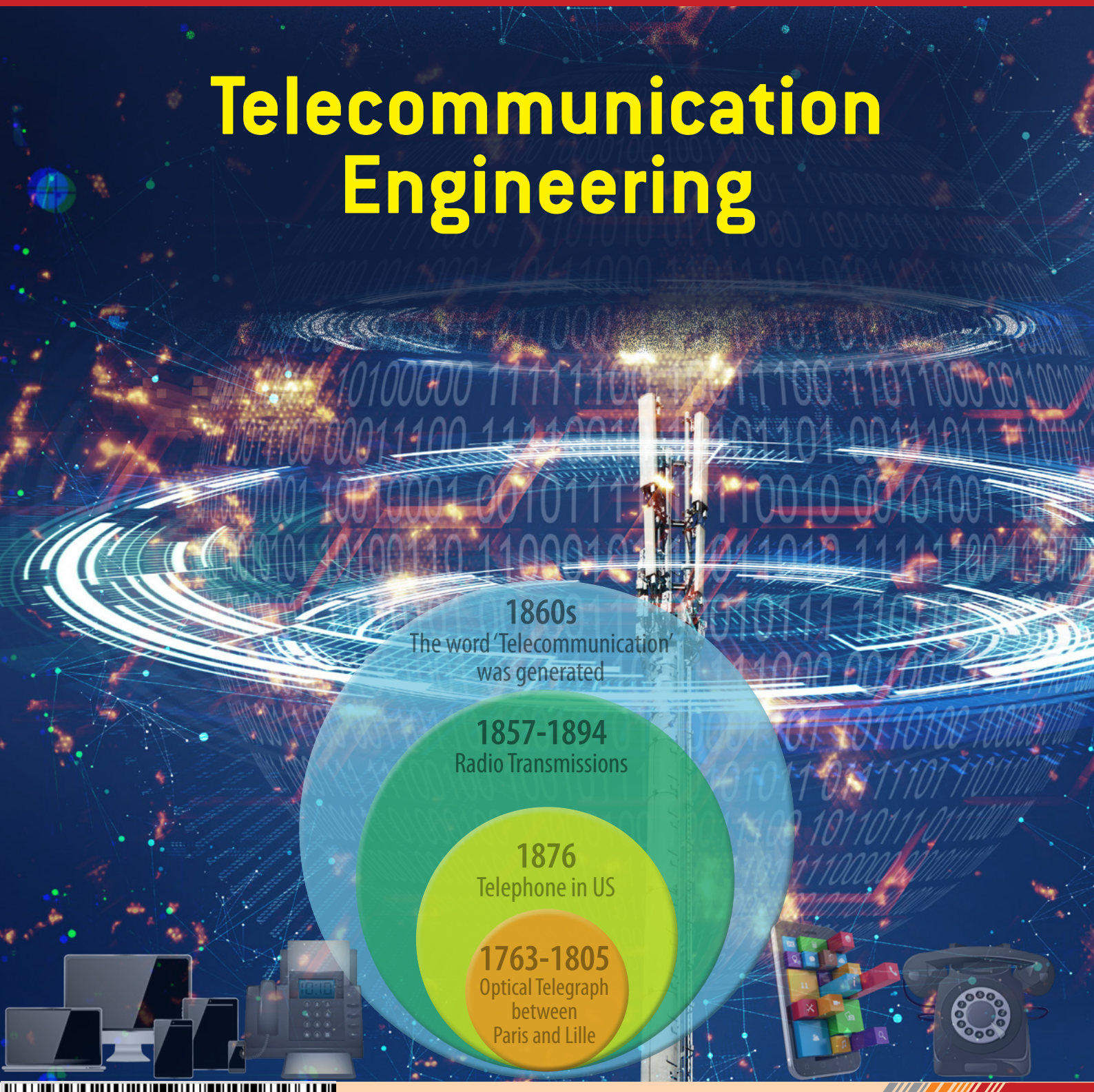
The Institution of Engineers of Kenya
Founded 1972

Engineering in KENYA

ISSUE 011

PUBLISHED BY THE INSTITUTION OF ENGINEERS OF KENYA | FEBRUARY 2023

Telecommunication Engineering



ISSN : 2710-3951

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Engineering in KENYA

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Call for Papers

Engineering in Kenya Magazine - Issue 012

The Institution of Engineers of Kenya (IEK) publishes Engineering in Kenya magazine, whose target audience includes engineering professionals, practitioners, policy makers, researchers, educators and other stakeholders in engineering and related fields. The publication is distributed to its target readers free of charge through hard and soft copies.

IEK invites you to contribute articles for our next and future editions. Articles should reach the Editor not later than **20th March, 2023** for our next issue, whose theme shall be "**Manufacturing and Mechanical Engineering**" and related sub-themes, across all engineering disciplines. An article can range from engineering projects to processes, machinery, management, innovation, news and academic research.

The articles must be well researched and written to appeal to our high-end readers in Kenya and beyond. The IEK Editorial Board reserves the right to edit and publish all articles submitted, in line with standing editorial policy. All articles should be in Word document format, 500-700 words, font type Times New Roman and font size 12.

Send your article today, and get a chance to feature in the magazine!

Send your article to:
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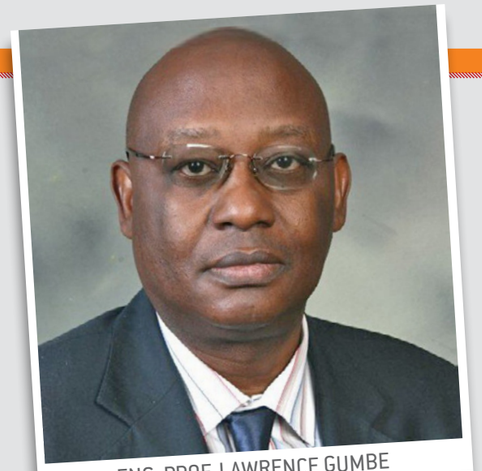

ENG. PROF. LAWRENCE GUMBE

Information and Telecommunication Engineering

WE welcome you to the eleventh issue of *Engineering in Kenya* magazine. The theme of this issue is *Telecommunication Engineering*.

Civilisation is majorly about information – its generation, storage, transmission and use. Early civilisation gave rise to the need for communication over a distance greater than that feasible with the human voice. Homing pigeons, talking drums, mirrors and signal flags were used in history to communicate remotely before the harnessing and use of electricity and electromagnetic systems for telecommunication.

> A functional definition of information is knowledge or data which can be collected, analysed, stored and communicated. Telecommunication in the modern world is the transmission of information by various types of technologies such as wire, radio, optical or other electromagnetic systems. The modern and future worlds cannot function without telecommunication engineering (TE).

The recent Covid-19 pandemic demonstrated the importance of information and telecommunication engineering to the world. In education, universities and schools were variously forced to discontinue physical instruction and revert to virtual learning, which could not have been possible without TE.

TE has also been instrumental in the biomedical area. The coronavirus pandemic began in China in 2020. Initially, there were many deaths. The government took strict measures to control the pandemic, these measures included strict lockdown. In addition to the lockdown, the Government of China was able to use TE to trace and quarantine all the contacts of people who tested positive for the virus. Using TE, China was also able to deploy massive resources to build (in record time), equip and run huge hospitals specifically dealing with Covid-19 patients, saving many lives. TE was also instrumental in the development and administration of Covid-19 vaccines worldwide.

In Kenya, measures to combat the pandemic included discouraging cash transactions. TE provided a ready solution for alternative payment methods through M-Pesa, Airtel Money, etc. The filling of physical forms for government services is largely being replaced by online ones through TE. In agriculture, various smart TE systems for the leasing of tractors, input procurement, marketing of produce and other pertinent issues are increasingly being available to farmers.

In engineering design and infrastructure, TE has the potential advantage of bringing about more effective and efficient design processes, faster construction through 3D printing, lower labour costs, increased complexity and/or accuracy, greater integration of function, and less waste.

The significance of TE to the world economy cannot be understated. The five largest TE firms in the USA, the Big Tech of FAANG, Facebook, Amazon, Apple, Netflix and Google, are all valued at over USD3 trillion, which, incidentally, is the GDP of India. A walk down any street in a Kenyan town or city would immediately indicate to one the significance of the ITE industry. The streets are dominated by shops selling telephone handsets, mobile money agents and related activities. Safaricom alone is a major contributor to the Kenyan economy.

Safaricom, in its ***Sustainable Business Report for 2020***, showed that the company's social impact was valued at KSh654 billion (US$6 billion) for the year, which is nine times the financial profit the company earned during the year. Kenya's GDP in 2019 was $95.5 billion, according to the World Bank.

Safaricom said it added economic value worth KSh358.6 billion ($3.3 billion) to the Kenyan economy during the past financial year, through operations and taxes. It also sustained more than 1 million direct and indirect jobs, an increase from 979,000 jobs the previous year.

The contribution of TE to agriculture, industry, entertainment and other sectors in the Kenyan economy is immense and has potential for more spectacular growth, leading to the creation of quality, stable jobs.

The primary actors in the TE sector are engineers. Engineers are playing a leading role and will continue to do so in the future, hopefully, very gainfully.

This year, the Institution of Engineers of Kenya Annual International Convention is being organised jointly with the ***World Council of Civil Engineers***. The convention will be held in Mombasa on 13th to 17th November, 2023. The theme of the convention is ***"Engineering a New World"***. We welcome you to participate in the convention as sponsors, paper presenters and active listeners.

ENG. ERIC OHAGA

Telecommunication and Information Engineering Drives our Social and Commercial Lives Today

> THE BASE INFRASTRUCTURE FOR THE REALIZATION OF AI AND ACHIEVEMENT OF THE INDUSTRY 4 REVOLUTION IS TELECOMMUNICATIONS AND INFORMATION ENGINEERING

HAPPY New Year.

The anxieties of the past year, 2022, are now behind us with the challenges of low economic activity due to heightened election campaigns and subsequently the onboarding of new government administrations both at national and county levels. The election year is also the period Kenyans elect their representatives for the National Assembly and the Senate. Election periods, from past experience, lead to reduced investments and development activity in the country.

I welcome you all to the New Year, 2023, and we are forecasting a full resumption of economic activities soon, thus engineers and the engineering fraternity will advance the discourse of leading the country to economic growth. As an Institution, we are well positioned to work with the new administrations, and have developed strategies and frameworks to entrench this collaboration. I therefore wish all our members, stakeholders and sponsors, a year full of collaborative partnerships.

Engineering discussions have in the past 12 years been centered on the terminology "SMART". We talk of smart cities, smart buildings, smart transport, and smart data centers. Smart solutions are systems combining innovative technologies, both in terms of hardware (Internet of Things) and software. They are widely applied in many fields of life – starting from smart offices, cars, and finishing on cities. Smart systems are the products of Artificial Intelligence (AI). Machines today can learn from experience, adapt to new inputs, and even perform human-like tasks with the help of AI. Artificial Intelligence products today, from chess-playing computers to self-driving cars, are heavily based on deep learning and natural language processing. We have increasingly been talking about Industry 4, which refers to the "smart" and connected production systems that are designed to sense, predict, and interact with the physical world, so as to make decisions that support production in real time. In manufacturing, it can increase productivity, energy efficiency, and sustainability. It increases productivity by reducing downtime and maintenance costs.

The base infrastructure for the realization of AI and achievement of the Industry 4 revolution is Telecommunications and Information Engineering. Information Engineering is the discipline that deals with the generation, distribution, analysis, and use of information, data, and knowledge in systems. The field first became identifiable in the early 21st century. The ability to convert analogue signals to digital signals championed the discourse

towards digitization. Today, Information Engineering finds application in diverse fields of both social and commercial life. It's not limited to fields of influence and operationalization. It finds application in almost all sectors of an economic and social society. I therefore call upon all our engineers to train and re-train themselves on subject themes that inform digitization.

At the national level, The Institution of Engineers of Kenya (IEK), in collaboration with Engineers Board of Kenya (EBK), held its 29th IEK Annual International Convention, themed *"Sustainable Engineering in the Era of Climate Change"*, from November 21 to 25, 2022. A total of 3,133 delegates were registered to have participated. The successive growth in numbers of attendance of our annual international conferences/conventions speaks of the goodwill and enthusiasm with which engineers are coming out to share knowledge, content and networking. The convention also drew delegates from the international scene, led by leaders of equivalent professional engineering institutions in Africa and beyond. To mention but a few, the convention was graced by leadership of societies from the World Federation of Engineering Organizations (WFEO), Federation of Africa Engineering Organization, New Zealand, UK, South Korea, Malaysia, South Africa, Sierra Leone, Rwanda, Nigeria, Uganda, Ghana, South Sudan, Tanzania, Zambia and Ethiopia.

Participation from corporate organizations from both the government and the private sector added to the rich mix that produced the success of the convention, despite last-minute force majeure. We clearly don't take such participation for granted as the numbers and diversity of the delegates in attendance is a clear message that Engineers and the engineering practice is on the correct path towards claiming its rightful authoritative place.

Kenya was indeed elevated on the international level with the admission of the EBK as an affiliate member of WFEO in an assembly in Paris. We are grateful to our international body for extending to Kenya this honor, which positions us well in our pursuit of being a member of The Washington Accord. As IEK, we continue to find representation in the international scene. Besides other representations, we were honored to have one of our members being appointed as Chair of the Young Engineers Chapter of the World Council of Civil Engineers (WCCE).

The current world is more collaborative than it was before. The ability to hold meetings virtually in addition to such premier features as voice and video conferencing speak of the truly significant role that an engineer plays in transformation of the lives and living.

The breakthroughs in the fields of Telecommunications and Information Engineering have opened up an era of further transformation.

(Photo Courtesy)

ENG.SHAMMAH KITEME

Engineers Must Stay Ahead of the Pack in 2023

IN this 11th edition we focus on Telecommunication Engineering.

On March 10, 1876, Alexander Graham Bell, who was the inventor of the telephone, made the first call. The world was convinced that a new era of conveying voice data through the telephone had arrived.

Since then, data has been conveyed using fax machines and today mobile phones and satellite phones, which are enabling instant communication for people thousands of kilometres away. Certainly, the information and communication area is a forte for Engineers who have led in great innovations, making communication possible all over the world.

Indeed, through the entire infrastructure touching on instrumentation, light current and signaling, Engineers contribute a lot in this crucial sector of the economy.

Perhaps it is in the era of digitisation that this innovativeness converges. Our innovation is not only in the novice tools and assets that we develop but much more important in the process required improving efficiency in services and operation in organizations. This is the crucial area where digitisation will play a critical role.

Recently the government indicated that in the next six months all its operations will be digitized. This then affords Engineers in this space an opportunity to play a critical role in improving efficiency in government operations. The call for Engineers is to be proactive and not reactive. By now, we must be crafting solutions to this government's call and offering them for consideration.

Other recent pronouncements that Kenya will set up a smart phone manufacturing plant locally is a wake-up call for Engineers to plug in fully. This has the potential to engage many of our Engineers in semi-conductor design and production.

It is important that Kenya takes a leading role in these initiatives as the business hub in East Africa and the biggest economy in the region. With opportunities presented by the East Africa Community (EAC) and the African Continental Free Trade Area agreements (AfCFTA), there is a big market in the region.

Africa must move towards self-reliance and this was emphasised by the Covid-19 pandemic. The entire global supply chain was disrupted and with the wealth of minerals in Africa, all that the continent needs can be produced in these 55 countries.

If this is achieved and more intra-Africa trade is enhanced, we stand a good chance of becoming the next global growth frontier.

Our role as Engineers is to ensure proper frameworks are put in place to protect intellectual property rights, especially in the area of Information Communication and Technology. Big data decision making, virtual reality and machine learning, Artificial Intelligence and Internet of Things are going to be widely applied in many of our daily tasks, especially those that are repetitive. Digital Twin and its role in infrastructure is also an area where Engineers must take a leading role.

Application of Building Management Services and collaboration in projects is going to increase demand for data infrastructure and internet security. More and more work will be digitized and Engineers must now equip themselves with skills to be able to code so that they can master their work.

This year, IEK looks to aggressively fight for the space of the Engineer. Our engagement with key players in the private and public sectors has already started on a very high note. The year will also witness IEK host the World Council of Civil Engineers General Assembly alongside the 30th IEK International Convention.

The council has sent members information they need to submit the abstracts for consideration in order to submit papers at the World Engineers Convention that will take place in Prague, Czech Republic, from 11th to 13th October this year. We hope members will show interest as this is a great opportunity to exchange ideas at the global level.

In this first edition of Engineering in Kenya for 2023, I take this opportunity to wish all Engineers a productive year.

REPUBLIC OF KENYA

ENGINEERS BOARD OF KENYA
Enhancing Professionalism

KENYA'S JOURNEY TO SIGN WASHINGTON ACCORD BY 2024

The Engineers Board of Kenya (EBK) is well on course towards signing the Washington Accord by 2024. The Board started the journey in 2019 when it made a presentation at the World Federation of Engineering Organizations (WFEO) and International Engineering Alliance (IEA) joint meeting in Melbourne, Australia.

Emeritus Prof Elizabeth Taylor, who is the Chair of the Washington Accord, says by signing the accord, EBK will join IEA and have the engineering university programmes the Board has accredited recognized globally.

This means that Kenyan engineering students will easily be accepted in international universities that have signed the accord. Accredited engineering programmes in Kenyan universities will also be able to attract students from other countries and become foreign exchange earners.

The IEA is a global not-for-profit organisation, which comprises members from 41 jurisdictions within 29 countries, across seven international agreements. These international agreements govern the recognition of engineering educational qualifications and professional competence.

Through the Educational Accords and Competence Agreements members of IEA establish and enforce internationally bench-marked standards for engineering education and expected competence for engineering practice.

Under IEA, there are three accords. The Washington Accord is an international agreement between bodies responsible for accrediting engineering degree programmes. It acknowledges that accreditation of engineering

academic programmes is a key foundation for the practice of engineering at the professional level in each of the countries or territories covered by the Accord.

The Sydney Accord is responsible for accrediting engineering technology academic programmes, while the Dublin Accord establishes the required educational base for engineering technicians.

In Africa, only South Africa is a signatory to the Washington Accord and this explains why many Kenyan engineering students study in South Africa.

When the EBK journey towards signing the Washington Accord started, the Board of Engineers Malaysia (BEM) accepted in 2020 to mentor Kenya and walk with her towards having her application accepted.

Speaking during the 29th Institution of Engineers of Kenya (IEK) International Convention in November 2022, Prof Taylor said WFEO also identified the Pakistan Engineering Council (PEC) as a co-mentor for Kenya.

After a slowdown in the process caused by the COVID-19 pandemic, the mentors are expected visit Kenya to inspect their educational institutions, the programmes accredited by EBK and how local professionals practise engineering. These visits will inform the mentors' advice to EBK on how it can improve its operations and have its application accepted by IEA.

The Board is now able to engage the mentors directly after it became an affiliate of WFEO. This will help to streamline communication and hasten the mentorship process.

Prof Taylor says when Kenya signs the Accord, there may be some sacrifices, but all for the greater good of the engineering profession and practice.

For instance, currently Kenyan Graduate Engineers have to practise for at least three years before they can apply to become professional engineers. However, globally, the standard practice period is seven years.

The EBK only registers engineers who have studied courses accredited by the Board. With the Washington Accord, the accredited engineers will also now have international recognition.

Once EBK signs the accord, Kenya becomes an associate member of IEA and starts enjoying the benefits immediately. However, the journey does not end there, the mentorship continues until EBK becomes a full member after which it will be able to mentor others who want to sign the accord.

Kenya's membership will, therefore, be of immense benefit to many other African countries who want to sign the accord, since they will have a potential mentor close by.

After becoming a full member, again the journey will begin for Kenya to sign the other two accords. For this to happen, however, all engineering cadres will have to be under one Board through which they can apply for IEA membership.

Author: Eng. Margaret Ogai, CE, FIEK
Registrar/CEO, EBK.

About the Engineers Board of Kenya

The Engineers Board of Kenya (EBK) is a statutory body established under section 3(1) of the Engineers Act, 2011. The Board is responsible for the registration of Engineers and Engineering firms, regulation of engineering professional services, setting of standards, development and general practice of engineering.

Government's Role in Revolution of the Digital Infrastructure and Economy

Eliud Owalo, Cabinet Secretary Information, Communication and Digital Economy.

Engineering in Kenya spoke to Hon Eliud Owalo, the Cabinet Secretary for Information, Communications and the Digital Economy, on the role ministry plays in digital revolution in Kenya.

President William Ruto recently said coding will now be part of the curriculum right from primary school. How will the incorporation of digital technologies into the curriculum impact Telecommunication Engineering education and service delivery in the country?

The incorporation of digital technologies, such as coding, into the primary school curriculum will have a positive impact on the field of Telecommunication Engineering, as the introduction of coding from a young age will help in the development of necessary skills and knowledge for students to pursue careers in the field of Telecommunication Engineering. This will increase the number of qualified Engineers available for employment in the industry and improve the overall quality of service delivery in the country.

Additionally, this move will also pave way for more innovation and research in the field of Telecommunication Engineering, as students will have a greater understanding of the technologies involved and the potential applications of these technologies. This will also increase the number of tech-savvy citizens, which in turn will promote digital literacy and enhance service delivery across all electronic platforms.

Recently, the government launched a digital innovation hub at Kabete Technical Institute to leverage technology. How is your Ministry planning to enable access of digital technology in remote and off-grid areas?

The Ministry has embarked on ensuring equity access to information and ICT digital technologies through citizenry capacity training. It aims at training approximately 20 million citizens ***(ICTA website-citizen training)***, as well as through the Ajira training centers currently in all sub-counties in the country.

The government is also expanding the digital infrastructure by rolling out 100,000km of high speed fiber, 25,000 hotspots and 1,450 digital innovation hubs across the country with the intention of promoting inventions, innovation and mentorship of citizens in off-grid and remote areas through information access and training done on ***Whitebox*** **platform.**

We are also planning to work with the private internet service providers and other stakeholders to come up with ways of reducing the cost of data. However, as government we have gone further and is now providing free Wi-Fi through the hotspot facilities being set up across the country.

What is the future of Telecommunications Engineering in Kenya and what resources are you investing as a Ministry to ensure there is adequate capacity and facilities to train professionals in this field?

Telecommunications is a rapidly-evolving field and the future of Telecommunications Engineering in Kenya is likely to involve continued growth and development in areas such as mobile telecommunications, internet infrastructure, and the use of technologies like 5G and fiber optics.

The government and private sector organizations have been investing in various initiatives to improve telecommunications infrastructure and capacity in the country. These include efforts to expand mobile networks and increase access to high-speed internet, as well as initiatives to train professionals in the field of Telecommunications Engineering.

For example, our universities and colleges offer degree and diploma courses in Telecommunications Engineering. Other private training institutions offer specialized courses and training in specific areas of the field. In addition, the Ministry of Education and other industry associations and professional bodies such as the Institute of Engineers of Kenya (IEK) support the development and training of Telecommunications Engineers in the country.

My ministry has also partnered with private institutions like Huawei to help provide the latest cutting-edge training to the students through programmes such as the DigiTalents. We are also setting up innovation hubs and assisting other players in setting up incubation hubs across the country to train and support development of ideas. My ministry, in collaboration with that of Education and other ministries, is assisting students by offering industrial attachment placements in their various departments. This helps the young professionals to get hands-on job training to equip them for the job market in Telecommunications Engineering.

Only a handful of universities are currently offering the Telecommunications Engineering course. How best would your Ministry support the expansion of this course into many other universities to make it more accessible to many students?

My ministry is currently supporting Telecommunications Engineering training in institutions of higher learning by providing the necessary ICT infrastructure. We also collaborate with industry partners to make available internship opportunities and donate equipment, professional accreditation bodies to ensure that universities have the necessary standards and resources in place to offer high-quality telecommunications engineering programmes.

