

ABSTRACTS

Technology the Future for Housing

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Abstract

As the world population grows, the need for decent and affordable housing increases in the same proportion and this calls for innovation and technology for mass production of houses. The Government has embarked on provision of affordable housing under the “Big 4 Agenda” and in line with Article 43 of the Constitution that guarantees the right to adequate housing and reasonable standards of sanitation to the citizens. National Housing Corporation (NHC) is the Government Agency mandated to implement Government housing policies and programmes. Since its inception, NHC has developed approximately 60,000 housing units across the country through completed houses, starter units, site and service schemes, and disbursement of rural and peri-urban housing loans. In 2013, NHC set up a Factory in Mlolongo, Mavoko County that manufactures EPS panels and associated accessories for mass production of houses. EPS panels have unique properties and features that include: sound proofing, heat proofing, ease of installation and superior strength-to-weight ratio. The Factory produces single and double wall panels, floor panels of various thicknesses and galvanized high strength steel wire mesh. Engineers are encouraged to embrace emerging technologies for mass production of houses. NHC looks forward to working with IEK and EBK to this end.

Keywords: housing, technology, EPS panels

Sub-Theme 1: **Engineering the Sustainable Development Goals (SDGs)**

Paper 1: Session 1(S1) – 1.1

PROCESS MODELING OF A MEDICAL VENTILATOR USING CYBER-PHYSICAL SYSTEMS

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Abstract

Recent innovations in the medical ventilator development have begun to radically change traditional engineering practices towards Cyber-Physical Systems (CPS). Early this year, public and private hospitals procured a number of medical ventilators from various manufacturers as one the responses to COVID-19 pandemic. A core challenge associated with medical ventilators procured is maintenance and troubleshooting of the control systems due the gap between technologies used by the manufacturers. Currently the cost of maintaining a standard intensive care unit (ICU) ventilator skyrocketed with over 200% leading unsuccessful fight against COVID-

19 and other acute respiratory diseases (ARDs). Virtual Reality (VR) may contribute to this endeavor, since this technology is inherently suitable to visualize medical ventilator and allows intuitive user interactions within a highly immersive virtual environment. In one hand this paper presents a low cost physical medical ventilator (MV001-2020) that delivers breaths in real time via controlled proportional pressure and flow regulator valves driven by a Programmable Logic Controller (Siemens PLC S71214DC/DC/DC). On the other hand, a virtual model of the medical ventilator that monitor and control clinical parameters such as tidal volume, Oxygen-Air-mixture (FiO₂), Frequency /breaths per minute (bpm), Inhalation/Exhalation(I/E) ratio. Alarms are set via a user-friendly cyber and physical touch screen Human Machine Interface (HMI) based on SIMATIC HMI (KTP700) display. The ventilator features two control modes: Volume controllers (VC-CMV) and pressure controlled (PV-CMV). Through the prototype, the following parameters were successfully set and tested: tidal volume of 200~800mmHg at ± 50 steps increment, bpm of 10~30 at ± 2 values increment, flow rate of 4~50l/min, FiO₂ of 21~100% and a peak pressure of 60 cmH₂O.

Keywords: Cyber-Physical Systems, Virtual Reality, Medical Ventilator, Programmable Logic Controller, Human Machine Interface

Paper 2: Session 1(S1) – 1.2

Pump Stations: Dealing with the Non-Revenue Power in Water

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Abstract

No water utility operates a self-sustaining business in Africa. This is due to many factors like high non-revenue water, incompetence, high energy bills and poor choice of equipment. While Non-Revenue Water Projects have received a lot of attention and rightly so, energy audit has not. The life cycle cost of a pump consists of 20% and 80% capital and operational costs, respectively. Operational and maintenance costs can be divided as staff, parts, and energy. In rational environment little can be done to reduce staff and parts costs, but energy can be managed by installing high efficiency equipment. Unfortunately, Africa happens to have the highest energy charges in the world making the situation worse. Towards this end scientists and engineers have come up with many solutions including solar power plants, power factor correction capacitors, better pump designs, soft starters, variable frequency drives, permanent magnet motors, IEE motor classification. These are aimed at delivering more reliable, cost effective, highly efficient, and longer lasting equipment. Despite the progress practitioners, to date grapple with challenges such as diversity of the field, high energy costs, outdated technology, poor understanding of equipment, inexperience, language barriers, corruption, and poor knowledge of Contract Management. This paper explores the various scenarios that can be employed to address the energy challenge in the water and sewage pumping industry.

Keywords: Efficiency, Life Cycle Cost, Energy Audit

Paper 3: Session 1(S1) – 1.3

Design of Durable Concrete Mixes for Reinforced Concrete Structures

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Abstract

In the construction industry, there are growing concerns with the use of concrete due to: i) its carbon footprint arising from the high CO₂ emissions during the production of clinker, the main constituent of cement, and, ii) lack of durability of reinforced concrete (RC) structures resulting in costly repairs and rehabilitation. Various approaches of reducing emissions from clinker production have been implemented by cement manufacturers. A further approach proposed for reducing this carbon footprint is a reduction of clinker (effectively cement) content in concrete. The reduction of clinker content, however, is not readily feasible in most design standards as a minimum cement content is required for durability. This prescriptive approach has several limitations which has resulted in a shifted to a performance-based approach where both the compressive strength and durability are determined. This paper is based on an ongoing study that proposes such a shift from the prescriptive approach in Kenya. An overview is given on the data collection stage that involved the use of a research questionnaire with an aim of determining design approach for durability. The respondents were various parties involved in design and construction of RC structures. General observations revealed that majority of the respondents were concerned about the lack of durability of RC structures. This was mainly attributed to poor workmanship.

Keywords: sustainability, reinforced concrete (RC), durability, performance-based approach, interviews, specifications

Paper 4: Session 2(S1) – 2.1

Paradigm Shift in Linking Engineering with the Roots; Engineering the Food Security Agenda

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Abstract

The Government development blueprints, the Big Four Agenda and Vision 2030 seek to catapult development through food security amongst others. Realization of the food security agenda has been hampered by a number of factors including; inadequate funding for irrigation developmental projects, the threats of famine and drought occasioned by climatic changes leading to failed rainfed agriculture, runaway corruption where funds earmarked for irrigation related projects are diverted or just embezzled, and shifting food habits from traditional staple foods. The growth of a strong environmental and public good lobby group has also made the planning and execution of large projects an Engineers nightmare. Cognizant of the need for a paradigm shift, the Agricultural Sector Transformation and Growth Strategy, 2018-2028 aims to move “Towards Sustainable Agricultural Transformation and Food Security in Kenya. Two recent interventions to demonstrate this shift in policy thinking are the; “one million Home/Kitchen Garden Project” and the World Bank funded Small Irrigation value addition project (SIVAP). The need for secure food systems has been magnified by the Covid19 pandemic which left families poorly exposed to vagaries of hunger due to disruption of market and transport systems. In order to be in tandem with the foregoing, it’s imperative that engineers rethink their approach to application of engineering principles from large scale high impact almost guaranteed to fail projects to small, time tested undertakings which have a much higher chance of success, are easily up scalable and cost effective.

