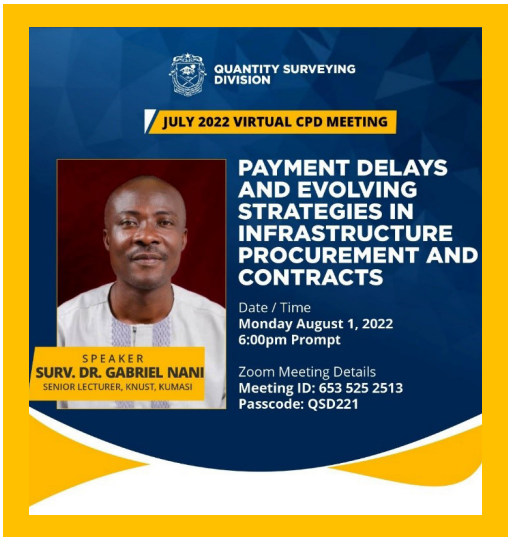
JUNE 2022

The Trainee's Supervisor and the Trainee Surveyor: Roles & Responsibilities

By: **Surv. K. H. Osei-Asante** (FGhIS)
Past President, GhIS

Highlights

The Unique roles expected of the Trainee's Supervisor during the Probational period and the responsibilities of the Trainee Surveyor. This presentation unearthed the "making" of a Professional Surveyor.



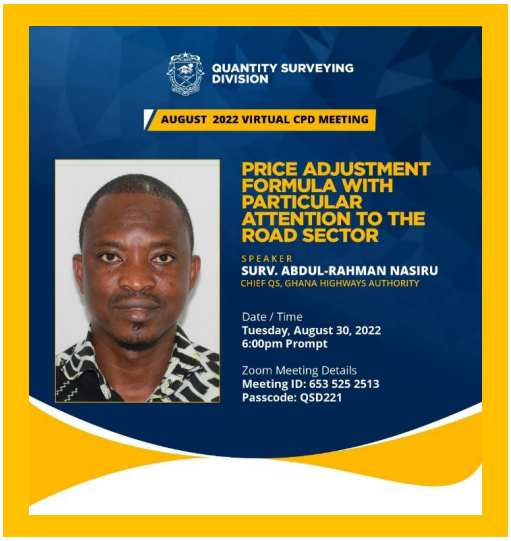
JULY 2022

Payment Delays and Evolving Strategies in Infrastructure Procurement and Contracts

By: **Surv. Dr. Gabriel Nani** (FGhIS)
Senior Lecturer, KNUST, Kumasi

Highlights

Project Payment delays often result from employer's cash flow constraints in the procurement of infrastructure. The ramifications are dire on many sectors of the economy. Varied strategies have been adopted in various jurisdictions to handle the effect. This presentation explored the evolving strategies.



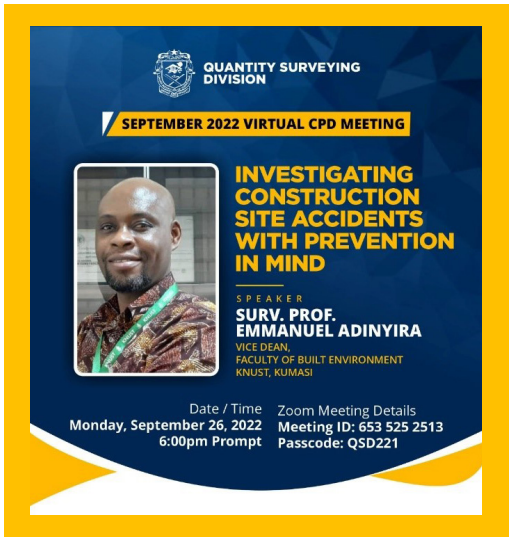
AUGUST 2022

Price Adjustment Formula with Attention to the Road Sector

By: **Abdul-Rahman Nasiru** (MGhIS)
Chief QS, Ghana Highways Authority

Highlights

This presentation outlined the two common approaches used in deriving price fluctuation weightings for civil engineering works and highlight the difference between the two methods.



SEPTEMBER 2022

Investigating Construction Site Accidents with Prevention in Mind

By: **Surv. Prof. Emmanuel Adinyira** (MGhIS)
Senior Lecturer, KNUST, Kumasi

The cost of construction site accidents is high in people, productivity, and profit. The Factories , Offices and Shops Act 1970 and the Labour Act, 2003 (Act 651) both require organizations to report workplace accidents and dangerous occurrences and to take steps to prevent accidents and injuries to their workers. Accident investigations or analyses are conducted with prevention in mind hence, is a direct response to these requirements. This presentation sought to do just that and also aims at simulating further discussions around the issue of accidents on our projects.

QSD Retreat

2022 GHIS Examination

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GHANA INSTITUTION OF SURVEYORS

2022 QUANTITY SURVEYORS ANNUAL SEMINAR

Theme

Sustainability - The Impact on the Quantity Surveyor's World

Format Hybrid of Virtual and In-Person

Venue: Auditorium, University of Ghana Law School, Legon, Accra

Date: 19th - 21st October 2022

Time: **2:00pm - 5:00pm** Each Day

In Person		Virtual	
GHS 350.00 Members & Non-members	**GHS 100.00** Trainees & Students	**GHS 200.00** Members & Non-members	**GHS 50.00** Trainees & Students

Registration Details to be circulated shortly

2022 Quantity Surveyors Annual Seminar

2022 Quantity Surveyors Annual Seminar