In addition, we work with other government agencies to create policies that encourage the growth of the telecommunications industry and promote the development of a skilled workforce in the field. Overall, the government is using different initiatives to provide resources, financial support and regulations to create an environment to expand the course in universities and make Telecommunication Engineering Education more accessible to students at the universities.

With President Ruto's bid to transfer 85% of government services online, how prepared are you as a Ministry to ensure this is achieved? What challenges do you anticipate and how do you plan to deal with them?

> As a ministry, we are in the process of transferring 5,000 government services to the existing digital E-Citizen platform, which is being upgraded to handle more data and more services, within the next six months. The government has taken stringent measures to ensure its citizens' personal data is safeguarded, through the establishment of the Office of the Data Protection Commissioner as stipulated in the Data Protection Act 2019.

Among the challenges anticipated are:

- Financial sustainability of this project: To ensure that the platform operates, the government charges a service fee for maintenance.
- Digitisation of content: Most government data is in analogue format, so it has to be digitized first, and then digitalized on this platform.Top of Form

The Kenya Kwanza government is going big on ICT and innovation. What will be the role of Telecommunication Engineers in this digital revolution?

Telecommunication Engineers will play a vital role in the digital revolution spearheaded by the Government. Their expertise is required to design, develop, and maintain the infrastructure and systems that support the delivery of digital services.

Some specific areas where telecommunication engineers may be involved include:

- Building and maintaining high-speed broadband networks to ensure reliable internet access for citizens and businesses.
- Designing and implementing secure networks and systems to protect citizens' personal data.
- Developing and maintaining cloud-based systems and services to support the delivery of government services online.
- Developing 5G mobile networks, which support high-speed data transfer and low latency for various use cases, such as Internet of Things (IoT) devices, remote surgery and autonomous vehicles.
- Developing digital infrastructure that can support emerging technologies such as Artificial Intelligence and Block chain.
- Developing secure and efficient systems for online identity verification to ensure that only authorized individuals can access government services online.

Telecom Engineers will also play a key role in ensuring that the ICT infrastructure addresses the needs of all citizens, including those who are geographically isolated or have limited access to technology. This involves identifying and addressing digital divides or working to ensure that digital services are accessible to people with disabilities.

Additionally, Telecommunication Engineers will assist the government to ensure compliance with the laws and regulations in place, as they design and implement the infrastructure.

Overall, Telecommunication Engineers will play a critical role in ensuring the success of the government's digital revolution by providing the requisite technical expertise for public service delivery.

What is the Government's estimated budget for the implementation of the Digital Agenda, and what obstacles do you foresee in this cause? How do you plan to tackle these challenges, if any?

As per the Kenya Kwanza Manifesto, the government plans to establish Kenya as an African digital hub. This plan, for which US$ 400 million (Ksh49.6 billion) will be allocated, represents a broad tech strategy that will go as far as developing digital software with export viability. This ambitious plan is no mean feat. It represents a daunting task for the new administration, whose grand plan on ICT will require concerted efforts

to overcome a chain of challenges to realize the dream of making Kenya a local software development hub and market it globally as an epicenter of tech products, services and talent.

Obstacles that government is facing include inadequate financial resources, limited infrastructure and resistance to change by stakeholders.

To tackle these challenges, we as a ministry plan to improve the digital infrastructure by making available high quality internet across the country. We also want to increase digital literacy among the citizens through training and capacity building to maximize the benefits of these digital resources.

You have said more than once that your Ministry is planning to support the Kenya Broadcasting Corporation (KBC) to make it a more vibrant and competitive media house. How do you plan to achieve this and what timelines are we looking at?

We are going to thoroughly shake up the Kenya Broadcasting Corporation (KBC) and breathe fresh life in it. The national broadcaster must step up to the plate. It must punch at its right weight. Its revitalization is a priority that we intend to embark upon almost immediately.

We will support KBC in order to make it more vibrant and competitive to reclaim its space as the national broadcaster. We intend to help it rebrand, upgrade equipment, change content to that which is appealing and relevant to the current target audience, training of personnel and venturing into new media in order to be competitive. All these will be done within the next five years.

The African Continental Free Trade Agreement (AfCFTA) relies on inter-market connectivity, data access, and soft infrastructure for its success. What role is the Ministry playing in enabling digital connectivity in Kenya to the outside world?

The President has promised Kenyans that he will pursue a bottom-up transformational agenda. Through the digital, information and communication component, we in this ministry are expected to be the engine. We want to make Kenya an empowered digital society, with high standards of living for our people, in line with the mandate of the ministry.

We must facilitate Kenya's economic transformation by leveraging upon ICT for competitiveness and sustainable human development. Our innovative and creative abilities are amazing, and especially those of our creative youth. We can leverage on our gains to become global leaders in ICT and in the digital economy.

Let me emphasize that I especially recognize the key mandate of my ministry as a facilitator and regulator of information and communication technology, for efficiency and productivity in all other sectors. ICT is the engine that is driving the global community today. My ministry must place Kenya at the cutting edge of ICT as a digital economy in this age of the Fourth Industrial Revolution. We cannot afford to let the world leave us behind.

In support of the African Continental Free Trade Agreement (AfCFTA), the ministry is working to improve inter-market connectivity, which includes building and maintaining the necessary digital infrastructure to facilitate trade among countries within Africa and beyond. This includes increasing access to high-speed internet and mobile networks, as well as expanding the use of e-commerce platforms and other digital tools that can be used to facilitate trade.

Additionally, the ministry is playing a role in ensuring access to data, which plays an important role in the success of AfCFTA, as data is used to inform trade-related decisions. The industry players have been able to come up with cross-border mobile communications infrastructure, enabling citizens to communicate across borders with ease. Our mobile companies have ventured into other countries through the innovative products they offer.

What is the role of the Ministry of ICT in transforming the e-commerce sector and digital infrastructure in Kenya to boost the economy?

My ministry, in collaboration with that of Trade, Investment and Industry, is developing policies for the development of e-commerce.

Some areas that the ministry is working on to boost the e-commerce sector include:

- Developing and implementing policies and regulations that promote e-commerce and digital infrastructure development to remove any barriers to the growth of the sector.
- Encouraging the development of a robust and reliable digital infrastructure, such as high-speed broadband networks, that can support the growth of e-commerce and other digital services.
- Fostering the development of e-commerce ecosystems that support small and medium enterprises, encouraging the formation of partnerships between government, private and development partners to provide funding and technical support for e-commerce and digital infrastructure projects.
- Encouraging the development of digital payment systems, identity and trust services, and other digital tools to support e-commerce transactions and protect consumer rights.
- Supporting the development of a skilled workforce with the necessary technical skills to design, develop and maintain the digital infrastructure and services.
- Promoting the development of cross-border e-commerce by encouraging co-operation with other countries and regional organizations, facilitate the movement of goods, services and data across borders.
- Encourage public-private partnerships to support the digital infrastructure and innovation through investments in research and development.
- Revamping the Postal Corporation to conform to the modern e-commerce business models.
- Mapping and changing the national address system to enable easy identification of households.

Communication Authority of Kenya: Expanding Digital Infrastructure to Enhance Online Safety, E-learning and E-commerce in Kenya

Engineering in Kenya spoke to Mr. Ezra Chiloba, the Director General of Communications Authority of Kenya on its role in regulation of Telecommunication services, sensitising the public on cyber security and e-commerce in Kenya.

By Maureen Mwangi

Ezra Chiloba, Director General Communications Authourity of kenya

What is the role of Communications Authority of Kenya in safeguarding the interests of users of ICT services in Kenya?

In the interest of empowering consumers, the Authority undertakes a nationwide Consumer Education Outreach Programme with the aim of offering consumers a broad range of concise and current information on many aspects of the communications industry. Through the County ICT Consumer Forum, Kikao Kikuu, the Authority now has a platform to engage with consumers across the country, listening to and addressing their concerns.

Consumer protection is based on the concept that the consumer must be protected against undesirable and unfair trading practices. The best ways of protecting the consumer is to empower them by educating them on their rights and obligations and how they can stand for those rights whenever they are violated. It also relates to the development of skills, attitudes and knowledge that enable the consumer to make informed and responsible choices.

The Authority can offer protection to the consumer in a number of ways by ensuring that all service providers adhere to the conditions stipulated in their licenses. Licensees have certain conditions, which stipulate what the provider can and cannot do when supplying services to the consumer. The conditions address such aspects as:

- The minimum quality of services that may be offered to the consumer
- The pricing of such services
- The procedures that must be followed in the supply of services
- The technical standards that must be met and maintained
- The benchmarks that have been set to maintain such standards
- The method of redress available to the consumer in the event that the service offered falls short of that stipulated by the Authority
- The tenets of good governance in relation to 'fair' competition, by which all members of the industry are expected to abide

Internet of Things technologies. What opportunities does the country stand to benefit from full adaptation of IoT?

The emerging disruptive technologies such as IoTs, OTTs, Distributed Ledger Technology, Artificial Intelligence, Quantum Computing, Robotics, Virtual Reality, among others, are creating a new set of opportunities. These emerging technologies can support various government agenda items, ranging from improving health coverage by employing the Internet of Things (IOT) and Artificial Intelligence (AI) to improving food sustainability using Blockchain technology to eradicate counterfeit seeds. The use of Blockchain and AI technologies could be transformative across several key sectors in Kenya, including healthcare, agriculture, education and government services. The improved efficiency, transparency and accountability of Blockchain can considerably benefit government services in which several emerging markets struggle with inefficient legacy infrastructures and an inability to provide citizens with fast, accountable and transparent service delivery.

For example, creating a Blockchain-based land registry would considerably improve the citizens' ability to prove land ownership (and provide access to credit). It would also reduce the corruption that is prevalent in the existing system. In the education sector, AI exhibits the potential to improve learning outcomes by supporting the delivery of personalized virtual lessons. A good example here is M-Shule, an SMS-based learning platform in Kenya, which uses AI to track and analyze student performance and to deliver lessons that satisfy their needs and increase their competency. The platform reduces the fear of failure that is inherent in several learning environments, allowing students to advance at their own pace and to ultimately improve their learning outcomes.

The digital era opens Kenya to many opportunities, especially in e-commerce. How is the Authority leveraging the immense opportunities in e-commerce?

The Authority has made considerable strides in facilitating the growth of e-commerce in the country in line with its mandate. This includes fostering confidence of consumers in digital platforms as avenues for doing business. E-commerce as it is now, would not be where it is, were it not for the stable ICT environment we have fostered, where multiple data carriers offer services at relatively competitive rates, leading to widespread access to the Internet.

The Authority has put in place protective mechanisms for the courier industry, which is responsible for delivery of items purchased online. The e-commerce guidelines for courier operators seek to ensure highest levels of professionalism when conveying customer items. These guidelines obligate courier operators to implement processes and procedures for adequate security of consumer packages as well as the implementation of track-and-trace services of couriered items.

The Authority has also coordinated efforts towards the establishment of a National Addressing System (NAS) for the country. A well-designed NAS will provide a robust mapping of properties and places, and will subsequently catalyse the growth and adoption of e-commerce in Kenya by making it easier for deliveries to be made directly to consumers.

Through other mechanisms such as the Universal Service Fund (USF), we have rolled out initiatives that will greatly enhance access to communication services, including mobile and broadband connectivity. These initiatives are envisaged to fundamentally impact the literacy levels in the country, and further open new frontiers of opportunities that abound on the digital platforms, including e-commerce, to a greater proportion of the population.

E-commerce now presents innumerable opportunities for driving the digital economy in Kenya. With a substantial portion of the population yet to access broadband services (4G), it means that the room for innovative digital solutions and services, including e-commerce, is still wide.

What amount of effort are you putting in place to ensure there are adequate facilities to train and educate ICT users on online safety measures?

The Authority is currently working with the Ministry of Education to ensure that the Kenya Institute of Education and Curriculum Development (KICD) portal is linked to all public secondary schools in the country in order to enhance learning and school management procedures. This initiative will also provide publishers with an opportunity to develop rich digital content to enrich the curriculum. The Authority has been running a Child Online Protection (COP) campaign, in conjunction with UNICEF aimed at educating children and other stakeholders on safety while using the Internet.

Tell us more about the Universal Service Fund (USF). What impact has it made in improving the availability and accessibility of ICT services in remote and off-grid areas?

In an effort to identify and determine the extent of communications infrastructure and services coverage in all parts of the country, the Authority undertook an ICT Access gaps study in 2016. Through this study, the Authority has identified two priority projects that will be supported through the Universal Service Fund in order to address the gaps and communications challenges identified by the study. These projects are the Voice Infrastructure Project where the Fund is supporting provision of telecommunication voice service in 78 sub-locations across the country; and the Education Broadband Project, where the Fund is supporting Internet connectivity in 896 secondary schools in all the 47 counties. Prior to the implementation of these projects, the Authority has since 2007 been implementing school-based ICT pilot projects in 16 secondary schools, eight institutions for Persons with Disabilities (PWDs), four community telecentres and access points and 56 e-resource centres within the Kenya National Library Services (KNLS) libraries. The lessons learnt from these pilot projects have greatly informed the scalability of these projects at the national level. To ensure that there is equitable distribution of ICT services to all Kenyan citizens, the Authority in 2020 embarked on the implementation of USF Phase II projects, which envisages to further close access gaps in 101 sub-locations distributed across 17 counties countrywide. The deployment of services in the beneficiary 101 sub-locations has facilitated the residents of the selected sub-locations to enjoy a host of services, including mobile voice, data, Internet and a bouquet of other value-added services, including mobile money transfer services. The timely completion of Phase II projects will not only allow people in these unserved sub-locations to communicate with ease but also deepen financial inclusion and e-commerce. We are currently embarking on the implementation of USF Phase III that will connect a further 67 sub-locations spread over 12 counties at a cost of Ksh1.5 billion.

Eng Tom Ochanda (left) and Mr Hyeon Lee (third right) of BoMI receive a copy of Engineering in Kenya magazine from Editorial Board Secretary Eng Paul Ochola at the Kenya Advanced Institute of Science and Technology in Konza Technopolis.

Mr Hyeon Lee and Eng Tom Ochanda take the IEK team around the Education Band at the Konza Technopolis.

Mega Pipes Solution Technical Sales Engineer Tony Achila (second left) takes the IEK team around the factory premises in Ruiru, Kiambu County.

Devki Chairman and Founder Narendra Raval (Dr Guru) receives a copy of EiK from Eng Paul Ochola.

Eng Paul Ochola (third left) and Konza Technopolis Chief Engineer Anthony Sang (third right) with a team of graduate engineers in the Konza GEIP programme at the smart city.

Eng Paul Ochola hands a copy of the magazine to Car & General Group CEO Vijay Gidoomal. Looking on is Car & General Head of Communications Raphael Atanda and IEK team members.

Why Telecommunication Engineering, ICT are Central to Ruto's Government Agenda

By EiK Correspondent

THAT Kenya's new government is focusing heavily on ICT and innovation to deliver its agenda cannot be overemphasised.

From the Kenya Kwanza manifesto to nearly every speech made by President William Ruto since he was sworn into office, it is evident that ICT and innovation are central to the government's masterplan.

"It is time to innovate our way into the future," President Ruto said during the Jamhuri Day celebrations on December 12, 2022.

"Innovation is frequently associated with technology, and we must avoid the pitfalls of viewing technology and innovation as preoccupations with things at the expense of people. The most significant breakthroughs in technological innovations have greatly enhanced human well-being," he added.

The President believes that ICT and innovation will not only help to deal with joblessness among millions of young Kenyans, but also ease access to government services and improve small and large businesses alike.

He said the country was staring at a digital revolution starting from how they access government services, browse the internet, earn from the digital space, access to education as well as the employment crisis facing the country.

"We have a target of one million jobs from our technology space. We've had a candid conversation with our technology and digital space leaders that. it is important that all of us understand the importance of technology and the place of innovation going into the future," President Ruto said.

The theme of the celebration itself was 'Connect, Innovate and Inspire'.

Kenya Kwanza's flagship project, the Hustler Fund, is based solely on ICT and telecommunication, as Kenyans can now borrow money from the government through their mobile phones.

"The platform that supports all the transactions on the Hustler Fund was developed locally, has opened up access to affordable credit, liberated millions of hustlers from the vicious grip of shylocks and other predatory lenders, and enabled Kenyans of all walks of life to mobilise savings," Ruto said.

The president said they were also exploring ways of making the benefits of monetisation of online activity available to Kenyan content creators on more platforms.

"I have spoken directly to Meta, the parent company of Facebook, Whatsapp and Instagram, to monetise content for our digital entrepreneurs that will exponentially multiply incomes and create employment opportunities for others," he said.

"If I was not a State officer, I wonder what the content on my small Facebook page, with 2.3 million followers, would earn me daily."

Just a day before the Jamhuri Day fete, the President, accompanied by ICT Cabinet Secretary Eliud Owalo and other senior government officials, hosted the Jamhuri Tech and Innovation Summit at the Kenyatta International Convention Centre (KICC) in Nairobi.

During the summit, the President said that coding, which is another product of ICT innovation, will be introduced in the primary school curriculum beginning this year.

"We need to know how to grow our technology from primary school. You have heard about coding that is now going to be part of our curriculum to ensure coding and the whole computer and technology eco-system becomes part of our journey from the basic primary schools all the way to the universities," he said.

In its manifesto, Kenya Kwanza recognises that the country has invested heavily in ICT infrastructure and services over the last two decades, including six submarine fiber-optic cables offering broadband connectivity, 9,000km of terrestrial fiber-optic cable connecting virtually all county headquarters, and geographical and population mobile broadband coverage of 56 per cent and 96 per cent, respectively.

The government commits to leverage on this development to ensure universal broadband availability throughout the country within five years.

> "We shall increase and fast-track broadband connectivity across the country by construction of 100,000km of national fibre optic connectivity network," reads the manifesto.

Apart from plans to enhance government service delivery through digitisation and automation of all government critical processes and make available 80 per cent of government services online, Ruto's regime also commits to reduce the cost of calls and data to allow Kenyans, and especially the youth, to use online platforms for entertainment, information and business.

"The administration will strengthen Konza Technopolis to bring together industry, academic institutions and other innovators to co-invest in emerging technologies to create high-quality jobs that leverage on artificial intelligence, robotics and other technologies and thus enhance our regional and global competitiveness," reads the manifesto.

With these grand promises, it remains to be seen how the government will use telecommunication engineering and ICT to help solve everyday problems that have stifled Kenya's growth for decades.

Application of Automatic Vehicle Locator (AVL) System to Enhance Traffic Flow of Bus Stations: A Case Study of Nairobi Central Bus Station/Hakati Terminus

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Introduction

THE Nairobi Central Bus Station is situated on Temple Road, amid Mfangano Street and Uyoma Street. The Station was initially planned for use by the Kenya Bus Service (KBS). Lobbying by local transport sector led to Nairobi City Council, now Nairobi City County Government, opening up the Central Bus Station to other transport operators in the 1970's (Kenya Bus Services Management Limited, 2016).

Over the years, Nairobi population has rapidly grown from 531,000 in 1970's (United Nations World Urbanization Prospects, 2018) to 4,397,073 as per the 2019 census (Kenya Central Bureau of Statistics 2019). Over the years, the trajectory of infrastructural development compared to population growth has not matched hence a strain on NCBS to provide adequate transit. Given that available space for expansion is limited, there is need for an alternative system to improve efficiency is proposed.

Use of AVL as a means for determining and transmitting the geographic location of a vehicle can be useful for NCBS. The vehicle location data, from one or more vehicles, may then be collected by a vehicle tracking system to manage an overview of vehicle travel in NCBS.

Methodology

For the case of NCBS, it was established that the important parameters to evaluate congestion and delays in the station were dwell times and station capacity. Dwell time is elapsed time between the instant a bus enters a station and the instant it leaves the station (Highway Capacity Manual, TRB, 2000). Bus Station capacity may be defined as the largest steady state flow of buses that can enter a bus station under prevailing conditions. (Gibson, et.al, 1989)

The traffic surveys were done for three days (Monday, Wednesday and Friday). Critical points for collecting traffic data were the entrance, exit and the terminal berths. The weekends were excluded because the problem of congestion was not observed during the survey days. The time of the traffic study was between 0830HRS and 1730HRS since it is this period that NCBS had the highest transit. The data was collected in August 2020. Dwell times in NCBS were observed not to be affected greatly by passenger demand and vehicle carrying capacity since the service times at the loading areas were averaging to about 5-10 minutes. Queues were more influenced by such factors like trip restrictions and oversupply of vehicles as opposed to vehicle length. Trip restrictions also made drivers unable to carry passengers before the other drivers managed two trips.

Transit Capacity and Quality Service Manual Third Edition, 2013 (TQSM 2013) (Ref.) gives the procedure in table 1 for determining station capacity and which was applied for this case. Figure 2 below shows data sheet for gathering input data. Failure rate (Za), is described as the percentage of buses arriving at a station and finding all available loading areas occupied. The design capacity is effectively maximized at a 25% failure rate (Za = 0.675) and is called maximum capacity according TCQSM. Another variable, coefficient of variation of dwell times(cv) is obtained by dividing standard deviation by mean dwell times and used as shown in equation 2. Dwell time () can then be calculated from the input data obtained from the data sheet using equation (1).

$$T_{dwell} = T_{pst} + T_{ext} + T_1 + T_2 \quad \text{(1)}$$

Where, T_1 = Time taken to reach berth from station entrance, T_{pst} = Passenger service time, T_{ext} = External delay, T_2 = Time taken to reach station exit from terminal berth

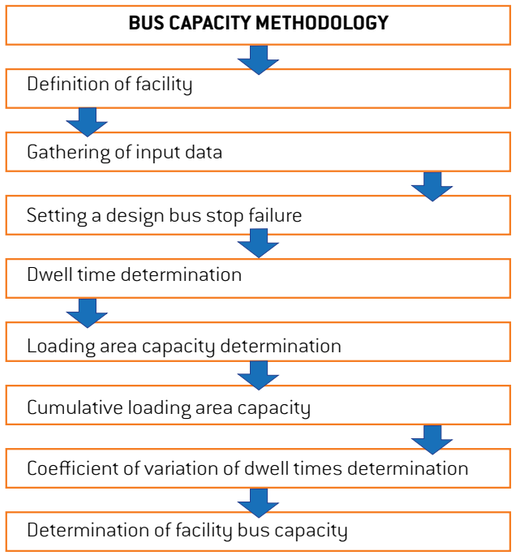


Figure 1: Bus capacity methodology (TCQSM, 2013)

Using dwell times calculated for various stations, loading area capacities (q_c) can then be determined using equation 2 below.

$$q_c = \frac{3600}{T_{dwell} + T_{clear} + Z_a . c_v . T_{dwell}} \quad \text{(2)}$$

Where, T_{clear} = time difference between two successive vehicles occupying the same terminal berth, Z_a = one tail normal variate corresponding to probability queues will not form behind the stop, c_v = coefficient of variation of dwell times. For terminals with more than one berth, and is the number of loading areas within the berth;

$$q_c = N_e \frac{3600}{T_{dwell} + T_{clear} + Z_a . cv . T_{dwell}} \quad \text{(3)}$$

Table 1: Sample Data sheet

	Parameter
1	Vehicle plate number
2	Vehicle passenger capacity
3	Vehicle Arrival time in station (24HR)
4	Vehicle arrival time in berth (24HR)
5	Time vehicle takes to reach berth (T_1)
6	Time vehicle is full and can leave berth (24HR CLOCK)
7	Passenger service time (H/MM) (T_{pst})
8	Time taken to reach exit (T_2)
9	Dwell Time (H/MM)

(Source: Isaac Were, Personal Publication, TUK, 2020)

Standard deviations for daily average dwell times were used to compute for loading area capacities using the general equation shown below.

$$(\sigma) = \sum_{i=1}^{n-1} n(xi - \bar{x})^2 \quad \text{(4)}$$

Where

(σ) = standard deviation

xi =Value of the ith dwell time variable in the data set

$\bar{x}$ = the mean value of dwell time in the data set

n =The number of data points in the data set

Finally, the facility bus capacity (Q_c) which is the summation of loading area capacities and is expressed in vehicles per hour is given by

$$Q_c = \sum q_c \quad \text{(5)}$$

Results

Table 2: Least dwell times (Were, 2020)

BERTHS	RECORD	PERIOD	TIME OF DAY	DWELL TIME (MINUTES)
INDIMANJE	LOWEST	MORNING	08:30-09:30	67
		AFTERNOON	15:30-16:30	60
NABOKA	LOWEST	MORNING	08:30-09:30	34
		AFTERNOON	15:30-16:30	64
HIGHRISE	LOWEST	MORNING	08:30-09:30	43
		AFTERNOON	15:30-16:30	53
ST MARY'S	LOWEST	MORNING	08:30-09:30	39
		AFTERNOON	15:30-16:30	58
WEST MADARAKA	LOWEST	MORNING	08:30-09:30	44
		AFTERNOON	15:30-16:30	51
12CT/ARBAB	LOWEST	MORNING	08:30-09:30	36
		AFTERNOON	15:30-16:30	52
SBMO	LOWEST	MORNING	08:30-09:30	36
		AFTERNOON	15:30-16:30	48
COUNTYLINK	LOWEST	MORNING	08:30-09:30	47
		AFTERNOON	15:30-16:30	43

(Source: Isaac Were, Personal Publication, TUK, 2020)

Table 3: Highest dwell times

BERTHS	RECORD	PERIOD	TIME OF DAY	DWELL TIME (MINUTES)
INDIMANJE	HIGHEST	MORNING	10:30-11:30	102
		AFTERNOON	11:30-12:30	104
NABOKA	HIGHEST	MORNING	10:30-11:30	56
		AFTERNOON	13:30-14:30	89
HIGHRISE	HIGHEST	MORNING	10:30-11:30	83
		AFTERNOON	12:30-13:30	105
ST MARY'S	HIGHEST	MORNING	10:30-11:30	60
		AFTERNOON	12:30-13:30	91
WEST MADARAKA	HIGHEST	MORNING	10:30-11:30	51
		AFTERNOON	12:30-13:30	77
12CT/ARBAB	HIGHEST	MORNING	10:30-11:30	66
		AFTERNOON	12:30-13:30	66
SBMO	HIGHEST	MORNING	10:30-11:30	59
		AFTERNOON	13:30-14:30	74
COUNTYLINK	HIGHEST	MORNING	10:30-11:30	103
		AFTERNOON	11:30-12:30	103

(Source: Isaac Were, Personal Publication, TUK, 2020)

The hourly average dwell times of various loading areas were analyzed and resultant least and highest dwell times obtained. The highest and least dwell times were used to generate a dwell time curve as shown in figure 3. From Tables 1 and 2, it is easier to spot which vehicles take the longest time and the shortest times to enter and leave the station at different time periods.