Keywords: Food security, sustainable, technology, youth

Paper 5: Session 2(S1) – 2.2

Underground Spaces Construction Technology and its Impact Post COVID-19 Pandemic in Kenya

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Abstract

Underground spaces and other subsurface infrastructure like shopping malls, sewer lines and nuclear waste storage repositories are becoming increasingly important for society’s development. Recently, many cities and towns in Kenya and around the world are being overrun spatially by rapid urban population growth, booming metropolises, scarcity of urban land, environmental awareness, as well as an increase in specific needs for protection, storage, security, and sheltering, have all contributed to the use and development of underground spaces population growth and the movement of the people from rural to urban areas has resulted in significant demands for growth in city infrastructures, especially in megacities throughout the world. Such growth can only be supported by the efficient use of underground space. This paper explores the impacts of underground infrastructure on social, environmental and economic in Kenya in relation to COVID-19 pandemic. Two case studies will be evaluated in this paper to demonstrate the impacts gained so far.

Keywords: Subsurface infrastructure, COVID-19 pandemic, impacts gained

Paper 6: Session 2(S1) – 2.3

Role of Nuclear Energy in Combating Climate Change

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Abstract

Climate Change has become a subject of national, regional and international discussion. The effects are being felt currently. The Energy Sector has had a role in contributing to Climate Change in the whole world. The complementary role of Nuclear energy, hydropower and renewables is key in ensuring a low carbon economy by 2050. It is stated that between the periods 1970-2013, this combination has helped in avoiding the emissions of about 163 Gt of CO₂ emissions in total. Hydropower accounted for 53% (87Gt CO₂) and Nuclear Power contributed 41% (66 Gt CO₂) and other renewables saved 6 % (10Gt CO₂). Nuclear power has been considered to have the potential to meet the climate change challenge by providing electricity for domestic and for industrial processes, generated with almost zero greenhouse gas emissions. The potential role for Nuclear has also been cited in the Intergovernmental Panel on Climate Change (IPCC) Special Report on global warming of 1.5 °C. This paper will enumerate the importance and role of Nuclear Energy in meeting the climate change goal in the country and world over.

Key Words: Nuclear Energy, Climate Change, Green House Gasses



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VIRTUAL MACHINES CONTROL

A core challenge of research associated with Industry 4.0 and CPS is to bridge the gap between the physical and digital world. Virtual Reality (VR) may contribute to this endeavor, since this technology is inherently suitable to visualize digital contents and allows intuitive user interactions within a highly immersive virtual environment.

The most important features of CPS are the high degree of (partial) autonomy, network communication, the ability to personalize it and general user-friendliness.

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Sub-Theme 2: **Big four Agenda and Vision 2030**

Paper 7: Session 3(S1) – 3.1

Applicability of Public Private Partnerships in Development of Low-cost Housing to Meet Kenya Vision 2030 and Related Goals

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Abstract

Article 43 1 (b) of the constitution of Kenya, vision 2030, big four agenda and international conventions, like Sustainable Development Goals and the New Urban Agenda, obligates the government to provide adequate, accessible, decent and quality housing for citizens. The country has sought the application of the best strategies to address this requirement, especially low cost housing, because the current demand for housing stands at 250,000 units per year, while supply remains at 50,000 units p.a, hence deficit of 200,000. Application of Public Private Partnerships (PPPs) has emerged as one of the most plausible option. This study utilized three rounds of Delphi method to gauge the prospects of providing low cost housing through application of PPPs. 88 respondents of housing practitioners, financiers and developers were used, where it was found out that there are high prospects for applying PPPs in housing delivery. It was concluded that PPPs are applicable in the provision of low cost urban housing, and as such the country should embrace its application.

Keywords: Public Private Partnerships, low cost housing, Delphi method.

Paper 8: Session 3(S1) – 3.2

KenGen CSR Project to Expand Naivasha Hospital during the Covid-19 Pandemic by Construction of an Outpatient Departmental Complex.

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Abstract

Naivasha hospital receives about 600 outpatients daily from Nakuru and the surrounding counties. This number is projected to increase to 2,000 by 2030 due to existing developments and the planned infrastructure projects in the area. There is no dedicated outpatients' facility. The objective of this project is to expand and modernize the Naivasha public hospital to cater for the current and future outpatient services. KenGen being a major investor at Naivasha in the Olkaria Geothermal Complex, offered KES 300 Million as Corporate Social Responsibility and assist in executing this project. This was announced by the President of Kenya on 14/12/2018 while officiating a geothermal power project at Olkaria. The County Government was to design the required hospital buildings and provide the balance of funds while the National Ministry of Health would provide medical equipment. Tendering for the project was conducted and awarded through national competitive process for citizen contractors. Construction commenced on 14/4/2020, despite the prevailing Covid-19 pandemic. Management of Covid-19 is a major concern at the construction site, but sufficient control measures have been engaged. Construction has progressed well ahead of schedule. All super structural work and walling is complete in readiness for roofing.

Keywords: Big four agenda, health Care, KenGen CSR, Naivasha hospital, Out-Patient Departmental Block,

Paper 9: Session 3(S1) – 3.3

Post-COVID Economic recovery: Rethinking Kenya's road infrastructure development model

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Abstract

Infrastructure comprises public facilities in a nation, including roads, railways, national buildings and power lines. Good infrastructure raises productivity and lowers the cost of doing business (OECD, 2002). Poor infrastructure impedes a nation's economic growth and international competitiveness. In Kenya, only 58% of the citizens have access to basic drinking water, 30% have access to basic sanitation while 25% do not access to electricity and 30% are not served by an all-weather road. Under Kenya's development plan, Vision 2030, infrastructure is identified as an enabler for Kenya's economic development. However, COVID-19 pandemic has hit Kenya's economy hard disrupting its recent broad-based growth path. Real gross domestic product (GDP) is projected to decline from an annual average of 5.7% (2015 – 2019) to 1.5%- in 2020 (World Bank, 2020). Since over 90% of Kenya's passenger and goods are transported by road, this sector is critical to the post COVID economic recovery strategy. This paper will examine the policy and institutional framework for roads infrastructure development and management over the last decade, analyse the basic objectives of roads policies and assess the effectiveness of ongoing road programs in delivering Vision 2030 goals. The paper will discuss what kind of road infrastructure is necessary, where it is best suited, and who is to benefit from it in post COVID era.