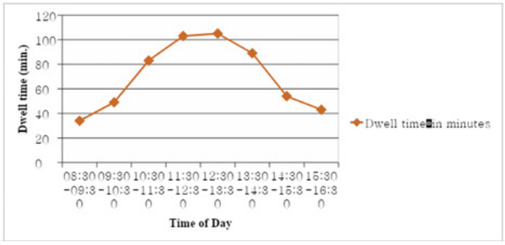


Figure 3: NCBS dwell time curve against time of day

(Source: Isaac Were, Personal Publication, TUK, 2020)

Hourly and Daily Capacity

N.C.B.S hourly capacity was determined to be **10 vehicles/hour,** establishing most of the vehicles dwell times to 60 minutes. From the size of the N.C.B.S a capacity **of 10 vehicles/hour** seems unreasonable and impractical. Instead of vehicles losing time in the highway, most time is spent in the station queuing to access terminal berths.

The study revealed that 80 vehicles are serviced by the N.C.B.S daily. With Improved dwell time management, dwell times could be cut to 30 minutes, doubling the capacity from 1 vehicle/hour, to 2 vehicles/hour and the daily capacity to 160 vehicles/day.

Table 3: Hourly and Daily average capacities to nearest whole numbers

BERTHS	q_c mean	N_e	$N_e.q_c$ mean	Vehicle/ hr.	Vehicle/ day
INDIMANJE	0.5896	1	0.6	1	8
NABOKA	0.7235	1	0.73	1	8
HIGHRISE	0.6321	1	0.64	1	8
ST MARY'S	0.7654	1	0.78	1	8
WEST MADARAKA	0.8404	1	0.85	1	8
12CT/ARBAB	0.8926	1.85	1.65	2	16
SBMO	0.9152	1	0.92	1	8
COUNTYLINK	0.6272	2.525	1.58	2	16
TOTAL VEHICLES				10	80

(Source: Isaac Were Personal Publication, TUK, 2020)

Discussion

The results revealed that NCBS recorded high dwell times (up to 105 minutes against Nairobi City County guidelines of 45 minutes). High dwell times and low capacities were mainly due to; 1) Restriction of trips i.e. 2 trips for each vehicle, until another round of 2 trips begins. 2) Queuing of vehicles trying to access terminal berths. 3) Breaking down of vehicles in the berths and in queues to berths.4) Improper marking of berths and service lanes. 5) Lack of designated areas for traders within the station, causing conflict with both passengers and vehicles. 6) Lack of a passenger information system.

Station based fleet management system

Dwell time management is key in enabling efficiency in bus stations. A method for dwell time management proposed in this paper is the use of AVL system. This system has components such as; 1) Tracking device embedded in the vehicles with details such as; vehicle plate number, fleet number, capacity and route plied. 2) Monitoring platform housing the server where all system information such as real time vehicle location used to schedule available vehicles trying to access the berths within the station, available berths to be occupied, allowable number of vehicles queuing behind the berth. Here this information is relayed and stored. 3) User Interphase (UI) which include display screens like Variable Message Signs (VMS) and mobile applications which display vehicle information such as; availability, route plied, occupancy and expected departure from the station.

Advantages of AVL systems for NCBS

Given that there are already established routes to follow by the vehicles using NCBS, the station-based system can be used to; 1) Manage fleet i.e. controlled movement within the station and schedule adherence for berth access. 2) Assist passengers to make travel decisions and plan for their trips. 3) Allow booking for seats and payment of bus fares using Automatic Fare Collection System (AFCS).

With a proper automated transport system, ideal capacity and dwell time can be established through continuous monitoring and adjustment, according to prevailing conditions, so as to enhance efficiency of bus stations. When AFCS for bus fare payments is integrated within the system, the AFCS would use the M-Pesa option for ticket payment or other options such as tap and go or Near Field Communication NFC using smart phones.

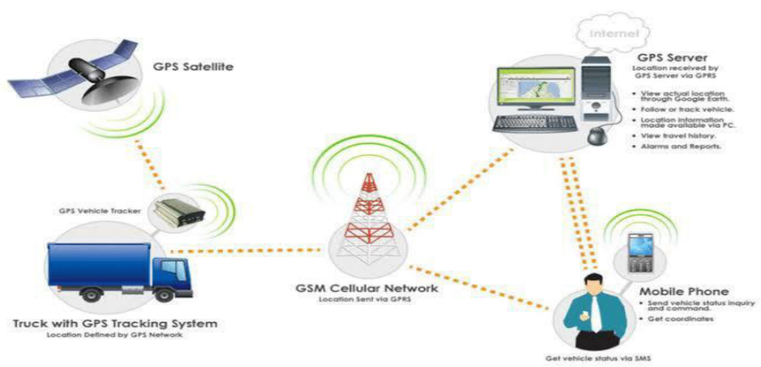


Figure 4: GPS Network Operation (Source: Saghaei, H, 2016)

Conclusion

The paper, demonstrates that dwell times were extremely high (up to 105 minutes) and the station capacity was established at 8 vehicles/hour, culminating to 80 vehicles per day. We have introduced the usage of AVL system such that we can have stationed based fleet management providing an optimized real time service to passengers using NCBS.

AVL system integrates vehicle tracking, remote booking, visual display of schedules which allows passengers flexibility of choices to travel. It also aids in avoiding queues besides furnishing the stakeholders with critical vehicle information to help manage fleet within the station & improve efficiency. Use of AVL systems have been proven to encourage vehicle discipline and security of its users. The overall station capacity could be improved to service about 2 vehicles/hour per berth through application of this station based AVL system, meaning an average dwell time of between 25 to 30 minutes. This also improves headway and promotes efficiency.

Acknowledgement

Much appreciation to my able co-authors Eng. Nicholas Airo and my colleague Isaac Were for allowing constant consultations and discussions about this paper and their immense contribution on helping improve the ideas and present them in the most appropriate manner.

REREC Going Smart to Save Energy, Conserve Environment

FOLLOWING the enactment of the Energy Act 2019, Rural Electrification and Renewable Energy Corporation (REREC) has an expanded mandate of spearheading Kenya's green energy drive, in addition to implementing rural electrification projects. One of the mandates of the Corporation under the new Act is to support the establishment of Energy Centres in the counties.

The Energy Centres which were previously under the Ministry of Energy, are the technical outreach arm of REREC in the promotion of renewable and sustainable energy technologies and conservation techniques such as biogas, biomass, solar energy applications and improved cook stoves among others

There are currently sixteen (16) Energy Centres operated by REREC; i.e., Bukura, Busia, Garissa, Jamhuri, Kericho, Kisii, Kitui, Lodwar, Marsabit, Migori, Mitunguu, Mirangine, Mtwapa, Uasin Gishu, Wajir and Wambugu.

In recognizing that technology development in the energy space is moving at lightning speed and in an effort to keep up, REREC has proposed to develop a number of smart technologies in the Energy Centres, which are envisaged to be centres of excellence on renewable energy, energy efficiency and sustainability.

The first of such technologies is the Smart Solar Photovoltaic (PV) System, which is envisaged to allow remote monitoring and control solar systems. Most of the Solar PV systems are currently controlled manually in terms of energy production, utilisation and maintenance. Remote monitoring can improve the performance of solar systems for the end users in order to maximise savings. A smart solar PV system is fitted with remote monitoring system composed of smart management hardware and software that enable the user to produce, utilise, monitor and track performance, and provide real-time data on their performance from anywhere with internet or mobile phone connectivity.

It also has a smart battery to keep the system running at least cost. A built-in rapid shutdown is activated in case of emergencies for the safety of the users. A communication device is used to send all the important details from the solar energy system to the cloud for monitoring the system over time. This can be done from a central place or within the precincts of the solar system. The system can be optimised to generate the most power during all daylight hours and it is also smart enough to know when something is not right for repairs to be done. The system gives the user control of the energy usage, how much is saved and how to manage the energy at home and also proactively monitor the health of the solar system.

Secondly is the Battery Energy Storage System (BESS). Given the possibility that an energy supply can experience fluctuations due to weather, blackouts, or for geopolitical reasons, battery systems are vital for utilities, businesses and homes to achieve a continual power flow. A BESS is no longer an afterthought or an add-on, but rather an important pillar of any energy strategy. It can be integrated with renewable energy sources, since batteries guarantee a smooth and continuous electricity flow in the absence of the availability of power from renewable sources.

The operating principle of a BESS is such that the batteries receive electricity from the power grid, straight from the power station, or from a renewable energy source like solar panels or other energy source, and subsequently store it as current to then release it when it is needed. When combined with software, a BESS becomes a platform that couples the energy storage capacity of batteries with the intelligence needed to deliver advanced management of energy consumption by harnessing AI, Machine Learning and data-driven solutions. This makes batteries a tool in the effort to offset climate change, because they enable a more flexible way of using energy that lets the user adapt to dips and peaks in demand and supply.

As the world races towards zero carbon emissions in the fight against climate change, e-mobility is another key smart technology that REREC is keen on developing. The transport sector is responsible for close to a quarter of global energy-related carbon emissions due to its heavy reliance on fossil fuels. Future power systems will increasingly be based on Variable Renewable Energies (VREs). Electro mobility (e-mobility) is the concept of using electric powertrain technologies in vehicle information and communication technologies and connected infrastructures to enable the electric propulsion of vehicles and fleets.

REREC Energy Centres will be used as sites to promote electric mobility and to study the impact of long-term evolution of mobility on smart charging. The Energy Centres as sites for public charging are expected to become more commercially sustainable as the electric vehicle market expands. Each Energy Centre will develop business models based on electricity or retail sales combined with grid services and other revenue streams such as advertising of the charging infrastructure, electrical system requirements and electric vehicle prototypes.

In adopting its role as a renewable energy and energy efficiency marketing hub, the Energy Centres will connect energy buyers with renewable energy and energy efficiency projects, thus helping clients save time, money and energy. The hub will be a full service end-to-end energy marketplace where deals between big energy buyers and renewable energy projects will be brokered.

The Energy Centres will be the bridge between the corporate world and the energy world. It will be a marketplace for renewable energy and energy efficiency, where providers will be able to connect with new buyers, and buyers will find best deals. Specific activities may take the nature of structuring innovative long-term Power Purchase Agreement contracts while clearing risks for the parties involved.

Finally, REREC is keen on minimizing the environmental burdens imposed by meetings/conventions through green conferencing. In taking up their role around this duty, the Energy Centres will act as centres of event planners where there will be an application of environmentally preferred practices to waste management, resource and energy use, travel and local transportation, facilities selection, siting and construction, food provision and disposal, hotels and accommodations, and management and purchasing decisions.

Innovation in Drilling of Geothermal Wells to Minimise Environmental Footprint in Menengai and Paka Geothermal Fields

By Eng. Martin Kibiwott Rotich, GDC Directional Drilling Engineer

Introduction

MANY geothermal sites in the world are located in remote and sensitive ecological areas, so project developers must take this into account in their planning processes. Most geothermal sites in Kenya are no exception as they are found in such sensitive ecological areas. Example is the Olkaria geothermal field which is home to a number of wildlife and plant species. The Menengai geothermal field is also a gazetted forest area with various wild animals and specific plant species. The planning of the road network, water line infrastructure, construction of wells pads and steam lines should be such that it doesn't interfere so much with the environment and the local human and wildlife population. In order to minimise most of the environmental impacts such as vegetation removal, soil erosion, land subsidence and landslides caused by road, well pad and steam line construction, the drilling industry has devised an innovative drilling technique of directional drilling where it is possible to drill several wells directed in different directions from a single well pad thus reducing the amount of infrastructure needed in exploiting the resource. This innovative technique has been applied in the Menengai and Paka geothermal fields by Geothermal Development Company (GDC).Geothermal exploitation covers large land areas, for example the Geysers in the US which is the largest geothermal plant in the world with a capacity of approximately 1,517 megawatts covers an exploitation area of approximately 78 square kilometres, which translates to approximately 13 acres per megawatt (Ucsusa,2013) .Without the innovation of directional drilling, a lot of damage to the environment can occur in those large exploitation acreage in opening up roads and constructing well pads.

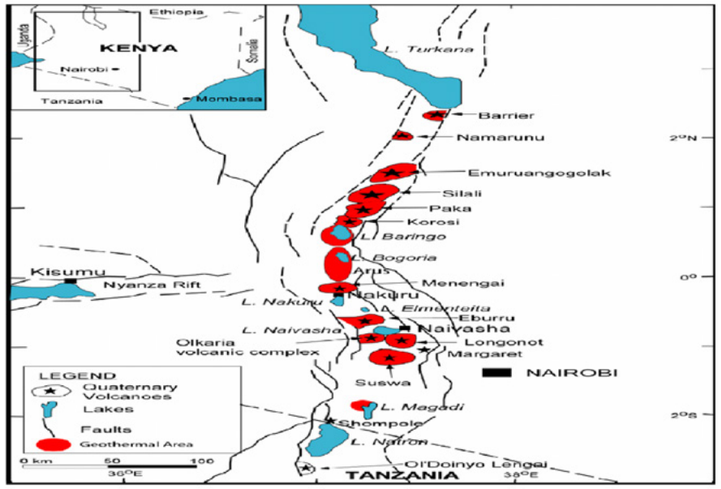


Fig. 1.Location of geothermal prospects in the Kenyan Rift valley system (Suwai, 2011)

Exploitation of the geothermal resource

Geothermal drilling entails drilling of wells to depths of up to 3000 metres or more in order to tap steam from subsurface reservoirs for power generation and/or hot water for direct use applications such as milk pasteurization, green house heating, aquaculture heating, and industrial process heating. Two techniques normally applied in drilling are vertical drilling and directional drilling. Vertical wells are normally drilled during exploration and appraisal drilling, whereas directional drilling is adopted for production wells (Nguyen,1999). Directional drilling in geothermal wells is adopted for a number of purposes:

(1) To intersect as many formation fractures as possible since the well has longer lateral displacement compared to a vertical well

(2) It is economical to drill several wells directed at different directions from one prepared well pad

(3) Side-tracking to bypass a fish or junk in hole

(4) To access inaccessible surface locations like built up areas, mountainous area or water bodies

(5) To overcome environmental restrictions in constructing roads and well pads.

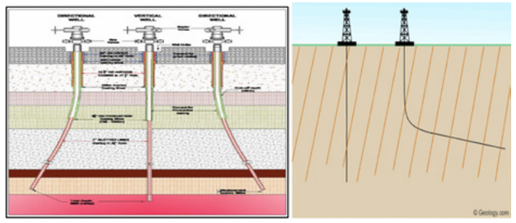


Fig. 2.Directional wells drilled in different directions from one prepared well pad. Directional well intersects as many formation fractures as possible since the well has longer lateral displacement compared to a vertical well (right picture)

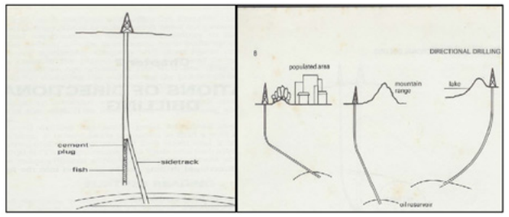


Fig. 3.Side-tracking around a fish and directional wells drilled beneath inaccessible surface locations (Iglis, 1987)

Additionally, where directional wells are drilled from a multi-well site, there are the following advantages:-

- Total site construction costs are reduced.
- Road construction costs are reduced.
- Water supply costs are reduced.
- Waste disposal ponds for drilling effluent can serve a number of wells.
- The cost of shifting the drilling rig and the time taken are both significantly reduced.
- When the wells are completed, the steam gathering pipe work costs are reduced.

Directional drilling technology

Directional drilling entails deflecting the well from the vertical and directing it along a defined trajectory (denoted by inclination and azimuth) to a predetermined target below the earth's surface (Petro skills, 2014). It is conducted using special tools such as whip stocks, jetting bits, and mud motors. The point at which the well is deflected from the vertical is referred to as the kick off point (KOP). At KOP, the well is built gradually with the deflecting surface oriented in the desired direction. By orienting the deflecting surface in a specific direction, called tool face angle, the driller can change the inclination and azimuth of the well path (Maidla and Haci, 2004). To maintain the orientation of the tool face and thus change well bore trajectory, the drill string must not be allowed to rotate when deflecting using a mud motor and jetting bit. When about 15° inclination has been reached in soft formation (8° in hard formation), with the desired hole direction, the Bottom hole assembly (BHA) can be changed (Nguyen, 1999).

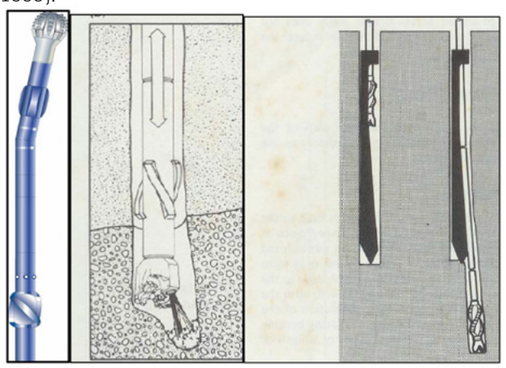


Fig.4.Deflection using a mud motor, jetting bit and whip stock

Regardless of the choice of the deflecting tool, the intention is to point the deflecting surface towards a specific direction when kicking off a well. The survey tool will measure this direction relative to the earth's magnetic North. In order to accomplish this, a small sub called the orienting sub is connected directly above the deflecting tool. The orienting sub has a small key (mule shoe key) that can be aligned to the deflecting surface (referred to as the tool face). When the survey tool is run in hole, it locks into the mule shoe key and hence the survey instrument will measure the direction the key is pointing (Deepak, 2015).

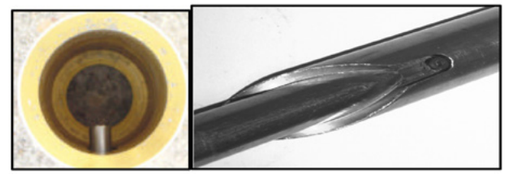


Fig.5. Orienting sub mule shoe key and the survey tool mule shoe slot

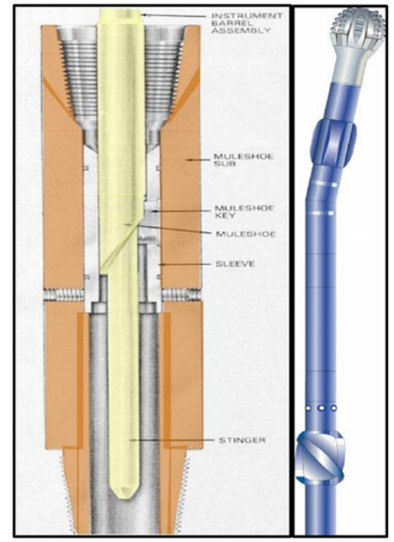


Fig.6. Mule shoe slot locked in the mule shoe key. The direction of the key is the tool face direction (well direction)

Design of Directional wells

Directional wells take on several geometrical shapes depending on desired well characteristics such as required displacement at casing points, well displacement at total depth (TD) and target True Vertical depth (TVD) at TD. This information is critical in deciding on the build and drop rates of the well and the length of the hold section. The geometry of a directional well can be defined by three parameters:

- The built rate
- Hold /drop inclination and
- Kick off point (KOP)

Directional well configuration can be determined by assuming any of the two of the above parameters and then calculating the third. For instance, once the desired build rate and inclination have been established, the kick-off point can be determined. Built rates are mostly chosen to minimise fatigue in drill pipe, minimise key seat possibility and minimise torque and drag. The optimum build/drop rates in conventional wells vary from place to place but are commonly in the range of 1.5° to 3° per 100ft (30m) to avoid severe dog legs (Slumberger,1996). Basic types of directional wells include:

Build & Hold (J-well)

J-shape well has a vertical hole to a relatively shallow depth, the KOP. At KOP, the well is steadily and smoothly deflected until a maximum angle and the desired direction are achieved. At the end of the built point, the hold/tangent section is drilled at the specific inclination until the total depth is reached. The wellbore hits the target at the maximum build-up angle. The hold inclination is determined from the required final well displacement and TVD at TD. This design is used when drilling shallow wells with single producing zones (Petro skills, 2014).

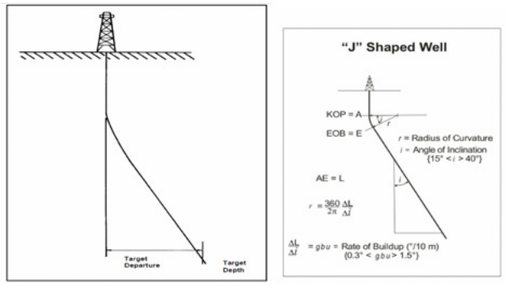


Fig.6. J-shape well (design calculations on the right)

S-Trajectory (Build, hold and drop)

Deflection is done at a relatively shallow depth and the well inclination is built to a specified value. The angle and direction are maintained until a specified depth and horizontal departure has been reached. Then, the angle is steadily and smoothly dropped until the well is near vertical. Thus, the wellbore hits the target vertically. S-type wells are generally used where multiple pay zones are encountered.

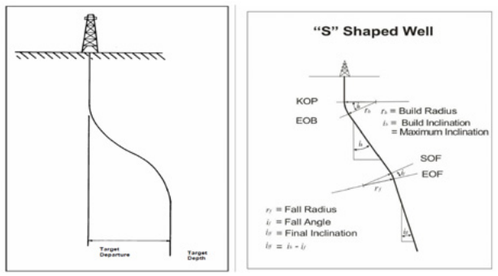


Fig.7. S-shape well (design calculations on the right)

Continuous build to target

The well is characterised by deeper kick off and small horizontal departure. The inclination is continuously built through to the target. Less expensive. This type of well is generally used for multiple sand zones, fault drilling, salt dome drilling, and stratigraphic tests.

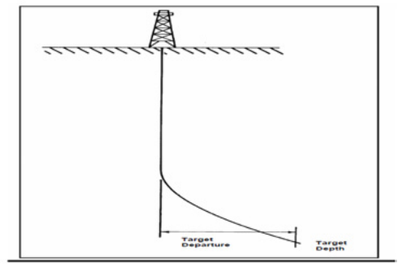


Fig.8. Continuous build to target well

Horizontal or extended reach well

This type of well is designed to have high inclinations and large horizontal departures. Horizontal wells will have an inclination greater than 80° (Mason et al, 2003). Applied where there is a long horizontal pay zone.

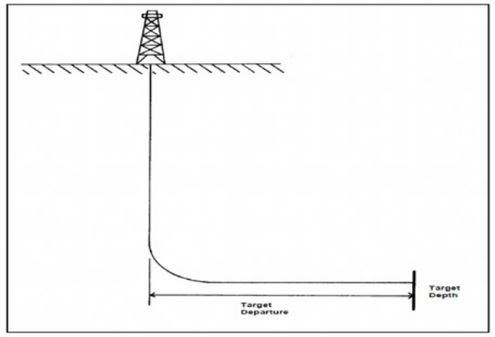


Fig.9. Extended reach well

The most common designs in directional drilling of the geothermal wells is J-shape and the S-shape (Hole, 1996)

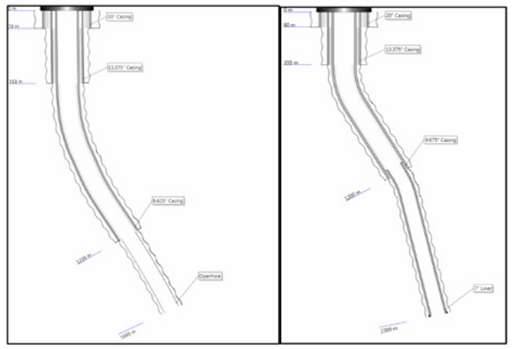


Fig.10.Complete directional drilled wells with casing (J-shape and S-shape)

Sample directional well drilled in Paka Geothermal Field (PW-06A)

The well was planned as a J-type well directed at an azimuth of N55E° with a target depth of 2500-3000 metres. The kick-off point was planned at 350m, at which inclination angle was progressively built at the rate of 1.5° per 30m using a mud motor to attain a horizontal departure of at least 250 metres at the production casing depth as required by the geologist. The 13 3/8" anchor casing is set in a vertical hole at a depth of 338m. At a depth of 678m the mud motor assembly was pulled from the hole and a rotary hold assembly run in. Drilling of the 12¼" hole continued to a measured depth (MD) of 987m where final inclination of 27° was reached. The 9 5/8" production casing was run in and set with the shoe at 977 m MD. An 8½" "locked-up" rotary drilling assembly Sperry-Sun, 2004) is run in and the well drilled to the final measured depth of 2800m. The resulting target point has a lateral displacement of 950m from the wellhead, in a direction of 50° North East. The vertical section and plan views of this well is depicted in Figures11 and 12 below.

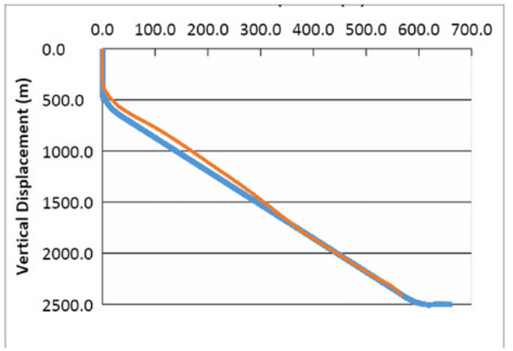


Fig.11. MW-15A Vertical section plane view (blue-planned path, red-actual path)

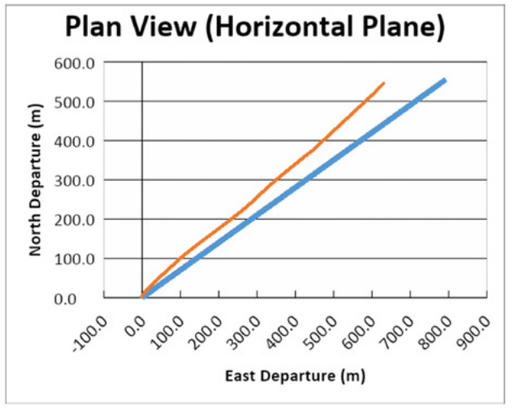


Fig.12. MW-15A Plan view (blue-planned path, red-actual path)

The idea of drilling directional wells from a multi-well site has been applied in several geothermal fields in the world including the Olkaria field in Kenya (Theuri, 2014) and Mokai geothermal field in New Zealand (Hole,1996).Below is a map of Mokai geothermal field in New Zealand showing 6 wells drilled from a single well pad.

Fig.13. Mokai, Well Pad MK-II with Wells MK-10, MK-11, MK-12, MK-13, MK-14 and MK-15 as drilled Well Tracks

(Cased sections indicated in grey/green; Production sections indicated in white). (Hole, 1996).

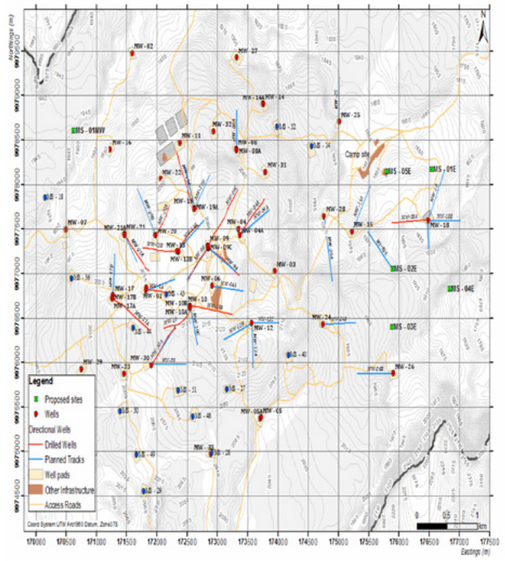


Fig.14. A map of Menengai Geothermal Field showing location and direction of drilled and planned directional wells

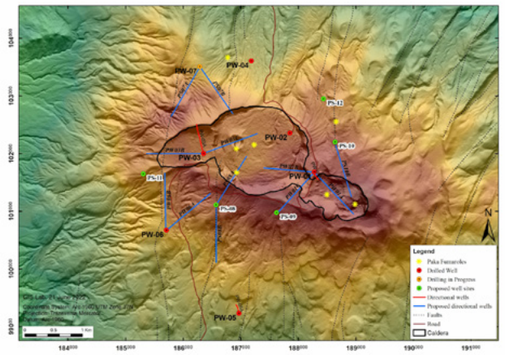


Fig.15.A map of Paka Geothermal Field showing location and direction of drilled and planned directional wells

Conclusion

From the above maps of Menengai and Paka geothermal fields a lot of environmental impacts resulting from road and well pad construction were mitigated by drilling several directional wells in single well pads. In Menengai geothermal field, single steam lines connected to the several wells drilled in a single well pad also reduce the impact of clearing vegetation to pave way for construction of steam lines; without the innovation of directional drilling it would have required several steam lines be constructed to connect to single wells drilled in several well pads.

Telecommunications Industry in Kenya: Where We Started and What Future Holds

By Maureen Mwangi

TELECOMMUNICATION is defined as the transmission of information by various types of technologies over wire, radio, optical, or other electromagnetic systems. The common types of telecommunication networks are but not limited to; ARPANET, Ethernet, Internet, and Wireless networks. Telecommunication reduces the time required to pass a message from the sender to the receiver and has been made easier through mechanical telegraphs.

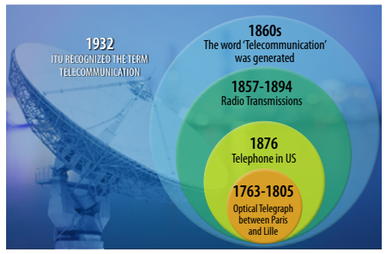
Evolution of Telecommunication

The evolution of the telecommunications industry has undergone several phases. The growth of telecommunication is credited to the pioneers who effortlessly created new applications, which have been further improved in the current times due to the growth of sustainable digitization.

The evolution of the telecommunications industry cannot be attributed to one event, it has been a steady and gradual process. It traces back to 1763-1805 when Claude Chappe successfully operated an optical telegraph between Paris and Lille. In 1876, Alexander Graham Bell invented the telephone in the United States for a two-mile stretch. The line of operation was between Cambridge and Boston. Heinrich Hertz laid the basis for radio transmissions in 1857-1894, which was later taken over and made operational by Guglielmo Marconi after the death of Hertz.

The word communication was derived from 'communicatio', the process of exchanging information from one channel to another through a medium. The word 'telecommunication' was generated in the 1860s by *Edouard Estaunie, who defined it as information exchange by means of electric signals.* His definition limited telecommunication to electric signals but later it became more complex and more definitions came up. For centuries, the transmission of information was done through drums in Africa and smoke signals in North America and China, mostly to confirm prearranged messages.

In 1932, the International Telecommunication Union (ITU) officially recognized the term telecommunication and defined it as *"any transmission, emission or reception of signs, signals, writings, images, and sounds; or intelligence of any nature by wire, radio, visual, or other electromagnetic systems."*



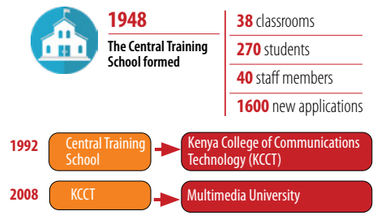
Telecommunication services in East Africa

In East Africa, the earliest telecommunication connections to the outside world were the submarine cables linking Zanzibar, Mombasa, and Dar-es-Salaam. The cables were laid by the East and South Africa Telegraph Company in **1888**.In Kenya, the construction of a telegraph network began with a 200-mile coastal line linking the Port of Mombasa with Lamu. Extension to the interior of the country began in 1896 in conjunction with the building of the railway system. The extension of the telegraph line even overtook the railway construction, reaching Nairobi in **1898 and Kampala and Entebbe in 1900. (Patrick Mugo, 2004. The determinants of telecommunications growth in Kenya)**

From 1948 to 1977, East African Posts and Telecommunication Cooperation (EAP&TC) was established after the II World War to provide telecommunication services for Tanganyika, Uganda, and Kenya. Before the formation of EAP&TC, postal services were delivered via Kenya-Uganda Railway. The East African Posts and Telecommunications Administration enjoyed a privileged constitutional position. It was responsible for the Central Legislative Assembly and raising its capital by commercial loan, the Post Office suffered little government control over its political or financial policies. This structure had no precedent. It developed out of the problems inherent in the operation of an inter-territorial service. **(Alan Brian Smith, History of the East African Posts and Telecommunications Administration)**

Telecommunication Engineering Education in Kenya

The rising demand for telecommunication services led to the emergence and need to train professionals specialized in telecommunication operations. The Central Training School was then formed in 1948 to bridge the gap. The facility offered training in telecommunication and postal operations. The facility was equipped with 38 classrooms that catered for 270 students and 40 staff members. The facility that was located in Nairobi, started gaining popularity and started receiving up to 1600 new applications.



The expanding economic variation in Kenya, Uganda, and Tanzania led to the collapse of the East African Community in 1977. As of 1977, control of the training facility vested in Kenya Posts & Telecommunications Corporation (KPTC) after the collapse of EAC where it was training solely Kenyan postal workers.

In 1992, Central Training School was renamed the Kenya College of Communications Technology (KCCT) and extended its scope to training more learners not limited to Kenyan postal workers only. KCCT operated and drew its academic policies from Jomo Kenyatta University of Agriculture and Technology (JKUAT) having operated as a constituent of the institution.

In 2008, KCCT transformed into the Multimedia University of Kenya under a legal notice No.155 of 2008. The facility underwent transformational change thereby being upgraded to a fully-fledged University in 2013. To-date Multimedia University still offers academic training in Electrical & Telecommunications Engineering. The Institution is investing heavily to enhance opportunities and expand its capacity in training holistic telecommunication engineering professionals.

Penetration and Growth of Telecommunication in Kenya

Kenya Post and Telecommunications Corporation (KPTC) was the sole provider of postal and telecommunications services, having been established in April 1999. The KPTC later split into the Communications Commission of Kenya (CCK), Postal Corporation of Kenya, and Telkom Kenya with the mandate of telephony services. As the population grew and economic activities evolved as the world become a global village, demand for telecommunication services increased there was need to modernize telecommunication operation, this saw the birth of Safaricom and Kencell.

The Communications Authority of Kenya (CA) is the regulatory authority for the communications sector in Kenya.Established in 1999 by the Kenya Information and Communications Act, 1998, the Authority is responsible for facilitating the development of the information and communications sectors including; broadcasting, cybersecurity, multimedia, telecommunications, electronic commerce, postal and courier services.

This responsibility entails:

- Licensing all systems and services in the communications industry, including; telecommunications, postal, courier and broadcasting.
- Managing the country's frequency spectrum and numbering resources.
- Facilitating the development and management of a national cyber security framework.
- Facilitating the development of e-commerce.
- Type approving and accepting communications equipment meant for use in the country.
- Protecting consumer rights within the communications environment.
- Managing competition within the sector to ensure a level playing ground for all players.
- Regulating retail and wholesale tariffs for communications services.
- Managing the universal access fund to facilitate access to communications services by all in Kenya.
- Monitoring the activities of licensees to enforce compliance with the licence terms and conditions as well as the law.

Kencell, a mobile company was jointly launched by Sameer Group, local entrepreneur Naushad Merali's investment company together with Vivendi in 2000. In 2005, Vivendi, the French co-owner of Kencell, sold its 40 per cent shares in Kencell to Celtel International, the latter adopted a pan-African marketing strategy. Celtel later rebranded to Zain Kenya and now Airtel due to a change in shareholding. Safaricom, meanwhile, became the market leader.

Safaricom, which started as a department of Kenya Posts & Telecommunications Corporation, the former monopoly operator, launched operations in 1993 based on an analogue ETACS network and was upgraded to GSM in 1996 (license awarded in 1999). Safaricom was incorporated in April 1997 as a private limited liability company after being hived from Telcom Kenya. It was converted into a public company with limited liability on 16 May, 2002. *(Source: Safaricom Company Profile & History).*

In 2007, France Télécom (**Orange Kenya)** acquired 51% of Telkom Kenya's shares, while the remaining shares were held by the Kenyan government.

In March 2008, Telkom Kenya launched its mobile network under the brand Orange Kenya, ensuring that it was no longer a fixed-line business but a fully integrated telco service provider.
In 2009, Telkom was part of the team that was involved in the setting up of the country's first submarine cable and has shareholding in TEAMS (The East African Marine System) and LION II (Lower Indian Ocean Network II).

In 2011, Telkom Kenya launched its 3G network in the country.

In November 2012 it was subsequently confirmed that the Kenya government would retain 40% shareholding down from 49% with the remaining shares held by France Télécom.In January 2013, France Télécom increased its stake in Telkom Kenya to 70% as a consequence of the government's failure to provide its full portion of 2012 funding.

On June 13th 2016, **Telkom Kenya** went through a change of ownership. Helios Investment Partners, the largest African only Private Equity firm, acquired a 60% stake in Telkom and the Government of Kenya increased its stake from 30% to 40%.This saw the exit of Orange Kenya from the Kenyan market and Telkom Kenya was to continue using Orange branding for a period of 18 months, after which the company would be required to rebrand.

Although wireless telecommunications have gained popularity around the globe over the years, it took time before it could largely spread to the public domain in Kenya.

The telecommunications industry is undergoing radical transformation, creating exciting new opportunities and new challenges for infrastructure and service providers. The modern world has proven that Information Communications Technology (ICT) is the bedrock of the global economy.

For developing countries to effectively compete with the world's economic giants, they have to embrace ICT. The current world heavily relies on Information and Telecommunication to successfully transact business. The development of telecommunications has and will have a positive impact on the economy, and this impact has been felt in every sector. This means Kenya has to embrace and invest massively in telecommunications to promote the growth of the country's GDP. Both the government and private sector heavily rely on information. Through telecommunications, the world has become a global village, and it has become easy to facilitate national and international trade.

Table 1.3 Mobile Telephony Services as of 2015/19

Operator	Jun-15	Jun-16	Jun-17	Jun-18	Jun-19
Safaricom PLC (Mpesa)	21,338,328	17,120,278	22,624,298	23,946,174	26,900,772
Telkom kenya Limited (T-Kash)	192,531	193,831	194,445	63,023	76,061
Airtel Networks limited (Airtel Money)	3,119,812	4,853,869	1,530,645	3,619,415	3,681,194
MobiKash	1,714,170	1,772,466	1,772,466	-	-
Mobile Pay Limited (Tangaza)	503,556	503,556	87,786	90,442	94,416
Finserve Limited (Equitel Money)	873,643	1,860,647	1,864,838	1,959,009	1,882,440
Total Number of Subsribers	**27,742,040**	**26,304,647**	**28,074,484**	**29,678,063**	**32,634,883**

Source: Communications Authority of Kenya Report 2018/19

Telecommunication is also critical for national security. Kenya's former President Uhuru Kenyatta launched the National Security Telecommunications Service (NSTS), an integrated communications platform aimed at enhancing sharing of information between security agencies. He said this would enable the military, police and the National Intelligence Service (NIS) to communicate at intra- and inter-agency levels.
Enhanced internet access has been made possible with the improved broadband infrastructure. Fibre Optic cables have turned out to be a critical bridging element of the large digital divide in most developing countries. Other than the fibre optic cables, there is also the satellite transmission, which refers to communication that takes place between any two earth stations through a satellite. Through this communication, electromagnetic waves are normally used as carrier signals.
However, insufficient structures in the government have derailed the implementation and enforcement of telecommunications services in Kenya. The question remains, is Kenya ready for growth and full adaption of telecommunications?

Compiled from Communication Authority of Kenya digital library

Young Engineers Committee Report on the 8th African Engineering Week and the 6th FEAO Conference in Addis Ababa, Ethiopia

FAEO President Eng Carlien Bou-Chedid, YEC-FAEO Chairperson Eng Doreen Kirima, Eng Beyordanos Tetemke, the chairperson of Young Engineers Committee in Ethiopia and Eng Diallo Mamadou Cellou, the chairperson of Young Engineers Committee in Burkina Faso pose for a photo with graduate engineers in Ethiopia during the African Engineering Week. In the photo is Eng. Ovens F Ehimatie, the Executive Director of FAEO, Eng Rizwan Qadri, the President of the Institution of Engineers of Tanzania, and Eng Aishatu Aliyu Umar, Africa representative at the World Council of Civil Engineers.

Eng Doreen Kirima (YEC-FAEO chairperson), Eng Beyordanos Tetemke (chairperson of Young Engineers Committee in Ethiopia) and Eng Diallo Mamadou Cellou (chairperson of Young Engineers Committee in Burkina Faso) enjoy a cup of coffee at Tomoca coffee shop. With them is Eng Maxime Somda (President of the Order of Civil Engineers of Burkina Faso).

Ms Charity Amani makes a presentation on "How Green are Nairobi Green Walls? A Review of Nairobi's Expressway Green Walls". Her participation in the conference was a proof of commitment by the Institution of Engineers of Kenya in supporting student and graduate engineers.

The Women in Engineering Committee in collaboration with the Young Engineers Committee visited Nazret School. During the visit, the students were taken through different engineering disciplines and the role of engineers in society.

AFTER months of discussions, zoom meetings, webinars and a lot of planning, Addis Ababa was ready to receive guests for the 8th African Engineering Week (AEW) and the 6th Federation of African Engineering Organisation (FEAO) conference.

The reception was out of this world. The hospitality of Ethiopians was heartwarming right from the time we arrived, being welcomed at the Airport to the very last day of the conference. Addis was home. The venue for the conference at the Science Museum, the dinner galas and the visit to the city gave a true Pan Africanist experience.

The AEW was graced by Ethiopia President Sahle-Work Zewde, Ethiopian Minister of Labour and Skills Mufriyat Kamil, FAEO President, Eng Carlien Bou-Chedid, the 21 country presidents of Engineering institutions and international delegates.

The Young Engineers Committee (YEC) actively participated in the conference, with the chairperson and a student engineer from Kenya making presentations.

The Silver medal awarded to Eng Doreen Kirima, Chairperson of the YEC-FAEO

Eng Erick Ohaga, the President of the Institution of Engineers of Kenya, poses with Eng Doreen Kirima (Chairperson of the YEC-FAEO) and Ms Charity Amani (A Civil Engineering student at the University of Nairobi, Kenya).

The Chairperson of the YEC-FAEO, Eng Doreen Kirima, presented the findings on Working Post Covid-19 survey; Expectations of Young Engineers Across Africa. The message brought home was "Generation Z is with us" and inclusion and diversity in engineering is inevitable for sustainable development in Africa and the world at large.

The highlight of the conference was the Silver medal award to Eng Doreen Kirima, the YEC Chairperson, for excellence, commitment and dedication for the most outstanding committee.

Words cannot express enough the pride we felt to be in Addis Ababa. Apart from the conference, the side talks, the interaction with Ethiopian crowds, schools, visit to historical sites and modern places, a week was just a drop in the ocean.

After the conference, the young engineers made it to the most popular coffee shop in Addis, 'Tomoca', at the city centre where the magnanimous Municipality of Addis Ababa is standing tall.

Car & General Investing in Green Mobility for Sustainable Climate Change Solutions

By EiK Correspondent

CLIMATE Change has brought up the urgent need for countries to adopt means to reduce global warming and pollution of the atmosphere. The goal of Paris Agreement on Climate is to reduce temperatures from rising more than 1.5 degrees or 2 degrees Celsius above pre-industrial levels.

As part of their efforts to curb climate crisis, automotive distributors in Kenya are shifting gears to invest in Electric Vehicles (EVs) and charging infrastructure in major cities.

Car & General, a power generation, automotive, construction and industrial engineering products specialist in East Africa has started its move into green mobility.

> "The future of Electric Vehicles in Kenya is taking the right shape. In the next six years, 30% to 40% two wheelers and three wheelers will be electric with several charging infrastructures. The challenge comes in remote and off-grid areas where infrastructure is a challenge," says Vijal Gidoomal, Car &General Chief Executive Officer.

Mr. Gidoomal adds, "For the four wheelers, the penetration of EV into the market will not be very high because it heavily depends on the infrastructure set up. The government needs to invest in infrastructure for EVs for full adoption of electric mobility in Kenya. Consumers need to be assured that local manufacturers are able to manufacture quality batteries to match Kenyan terrains."

He says the company is working towards and heavily investing into green mobility as the industry shifts gears towards that sector. To this end, the firm plans to launch an electric three wheeler program in March with a fixed charged battery and swappable battery to make it convenient for the consumer to charge from their homes.

In the next 10 years, says Gidoomal, internal combustion batteries will be outdated and the company has to remain relevant to fit the current market needs.

He calls upon the government to support the development of Electric Vehicles infrastructure to expand the market. The sector has a potential of growth amid the United Nations push to achieve 1.5 to 2 degrees Celsius temperatures around the globe.