Keywords: Road infrastructure, Vision 2030, post COVID-19

Sub-Theme 7: **Climate Change Resilience**

Paper 10: Session 4(S1) – 4.1

Are Rainfall Intensities Changing, Could it be Climate Change and what could be the Impact on Engineering Hydrologic Design and Structures?

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Abstract

Climate change is a contentious topic. There is evidence of climatic shifts globally. The change in climate over time is natural and expected. However, industrialization during the past century may have influenced variations exceeding natural cyclic change. This paper presents findings on research done to determine if there has been a significant change in intensity and amount of rainfall received in Eldoret town occasioned by recent flooding and to stimulate further research. Engineers have a duty in the determination of peak storm discharge for sizing of hydrologic structures for safe conveyance of discharge. Hydrologic design use either empirical or deterministic methods based on historical data. Based on the recent weather patterns, the question is whether the historical data can still be used as a basis for providing accurate possible future events for hydrologic design. Different analytical methods were formulated to investigate different rainfall indices for 50 years using data from Eldoret Meteorological Station. Results are indicative of decreasing but more intense rainfall events with variations exceeding natural climatic cycles previously experienced. Could this be climate change? Despite the localized nature of this research, it is indicative of the global change in rainfall trends being experienced.

Keywords: Climate change, rainfall events, intensity, hydrologic design.

Paper 11: Session 4(S1) – 4.2

Climate Resilience for Hydro Power Projects at Project Development Stage

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Abstract

One predominant sector which has been cited in the Seventh National Development Plan launched in 2017 by the Zambian government, is the energy sector. This is also in line with the Sustainable Development Goal No.7 regarding infrastructure expansion and the provision of clean energy. Hydropower projects despite being a renewable energy source, it is site-specific which require huge investment and have long gestation periods. These characteristics expose hydropower projects to various uncertainties and risks such as economic, environmental, social, geological, regulatory, political, technological, financial, natural, and safety. The environmental risk is so predominant in this energy sector if not appropriately managed, there is the potential of project failures. One of the risk factors of the environment is climate change. Sustainability has also become a critical and unavoidable issue in hydropower development due to climate change risks. Sustainable development is related to techno-economic development along with preserving the environment. To mitigate this climate change risk, there is a need for a comprehensive and well-designed Risk Management Framework/Model (RMF/RMM) to effectively manage the climate change risks and many others at the project development stage. This is a critical stage as when risk mitigation measures are well managed during feasibility, planning, and procurement, it enables minimization or elimination of these risks impacts on hydropower projects on other project life cycle. Hydropower projects risk planning with the integration of climate-resilient perspective it enhances the designing of infrastructure that has capabilities to resist climate change.

Keywords: Risks, Hydropower, Climate Change, Framework, Model, Impact

Sub-Theme 4: **Development of National, County and Regional value chains**

Paper 12: Session 4(S1) – 4.3

Formulation of Sustainable Road Maintenance Policies in Counties: A Study of Bomet County

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Abstract

The 2016 Road Classification register has a total of 161,451.5 Km of classified roads in the country. Out of which 121,456.4 (75.2%) Km are classified as class D and below. These roads, together with all unclassified roads fall under the jurisdiction of County Governments. They form the majority of the road network within the country. Yet the counties get only 15% of the total budget for road maintenance. This paper seeks to evaluate and understand the measures taken by County Governments in ensuring sustainable maintenance of their large road networks. All while keeping up with the economic and political demand to increase rural access index with a very small budget. Bomet County is formulating a road maintenance policy and will be used as a case study for the paper. Bomet County has a total road network of 7573.8Km both classified and unclassified. The National Road Agencies manage 534 Km while the County Government of Bomet has in its jurisdiction the rest of the road network a total of 7,039.8Km. The paper will explore; the best practices like the incorporation of the Roads 2000 Strategy in order to reduce cost, increase efficiency and include the community especially the youth, women and people living with disabilities in road maintenance, the challenges that may face the county while trying to implement the policy and process through which the county plans to implement sustainable road maintenance projects, ensuring the inclusivity of the community. The source of data will be from the County Government of Bomet department of Roads, Kenya Rural Roads Authority (Bomet Region), Kenya Roads Board (KRB), secondary data from various public and private institutions and reviews from stakeholders.

Keywords: Road Maintenance, Road Classification, Bomet County, Roads 2000 Strategy, Policy.

Paper 13: Session 4(S1) – 4.4

Integrity: A Tool for Competitive Advantage for Engineers in Post Pandemic

Joel Alfred Mwendwa

Abstract

Since the first case of COVID-19 was reported in Kenya, the effects of the pandemic have been felt by and large. Businesses have closed down as many investors pull out of the markets which continued to exhibit poor and unpromising trends. The engineering sector has not spared by the pandemic either. Since the pandemic hit the country, the government cushioned spending so as to consolidate funds to address the pandemic. This resulted to projects stalling due to nonpayment of certificates while other projects that had been planned to be undertaken having to be cancelled. Arising from the effects of the pandemic, the government and private sector are both looking for a comeback to resume operations (the new normal). As the government puts in place measures to revive the economy, engineers will be key and must play key role as creators to ensure that key steps and milestones are covered within reasonable time plans. As this happens, it's envisaged that businesses and individuals will try as much as possible to normalize and recover economically within the shortest time possible. We all expect the war on graft on the other hand to be hyped more than before. This desire to quickly make margins may see engineers being on the wrong side of the law and eventually face criminal prosecution over corruption related allegations. The built environment is key to the economic growth of any nation but is also subject to complex web of corrupt activities which lowers the expected growth in the economy. This paper seeks to address the role of professionals in the built environment in tackling graft in post COVID-19 pandemic.