A Technical personnel working at Car & General

Telemedicine Adoption at Kenyatta National Hospital

By Eng. Richard Binga, CE, CEM, MIEK

Introduction

KENYATTA National Hospital is a public hospital mandated to provide specialised medical care, facilitate training and research, and participate in policy formulation. The hospital has been delivering its mandate since its establishment in 1901 as King George Hospital. It was operated as a department of the Ministry of Health until 1987 when its status changed to a State Corporation through Legal Notice No 109 of 6th April 1987.

> Over the years, KNH has grown to its present capacity of 1,800 beds and attends to an annual average of 700,000 inpatient nights and 600,000 outpatients. It offers specialised healthcare services to patients from the Great Lakes Region, Southern and Central Africa, mainly on referral. These services include open heart surgery, neurosurgery, orthopaedic surgery, reconstructive surgery, burns management, critical care services, newborn services, ophthalmology (cornea transplant), oncology, palliative care and renal services (including kidney transplantation), among others.

The hospital also provides training facilities for the University of Nairobi (College of Health Sciences) and the Kenya Medical Training College (KMTC). KNH works closely with the Kenya Medical Research Institute (KEMRI), Government Chemist, National Radiation Protection Board, National Public Health Laboratories Services (NPHLS), National AIDS and STIs Control Programme (NASCOP), National AIDS Control Council (NACC), National Blood Transfusion Services (NBTS) and African Medical and Research Foundation (AMREF), among other linkages and collaborations with other international institutions in providing various clinical services, outreach programmes and research.

Background

Rapid advances in Information Communications and Technology (ICT) worldwide have contributed significantly to the improvement of health outcomes for patients. This has resulted in smarter and more efficient ways of working and offering solutions to the hospitals and patients. In addition, citizens are becoming more technically savvy, demanding instant connectivity and efficient services.

Telemedicine is the remote consultations, diagnosis, treatment and e-theatre of patients via means of telecommunications technology using a platform that connects other health facilities and patients to doctors. The country has embraced e-health as one of its priorities in its health policies as means of enhancing access, affordability and quality of care. Several initiatives have been put in place to support the establishment of telemedicine. The pilot telemedicine project was done at Kenyatta National Hospital, linking it to Machakos Level Five Hospital. This linkage has enabled KNH to provide expertise to Machakos Level Five Hospital, which has led to realisation of positive clinical outcomes. In view of this, there is a need for expansion of the telemedicine services to other regions of the country.

Telemedicine – Bridging the gap in Healthcare access

The Covid-19 pandemic effected healthcare globally, it revolutionised service delivery and enhanced digital transformation in the health sector countrywide. KNH made significant progress during the pandemic period by adopting the Hub and Spoke model, which has positioned it as a central hub for telemedicine, partnering with county referral hospitals plugging in as spokes. This model entails an arrangement of service delivery assets into a network consisting of an anchor establishment (hub) that offers a full array of services complemented by secondary establishments (spokes) that offer a more limited-service array, thus routing patients who need heightened intensive services to the hub for treatment.

The practice of telemedicine entails the use of a telephone for consultations between patients and clinicians and the use of radio to link emergency medical personnel to medical centres. On the contrary are largely experimental innovations such as telesurgery in which a surgeon receives visual and tactile information to guide robotic instruments to perform surgery at a distant site. In between the two ends of the spectrum lies an array of video, audio, and data transmission technologies and applications.

The relatively expensive interactive video conferencing allows clinicians to see, hear, examine, question, and counsel distant patients for real-time diagnostic and therapeutic purposes. Through technology, digital images and other information can now be saved and transmitted cheaply to consultants, who in turn receive and interpret them when convenient, thus offering more scheduling flexibility for the parties on both ends of the communication link. KNH management says that technologies will remain integral to inpatient care, with a multiplicity of current and possible uses in professional education, research, public health, and administration. This is despite many forms of clinical medicine failing to be integrated into most facets of healthcare delivery.

Emerging concerns

Telemedicine continues to impact the provision of quality healthcare services globally, its challenges notwithstanding. According to the current developments, some of the notable concerns of telemedicine include;

System development cost

Apart from the required medical issues, setting up a telemedicine infrastructure is costly. A large budget is required to invest in necessary computer equipment and developing tools. The cost of hardware, software, maintenance, as well as qualified personnel, and knowledge transfer can be daunting.

System implantation

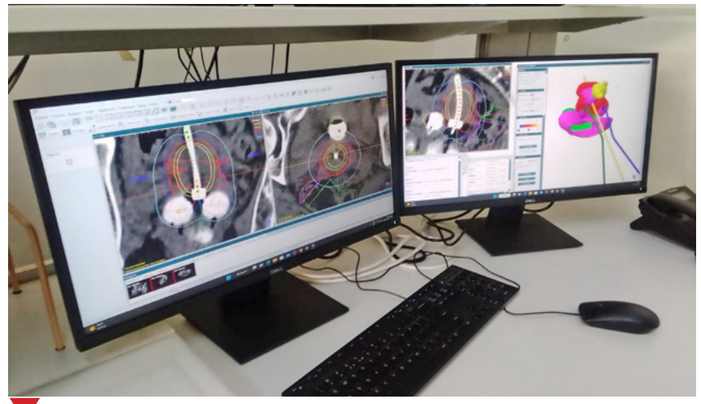
Several parties are involved in the implementation of telemedicine services. Like other fields, telemedicine implementation is not only technological but also managerial. Telemedicine affects traditional medical care processes, and several social concerns may arise, key among them legal, regulatory, security, and human resource issues.

Digital literacy

For telemedicine to be effective, the elderly, who are most affected by the digital disruption, must learn how to use some devices like smartphones and interact with applications such as health-based applications.

Neusoft CT scanner at Diagnostic Centre is connected to Reporting Desk via Cloud. The images from the machine can be accessed at six reporting desks where radiologists can read and write reports.

Somaton CT scanner images have been connected via Local Area Network to Linear Accelerator cancer treatment Planning Room where the Physicists can access and programme further management of the patient.



Somaton CT scanner is also connected to Brachytherapy Unit where the clinician gets data for patient for further management.

Technical Remote Monitoring of the GE Radiology Equipment and Philips Equipment is linked to them for remote support for both users and Biomedical Technical Team.

Diagnostic Centre at Kenyatta National Hospital (KNH).

Digital technology acceptance

Even though digital technology has been integrated in many activities in people's lives, some people do not readily accept it, citing privacy and security.

Diagnostic accuracy

Accuracy of the diagnosis is one of the key concerns that is addressed by face-to-face medical care, which usually brings confidence to patients.

Telemedicine Opportunities

Globally, most countries continue to grapple with a shortage of healthcare workers, coupled with a heightened need for specialised care. Rural populations are most affected by these challenges, compared to their urban counterparts, a situation worsened by health emergencies. Through telemedicine, medical services can be accessed over distance and time via information and communication technology. Opportunities for telemedicine include:

Cost reduction

Costs such as travelling can be reduced as patients can access services online and receive medical care at any place and anytime.

Preventive medical promotion

Preliminary diagnosis and following procedures are performed by using telemedicine, thus possible illness can be prevented or found at an early stage.

Medical education

Telemedicine can be used as a continuing medical education where medical staff and professionals meet, learn, and exchange their knowledge and experience.

Health equality

Limitations of distance and time are tackled by the information and communication technologies where people can access services upon connection to the internet.

Service diversity

Through telemedicine, data delivery and processing are improved. Multimedia streaming over the internet is more efficient. Telemedicine services such as tele-consultations, tele-radiology, tele-psychiatry and counselling, tele-mentoring and couching, tele-dermatology, tele-pathology, tele-nursing, and tele-surgery are addressed.

KNH management endeavours to spur health service delivery as part of the fulfillment of the government's Big 4 agenda, key of these being universal healthcare.

Specific examples of telemedicine use at KNH are telemedicine in Radiology and Cancer Treatment Centre (Radiotherapy) Departments.

Telemedicine for radiology has broadened availability of radiologists who read and interpret imaging reports in a more flexible fashion. The following are the areas where KNH has applied telemedicine;

Technical Remote Monitoring of the GE Radiology Equipment and Philips Equipment is linked to them for remote support for both users and Biomedical Technical Team.

The hospital recognises technology as key driver for service delivery. In this regard, all new projects are designed and implemented with adequate facilities to support digital services with data archiving and retrieval capabilities. KNH is also in the process of rolling out a robust enterprise resource management system to set up a digital platform for its operations, including digital registration and review of patients, dispensing of drugs, management of commodities and other operations.

Eng Richard Binga, CE, CEM, MIEK is the Director Facilities and Services KNH

Telecom Engineering Programme at Moi University has Grown in Leaps and Bounds

By Dr. Emmanuel Mukubwa & Dr. Chege Simon

Students demonstrate how to use telecommunication equipment at Moi University laboratory.

TELECOMMUNICATION engineering education in Kenya was first introduced in 1948 under the central training posts (CTS). The CTS was later upgraded to Kenya College of Communications Technology (KCCT) in 1992 under the Kenya post and telecommunication corporation (KPTC). Since then various institutions have come to offer telecommunication engineering education at different levels including certificates, diplomas, undergraduate and later postgraduate courses. Telecommunication as an industry came to limelight at the advent of mobile and wireless communication under the trade name Global System for Mobile communication (GSM) which was introduced into Kenya in 1999 through Safaricom under KPTC. This created the need for expertise to build, operate and maintain the GSM networks. Initially the service providers had to rely on expertise from outside the country. This further created the impetus in telecommunication engineering training in Kenya. This saw Safaricom seeking collaboration with universities to fast track the telecommunication engineering training in Kenya.

> Telecommunication Engineering education programmes in Kenyan universities have undergone tremendous evolvement since inception at pioneer universities in Kenya – the University of Nairobi and Moi University.

The Kenyan universities offering Telecommunication Engineering degree courses include Jomo Kenyatta University of Science and Technology, Dedan Kimathi University of Technology, Multimedia University and Kenyatta University. Several other colleges offer diploma in Telecommunication Engineering.

At Moi University, the Department of Electrical & Communications Engineering was established in October 1986 as one of the pioneer Departments in the Faculty of Technology. The Department initially offered a Bachelor of Technology (BTech) degree in Electrical & Communications Engineering since 1986 to 2010. In 2010 Safaricom and the university signed an MoU to collaborate on telecommunication engineering training under the Department of Electrical and Communication Engineering. This birthed the telecommunication engineering education at Moi University. Since then this has grown in leaps and bounds to become a full-fledged programme. Now, quite a number of Telecommunication Engineers owe their career to the Telecommunication Engineering programme at Moi University.

In the first two years of the bachelor programme, students are introduced to a wide range of basic science and engineering topics such as chemistry, calculus, engineering drawing, circuit and network theory, mechanical engineering, etc. In the third, fourth and fifth years, courses are more specialised and industrially oriented, including optical communication, signal processing, microprocessor design, image processing, computer communication, cellular communication, digital signal processing, tele-traffic engineering and engineering project. The lectures and laboratories, including industrial training, provide the student with invaluable experiences and knowledge of the design and implementation of industrial system. Though the Telecommunication Engineering training in our labs at Moi university is not fully operational, the mobile lab comprises components that would normally be found in a commercial mobile network operator. They include a mobile switching centre, a media gateway, a base station controller and a microwave digital radio link. The mobile lab was set up with the help of Safaricom Limited, Huawei Company and the host institution. When the lab is completed and commissioned, the department will be able to produce graduates in telecommunication engineering who will literally hit the

ground running.

The higher education programmes in Kenya have grown very rapidly to meet the needs of the explosive growth in the telecommunications industry. The telecommunication engineering programme in Moi University, for instance, has experienced tremendous growth, with the number of students taking up the course doubling since its inception. However, the gap between the requirements of the telecom engineering sector and the courses taught at the institutions of higher learning has been widening. In recent times, a lot of emphasis has been placed on developing higher education in emerging technologies in Kenya, although facilities in various institutions, scholarships and encouragement of research activities in the local universities through grants is lacking. The telecom sector in Kenya has also witnessed an unprecedented growth in the last few years. However, in principle, the telecom sector in Kenya remains a service provider and a consumer market. We have hardly made any progress towards establishing any manufacturing unit, product development and research in the telecommunications' engineering sector.

The higher educational degree programmes are very precisely focused on producing quality graduates who have highly refined technical skills. Unfortunately, those skills rarely get utilised in an industry that mainly requires engineers for operation and maintenance related activities. These conflicting interests of academia and the industry are forcing them to diverge needs and not facilitate a university/industry liaison process.

Engineering Education in Kenya remains the major determinant of the country's economic agenda. The demand for increased capacity, enhanced data rates and massively connected machine type devices necessitate a paradigm shift in both Telecommunication Engineering training curricula and student industrial exposure. The uptake of services such as Fibre to the Home, Internet of Things (IoT), Cloud Computing and building of Smart Cities has revolutionised the Telecom industry. However, at the moment the education system offers the industry and society unsatisfactory knowledge and services due to mismatch between the supplied educational talents and the ever changing world of engineering. It is imperative that the Kenyan engineering education be designed to tackle challenges emerging in our societies and industries by providing real tangible practical skills. Moi University has been at the forefront in training Telecommunication Engineers who are ready to enter the job market with the required skills.

With the revival of existing industrial collaborations, establishment of new collaborations and proper training of the staff, Moi University can position itself as a centre of excellence in Telecoms. The department has also ripped big from the Higher Education Partnerships in Sub Saharan Africa (HEPSSA) project that is funded by the British Royal Academy of Engineering. The project objective is to enhance the quality of engineering education and training through academic staff secondment to industry; invitation of industry experts to university as guest lecturers; collaborative research with industry; industry supported curriculum review and knowledge sharing workshops with the goal of producing graduate engineers and technicians who possesses relevant skills, meet the expectations of modern industry and engineering professional bodies. The government, on its part, should take its share by supporting and giving direction to institutions offering Telecommunication Engineering training since the future is technology. In order to produce graduates with employable skills, institutions of engineering must aim at quality while ensuring massification of students into programmes never happens.

Authors

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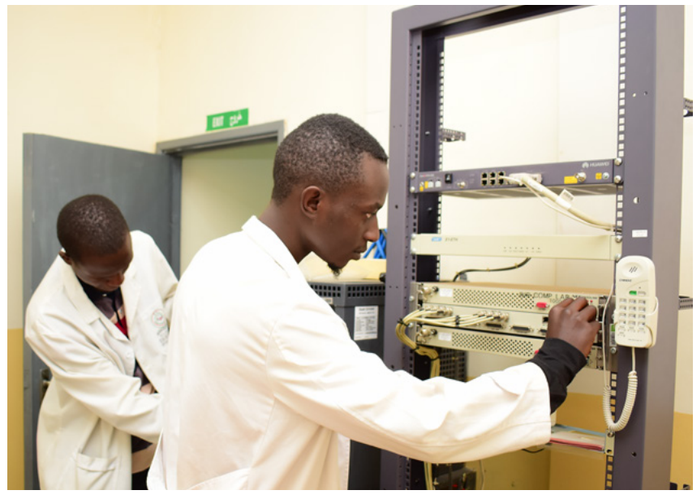
Dr Chege Simon; PhD in Electronic Engineering from the University of KwaZulu-Natal, Durban, South Africa, Master of Technology in Digital Electronic and Communication Systems from JNTUA, India and Bachelor of Technology in Electrical and Communication Systems from Moi University. He is a registered graduate member of both EBK and IEK.



Moi University Telecommunication Engineering students during a laboratory session.

Positive Safety Culture in Kenya Construction Industry

By Eng. Francis Mwangi

SCEE Workshop attendees on a site tour to Kenya Ports Authority. Insert: VC TUM Pro Laila Abubakar issues Attendance Certificate to Prof Eng Stanley Shitote.

THE construction world has a new banner – sustainability. There may be no universal definition but there is consensus that sustainability involves undertaking current needs without impacting on the future needs (Thiele, 2013). There are many facets to the actual implementation, this is because some needs are services and others goods. To ensure optimal utilisation of the resources, there is a need to have a safe working place, a healthy workforce, and a structured way to achieve the two. Safety is therefore shown to be one of the critical elements in sustainability as it has a direct impact on the people who deliver the projects (Muhammed, and Ashiru, 2018).

> The International Labour Organisation (ILO) estimates that, worldwide, 2.78 million deaths and 374 million non-fatal work-related injuries and illnesses occur because of poor H&S Project safety, health, and the environment practices at work.

In financial terms, this equates to 3.94 per cent of the global gross domestic product. The ILO estimates that 160 million new cases of work-related illnesses occur each year and at least 60,000 fatal accidents on formal and informal construction sites worldwide. This means the construction sector accounts for about 17 per cent of occupational fatal accidents while it comprises only 7 per cent of the workforce.

Health and safety on construction projects have a notoriously bad record and many countries have a low inspection rate. These estimates include new categories of illnesses, such as stress-related disorders and mental health issues (Fewings, 2013).

Safety is a state in which hazards and conditions leading to physical, psychological, or material harm are controlled in order to preserve the health and well-being of individuals and the community. This definition is basic but useful in understanding the key requirements for safety.

The goal would be to have a safe ecosystem and this can only be achieved through having a positive safety culture in any workplace. The culture would cultivate elements like Preparedness, Preventiveness, Protective and Responsive. It ultimately leads to a safer environment and optimises on productivity (Pavelschak, 2017).

Moi University, Technical University of Mombasa (TUM) and Konza Technopolis Development Authority participated in a competition hosted by Royal Academy of Engineers and won a grant to improve on safety in the construction sector. They are in the process of stakeholder engagement and on December 9 to 11, 2022 they held a workshop to validate data collected on the construction safety in Kenya as well as get input from the industry's key stakeholders, including Engineers Board of Kenya (EBK), Directorate of Occupational Safety and Health (DOSH), Institution of Engineers of Kenya (IEK), Kenya Power and Lighting Company (KPLC), National Construction Authority (NCA), among others.

It was established that among other issues that continue to introduce unsafe working environment is minimal engagement of professionals where county governments are most affected, limited training on safety as well as an attitude issue. The aim of the workshop was therefore achieved as data that had been collected via online questionnaires was seen to be representative of what the industry faces. The next step will include compiling of the workshop findings and final analysis of the data to allow meaningful recommendation on the issue of a safe work environment (National Academy of Science, 2016).

The emphasis of the study is to entrench the safety culture at the lowest educational level to ensure a culture shift, which is difficult to introduce at the top level. The Five Es of safety are Education, Encouragement, Engineering, Enforcement, and Evaluation. Education would be the strategic intervention that would enhance construction safety in the workplace. The rest will be painful or expensive interventions.

On the sidelines, a speaker was able to point out that the construction work environment is particularly unsafe for women; therefore, concerted efforts to make them more comfortable and safer should be introduced. These would include availability of Personal Protective Equipment (PPE) for all genders; safe, clean and separate lavatory for both genders; breastfeeding area for lactating mothers, among others. This was also echoed by the TUM Vice Chancellor Prof.Laila Abubakar, who said they had undertaken a raft of measures to give both genders a favourable work environment at the Technical University of Mombasa.

Eng.Francis Kibara Mwangi is a registered Civil Engineer. He has a passion for safety and is one of the safety champions at Konza Technopolis.

3D Printing of Hydroponics Components using Recycled Waste Obtained via Machine Learning Detection Algorithms

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Introduction

LIKE many other developing countries, the issue of solid waste management remains a predicament for the nation. Rural-urban migration coupled with poor waste management strategies, rapid development, and escalating living standards poses a major threat to the Kenyan ecosystem (California Institute of Technology, 2018). Research conducted by World Bank poses that an estimated 2,400 tons of solid garbage are produced daily in Nairobi, the capital city with 20% of the waste being plastic (White et al., 2018). Further, only 45% of the waste generated is recycled, transformed into useful products, or reused, which is far below the National Environment Management Authority's target of 80% (The World Bank, 2016).

Several measures have been adopted both locally and nationally to mitigate and manage solid waste. These include the introduction of triple bins to aid in waste separation, regular collection and disposal of waste through trucks, and composting of biodegradable waste into organic manure (UN Environmental Program, 2022). However, continued disposal of waste remains unsustainable since it poses health risks to people who work in these dumpsites and those living in the neighborhood. Accumulation of toxins from the waste exposes these people to health complications which further pose a threat to the healthcare sector. Plastics have become incredibly useful in the modern world but their unmitigated use will soon impair the ecosystem making it unsustainable (Parker, 2019). They find most of their applications in the packaging of final products including food, some car parts, building and construction, and the electrical industry. Uncontrolled disposal of plastic waste has become a major talk in recent years due to the danger imposed by plastic to the environment. These plastics, emit hazardous chemicals which build ups on lakes, oceans, and rivers resulting in an ecological crisis. This is attributed to a long time takes for plastic to decompose naturally in the environment (California Institute of Technology, 2018).

Plastic bottles have over the decades been used due to their versatile characteristics including transparency, strength, reseal-ability, and shatterproof. According to UNEP, the number of plastic bottles purchased every minute totals to one million. This has been fueled by the addiction to single-use plastic products which are now killing marine life. Only ten percent of the waste produced globally has successfully been recycled out of the seven billion tones generated (UN Environmental Program, 2022).

Recently, 3D printing has emerged as a suitable method of plastic recycling. This is attributed to its advantageous printing resource that can utilize a filament made of recycled materials, as well as the ability to fabricate customized parts using rapid prototyping means. The possibility of 3D printing components using waste is growing rapidly to aid in environmental protection and conservation. For instance, [Mikula et al. 2021] revealed that several filaments made of polymeric materials to aid in 3D printing exist in various forms, and help in reducing plastic waste in landfills and attaining the 6Rs (Reuse, Reduce, Recycle, Redesign, Recover, Remanufacture). It is worth noting that the quality of filaments produced from recycled waste poses a significant drawback in the fabrication of quality components with increased service life. To overcome this challenge, machine learning algorithms have emerged as a solution since they can detect a certain type of plastics in a landfill, thus resulting in similar property materials with enhanced material functionalities. Thus, this work employed Artificial Neural Network Model in the selection of plastic waste from a landfill. Furthermore, the plastic bottles were crushed to produce the 3D printing filament (see Fig. 1).

Advancements in technology have heralded the use of artificial intelligence in everyday tasks. Faster processors and larger memories mean that smaller devices are able to use the power of Artificial intelligence in data analysis and decision making. Some of the features that have come available due the advent of these devices called edge devices are image classification, object detection and motion detection. All these features are powered by the use of cameras where computers are able to "see" hence perceive and infer from their environment. Object detection enables a computer to identify the location and type of an object in a still or moving image. This technology

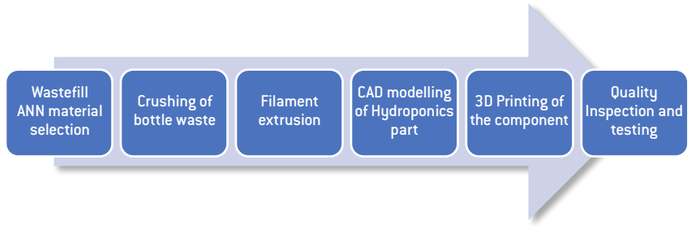
Figure 1. Selection of plastic bottle waste via ANN for crushing and generation of 3D Printing filament.

enables computers and systems to identify objects and make decisions with this information. Object detection is powered by machine learning algorithms called Convoluted Neural Networks (CNN). A CNN is a deep neural network (an artificial network that mimics human neural networks) that mimics human vision. This algorithm enables the computer to process images much like a human does. Object detection is an emerging technology which can have a wide range of applications including that of identifying recyclable materials.

A Convolutional Neural Network is a deep learning algorithm which takes an image as input, then assigns learnable weights and biases to various features in the image and finally differentiates the features. CNNs can filter the images into different classes based on the input-output pairs. Their architecture is similar to the internal connecting system of neurons in the human brain. It is a combination of convolutional layers, pooling layers, fully connected layers, and normalization layers.