Keywords: built environment, engineering sector, pandemic

Paper 14: Session 5(S1) – 5.1

Role of Big Four Agenda and Vision 2030 for Kenya's Sustainable Development

Eng. Peter Mutinda

Abstract

Kenya, like all other developing countries in the world, is faced with the task of working strategically towards the achievement of the United Nation's Sustainable Development Goals (SDGs). These goals whose due date of accomplishment coincides with those of the national development blueprint, namely, the Kenya Vision 2030, have become a major focus of attention in the country. There are great areas of concern or priority areas that the country is focusing on as a strategic focus towards the achievement of the Kenya Vision 2030 and SDGs 2030. These strategic areas of focus have been isolated and declared, as the country's "Big Four priority areas". The Kenya Vision 2030 comprises of three key pillars; Economic, Social and Political. Foundations for the three pillars consist of Infrastructure; Information and Communications Technology (ICT); Science, Technology and Innovation (STI); Land Reforms; Public Sector Reforms; Labour and Employment; National Values and Ethics; Ending Drought Emergencies (EDE); Security; Peace Building and Conflict Resolution. The "Big Four" Agenda is the Government's set of priority programs and reforms, which will be implemented over a period of five years, that is, from 2018 to 2022. The Big Four include; food security, affordable housing, manufacturing and affordable healthcare for all. This Big Four Agenda was integrated into the Third Medium Term Plan of Kenya's long-term development blueprint – the Kenya Vision 2030. The MTP III is expected to consolidate the significant achievements of the Economic Transformation Agenda that has been implemented since 2008 under Vision 2030. The goal of the Kenya Vision 2030 is to create a globally competitive and prosperous country with a high quality of life by 2030. The Budget Policy Statement (BPS) published by the National Treasury noted that the National Treasury issued guidelines directing Ministries, Departments and Agencies (MDAs) to prioritize public investments geared to the realization of The Big Four Plan and that these are the Government priorities aligned to the MTP III of the Vision 2030. Delivery of the Big Four Agenda requires the input of engineers and other key stake holders (partners from different sectors) to work in a collaborated way. The paper aims at highlighting the goals of implementation of the Big Four Agenda, the role of engineers and other key players critical in achievement of the Big Four Agenda and the interventions needed for achievement of Big Four Agenda. Secondary data was obtained for the paper. Findings of the paper show that little progress has been achieved with regards to implementation of the Big Four Development Agenda. This has been attributed to low resource allocation, inadequate planning for execution of the projects, shifted focus towards dealing with effects of COVID-19 Pandemic where significant financial resources have been directed for the exercise, among others. Since the Big Four Agenda forms part of Vision 2030, the paper gives more focus on this area.

Keywords: Sustainable Development Goals, Big Four Development Agenda, COVID-19 Pandemic

Paper 15: Session 5(S1) – 5.2

Plant Commissioning Post Covid-19; Remote Commissioning

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Abstract

The Covid-19 pandemic brought challenges worldwide; industries were looking at delayed commissioning and running of new plants or delayed repairs particularly where specialized personnel were required from manufacturers. With the travel bans and curfews, companies had to look for alternative ways to ensure that production of essential goods and services was not only maintained but increased and enhanced. Is it possible to fully commission a plant remotely? This paper gives a practical experience of remote commissioning of an industrial plant. Several steps need to be followed; the basic assumption is that the plant has been built as per the manufacturer specifications and drawings. First, there is pre-commissioning checklist; the plant owner sends photos and/ or videos to the manufacturer as proof that the plant is built as designed. After review and an approval, the next step is the testing. This heavily relies on cameras (linked to zoom for visual) and WhatsApp or any other communication platform. The SCADA/PLC should be accessible through Any desk or TeamViewer or similar platforms. This facilitates testing and actual commissioning of the plant. To the plant owner the main benefit is that the team on the ground gains experience to run the plant as they encounter and solve challenges in real-time. The manufacturer's team benefits from simultaneously viewing different sides of the machine using the cameras. With this successful commissioning, it will be difficult to justify accommodation and flight costs for Commissioning Engineers.

Keywords: Remote Commissioning; Covid-19; SCADA/PLC

Paper 16: Session 5(S1) – 5.3

Mobile GIS based Traffic Count using AR-Traffic Count.

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Abstract

Traffic Data Collection plays a fundamental role in the planning of road development and management schemes, which rely heavily on existing traffic data such as average daily traffic, traffic flow patterns and economic traffic forecasting, to inform planning decisions. Traffic Data Collection can be carried using different platforms from Artificial Intelligence systems to the manual paper-based counting. Most developing countries use the inefficient manual paper-based counting method which involves a tedious process of manually collecting and then entering of the data into a database or spreadsheet. It was therefore noted that improvements needed to be made to the current process used in developing countries, and a cost-effective, user-friendly alternative to manual paper-based collection needed to be offered. Supportive research trends show that mobile applications are readily available to end-users due to an exponential increase of the use of smartphones since 2008. There are currently more than 3 billion Smartphones in use in the world, with almost 45% of population owning one. AR-Traffic Count, a mobile application, was developed to offer a solution to the inefficient, time-consuming, and error-prone manual paper-based method of Traffic Data Collection, recognizing the potential for the use of a mobile application in this area. The application allows traffic data to be collected in person and recorded directly into a mobile device, rather than on paper, thereby negating the need for the data to be typed up, or the location to be identified, since it can be automatically georeferenced (using GPS) and easily shared and exported to excel. AR-Traffic Count is a cost-effective proprietary mobile application which has the ability to work in offline mode, with internet connection required only during the sharing of the report. It allows for real-time traffic data collection on the road with increased accuracy, with the ability to undertake a classified vehicle count at the press of a button on your mobile phone.

Keywords: Traffic Data, AR-Traffic Count, Data Collection, Mobile Application, Planning.

Paper 17: Session 5(S1) – 5.4

The Potential Application of Solar Thermal Powered Adsorption Chillers for Cooling Buildings in Nairobi County-Kenya

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Abstract

One of the pillars of the 'Big Four Agenda', for the current government in Kenya is provision of sustainable and affordable housing, through which over 500,000 units are set to be constructed by 2022. Nairobi county with its high population, would host most of the houses. The houses would need some form of cooling to make them habitable during periods characterized by high temperatures. This study sought to determine the viability of using solar thermal run adsorption chillers to cool residential unit buildings in Nairobi. The study first developed an Excel mathematical model to compute the solar thermal heating potential per square meter for Flat Plate collectors (FPC). Next, the cooling load of standard 3-bedroom house in Nairobi was determined, assuming a Coefficient of Performance of 0.3, as well as the size of FPC needed to heat water for running the adsorption system to meet the cooling demand. The results found that 32m² of FPC's would be needed to provide a cooling load of 6.25 KW for a standard 3-bedroom house in Nairobi. The high initial investment cost is offset by low running and maintenance cost for adsorption systems.