Materials and Methods

In this study, experimental work was carried out in a sequential process (see Fig. 2). The visits were conducted to JUJA Town damping site for the purpose of the study. The town, being one of the fast-growing areas in Kiambu County has over the years being on the spotlight for its vast growing population and real estate development. Being relatively dry, and the host town to Jomo Kenyatta University of Agriculture and Technology, most people depend on processed and fast foods which are packed. This in turn leads to increased plastic waste in the town, plastic bottles taking the lead.



Artificial neural network

TensorFlow being an open-source library finds its application in machine learning applications and numerical computations due to its robust capability and computation power. Due to its high accuracy and faster training speed, the following steps were followed to develop our custom artificial neural network model for detecting plastic bottles.

1. Creation of a dataset

This section involved obtaining images of plastic bottles to create a dataset. This dataset featured several types of bottles. The images were filtered, labeled using labeling and grouped. The dataset was curated to ensure that the images did not have a bias and that features from the bottles were easily identifiable. The dataset was split to obtain train and test data.

2. Downloading pre-trained model

One of the advantages of TensorFlow is the provision of pre-trained model for object detection. The ssd_mobilenet_v2_coco model was downloaded for training with our custom data.

3. Testing and validation

The generated model was then tested using the test portion of the data set. The weights of the model were adjusted to optimize performance by increasing accuracy and removing bias.

4. Deployment

The generated model was deployed using a simple web camera to validate performance.

CAD Modelling

One of the powerful aspects of 3D printing is the ability to print complex things which would be practically impossible by other means such as subtractive manufacturing. In order to design the hydroponic component for 3D printing, Inventor Autodesk computer aided design software was used. The software was selected due to its robust features which include stress analysis, user friendly and topology optimization. The final design was exported as a Standard Triangulate Language (STL) for slicing process which was done using Prusa 3D printer.

3D printing

Plastic bottles were collected having being identified by the artificial neural network model and secured safely in a bag. They were cleaned using warm water and soap bath to clean the dirt and the pungent smell as a result of pile up with other waste. Product labels were removed to ensure good quality filament was produced. The glue remains on the labelled area were removed by the aid of acetone as further measure to improve filament quality. Dying of the bottles was carried out on a solar dryer to reduce the moisture content and make them more brittle for shredding. After one hour of drying, the dry plastic bottles were reduced to small pieces by scissors and shredded using 3DEVO plastic shredder to attain small chunks of less than 4 mm. Due to hygroscopic nature of Polyethylene Terephthalate (PET), the shredded chunks of bottles were dried at 140 degrees for 3 hours in an oven.

The extrusion process was carried out after preheating and cleaning the extruder to remove the previous material. In this process, heater temperature was set to 245 °C, extruder speed to 7 rpm. and fan speed to 15%. Extruded filament was spooled and removed from the extruder for 3D printing.

Results

ANN Modeling

The CNN model had an average accuracy of 87% with minimal bias. This represents an ability to identify eight in ten bottles correctly thus enabling sorting of the plastic bottles.

3D Printed Component

The printing process was done using Prusa Printer manufactured by Prusa Research, a Czech based company operating under trademark name Original Prusa i3. The following are the results of the process

Table 1. 3D Printing results.

Parameter	Results
Bed temperature	70 °C
Weight of the component	10.81 grams
Time taken to print	1 hr. 31 min
Printing speed	20 mm/s
Filament used	Polyethylene Terephthalate (PET)
Infill percentage	50%

Discussion

Training of a machine learning model to attain a higher accuracy requires substantial amount of data. To archive an accuracy of more than 95%, thousands of images are required to train the model using TensorFlow which becomes harder doing the work manually. This attributes the harder low accuracy which can be improved by using more annotated data for the task. Significant improvements were noted after carrying out hyper parameter tunings.

Due to the nature of the PET material, several attempts Significant were made in order to obtain the best parameters for the best filament which influences the quality of the print. An infill of 50% was used to increase the strength of the component as well as maintaining its weight relatively low due to the nature of its application. This was after several tests with different infill percentages which led to the current one being the best.

The design of the CAD model was ideal to allow flow of water from the hydroponic conveyance pipes to the cups and also providing maximum support to the plants. Circular infill pattern was chosen during 3D printing since it gives maximum strength to the printed component.

Conclusions

The viability of 3D printing components using waste material has been presented. Recycling plastic bottles has been found as an efficient way of reducing environmental pollution and undesirable harmful emission. In addition, ANN was successfully employed in material selection and the following conclusions can be drawn:

- ANN is a technique well-suited for material identification in waste fills.
- The quality of filament depends on process parameters employed during extraction as well as the homogeneity of bottles obtained.
- More data required to obtain a higher accuracy of the model

Acknowledgement

The authors express profound gratitude to the Jomo Kenyatta University of Agriculture and Technology for providing the equipment required for experimental work. Further, much appreciation to Mr Matunda at the Department of Mechanical Engineering for assisting with crushing and filament extrusion. This work would not have been without the equal contribution of the authors.

JKUAT's Telecommunication Engineering Graduates Ready to Support Government's Digital Revolution

By Omae M. Oteri

Equipment donated by Safaricom Ltd.

TELECOMMUNICATIONS and Information Engineering (TIE) is a branch of Engineering that integrates the principles of Electrical and Electronics, Computer Science, and Information Engineering. It mainly deals with telecommunication systems, both hardware and software, in terms of the theoretical principles, their design, construction, features, operation, and applications. In terms of construction, it starts from raw materials that are modified into electronic components both analogue and digital. These two types of components are then used to come up with sections of the telecommunication system that includes a processor, memory, storage, input, output, the power supply, and the motherboard that interconnects all these sections together. This is famously referred to as the Von Neumann model. The other representation commonly known as the signal flow model includes the sensors, pre-filters, analogue to digital converter, the processor, digital to analogue converter, post-filter and actuator, which represent the way the signal flows through the system from input to output. Apart from hardware, these systems also have the software part, which consists of the operating system and the applications software. In terms of applications these systems are used almost in every sphere of our lives, including industrial, medical, astronomy, instrumentation, military, transport, communication, entertainment, and security. Specific examples range from satellite communication systems, mobile telephony, Internet communication systems, Wireless Local Area Networks (WLANs), auto-drivers, auto-pilots, robot teachers, robot doctors and nurses, robot soldiers and wireless sensor networks. The other concepts include Internet of Things (IoT), Data Science and Artificial Intelligence, among others. The common factor in these technologies and applications is Information Technology, which in itself is driven by computer technology and Electrical/Electronic Engineering.

The TIE programme was launched at Jomo Kenyatta University of Agriculture and Technology (JKUAT) in 2003. Since then, the university has continued training TIE graduates who are highly sought for in the different fields in Kenya and the world. Among the areas that have been benefiting from our graduates include banks, mobile phone operators, internet service providers, parastatals that include Communications Authority of Kenya (CA), Information Communication Technology Authority, Kenya Bureau of Standards (KEBS), Kenya Power and Lighting Company (KPLC), Kenya Broadcasting Corporation (KBC), Kenya Pipeline Company (KPC), Telkom Kenya, to mention but a few.

The curriculum review processes for this course is done through interaction with stakeholders in the industry to include the most current technological advances in relation to the telecommunication and relevant industries. As part of the support for the process, one industry stakeholder (Safaricom Limited) donated an equipment worth Ksh80 million for our telecommunication laboratory. The equipment is currently being used by students in our department, Electrical/Electronic, Electronic and Computer, Computer Science, Information Technology, and others from the School of Business. Besides this lab equipment, there are many more that are available for our students to undertake practicals relevant to the industry, including the use of mobile laboratories. In the most recent review, the recommendations by Engineers Board of Kenya (EBK) were also included.

In relation to the digital economy, as announced by President William Ruto that all government functions are going digital, the TIE graduates will be the cornerstone and shall have a big role to play in supporting its different elements that include the digital government, digital business, infrastructure, innovation-driven entrepreneurship and digital skills and values. The TIE graduates will take the lead in making it possible for the government to take technology to all levels of learning starting from primary all the way to university and beyond where there is demand for learning devices with content. This way the digital economy shall be fuelled to facilitate the country towards achieving Vision 2030.

With the great leadership from our Dean, Prof Stanley Kamau, Principal Dr Eng Hiram Ndiritu and Vice Chancellor Prof Victoria Ngumi, together with support from the Institution of Engineers of Kenya (IEK) and EBK, the department is committed to training the best Telecommunication and Information Engineering graduates who will facilitate the telecommunication industry revolutions in all sectors of the world economy.

Mr Omae M. Oteri is the Chairman, Department of Telecommunication & Information Engineering at JKUAT

Improving Commercial and Hospital Buildings Energy Efficiency and Reduction of Operation Costs

By Davis Chesoli

HIGH supply, operational reliability and flexible use are the key factors of every modern power distribution system in both commercial and hospital buildings. With the energy costs making up a greater share of the total operating cost of a building, optimization of the operating costs is an absolutely essential goal, even at the planning stage. Essential elements are ecologically and economically focused optimization of energy consumption. Even in high-rise buildings, energy analyses are called for. By high-rise buildings I mean five floors and above. Hospitals are highly complex facilities and many of the functions that take place within them consume a lot of energy due to equipment and the processes therein. Energy savings and the environment are presently high on the political agenda across Africa and beyond. But how do we go about introducing energy saving techniques and materials into our hospitals? On a closer look it is apparent that paying attention to energy and promoting sustainable healthcare is not only a good way of maintaining corporate social responsibility but also energy savings and sustainable healthcare are drivers of innovation and cost effectiveness.

Reducing energy bills is good for hospitals as well as the environment. Review of the current data on a hospital's energy usage is always recommended as the 1st step in saving energy. Energy savings can come from initial design (for best results), but also in updating and refurbishing certain areas such as equipment upgrades, operating room HVAC strategies, right sizing of fans, and the 24-hour heating and lighting teamed with ventilation, sterilisation, laundry and food preparation, among others. Together that combination creates a significant opportunity to reduce energy consumption. Some tactics are less common and have been explored before and suggest additional options to consider; for instance, doing simple things first – anything with a payback of 12 months or less before getting to the point of looking at really efficient chillers and retro commissioning or fine tuning the existing HVAC equipment and controls, which normally will fall out of calibration over time. Health facilities can reduce energy expenditures by 10% simply through retro commissioning.

Introduction

> Energy management is the clear-sighted, organizational, and systematized coordination of procurement, conversion, distribution and usage of energy to meet requirements, taking ecological and economic objectives into account.

New construction opportunity

New constructions offer the biggest opportunity for incorporating energy conservation best practices, such as incorporating LED lighting throughout, air-conditioning, heat recovery, variable speed pumping systems and improved thermal insulation on walls, windows and roofing systems. Innate shading opportunities from a building's geometry and orientation can help with energy efficiency in facilities like Kenyatta National Hospital (KNH), Moi Teaching and Referral Hospital and other level 4 hospitals in the 47 counties in Kenya.

New hospitals should be positioned and configured to improve energy efficiency. Anything that can be done to reduce demand from the outset is the first thing the facilities' directors should look at. Before considering any mechanical systems, it is advisable to reduce the load as much as possible through passive architectural strategies so that the equipment can be sized for what is really needed to be cost effective. There is a need to fire up interest in this challenge.

Low-hanging fruit

After bench-marking each facility's overall energy performance, health systems should undertake an audit to systematically assess energy usage. Generally, this would be conducted by outside consultants or service providers. Energy audits range from simple walk-through to detect inefficiencies to a comprehensive analysis that involves placing sub-meters on individual building systems and introduction of cost centers for each department or unit. It is advisable to focus on energy efficiency because that is where the financial returns are best. Energy transparency creates the data basis for action, reactions and improvements. Basically energy transparency is part of operational management, since energy flows can only be analyzed with precision in practice. Even so, the measuring, evaluation and data management systems shouldn't be forgotten in the per-planning stage. It is important to note that energy efficiency describes the relationship between energy outlay and the resulting benefits; hence efficiency targets are fundamental elements of planning. The author recommends the use of DOE health facilities guide when carrying out the energy efficiency audit.

Health facilities can reduce energy expenditures by 10% simply through retro commissioning and preventive maintenance to optimize HVAC efficiency. For example, air handling unit filters should be replaced regularly and cooling towers cleaned to maximize condenser performance. It is estimated that as much as 20% of steam generated by a typical boiler is lost due to leaking or failing steam traps, which should be repaired or replaced. My view is that energy-conserving hospitals should replace HVAC equipment and systems with more efficient options at the end of their useful lives. More often, hospitals wait until the equipment is completely depreciated before replacing it, let alone retrofitting it. It is advisable to replace any equipment that's a real energy hog a head of time.

After realizing significant savings from quick fixes, health systems need to consider projects with somewhat longer returns on investment. Operating room (OR) airflow setbacks, for one, can produce tremendous payback, especially for large institutions like Kenyatta National Hospital, Moi Teaching and Referral Hospital, among others. When the ORs are not in use, the number of air exchanges per hour drops from 20, the minimum required during surgeries, to four to six, while the temperature, humidity and pressure of the room remain the same.

Davis Chesoli is the Managing Director/CEO KGOBISA WACHERO EPC LTD, EBK registered Graduate Engineer, A Corporate Member of Association of Medical Engineering of Kenya and South African Federation of Hospital Engineering and a practicing Electrical Engineer.

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Secretariat Update

By Maria Monayo

Appointment of Grace Wanjihia as Ag. Chief Executive Officer

THE IEK Council appointed **Grace Wanjihia**, the Membership and Training Manager, as the Ag.Chief Executive Officer following the expiry of **Eng. Linda Otieno's** contract, having served the Institution from 1st December, 2019 to 1st December, 2022. The Institution thanks Eng. Linda for the service rendered and wishes her well in her future endeavors. The Council has set in motion the process to substantially fill the position of CEO in accordance with requisite procedure and policy.

And in other appointments, **Eng. Dr. Roy Orenge** joinned the Editorial Board as the Technical Editor for African Journal of Research and Innovation (AJERI). Eng. Dr. Samwel Roy Orenge is a registered Professional Electrical Engineer (EBK) and Cooperate Member, IEK. He holds a PhD in Electrical Engineering with a specialization in Sustainable Power Systems. He is an energy consultant with over 10 years' experience in academia and energy sector research. He is currently the Chairman, department of Electrical and Electronic Engineering department at JKUAT.

Editorial Assistant

LEONARD KIGEN joined the Secretariat on 1st January, 2023 as the Editorial Assistant for the *Engineering in Kenya* Magazine. Mr Kigen was selected for the internship position after a series of interviews held late last year. He is a Graduate Engineer-Mechanical from Technical University of Kenya.

Graduate membership drive-2023

IN a bid to promote growth in membership, we have an ongoing membership drive for Graduate Engineers in all disciplines from 6th January to 15th April, 2023. New registrants during this period will have their registration and subscription (2023) fees waived. These are some of the many benefits of an IEK membership:

1. Structured mentorship programmes that support your continuous professional development
2. Professional interviews that confirm your Engineering acumen, leading to transfer of class from graduate to corporate/professional engineer.
3. Resourceful knowledge and technological transfer sessions for transfer of class and subsequent licensing.
4. Professional references to employers, recommendation letters and certification after events and upon transfer of class.
5. Subsidised costs for attending IEK events, which also attract CPD points.
6. Access to Engineering publications such as the Engineering in Kenya magazine
7. Projected differentiated cost of access to group medical cover for IEK members.

KENYA RAILWAYS
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Modern Railway Signalling, Communication and Train Control Systems for Safe and Efficient Operations

The Case of the Standard Gauge Railway in Kenya

Prepared by: Isaac Kisengese
Ag. Railway Development Manager – Kenya Railways

Reviewed by: Eng. Tobias O. Otieno
General Manager Infrastructure Development – Kenya Railways

Introduction

In 2006 owing to the dilapidated state, low speeds and low payload on the Meter Gauge Railway (MGR) network within the East African Countries, the East African Community (EAC) came up with a Master Plan to adopt Standard Gauge Railway (SGR) technology for future development of rails within the region.

Each country was to be responsible for the development of the SGR network within her territory. During the period 2014 to 2019, Kenya developed 592km of SGR network, connecting Mombasa through Nairobi up to Naivasha. The SGR lines in Kenya have been developed based on China Railway Standards.

Consideration

Contemporary rail networks are characterized by fast trains, advanced signalling and communication systems, integration with other modes of transportation, automation and digitalization, and sustainability. All of these characteristics make them a more effective, dependable, and environmentally friendly mode of transportation, which can reduce traffic congestion, air pollution, and carbon emissions, and enhance the quality of life for the people.

Signalling, communication and train control systems are used to manage and control the movement of trains on a railway network. These systems are typically composed of electronic components that are connected to one another and to physical track-side components. The core of the system is the signaling system, which is responsible for controlling the movements of trains by providing information about the route ahead and the availability of track capacity. The communication system is used to send and receive information between the rail operator and the train. Finally, the train control system is used to ensure that the train follows the correct route and to provide information about the position of the train. These systems use a variety of technologies, such as radio, cellular, optical and satellite communications, to ensure that the information is sent and received accurately and reliably.

In June 2017, Kenya commissioned Operations on a new Standard Gauge Railway (SGR) network, following the completion of its construction. In order to ensure safety and efficiency, SGR design incorporated modern signalling and telecommunication technologies. They include:

Centralized Traffic Control System (CTC):

A remote control and remote signalling system composed of remote-control technology and railway transportation. The centralized dispatching system is built on the basis of the train dispatching command system. In addition to realizing all functions of the train dispatching command system, it also realizes the functions of train formation information management, shunting operation management, comprehensive maintenance management, train/shunting route manual and scheduled automatic selection, and decentralized self-control, among others. It integrates computer, communication and control technology so that the continuity and decentralization of railway transportation are closely combined with centralization and real-time transportation management. It relies on the accurate and real-time transmission of command traffic control information and relevant train operation indication information and unified dispatching and command train safe and effective operation.

1

Computer-Based Interlocking system (CBI):

A kind of signalling system equipment used to ensure the safety of trains and shunting operations and improve the passing capacity of the stations and yards. The computer is used to perform logical calculations on the operation commands of station operators and the information expressed by the status of field equipment, so as to realize centralized control of signal machines, turnouts, and approaches. This achieves mutual restriction and ensures the safety of train operations.

2

Indoor equipment:

The indoor equipment mainly includes axle counters, a centralized signal monitoring (CSM) system, switch gap detection system, an optical communication station-based safety information transmission equipment, various types of relays, air switch, fuse alarm, inductive capacity box, station frequency shift coding system, lightning protection unit, filament alarm, sound and light alarm system.

3

Outdoor equipment:

Outdoor equipment mainly includes the switch machine, track circuit, signal, and cable boxes.

4

On-board signal equipment:

comprised of monitoring and event recording system equipment, locomotive integrated wireless communication equipment, locomotive signal system equipment, and rail car operation control equipment.

5

Transmission system:

It is composed of OSN 3500, OSN 2500, OSN 1500 and other equipment. The transmission system is the carrier of all systems and provides a stable transmission channel for each communication platform in the railway communication system. The main services are digital dispatching system, ticketing system, CTC system of signal, GSM system, freight bill system, among others.

6

Data network system:

The data network system in railway communication system is the communication network used for data transmission. It is a regional network composed of data switches (packet switching, frame relay switching, ATM switching, advanced router, IP switch, etc.) as transfer points. It is based on computer hardware and software technology and modern transmission technology. The data network system of the Mombasa-Nairobi-Naivasha railway mainly carries the data of the office network, dynamic environment, optical monitoring, video conference, video monitoring, recorder, axle temperature and other systems.

7

Wireless communication system (GSM-R):

It is composed of base station control subsystem and core network control subsystem. The base station control subsystem is composed of base station equipment and management equipment along the railway, which mainly carries railway wireless communication services. The core network control subsystem mainly carries the train data information, which is responsible for the registration of the train and the data configuration of the station.

8

Communication line and equipment:

Includes both the long-distance optical cable, and regional (station yard) optical cable as well as the fiber monitoring equipment.

9

Communication power supply system:

It is composed of rectifier equipment, DC power distribution equipment, battery pack, DC converter, rack power supply equipment and related distribution lines. The power supply system provides AC and DC power for all kinds of communication equipment to maintain the stable operation of the communication system.

10

Dispatching communication system:

Railway dispatching communication system is a piece of special communication equipment for business contact between traffic dispatchers and station attendants in the command section under their jurisdiction. It is an important means to provide real-time information for the railway transportation industry and realize unified command of railway transportation. Dispatching communication plays an important role in railway transportation production.

11

Other equipment:

Emergency communication system, power supply and environment monitoring system, integrated video monitoring system, optical fiber monitoring system, synchronous system, video conference system, calling telephone system and other systems, realizing the functions of unified coordination and command of auxiliary transportation production and monitoring and control and monitoring of equipment and facilities, which are also indispensable communication equipment.

12

Overall, modern railway networks, like the case of Kenya's SGR, are designed to ensure safe and reliable operations by incorporating advanced signalling and communications systems, automation and digitization and sustainability. These technologies help optimize rail operations, improve safety and reduce environmental impact.

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Kenya Railways

Smart Poles the Answer to Efficiency of Konza and other Smart Cities

By William Momanyi

A view of the newly installed smart poles along the Konza City streetscape.

A streetscape view of one of the smart poles installed in Konza City.

WE are at a time in the 21st Century where racing to embrace and infuse technology at different levels in our day-to-day lives is imperative, instigating the emergence of one global village, a Smart City. An urban area that uses advanced technology and data analysis to improve the quality of life for its citizens and streamline city operations, majorly public transportation, citizen participation, e-governance, waste management, water and sanitation, power supply and IT connectivity. A key component of this is the use of the Internet of Things (IoT) to connect and collect data from various 'smart' devices and systems throughout the city.

One example of an IoT-enabled device in our very own silicon savannah, Konza City, is the smart pole. Smart poles are streetlights that have been fitted with a number of sensors and other technologies to collect data and provide various services. These services include adjustable LED streetlamps, digital signages, CCTVs, Wi-Fi access points, environmental sensors, which gather data on pollution and temperature in the city help button, and HD video surveillance. These smart poles have dedicated HD face recognition cameras that convey signals to the traffic light poles to secure pedestrian and/or motorist traffic, giving priority to road crossings where necessary.

Powered and designed by Huawei Technologies, these smart poles are made of hot, galvanised iron to withstand extreme weather conditions and give a long life.

The integration of smart poles into a smart city guarantees efficiency on the overall operation and liveability of the city, i.e., by collecting data on air and noise pollution, city officials can identify areas of the city that are particularly affected and take necessary measures to address these challenges. Similarly, by monitoring traffic patterns, data experts can optimise traffic flow and reduce congestion.

Smart poles can also be used to provide information and services to citizens. They can display real-time information on public transportation schedules, provide directions to nearby points of interest, and even offer a charging station for electric vehicles, transmit signals to the e-police devices that will be keeping an eye on any violation of traffic laws.

Further to the above, IoT technology also enables real-time monitoring of the smart poles and their connected sensors, which allow for performance monitoring and prompt response to any technical challenges.

The poles are hybrid and can be powered by renewable energy sources such as solar. This will help to reduce the city's carbon footprint, which is central to the attainment of United Nations Sustainable Development Goal No. 11.

Many of these smart poles are equipped with Wi-Fi routers or cellular antennas, which can be used to provide wireless connectivity to the city residents. This includes public Wi-Fi, cellular data services, and even 5G networks, therefore creating a seamless link to other telecommunication devices and internet connectivity to citizens and enables them to access information and services online. The real-time transfer of data between the smart poles and other devices is integrated with other applications such as traffic management, public safety, environmental monitoring as well as waste management systems. Particularly, the waste management system in place at the Konza City incorporates the Vacuum Solid Waste Management System and Wastewater Reclamation Facility (WRF). The data collected within the city will be analysed and processed to envisage the achievement of a sustainable global solution in the Silicon Savannah.

William Momanyi is an ICT engineer at Dar-Al-Handassah, currently working at the Konza Technopolis Development Authority project. He holds an Msc, and Bsc in Computer Science from Asia Pacific University, Kuala Lumpur, Malaysia.

South Korea and Kenya form Bilateral Ties in Engineering Practice

A team of IEK and EBK officials pose for a photo with Korean Professional Engineering Association representatives at the EBK offices in Nairobi.

KOREAN Professional Engineering Association (KPEA) and the Engineers Board of Kenya (EBK) have signed a memorandum of understanding (MoU) in engineering.

The EBK Chief Executive Officer, Eng Margaret Ogai, Capacity Building and Accreditation Director Eng. Grace Onyango and Principal Capacity Building and Accreditation Officer Tony Kibet were among those who witnessed the signing of the MoU in the presence of President William Ruto and Roads and Transport Cabinet Secretary (CS) Kipchumba Murkomen. The event took place between November 22 and 24, 2022 in South Korea.

> According to the MoU, three areas of collaboration between KPEA and EBK will include capacity building, which includes establishing Kenya school of engineering and exchange programmes; developing industry projects with joint consultancy and technology transfer; and cultural exchange with participation and support of youth and vulnerable persons in engineering.

The MoU followed the EBK's benchmarking visit to South Korea in September 2022 and a subsequent visit by KPEA to Kenya in November 2022.

KPEA is established under Article 14 of Professional Engineers Act in South Korea and is responsible for protection and promotion of public health, safety, welfare, and environment for experts in science and technology and promote engineers' rights and interests, cooperate and exchange with foreign engineers for the country and development of society.

The Engineers Board of Kenya is a statutory body established under Section 3(1) of the Engineers Act, 2011. The Board is responsible for the registration of engineers and engineering consulting firms, regulation of engineering professional services, setting of standards, development, and general practice of engineering.

Transport and Infrastructure Cabinet Secretary Kipchumba Murkomen witnesses the signing of the MoU between EBK and KPEA.

Calibration of GEOS-5 Satellite Data for Sparsely Gauged Stations: A Case Study of Nzoia Basin, Kenya

By Stephen Mureithi Kivuti

Introduction

SITUATED 8.3 light minutes away from earth, the sun delivers an electromagnetic energy flow of about 1365 W/m^2 (Beer et. al, 2000). This energy serves as the driving force for the weather, and has served to shape the daily, annual and millennial rhythms of the earth for every living thing in existence for more than 3 billion years. Consequently, life has found a way to exist around the turbulent but steady rhythms associated with the weather. These rhythms are commonly termed as the climate. However, the conditions on earth also have a role to play in keeping this delicate balance. Much of solar radiation is reflected back by the atmosphere, cloud linings, polar ice caps and many other reflective substances on the earth. This ensures that even though the tilt of the earth's axis results in every part of the earth's surface receiving 4,380 hours of sunshine, variations exist (particularly in temperature and precipitation) that occasion different climatic conditions, and effectively different habitats on earth.

Problem Statement

Recent human activity has led to the destabilization of this delicate balance which is the crucible for all life. One of the most significant of these changes is the release of Carbon (IV) Oxide into the atmosphere. Serving as a greenhouse gas, increases in the levels of Carbon (IV) Oxide and other greenhouse gases in the atmosphere have sought to retain a lot more of the solar radiation received than under normal conditions; leading to an unprecedented rise in global temperatures. Changes in the weather occasioned by climate change, which include but are not limited to erratic rainfall, high temperatures, strong winds, flooding, and droughts have had a direct impact on humans and animals alike, and is directly threatening existence and livelihoods (Chisale et.al, 2021).

Some of the hardest-hit areas by climate change repercussions include watersheds in Sub-Saharan Africa such as the Nzoia river basin (Chidumayo et.al, 2011). Already, Nzoia basin is subject to massive annual losses in human lives and property due to natural disasters, particularly flooding, whose severity and frequency is expected to increase concurrently with climate change (Government of Kenya, 2012). One major reason why these areas are severely hit is the poor preparedness in terms of meteorological data, which can serve to reduce disaster exposure if the data is incorporated into early warning systems. Ignorance is no defense especially when it comes to natural disasters, and therefore, it is imperative that management and mitigation of climate change is undertaken while considering such areas.

To effectively mitigate and manage Nzoia river basin against disasters, it is imperative that accurate meteorological data for the basin is available. No matter how good the strategy, it would be useless in application if it was ill informed. It is a mountainous task to be prepared for what you are unaware of, and this is why data scarcity for such areas as Nzoia basin is unacceptable. Gauging stations in Nzoia basin are particularly data scarce in terms of temporal adequacy, with only about 8 stations showing a percentage completeness of 95% and above (Mureithi et.al, 2022). Satellite technique is a very reliable alternative or a dependable support system to our conventional way of surveying, investigation, planning, monitoring, modelling, data storing and decision-making process. (American Meteorological Society, 2000) The synoptic concept of satellite image is fairly easy for identification of the broad physical features such as stream network, land use/land cover, soils surface, runoff etc. With the help of satellites, it is possible to get data useful for making management plans for usage and development of a watershed.

Objectives

The spatial scales of satellites (ranging from 100x100km 250x250 km and 250x375km etc.) are too coarse and wide for proper hydrological management and analysis, and their temporal scales are usually insufficient. Therefore, care should be exercised to ensure accuracy of the data by calibrating it with the available observing station information. By working out a calibration protocol for GEOS-5 satellite data with the observed data, the challenges posed can be solved and the resulting data could be suitable for further applications. The study therefore aimed to calibrate GEOS-5 satellite weather data with observed station data in order to improve it for further studies and management application.

Materials and Methods

Study Area

Nzoia basin is straddled within longitudes 33.5°E and 36°E; and latitudes 1.5°N and -0.2°S. Politically, the basin reposes exclusively in Kenyan territory, and bestrides Uasin Gishu, Trans Nzoia, Kakamega, Bungoma and Busia counties (Figure 1). Delineated using Arcmap in ArcGIS from USGS (United States Geological Survey) digital elevation models, the basin was determined to cover an area of 12,640 km^2, and to exhibit four general physiographic areas based on elevation.

The study determined that elevations above 2,850m ASL were the mountain regions. For the catchment, these were Mt. Elgon in the north-western locale of the basin and Cherengani hills in the eastern zone. These peaks represent the source of River Nzoia and its tributaries. It is the characteristic river in the basin. The highland areas (2,300-2,850m ASL) are forested and therefore serve the critical ecological role of water retention, erosion control and the succor of biodiversity. However, there is increased land degradation in this region due to human activity, which has in turn compromised the efficacy of the region to serve its ecological roles. The plateau region (1,900-2,300m ASL) is characterized by deep, well-drained and fertile soils. They therefore serve as the cash crop (particularly maize) and dairy

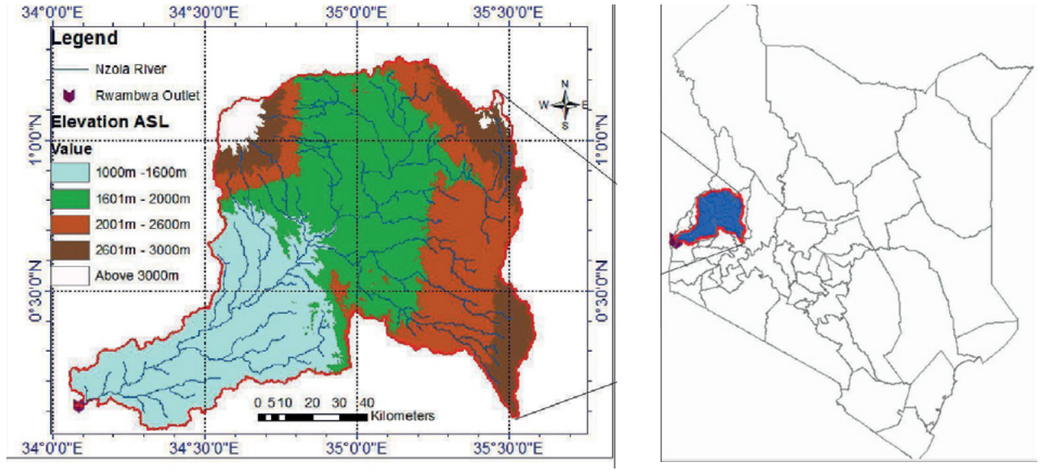

Figure 1: Nzoia river basin with location and physiographic regions indicated

farming region in the watershed. The transition zone (1,600-1,900m ASL) shows a gradual change in geology from that characteristic of the highland regions to the loamy soils typical of the lowland region. The lowland region (1,000m to 1,600m ASL) is also characterized by loamy soils, and is generally flood prone and swampy. Edaphology revealed that the transition and lowland regions are mainly used for sugarcane and small-scale farming. It is in the lowland region at the south-western edge of the watershed that Nzoia River eventually drains into Lake Victoria at Rwambwa.

Data Collection

Satellite data was obtained from the NASA observatory specifically NASA Prediction of Worldwide Energy Resources (POWER NASA). The surface solar energy parameters were customized and validated from NASA/GEWEX (Global Energy and Water Exchanges) Surface Radiation Budget Project and Clouds and Earth's Radiant Energy System (CERES) low latency FLASH Flux (Fast Longwave and Shortwave Flux) dataset. The meteorological parameters were based upon data from NASA's Modern Era Reanalysis assimilation for Research and Applications (MERRA-2) atmospheric reanalysis. The MERRA dataset was released in 2009. It is based on a version of the GEOS-5 atmospheric data assimilation system. It spans from 1982 through to 2016, and was produced on a 0.5° X 0.66° grid with 72 layers. MERRA was used to drive stand-alone reanalysis of the land surface (MERRA-land) and atmospheric aerosols (MERRA Aero).

For the weather stations on the other hand, data was collected from the gauging stations. This data is currently available for public domain and can be acquired with approbation from the Kenya Meteorological Department. Limited by the availability of meteorological data, satellite and observed data from 1982 to 2009 was collected and the relevant quality checks were carried out. It was then sorted, analyzed and its viability for consequent use was established using standard statistical procedures.

Choice of Stations

Data scarcity was a recurring issue among observed stations in the watershed. Therefore, for rainfall data, stations with the most complete data were chosen for calibration. For the study, stations satisfying 95 percentage completeness of data were used. This threshold did not satisfy the spatial distribution, however, and Kaptagat, Malava, Lukamanda and ADC Chorlim stations were added to improve the spatial distribution. For temperature data, only three stations were available viz. Kakamega, Eldoret and Kitale, and they were therefore consequently taken up for analysis. The 11 stations chosen are illustrated in table 1.

Table 1: Stations chosen (Temperature stations denoted in italics)

Station ID	Station Name	Latitude	Longitude	% completeness
8934059	Uholo	0.185	34.304	95.7
8934134	Bungoma	0.583	34.567	98.9
8934096	Kakamega	0.283	34.767	99.7
8934061	Malava	0.446	34.851	90.3
8934016	Lugari	0.667	34.900	97.9
8935181	Eldoret	0.533	35.283	99.9
8935170	Lukamanda	0.633	35.050	90.6
8834013	ADC Chorlim	1.033	34.800	91.3
8934008	Kiminini	0.900	34.917	96.6
8834098	Kitale	1.000	34.983	99.3
8935104	Kaptagat	0.867	35.500	81.6

Data Calibration

To calibrate both temperature and rainfall data, monthly regression factors between the concurrent satellite and observed data for the individual stations were calculated.

Rainfall Data Calibration

To calibrate rainfall data for the individual stations, regression factors were obtained by dividing the monthly total averages of the observed data by similar data from satellites. This implies that any fraction (value lower than 1.0) represented an overestimation by satellite data and any value above 1.0 represented an underestimation by satellite data. Calibration factors for the stations are shown in table 2. To test the viability of the calibration factors, they were calculated and tested for 10 years (1982 to 1992), 14 years (1982 to 1996) and 20 years (1982 to 2002). It was established that the larger the dataset, or the more the number of years, the better the calibration factors were at calibrating satellite data.

Table 2: Rainfall calibration factors

FACTORS (STATION/NASA) [F>1; UNDERESTIMATE F<1; OVERESTIMATE]												
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
ADC Chorlim	0.775194	1.4972145	1.070885	1.014651	0.894751	0.914261	0.937096	0.994219	1.075642652	0.869272	0.64068188	0.68872728
Eldoret	0.912777	0.8653222	0.907748	0.609996	0.498453	0.801108	0.948477	0.859249	0.572964624	0.443691	0.55474932	0.73510862
Kakamega	1.221241	1.3267672	1.242458	0.958481	1.051721	1.10361	1.131145	1.332233	1.193323038	0.917713	1.02638453	0.98622139
Kitale	1.015931	1.7530208	1.656558	1.138181	0.984723	1.09023	0.956008	1.090333	1.097180848	1.05542	0.97521006	1.02305026
Lugari	1.060861	1.0637667	1.127529	0.701625	0.807486	0.84361	0.883228	1.088437	0.945582691	0.714595	0.63844119	0.82525948
Uholo	0.911171	0.9911125	0.964686	1.046349	0.997606	0.838679	1.043089	0.986099	1.164713069	0.991205	1.00386397	0.80424686
Bungoma	1.152726	1.3219691	1.309379	0.977679	0.921109	0.693271	0.583553	0.574003	0.829506823	0.923663	0.89097483	0.94774422
Lukamanda	0.935679	0.8990195	0.978649	0.627649	0.833708	1.028561	1.020434	1.054403	0.865918701	0.62618	0.48907933	0.62184408
Kaptagat	1.382909	1.2044524	1.424361	0.904243	0.835531	0.751577	0.820241	0.624213	0.586650241	1.092546	1.21256872	1.31117376
Malava	1.020796	1.0910955	1.058743	1.007288	1.023772	1.420414	1.304247	1.319742	1.238145188	0.889556	0.75452151	0.93616308
Kiminini	0.851196	1.0299424	0.855914	0.828902	0.792088	0.796535	0.79624	0.803798	0.92431121	0.749905	0.70157396	0.73154857

Temperature Data Calibration

Temperature data monthly regression factors were obtained by subtracting observed data from the concurrent satellite data. Therefore, positive values (values above 0) represented an underestimation by satellite data, while negative values suggested an overestimation by satellite data. This was carried out both for maximum and minimum temperatures, and later combined to represent mean temperatures for further analysis. Table 3 shows the station calibration factors for maximum temperatures.

Table 3: Maximum temperature calibration factors

FACTORS (STATION-NASA) [D>0; UNDERESTIMATE D<0; OVERESTIMATE] -max temp												
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Eldoret	-1.94886	-2.78073	-3.14889	-1.97579	-0.76053	-0.60361	-0.64437	-0.53208	-0.68979	-0.87889	-1.0429	-1.12373
Kakamega	0.59129	-0.14395	-0.70176	0.14967	1.352242	1.886758	2.05	1.895113	1.449435	1.037855	0.891903	0.85122
Kitale	-0.77032	-1.57054	-2.28843	-1.89849	-0.60972	-0.24351	0.041861	-0.01099	-0.5571	-1.11949	-0.57205	-0.55791

Similarly, table 4 denotes station calibration factors for minimum temperatures. Regression factors for maximum and minimum temperature data were also calculated and tested for 14 years (1982 to 1996), and it was also determined that increasing the dataset for calculating the factors would greatly improve the efficacy of calibration.

Table 4: Minimum temperature calibration factors

FACTORS (STATION-NASA) [D>0; UNDERESTIMATE D<0; OVERESTIMATE] - min temp												
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Eldoret	-2.14964	-2.28355	-2.60416	-2.21247	-2.87943	-2.92043	-2.96964	-3.09767	-3.5133	-2.21308	-2.19609	-2.06379
Kakamega	-1.57749	-2.01247	-2.1006	-2.04164	-2.02608	-2.04383	-1.89071	-2.32594	-2.67118	-1.93793	-1.87357	-1.76801
Kitale	-2.05047	-2.4974	-2.33987	-1.96738	-2.05394	-2.12615	-2.39849	-2.72005	-3.04219	-2.26685	-2.36717	-2.37127

Results and Discussion

Watershed Hallmarks

The study observed that the average annual rainfall for the basin ranges between 1000 and 1500 mm. Daily mean temperatures for Nzoia basin were observed to range from 15°C in the highlands (Cherengani hills and Mt. Elgon areas) to 25°C in the lower regions. Annual observations surmised that average annual maximum and minimum temperatures were 27°C and 12°C respectively. Consequently, the watershed can be described as exhibiting a tropical humid climate.

Calibration Results

The study concluded that calibrating GEOS-5 data had the desired effect of improving the data. Table 5 illustrates the results from data calibration; when compared to observed values.

Table 5: Statistical test results on the efficacy of calibration

Weather Parameter Data	R-squared (Linear)		Water Balance	
	Uncalibrated satellite data	Calibrated Satellite Data	Uncalibrated Satellite Data	Calibrated Satellite Data
Rainfall	0.7	0.8	1.108	1.003
Maximum temperature	0.8	0.9	-	-
Minimum temperature	0.2	0.4	-	-

Calibration of rainfall data seems to reasonably improve satellite data. From figure 2, it is quite evident that this is achieved by taking care of the outliers and overestimations typical for satellite data in the watershed. This serves the effect of improving the water balance to within the desirable positive or negative 0.05 range from observed values. GEOS-5 satellite data tend to overestimate rainfalls. This effect is particularly burgeoned at high values. Calibrating satellite data therefore has the effect of reducing outliers and overestimations.

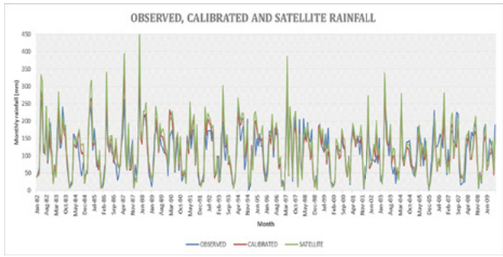

Figure 2: Monthly rainfall for the research period

Similar to rainfall, the best effect of calibrating maximum temperatures is that it serves to take care of the outliers occasioned by satellite data, particularly at high values. Figure 3 illustrates how this is achieved.

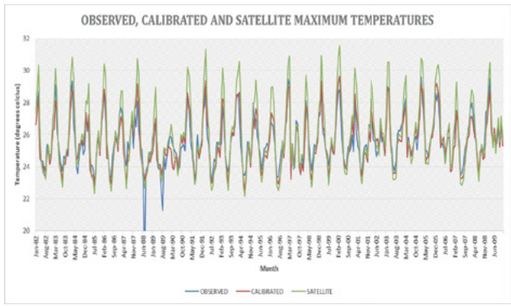

Figure 3: Maximum temperatures

From the study, however, a clear issue emerged pertaining to the accuracy of minimum temperature data. While calibration of the satellite data was able to improve the r-squared values from 0.2 to 0.4, this is still too low to be considered suitable. GEOS-5 satellite data for Nzoia basin is riddled with overestimations for low temperatures, with records of up to a 3-degree difference in some cases. Figure 3 illustrates the challenges coupled with calibrating minimum temperature.

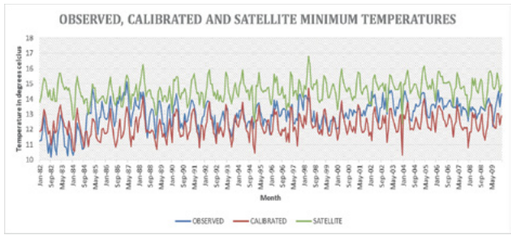

Figure 4: Minimum temperatures

Observations on Average Annual Rainfall for Individual Stations

The calibration of rainfall data for the individual stations seems to be effective in correcting satellite data when the datasets are boiled down to average annual rainfall. As observed in figure 5, satellite data is generally observed to overestimate rainfalls with the exceptions of Kakamega, Kaptagat Kitale and Uholo stations, which exhibit underestimations.

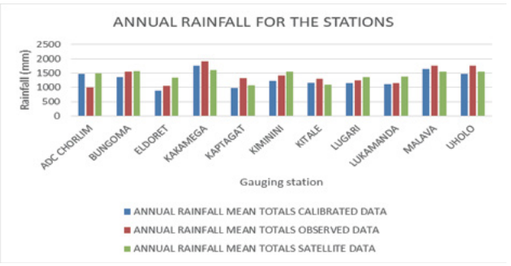

Figure 5: Annual rainfall data showing the efficacy of the calibration for the individual stations

Observations on Annual Rainfall Totals

Satellite data is generally observed to overestimate data when annual rainfall totals are laid out over the entire study period as illustrated in figure 8. Calibration efficacy seems to start deteriorating consistently from 2004 to 2009. This is not surprising since these represent the most data-scarce time periods for observed data. Change in land use over the years is also a factor of interest affecting the efficacy of calibration.

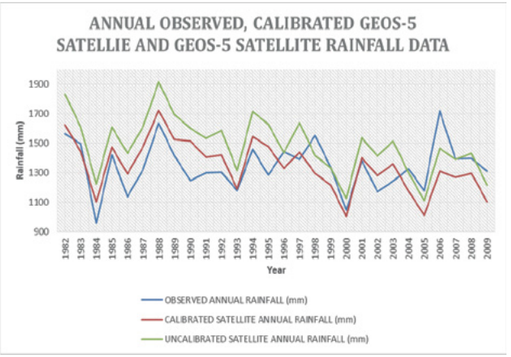

Figure 8: Annual rainfall totals for Nzoia basin

Observations on Annual Daily Maximum Rainfall

As opposed to observations made for daily and average values, calibration of rainfall data does not seem effective for high values. From figure 9, observe how drastically calibration improves in low values (see 1982 to 1984, 1994 to 1997 and after 2000). Above 30mm rainfalls, it is observed that the efficacy of calibration reduces drastically. This problem necessitates a need for alternative means to deal with values deviating far above the mean. Procedures like outlier checks and corrections may provide promising alternatives for this purpose.

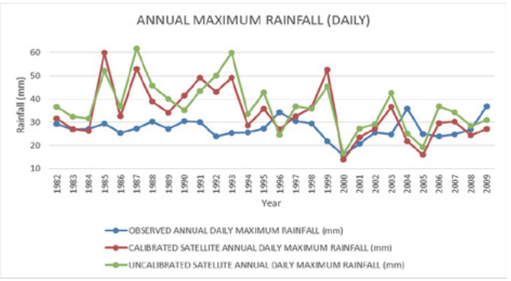

Figure 9: Annual daily maxima

Observations on Annual Mean Daily Rainfall

As observed with previous analyses, GEOS-5 satellite data is generally observed to overestimate data. From figure 7, it is immediately possible to tell that calibration factors perform much better on mean daily data when compared to annual maxima. As observed in multiple other analyses, the data scarcity in observed data from 2004 to 2009 means that the quality of calibration for the period severely deteriorates.

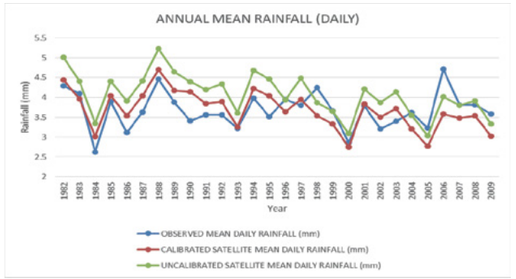

Figure 10: Annual mean daily rainfall

Observations on Mean Annual Temperatures

As evident in figure 8, mean annual temperatures show significant overestimations by satellite data. With few exceptions, this overestimation is for the most part consistent with a difference of 2°C. As expected, calibration efficacy and the ability of satellite data to reflect observed values are particularly compromised for high values. This can be observed in 1987.