Keywords: Flat Plate Collectors, solar thermal systems, adsorption chillers, adsorption cooling, adsorption systems

Sub-Theme 5: **4th Industrial Revolution and Industry 4.0**

Paper 18: Session 1(S2) – 1.1

Industry 4.0 and Potential Opportunities

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Abstract

Industry 4.0 involves a set of technological changes in manufacturing and sets out priorities of a coherent policy framework. The framework provides a comprehensive end-to-end approach to transformation initiatives. Generally, Industry 4.0 refers to the means of automation and data exchange in manufacturing technologies including Cyber-Physical Systems, Internet of Things, big data and analytics, augmented reality, additive manufacturing, simulation, horizontal and vertical system integration, autonomous robots as well as cloud computing. Other definitions look at Industry 4.0 as utilizing the power of communications technology and innovative inventions to boost the development of the manufacturing industry. Industry 4.0 concepts apply across various other industries besides manufacturing and promise great transformation and disruption as well. This paper will seek to further define Industry 4.0 and impact of its adoption. A further look at industry 4.0 main themes based on the foundation provided will be explored to help bring the subject in the context of direct application.

Keywords: Cyber-Physical, Big Data, Smart, Cloud Computing

Paper 19: Session 1(S2) – 1.2

Exploring the Applicability and Challenges of Implementing Industry 4.0 Technologies in the Small and Medium Sized Industries in Kenya

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Abstract

Industry 4.0 is a critical and indispensable aspect of modern manufacturing. Broadly, it entails the integration of Cyber-Physical Systems (CPS) and the Internet of Things (IoT) with traditional manufacturing units to yield smart factories. Key benefits include increased automation, flexibility and customisation; vertical and horizontal integration of manufacturing units; effective management of supply and distribution chain; manufacture of smart products with high quality; reduced lead times; better interoperability between design and manufacturing as well as effective decision making through artificial intelligence and big data analysis. The Micro Small and Medium-sized Enterprises (SMEs) provide 80% of employment to Kenyans and account for 98% of all businesses. The transition to industry

4.0 will have a significant impact on them. Using qualitative data analysis, key aspects and challenges of SMEs were analysed with regards to industry 4.0. The results indicate that SMEs lack knowledge, autonomous machines, capital, and information technology facilities. While SMEs may not fully realise the benefits CPS soon; phased implementation is beneficial in the short run and acts as an incentive to further developments. A vendor-based model such that a vendor provide industry 4.0 services to SMEs at a fee is proposed and analysed.

Keywords: Industry 4.0, Small Medium Enterprises, Cyber Physical System, Internet of things, Smart Manufacturing, Robotic, Flexible Manufacturing Systems

Paper 20: Session 1(S2) – 1.3

Implementation of Drone Technology in the Kenyan Construction Industry

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Abstract

The world is constantly evolving, creating a need for more efficient, safe and timely technologies. The increase in the number of construction-related injuries and fatalities in Kenya prompts the construction industry to look into more efficient and safe technologies for conducting time-consuming activities such as survey, mapping and quality assurance and control. High-rise structures, for instance, require regular inspection which can be costly in terms of the safety of the workers and time. This paper aims to replace visual inspection of high-rise buildings with the use of basic drones to ensure the safety of the workers and efficient data collection. This will be done by using Unmanned Aerial Vehicles (UAV) equipped with Drone Deploy software to collect real-time construction data. The data collected will then be used to generate 2D plans and 3D models of the building that can then be shared with the involved stakeholders for analysis and inspection. The construction industry is rapidly booming and adapting drone technology prospects manifold growth. The use of drone technology in construction shares countless advantages. If implemented, this would be a stepping stone for the construction industry as it is still lagging behind when it comes to adopting new technologies.

Keywords: Drone technology, Unmanned Aerial Vehicles, Drone Deploy Software, REVIT, 3D maps and models

Sub-Theme 3: **Smart cities and intelligent infrastructure**

Paper 21: Session 2(S2) – 2.1

Intelligent Transportation Systems Infrastructure gap in Nairobi City

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Abstract

Kenya has witnessed an expansion in its transportation infrastructure. Within Nairobi city, commuter rail service has been refurbished and plans are underway to increase its connectivity. The urban road network has improved and introduction of bus rapid transit (BRT) system is underway. This has necessitated the use of information technology to ensure optimal and efficient utilization of the transportation infrastructure. The Kenyan government for instance has deployed electronic traffic control on certain intersections in order to improve performance and safety. The information technology infrastructure has however been rolled out on a case by case basis and is not being built to fit a master plan that would expand to meet future needs. This paper uses comparative indicators from government and private agencies' documentation to establish current status of ITS infrastructure capacity and opportunities for improvement. This paper further presents the findings on the gap between the necessary and available qualified personnel, data server resources, control centers, software solutions, communication bandwidth and network necessary for full ITS implementation. The conclusions and recommendations of this paper address steps that can be taken to establish a foundation for the needed infrastructure for ITS with specific consideration to cost effectiveness, efficiency and data security.

Keywords: Intelligent systems, Internet of Things (IoT), Artificial Intelligence, Smart Cities, Connected Infrastructure

Paper 22: Session 2(S2) – 2.2

Machine Learning Use Cases in Electricity Distribution

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Abstract

The electricity distribution sector in Kenya has witnessed exponential growth over the last decade. The growth is underpinned by the Kenya National Electricity Strategy, which seeks to achieve universal access to electricity by 2022. The increased grid intensification has placed increasing demands on power system reliability, quality and efficiency. In addition, the increased penetration of distributed generation and regional interchanges, have given rise to the need for improvements in power system planning, operation and control. Consequently, there are rapid advances in adoption of information and communication technologies. Some of these include: advanced metering infrastructure, distribution and asset condition monitoring sensors. The proliferation of these technologies has led to the rapid generation of vast amounts of variable energy data. To unleash the full value of this data, there is immense potential for the application of big data and machine learning techniques in electricity distribution. This paper not only offers an overview of these tools, but also presents sample use cases and proposed use cases. Further, it presents overview of technical challenges, change readiness and risks of adoption of these tools.

Keywords: machine learning, big data, data streaming

Paper 23: Session 2(S2) – 2.3

Intelligent Infrastructure Integration for Smart Cities

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Abstract

Demand many times drives supply, and the Kenyan market largely operates under that principle. However, this is not always a good thing, especially in the case of housing, energy, transport as well as communication infrastructures. Whereas the telecommunication service providers have taken great strides to ensure there is sufficient bandwidth even for a projected spike in demand for the coming years, the transport counterparts are just starting to wake up and slowly catching up. This is a very healthy direction we are taking, but it is not sufficient if we desire to develop smart infrastructure. Most entities in the private environment are already smart, from smart phones, televisions, lighting among others, but what does it take to make the public spaces smart as well? Is it too late for integrated infrastructure development models? This paper explores the benefits of having an integrated infrastructure development model, and also proposes ways in which we can work as a country to achieve the integrated systems. The future of humanity is one where we are surrounded by man-made features that are able to adopt to the humans' behaviour and trends, not only limited forcing humans to adopt to how the features are built. It is the role of engineers to smarten our public spaces and crystallise this future.

Keywords: Integrated, Infrastructure, Smart

Paper 24: Session 3(S2) – 3.1

A Survey of Engineers' and Engineering Students' Perceptions on Ethical Behavior

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Abstract

The engineering industry is known for its low ethical performance. Professional ethics instruction in Kenyan engineering faculties is commonly conducted by examining case studies in light of the code of ethics and conduct for engineers. Although the tenets of a code of ethics may leave a lasting impression, students generally gain their professional identity from relatives, colleagues, and practicing engineers. Their engineering professional ethics tend to be mostly an extension of their personal ethics. Instruction on ethics during training generally serves only to reinforce students' inclination to act ethically and encourages them to act on these beliefs. This study based on survey on engineering ethics adopted moral awareness which is one of the Rest's model four processes. The survey was conducted (n = 164) to examine the personal ethical perceptions of engineering students (n = 120, consisting of n = 79 for 1st year and n = 41 for 5th year) and practicing engineers (n = 44). The survey consisted of 16 acts that challenged respondents by examining their personal ethical beliefs in light of the professional ethics requirements of the Engineering Board of Kenya (EBK) code. The survey measured how respondents perceive their own ethical beliefs and how they perceive the ethical beliefs and actions of their peers. After familiarization with the EBK code, respondents were also invited to comment regarding their beliefs regarding adherence to the code. Results indicate that, although generally, engineers and engineering students sampled agreed that the acts listed down were unethical, several items raised concern. In particular, the item concerning "continuous professional development" was rated as one of the least unethical behaviors. This result points strongly to the need to further reinforce the need for relevant lifelong learning for engineers both during training and practice. Also, results indicated that there is evidence of self-versus-other disparity. For six unethical acts for students and four acts for engineers, in the surveyed list, the means of data for self and colleague perceptions were statistically significantly different at the alpha level of 0.05. When the act was perceived as more unethical, both engineers and students tended to rate themselves more ethical compared to their peers. Action research through mentorship is recommended as part of the solution to addressing ethical issues in engineering practice.

Keywords: identity, ethics, engineering practice, perceptions, student, professional, development

Paper 25: Session 3(S2) – 3.2

Academia & Practice: Retrofitting Columns with CFRP

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Abstract

This research investigated the effect of Carbon Fibre Reinforced Polymer (CFRP) strengthening on the axial capacity and ductility of non-slender square concrete columns. There was a problem of buildings collapsing in Kenya. Retrofitting of the buildings vulnerable to collapse was of great importance to ensure the safety of the occupants and to address the housing deficit in the country. An experimental research programme was conducted on 90 non-slender square concrete columns to find out the gain in axial capacity and ductility of the columns strengthened by CFRP. The specimens (150mm x 150mm x 350mm) were made of plain and reinforced concrete. Three different concrete grades: C8/10, C12/15 and C16/20 were used. The specimen had varying configurations of CFRP wrap: partial and full confinement in one and two layers. Four parameters were investigated in this study: concrete grade, steel reinforcement, degree of confinement and the number of layers of CFRP wrap. The specimens were subjected to uniaxial compression up to failure, and the stress-strain curves were plotted. This study found that weaker concrete grades experienced the highest effect due to CFRP strengthening. Presence of reinforcement had a significant effect on the axial capacity and ductility of columns without CFRP strengthening. On the contrary, the presence of steel reinforcement reduced the effectiveness of CFRP strengthening. Partial CFRP confinement offered better material efficiency as compared to full CFRP confinement, and the number of layers had a direct relationship with the increase in strength and ductility

Keywords: Carbon Fibre Reinforced Polymer Wrap, Non-slender columns, retrofitting, axial capacity, ductility, CFRP, confinement, square concrete columns

Paper 26: Session 3(S2) – 3.3

Influence of Public Private Partnership on Implementation of Railway Transport Project in Kenya: a Case of Standard Gauge Railway in Nairobi

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Abstract

All over the world, the growing demands for transport infrastructure is on its high and with it comes overstretched and widened fiscal constraints, leading to governments to seek specialized financing cooperation between the public and private sectors, known as Public-Private-Partnership (PPP). The purpose of the study was to investigate the Influence of PPP on the implementation of Railway Transport Project: A case of Standard Gauge Railways (SGR) in Nairobi, Kenya. The study was guided by the following specific objectives: To determine the Influence of PPP's Project Financing, Private Consortium, Contract Models and Risk Transfer on Implementation of railway transport project. The study was grounded on three theories namely: Endogenous Theory, The agency Theory and Game theory. The

study's target population was the staff working at Kenya Railways, SGR Consultant, SGR Contractor and PPP Unit. The sample size for the research study that was 94. The study employed quantitative data collection methodology, with qualitative methods also used to collect data from key informants. Closed ended questionnaires and interview guides were adopted as the data collecting tools. A pilot study was conducted in Naivasha before the main research. Content reliability was tested using Cronbach Alpha and an acceptable level of 0.835 achieved. The quantitative data was coded by Excel Database and Statistical Package for Social Science V.21. Descriptive statistics were analysed by the use of arithmetic means and standard deviation and presented in frequencies and percentages table. Qualitative data was analysed using content analysis and transcribed in sentences to explain the findings. On the aspect of implementation of railway transport project, timely implementation of PPP projects had the highest mean score of 4.416 while PPP projects have poor completion time estimates had the lowest mean score of 3.558, against the composite mean of 3.995. On the theme of project financing, the line statement that PPP projects have unrealistic budget allocation having the highest mean score of 4.363 while PPP projects have poor funds management had the lowest mean score of 3.594 against the composite mean of 3.901. On the theme of private consortium, organization culture scored the highest mean of 4.210 while the line on local private consortium lacks project technical capacity scored the lowest mean of 3.757 against the composite mean of 3.911. On the theme of contract models, contractors' experience scored the highest mean of 4.218 while the line that project contracts are complex scored the lowest mean of 3.716 against the composite mean of 3.885. On the theme of risk transfer, the line of project risk factors scored the highest mean of 4.362 while probability of risks reoccurring in projects scored the lowest mean of 3.739 against the composite mean of 4.195. Study recommendations were made.

Keywords: Contract Models, Implementation, Private Consortium, Project Financing, Public Private Partnership, Risk Transfer, Standard Gauge Railway

Paper 27: Session 4(S2) – 4.1

**Determination and Mapping of the Bearing Capacity of Subsurface Soil:
A Case Study of Moi University, Eldoret Kenya.**

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Abstract

Ground investigation is a prerequisite for any construction work that ultimately transfers its loads to the earth. Geotechnical investigation eliminates the uncertainties of ground conditions and can be planned for and considered accordingly during actual design and construction. In Kenya, ground investigation is not given the weight it deserves since most players in the sector use their experience and physical inspection to judge on the soil conditions. This is however very risky especially for high-rise buildings. Moi University, the case study, is one of the institutions that has in its plan, a series of construction developments. This study aimed at investigating, determining and mapping of index properties and bearing capacity of subsurface soil. Direct shear box and tri-axial tests results were used to map soil bearing capacity by geospatial interpolation within geographical information system platform (GIS). Nine trial pits mapped by triangulation and visual inspection were excavated and soil samples obtained at a depth of up to 3 m. The soil samples were tested for soil index and engineering properties and classified using the USCS approach. A relationship between tri-axial and direct shear box test results was developed by correlating soil bearing capacity results from the two tests. This paper provides a thematic map of the bearing capacity for the study area derived from spatial interpolation. Four geospatial interpolation methods namely; Ordinary Kriging (OK), spline, Natural Neighbour (NN) and IDW were used. In this paper, the most suitable method for interpolating the soil bearing capacity of the four methods is provided. Six of nine sample test results were used for interpolation and the other three used for validation and error correction. Ordinary Kriging generated satisfactory results for soil bearing capacity for the study area with a relative error of 2.23 % and R^2 of 0.9993. From the safe bearing capacity map, the ground conditions of the study area varied gradually with the bearing capacity ranging from t_o . Generally, the amount of clay in the soil within the area affected to a large extent, the soil bearing capacity.

Key words: Soil bearing capacity, Geospatial interpolation, Deterministic interpolation, correlation.

Paper 28: Session 4(S2) – 4.2

Computer Program for Frame Analysis and Design

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Abstract

Commercial software for structural analysis are proprietary (black box) and not user friendly for the learning process. Also, Finite Elements and Design courses are inadequately supported by teaching software. From previous research, an open source beam analysis software was developed using Java. By extending it to handle 2D Frame elements and introducing design to the Eurocodes this paper sought to create a lab facility (program) that can be used at the institutions of higher learning for self or remote study in a post Covid-19 future. Findings of the study indicate that the program's results were consistent with those of hand calculations and commercial software. The resulting program has a simple and straight forward graphical interface for input and output of results. Moreover, being open source allows for extension to other Finite Elements and design to the Eurocodes.

Keywords: Structural Analysis, Beam Design, Computer program, Finite Elements, Eurocodes.

Paper 29: Session 4(S2) – 4.3

Sustainable Infrastructure in Kenya; Effect of local mixing methods on properties of concrete with low water/binder ratio

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Abstract

Construction of infrastructure is a key pillar of Vision 2030 with the most common material of construction being concrete. One of the major causes of flawed structures in the industry is poor concrete preparation methodology. Traditional concrete preparation and particularly mixing practices have numerous shortcomings. The amount of water used in concrete mixing is often reduced to a minimum required to hydrate the cementing paste, which increases its strength and durability. Workability is enhanced by addition of an admixture. Any loss of moisture during mixing can result in incomplete hydration of paste and loss of strength. On the other hand, effectiveness of the mixing method affects the homogeneity of the mix and affect its hardened characteristics such as strength. Loss of moisture and homogeneity of the mix reduces the initial workability increasing plasticizer demand. This paper explores effects of common mixing methods on initial workability and strength of concrete of low water/binder ratio. The effects of a paddle or active mixer and a rotating drum or a passive mixer are also investigated. Results show that concrete mixing, sequence of loading, and type of mixer used all have significant effect on initial workability and strength. In general, lower workability and strength were obtained when a rotating drum mixer was used.

Key words: Mixing methods, Workability, Mixer types

Paper 30: Session 4(S2) – 4.4

The Missing Link for Graduate Engineers: Transferring Academia into a Practical Engineering World.

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Abstract

The greatest challenge facing the current Kenyan Graduate Engineer is converting an engineering degree certificate into a sustainable income generating venture. Covid-19 pandemic has also worsened the situation as many graduates on contract lost their jobs and many more are finding it difficult to get new placements due to operational scaling down of firms. Very few graduates practice the trade after the intensive five-year learning, for various reasons ranging from better offers in other fields such as banking to unemployment on the other extreme. Few engineering graduates who venture into engineering start-ups cite large capital costs, inexperience and restrictive licensing requirements. Most graduates have outstanding education loans and defaults in payment of mobile app loans limiting their access to credit facilities for start-ups. This paper thus engages recent Graduate Engineers to understand their perspective and their experience whilst transitioning to the professional world from universities. This paper also seeks to highlight the evident gaps in Graduate Engineers' employability and industry preparedness, based on their skill set and knowledge acquired from colleges and post training done. It also explores reasons for more graduate engineers opting out of engineering practice to try or pursue other professions. The paper further looks into the current measures in place to encourage graduates to pursue professional engineering and comes up with further actionable resolutions to mitigate the challenges and counter the negative Covid-19 economic impact.

Key words: Graduate engineer, employability, skills and knowledge, engineering practise, university education.

Paper 31: Session 5(S2) – 5.1

Exploring Africa's Readiness for The Fourth Industrial Revolution

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Abstract

The Fourth industrial revolution is a term coined by Klaus Swab the director of world Economic forum where operation and activities revolve around domains, offline interconnectivity or integration of technologies to manage lives (Miller 2015). The COVID 19 pandemic activated a new regime where dormant terms like fumigation, masks, isolation, contact tracing, quarantine and working from home became the order of the day. Infected persons were isolated with an aim of reducing infection rates to flatten the curve. As a result of this pandemic health restriction, people began to innovate technologies to bridge the gaps generated by the restrictions in order to save humanity. We have had automatic washing machines, sanitizing booths using sensor technology, food distribution to isolation words using robots. Statistic became the order of the day where infection rates, deaths and recoveries were monitored real time to try and predict the trends across continents, states and regions. Previous world industrial revolutions were triggered by events similar to the COVID 19 Pandemic. A desire for increased productivity and change of how things were being carried out including war resulted in an industrialization process that has kept increasing from stage to stage. This paper evaluates Africa position in the absorption of previous industrial revolution and explores the opportunities available of deploying and harnessing the benefits in the Fourth industrial revolution. The opportunities include harnessing the benefits of artificial intelligence, integration of different techniques and domains, Robotics, 3D printing, online marketing and distribution of products. Manufacturing outfits and SME are expected to remodel their processes and align to the new environment. This will be possible by growing partnerships for faster transfer of first world technologies and knowledge. GIS will come in handy for data and information management. Academic institutions are also expected to repackage knowledge content to the new emerging world demands.

Keyword's: Forth Industrial Revolution, Artificial Intelligence, Geographic Information Systems, Robotics, Small and Medium Enterprises, Partnerships.

Paper 32: Session 5(S2) – 5.2

Impact of COVID-19 on Industry 4.0 and Implications for Kenyan Manufacturing

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Abstract

The Fourth Industrial Revolution (or Industry 4.0) is a project in the high-tech strategy of the German government that promotes the computerization of traditional industries such as manufacturing. It portends the ongoing automation of traditional manufacturing and industrial practices, using modern smart technology. Large-scale machine-to-machine communication (M2M) and the internet of things (IoT) are integrated for increased automation, improved communication and self-monitoring, and production of smart machines that can analyze and diagnose issues without the need for human intervention. Industry 4.0 technologies were already transforming manufacturers' operations before the COVID-19 pandemic. The proverbial "business as usual" has been forced to consider new ways of working and this has forced the implementation of technology to be fast-tracked in order to digitize the workforce. It has been observed that players utilizing Industry 4.0 are better-positioned to weather the storm, having moved faster and further than their peers during the crisis. However on the flip side adoption is costly and diverging between technology haves and have-nots. The role of Industry 4.0 becomes even more critical in the backdrop of a crisis such as COVID-19. This paper will discuss the major features of a post pandemic future; reimagining manufacturing operations after COVID-19 and the implications for Kenya Manufacturing.

Keywords: Industry 4.0, manufacturing, digitization, policy, COVID

Paper 33: Session 5(S2) – 5.3

Capacitive Sensing Car-Call in Elevators

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Abstract

As you first enter the lobby, you'll notice a bank of elevators clustered together. What you're actually seeing is one set of doors and a call button. When you press that call button, a command is sent to a computer controlling all of the elevators. However, recent research has found that coronavirus can remain infectious on certain metals like stainless steel for up to four days hence the need to reduce touching buttons. A capacitive proximity sensor can be used to detect metallic and non-metallic targets without physical contact. The purpose of this project is to design a contactless car call system for an elevator to accompany the contactless floor button inside elevator. A capacitive sensor would be installed preferably two inches from the door of the elevator so as to differentiate between those using an elevator and by passers. Just as the call button, the design has lights inside that turn green and red to indicate signal reception and arrival of the elevator respectively. This project is relevant as it mitigates the spread of COVID-19 and integrates technology from digital systems to a system that links and connects with the environment.

Keywords: Programmable Logic Controller (PLC), Touchless, Controller, Elevator, Automation, Capacitive Proximity, Weight Sensor, Signal

Paper 34: Session 5(S2) – 5.4

Design Consideration and Eco-Environmental Assessment for Electric Propulsion Ships: Case Study –Cruise Ship.

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Abstract

This paper studies the influence of electrification of the conventional propulsion systems of a cruise ship in terms of; technical layout of the propulsion systems, fuel consumption, emissions, and the operation and maintenance costs, based on real data of a referenced voyage. The designed electric propulsion systems use the same main engines of the conventional systems but eliminating the auxiliary engines and replacing them with the battery pack. The battery pack serves two purposes; maintaining the main engines at their optimum point and providing power demand when only the auxiliary load is requested. The results show that there is a reduction in fuel consumption by about 7.66% in addition to a decrease in SOX, CO₂, and NOX pollutants by 16Kgs, 5.3 tonnes, and 432 Kgs respectively per voyage. The decrease in SOX and CO₂ are directly proportional to the fuel consumed while the NOX is about 26.6%. Furthermore, the cost of the operation and maintenance for the electric systems is roughly 1.9% less compared to conventional systems.

Keywords: Energy Efficiency, Electric Propulsion Systems, Electrification, Emissions, IMO.

Paper 35: Session 6 – 6.1

Evidence on the contribution of engineering to tackling COVID-19 crisis in Africa

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Abstract

The COVID-19 outbreak is primarily depicted as a health and economic crisis, but it is fundamentally also a crisis of an engineering nature. While research has been carried out on the impact of the pandemic on engineering globally or in the Western world, little to no research has been conducted about its impact on the engineering sector in Africa. Ecorys was commissioned by the Royal Academy of Engineering, UK to collect evidence on the contribution of engineering to tackling the COVID-19 crisis in Sub-Saharan Africa; provide a forward-looking view on how the crisis is likely to impact engineering in Sub-Saharan Africa in the years to come, and develop recommendations for the engineering sector on how to make best use of the opportunities offered by the crisis. The research involved document review and interviews with engineering stakeholders across Africa with a focus on 10 African countries namely Botswana, Cameroon, Ghana, Kenya, Lesotho, Nigeria, South Africa, Uganda, Zambia and Zimbabwe. Ultimately, this research seeks to inspire and facilitate learning among engineering actors across the continent, to support their impact and crisis recovery efforts, and enhance their profile among governments and their constituents.

Keywords: health and economic crisis, pandemic, impact on engineering

Paper 36: Session 6 – 6.2

Integration of P.V. floating with hydroelectric power plants

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Abstract

Artificial water reservoirs have been made throughout history for various purposes such as hydropower generation, energy storage, flood control, fishing, irrigation, etc. as we continually embrace sustainable development goals, the demand for cheap, clean energy is increasing. Investing in renewable sources such as solar, wind, and thermal power is vital in achieving SDG 7 by 2030. Hydropower generation represents an enormous share of renewable electricity generation globally. Most of these reservoirs are Run-of-river capacity, and the rest are hydro-pumped storage controlled to different degrees. Floating solar photovoltaic (FPV) is an emanating and feasible application of photovoltaics where the systems are directly placed on water bodies. Despite its increased market interest and reduced price over the years, the potential adopters of this technology remain concerned about the benefits offered and the merits of incorporating it in hybrid systems. To support decision making, this paper aims to review the associated importance of a hybrid FPV-Hydropower system operation. Hybrid systems of floating solar systems and hydropower plants hold untapped potential to increase significantly renewable electricity generation across the globe. Due to connection to a standard grid, the operation of a hydropower plant is flexible, thus facilitating a “virtual battery” which consists of meeting the electricity demand with solar energy during peak hours while balancing the grid with hydropower during low peak hours, thus providing a zero impact area for FPV power plant deployment.

Keywords: Hydropower, Floating solar, FPV, Hybrid, Photovoltaics