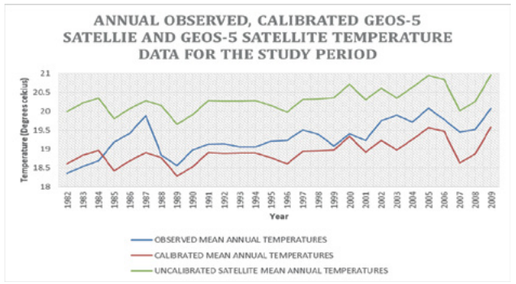

Figure 11: Mean annual temperatures

Observations on Mean Daily Temperatures

Figure 8 illustrates how calibration of data improves temperature data for Nzoia basin. A few errors and gaps in observed temperatures indicate records of temperature below 5.5°C. This is unlikely for the equatorial tropical humid climate attributed to Nzoia basin. Calibrated data seems to correct this error, and all temperatures are observed to lie between 15°C and 25°C; a feature which better represents temperatures expected for the equatorial region in which Nzoia basin is located.

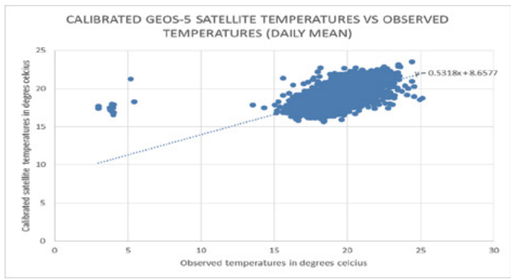

Figure 12: Calibrated vs. observed temperatures showing improvements to the observed database

Commentary on Climate Change and Global Warming

The effects of global warming are visible from figure 11. All datasets considered show consistent annual rise in average temperatures for Nzoia basin. Calculations conclude that annual temperatures for Nzoia basin generally increase steadily by 0.5°C over the study period (1982 to 2009); which is around 0.19°C per decade. This can be attributed to the acute degeneration of the land, particularly the forested highland areas, and the increased carbon emissions resulting from rapid industrialization in the basin.

The rise in temperatures by the estimated 0.19°C per decade is at par with the global warming rates. This exemplifies the fact that climate change is a global issue, and affects all of us no matter how isolated we may think we are.

Conclusion

Calibration of satellite data seems an effective way of improving the dataset. For rainfall data, an improvement from an r-square coefficient of 0.7 to 0.8; and the concurrent improvement of the water balance from 1.108 to 1.003 advocates for the efficacy of satellite data calibration. Similarly, an improvement of concurrent maximum temperatures from an r-squared coefficient of 0.8 to 0.9 further illustrated the efficacy of the calibration. Calibration of the data is particularly effective at reducing outliers and overestimations in the data. However, satellite data calibration for minimum temperature seems to be very poor; such that even though calibration was able to improve the dataset from 0.2 to 0.4, this is still not within suitable parameters. Additionally, the calibration of all datasets seems to deteriorate at high values. For daily rainfalls above 30mm for instance, it has been observed that the efficacy of calibration drops consistently. Additionally, data scarcity seems to plague and affect the calibration, illustrated by the poor reflection of observed data by calibrated data from 2004 to 2009 for all datasets. This region is the most data scarce for observed data, resulting in very poor calibrated results.

Recommendation

Observed temperature and rainfall data were observed to suffer from data scarcity. There are several missing values in the data, with even entire months seeming to pass without a single record. This poor recording was attributed to managerial inefficacies which resulted in poor staffing; resulting in short staffing of meteorologists (particularly in the remote areas). Therefore, it is recommended that the relevant administration should look into the staffing of hydrologists throughout the weather stations, and provide solutions that will result in better efficacy in the recording of meteorological data.

Acknowledgement

The author would like to acknowledge Dr. Job Rotich Kosgei (Moi University), Gilbert Nyageikaro Nyandwaro (Moi University), Ednah Jelagat Kemboi (Moi University), Noah Kipyego Sum (Moi University) and Prof. Yashon Ouma (Moi University) for providing technical consultation during the research phase of the project.

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KeNHA Internship Programme Trains 380 Graduate Engineers since 2020

By Godfrey Wekesa

KeNHA GEIP Facilitating Team with GEIP leaders during the end-year gathering for the KeNHA GEIP Cohort 1 on December 10, 2021 at the Carnivore, Nairobi.

KENYA National Highways Authority (KeNHA) is a State corporation established under the Roads Act 2007 and mandated to construct, upgrade, rehabilitate, and maintain national trunk roads.

In 2020, the Authority, under the coordination of Eng Ezekiel Fukwo, then Deputy Director (Head of Construction Department) and currently serving as the Director under the Directorate of Highway Design and Safety, established the KeNHA Graduate Engineers Internship Programme (GEIP). The programme is aimed at enabling Graduate Engineers to smoothly transition by registering with the Engineers Board of Kenya (EBK) as Professional Engineers. The training involves taking the Graduate Engineers through a thorough one-year on-site training on ongoing road construction and maintenance projects with weekly virtual trainings using voluntary services of Professional Engineers in diverse areas of expertise, equipping them with key salient knowledge and competency areas, including but not limited to;

a). Feasibility study (justification of design and functions verses economics)
b). Reconnaissance and detailed survey
c). Traffic counts, and traffic data analysis
d). Materials investigations and testing
e). Geometric design
f). Pavement design
g). Drainage structures design
h). Environmental, safety and social safeguards considerations
i). Design of road furniture
j). Tender documentation and procurement procedures
k). Preparation of contract documents
l). Project management and Contract administration.

> Since its establishment, the programme has trained 380 Graduate Engineers. The first cohort completed their training in 2021 through which 210 Graduate Engineers were trained. Some 170 Graduate Engineers were trained under the second cohort, which was completed in 2022

Towards the end of a cohort, Professional Engineers supervising their training evaluate the Graduate Engineers to establish the skill sets acquired by the trainees, the gaps in the training and areas of improvement in the subsequent cohorts. A Graduate Engineers Evaluation Test is usually administered to mark the evaluation. The trainees are presented with a case study problem for an ideal project, where they write an essay describing all the procedures and processes undertaken, engineering knowledge applied and socio-economic factors to consider in solving the problem. The trainees that merit after the evaluation are issued with recommendation letters and where opportunities arise within consultancy firms, they are engaged as Assistant Engineers, where they are assigned responsibilities. Those that do not to meet the evaluation criteria undertake further evaluation geared towards bridging any notable gaps. They are taken through a six-month training session structured particularly to address the missing practical skills and are re-evaluated.

Based on the training programme, it has been observed that there is a gap between academia and professional practice. KeNHA GEIP is aimed at bridging the gap of practical professional skills and academic knowledge. Through the programme, the level of professional growth and development and the potential of Graduate Engineers transitioning to Professional Engineers in the Civil and Structural Engineering profession has substantially improved. Their employability is also improved because the programme equips them with the requisite practical industrial skills. The programme is also geared towards being a key facilitator in realisation of the EBK's vision of registering 10,000 Professional Engineers by 2030.

Representatives from EBK, led by the Registrar, Eng Margaret Ogai, IEK led by the President, Eng Erick Ohaga and 1st VP Eng Grace Kagondu, ACEK led by the Honorary Secretary, Eng Jane Mutulili and KeNHA, led by Eng Ezekiel Fukwo, Director (Highway Design and Safety) during the end-year gathering for the KeNHA GEIP Cohort 2 on December 14, 2022 at Panari Hotel, Nairobi.

Representatives from EBK, IEK and KeNHA with GEIP leaders during the end-year gathering for the KeNHA GEIP Cohort 2 on December 14, 2022 at Panari Hotel, Nairobi.

The growth and development of the profession calls for collective responsibility from all stakeholders. There is a need to grow the number of qualified and competent Professional Engineers to march today's rapid infrastructural, manufacturing, energy and industrial developments within the region. This raises the demand for transitioning of Graduate Engineers to Professional Engineers to take up responsibilities in the process. Therefore, all State agencies, parastatals, public and private institutions should be encouraged to establish GEIPs to help in realisation of the agenda. Academic institutions, in collaboration with EBK, can develop a training curriculum through establishment of, say, a Kenya School of Engineering, where Graduate Engineers can be taken through a robust practical training on the industry-related skills. This will be essential in growing the profession and putting the country on the right path towards becoming a first world country as engineers form a key pillar in solving the myriad of societal challenges.

The Board and the management of KeNHA has furthered the programme by ensuring establishment of a department to steer training. The EBK and IEK have supported KeNHA and further collaboration is being planned. The end-year gathering for cohort 2 of KeNHA GEIP held on December14, 2022 at Panari Hotel was attended by EBK, led by the Registrar, Eng Margaret Ogai, IEK, led by the President, Eng Erick Ohaga and 1st VP Eng Grace Kagondu, ACEK, led by the Honorary Secretary, Eng Jane Mutulili and KeNHA, led by Eng Ezekiel Fukwo, Director (Highway Design and Safety) who appreciated the progress of the programme and pledged to support it.

Authors:

Godfrey Wekesa and Collins Olaki

Graduate Engineers EBK, Graduate Members IEK

Leaders, GEIP Facilitating Committee KeNHA HQ

Soliton Telmec: Connecting Lives through Tailored Digital Solutions

The demand for access to ICT services is growing at a phenomenal rate. Operators today are faced with demand for over-higher bandwidth, increased subscriber numbers and Average Revenue per User. ***Engineering in Kenya*** *spoke to Eng Abdirahman Sheikh, Chief Executive Officer, Soliton Telmec, to understand its role in transforming the digital spectrum in Kenya.*

Kindly tell us more about Soliton Telmec; its history, current position and future plans.

Soliton Telmec is a high-tech Kenyan company that is a pioneer in delivering the technology and services for broadband connectivity to service providers in Africa. We see ourselves as a Pan-African company. We have grown from Kenya into Uganda and most recently Democratic Republic of Congo and we plan to continue on this growth trajectory.

In your perspective, where are we coming from as a country in the Telecommunication sector and where are we headed in the next 10 years?

We have an enviable reputation as a Telecommunication powerhouse in the region, thanks in large part to Safaricom's MPESA money transfer service. In the past 10 or 15 years we have made apparent great progress in the Telecommunications sector. In reality, however, our bark is much louder than our bite. For example, according to Speedtest global index, in mobile broadband we are ranked 87 out of 141 countries surveyed at 22.7 Mbps against a global average speed of 36.74 Mbps. In fixed broadband Kenya comes a dismal 155 out of 178 countries surveyed at a paltry 9.23 Mbps against a global average of 75.18 Mbps. In contrast, Qataris enjoy mobile broadband speeds of 169.51 Mbps on average while Singapore tops in fixed broad at 225.71 Mbps, according to the latest data.

How has the fiber-optic cabling transformed e-services and the digital infrastructure in Kenya?

Fiber-optic cabling is one of the tools in our tool box. Fiber is a great technology for delivering broadband services. It is a passive medium that keeps giving once properly installed. The advent of fiber has truly transformed E-services and the digital infrastructure in Kenya. We at Soliton have been at the forefront of this transformation. We have helped major operators in this country provide the broadband services that Kenyans need. I would like to clarify that Soliton designs and builds broadband networking infrastructure for service providers and that we are not facing the end user. Ultimately, therefore, the decision of how, what and where to deploy lies with our customers. Nevertheless, we have seen that in the past 15 years, prices of 1 Mbps dropped from US$3,000 to under US$5 now. Availability has also tremendously increased. There is no doubt whatsoever that investments in fiber-optic technology has greatly enabled movements of high-capacity data at much lower costs and has the potential to further transform end-user experience in ever more sophisticated e-services.

The digital era opens Kenya to immense opportunities, especially in e-commerce. How is Soliton Telmec leveraging the many opportunities in e-commerce?

E-commerce is one of the many applications and services enabled by our digital infrastructure. This application needs robust and secure systems if it is to be trusted as a medium to transfer and receive funds. We will continue enabling e-commerce opportunities through our broad range of products and services that offer robust, secure and cost-effective solutions.

How is Soliton Telmec working towards enhancing internet connectivity in remote and off-grid areas?

Remote and off-grid areas are difficult to serve in that the cost per connection is very high in contrast to cities and other high population settlements. Internet connections need power. This means, in off-grid areas, one has to consider alternative sources of power such as solar and batteries. These are additional cost elements to consider. We handle these kinds of areas on a case by case basis using a mix of technologies such as fiber and radio solutions to bring the costs to reasonable levels. Having said that, the cost per connection in remote and off-grid areas is still quite high and would need some form of subsidy. We, in Kenya, do have programmes such as Universal Service Fund (USF) to help companies offer broadband to areas such as these.

What is the place of fiber-optic cabling in Kenya's built environment?

We are living in an increasingly interconnected world. These days we even have Internet of Things (IOT). It is not just about people to people connectivity. Fiber-optic is the nervous system that carries around the messages that modern society is relying on. The place of fiber-optic cabling in the built environment is similar to the place of the nervous system in the human body. That is to say, essential.

In green field developments, the additional cost of fiber is negligible at less than 2% of the total development cost.

In brownfield areas where fiber or telecom reticulation has not been foreseen there would still be a business case for building fiber-optic networks if we are able to deal with certain challenges.

> Firstly, industry players must invest in new technologies that increase speed of deployment of fibre at reduced costs. Secondly, regulators and other authorities must have an open mind to allow these technologies to be used in Kenya. We have identified four obstacles facing investors, particularly the smaller ones, of fiber in Kenya.

One is **Communication Authority (CA)** for Green Field areas. Imagine a developer of large-scale low-cost housing units wanting to deploy fiber reticulation in their green field development. Service providers would then be offered to access the network

Eng. Abdirahman Sheikh
Chief Executive Officer,
Soliton Telmec

on open access basis so that each provider does not have to build own infrastructure to access its customer, leading to lower acquisition cost for the operators and therefore lower service costs. This arrangement is prohibited to developers and the community of users unless they have a tier-3 license. In order to acquire and maintain a tier-3 license, you need to go through a long application process and pay Ksh360, 000 and an annual fee of over Ksh100, 000. In addition, you have to submit your annual audited accounts every year in order to maintain the license.

Two, **Kenya National Highways Authority (KeNHA)**. In order for service providers to reach their customers, they have to cross KeNHA roads sometimes multiple times. Nowadays, this is done by drilling across the roads without any disruption to traffic or interference with road infrastructure whatsoever. KeNHA charges Ksh100, 000 per lane of the road crossed plus an annual charge of Ksh5, 000 per kilometer along the road.

Three, **county governments** charge one-off fees plus annual way leaves. The charges vary widely from county to county. Some counties have unreasonably high rates backed by a Finance Bill passed by MCAs. Some counties do not have rates, leading to some interesting conversations between confused operators who want to stay on the right side of the law and equally confused county officials.

Finally, **Kenya Railways & RVR**. I have seen the Ministry of ICT, Innovation and Youth Affairs slapped with wayleave and supervision charges of over Ksh8,000,000 to cross railway tracks in Nakuru.

Investors have to face such unreasonable charges without any basis whatsoever from multiple quarters. Some of these charges could be illegal as they might not be backed by legislation. If you look around in Nairobi, you will see the impact this folly has on the built environment.

Airtel Kenya: Expanding Telecommunication Industry in Kenya to Improve Efficiency and Reliability

By Maureen Mwangi

AIRTEL Kenya is constantly rolling out a countrywide expansion and modernization programme of its technology and network footprint, says Chief Executive Officer Ashish Malhotra. This is in a bid to ensure accessible, reliable, and affordable communications services to Kenyans.

Airtel currently boasts of over 16 million subscribers.

With the increased demand for fast and reliable internet from Kenyans, the firm has expanded its fibre rollout to data centers to boost resilience and high-speed connectivity. Additionally, the telco has rolled out 5G-ready equipment in Nairobi and other major towns in the country.

> We are the most affordable network in the country as we offer Kenyans highly affordable and value-driven products, all in an effort to ensure digital inclusion and to ensure all Kenyans are connected to friends and family at all times, says Mr. Ashish.

The technological developments in the telecommunication sector have pushed most telco firms to improve their services and reliability to their customers.

At Airtel, Mr Ashish says customers are central to their operations, and they are developing strategies to bridge the gaps existing in the telecommunication sector. The company has so far rolled out 4G networks in all their sites around the country.

"With the rapid growth in technology, we have ensured our services are digitized through various platforms, such as the My Airtel application, which is a one-stop point for multiple services. Our SSD platforms have also been enhanced to ensure subscribers can self-onboard and raise queries. The workplace and Airtel shops countrywide are also fully digitized, which is why customers can have their challenges addressed promptly," he says.

He says telecommunication engineers are a crucial team in the firm, and have played a key role by building infrastructure on which the company's voice and data services are carried. This has improved the company's reliability, accessibility, and ensured secure communications infrastructure for the firm to be able to effectively reach the target market.

"At Airtel Kenya, in addition to building, operating, and maintaining telecom infrastructure, our telecommunications engineers are heavily involved in solving customer complaints by coming up with innovative solutions to such complaints," he says.

"They thus work with customer-handling departments such as marketing, customer experience and sales to get insights into the clients' network experience. With these insights, they can optimize the network for optimal customer experience."

Telecommunications engineers are also at the forefront of creating a digital and connected future, says Mr Ashish. They are devoted to creating communication means that are more accessible, faster, safer, reliable, and far-reaching. These will ultimately positively impact other industries, such as education delivery, finance, commerce, health, and transportation.

Mr Ashish Malhotra
Managing Director,
Airtel Networks Kenya Limited

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5G
READY EQUIPMENT

Mr Ashish says Airtel has continued to empower and build local telecommunication engineers through company-facilitated training and courses. This continued training helps the engineers to stay at the top of their game while delivering top-quality work to their clients.

Airtel's partnership with Communication Authority of Kenya has enabled the company to address the challenge of online abuse and cyber-bullying, especially against children. The telco is working around the clock to ensure children are not victims of online abuse. Their services have enabled clients who face this menace to report any kind of abuse to them efficiently through voice, SMS and WhatsApp.

Airtel Kenya is a subsidiary of Airtel Africa, a leading telecommunications and mobile money firm. The company traces its origins to India, where it started as Bharti Airtel. It set camp in Kenya in November 2010 after Bharti Airtel acquired Zain in June of the same year.

Asphalt Reinforcement Grids: A Solution to Reflective Cracks, Improved Load Distribution and Reduced Carbon Footprint.

Asphalt is a popular choice for paving airports roads, driveways, and parking lots due to its durability, flexibility and affordability. However, with time and increased traffic, asphalt surfaces may develop cracks, which not only reduce the aesthetic appeal of the area but also weaken the structure by ingress of water and lead to further deterioration. Reflective cracks, in particular, are a significant problem as they occur when existing cracks in the underlying concrete or asphalt layers are reflected onto the surface. This type of cracking is a major challenge in asphalt pavement design and maintenance. Reflective cracks reduce the lifespan of overlays to as little as 3months as opposed to the prescribed design of atleast 3 years.

Fortunately, the use of asphalt reinforcement grids offers a solution to this problem by eliminating reflective cracks and improving the load distribution over a larger area, leading to an increased pavement design life and reduced carbon footprint. In this article, we will discuss the benefits of using asphalt reinforcement grids, with a special emphasis on the Hatelit brand of grids.

Elimination of Reflective Cracks

Asphalt reinforcement grids provide a mechanical bond between the asphalt layer and the underlying layer and add strength to the overlay, which prevents reflective cracks from occurring. The grid works by distributing the load over a larger area, reducing the stress on any one point, and preventing the formation of cracks. This helps to maintain the integrity of the asphalt surface and prolong its lifespan. According to the Federal Highway Administration (FHWA), the use of asphalt reinforcement grids can reduce the formation of reflective cracks by up to 98%. Asphalt reinforcement grids also bridge areas of weakness on the existing pavement and hence extend the pavement service life.

Improved Load Distribution

Asphalt reinforcement grids help to distribute the load over a larger area, reducing the stress on any one point. This leads to an improvement of the stress distribution in the pavement, which can handle increased traffic without cracking. The grids act as a reinforcement layer, providing the necessary strength and stability to the asphalt surface, which prolongs its lifespan and reduces the need for maintenance and repairs. In a study by the University of Illinois at Urbana-Champaign, the use of asphalt reinforcement grids resulted in a 40% improvement in the load-bearing capacity of the pavement.

Reduced Carbon Footprint

The use of asphalt reinforcement grids not only leads to an increased pavement design life but also reduces the carbon footprint of the construction project. This is because the grids help to extend the lifespan of the asphalt surface, reducing the need for frequent repairs and replacements. Application of asphalt reinforcement grids also reduces the maintenance cycles, and this will also reduce the amount of traffic jams occasioned by bad roads. The consequence of this is reduced vehicle maintenance costs, exhaust emissions, respiratory diseases and lost manhours. Additionally, the manufacturing process of grids requires less energy compared to the production of traditional asphalt materials, further reducing the carbon footprint of the construction project. According to the National Renewable Energy Laboratory (NREL), the use of grids in pavement construction can reduce greenhouse gas emissions by up to 15%.

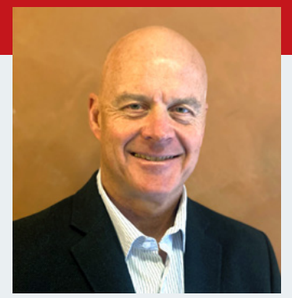
Hatelit Brand of Asphalt Reinforcement Grids

Hatelit is a brand of asphalt reinforcement grids that offers the ultimate solution to reflective cracks and improved load distribution. Made from high-quality, UV-resistant polyester, the Hatelit grids are strong, durable, and flexible, providing long-lasting performance. Additionally, the unique design of the Hatelit grids ensures that they provide a mechanical bond with the asphalt surface, ensuring that the load is distributed evenly, reducing stress on any one point, and preventing the formation of reflective cracks. In addition, Hatelit asphalt grids have a low density geofabric polypropylene material that is impregnated with at least 65% bitumen content, and this increases the bond between the existing road and the new overlay. It also enhances the waterproof characteristics of the asphalt layer. The Hatelit grids are certified to meet ASTM D-4439 standards for asphalt reinforcement, ensuring that they provide reliable and long-lasting performance.

Conclusion

In conclusion, the use of asphalt reinforcement grids offers a cost-efficient solution to the problem of reflective cracks and the high cost of milling. This raises the question: is it economically viable, environmentally sustainable, and engineering sound to build or maintain bituminous pavement layers without reinforcing them?

Engineering Kenya's **Tomorrow**



Africa's economy, driven by population growth, urbanization and food securities is expected to grow 10-fold to $29T by 2050. At Danfoss, we are committed to turning this challenge into an opportunity for Kenya.

By Emil Berning, Country Manager for Sub-Saharan Africa at Danfoss Turkey, Middle East and Africa

Food security is becoming a real serious problem with growing population and changing supply chain dynamics. The small farmers in East Africa, in many instances cannot afford the cold chain infrastructure. Out of 54 countries in Africa, South Africa takes the first position when it comes to cold chain infrastructure, and though not in the same scale Egypt comes distant second, followed by Maghreb countries especially Morocco and Tunisia. Presently, post-harvest food losses (between farm and fork) in Sub-saharan Africa are estimated to be about 37% of food produced, worth US $4 billion per year - or enough to feed at least 48 million people. However, we have started seeing many positive developments in many markets, especially in Kenya. We could see the rise of natural refrigerants in mature markets like South Africa. Also, our market presence has increased in markets like Egypt, Nigeria and Morocco.

Challenges that arise

Lack of policies, investments, large number of small farmers, awareness and technical capabilities are the main challenges in developing cold chain infrastructure. Another challenge we face are skills and training of local installers. This is crucial, they need to be well trained and skilled to work with all types of refrigerants/technology, and be able to make sure that installations are tight and well maintained to ensure safe and efficient operation, etc.

> *Danfoss has ambitious plans for East Africa. We want to help Kenya successfully tackle urbanization challenges with energy-efficient technologies, reduce food loss through cold chain applications and services, on-site energy-efficient cold room storage and distribution, and to optimize other industries.*

Also, counterfeit is a serious issue in many African countries that is heavily impacting the efficiency and reliability of the refrigeration systems. While hunger in the world is growing, significant amounts of food are lost and wasted. This comes at a huge cost for society and the climate: Today, 2.1 billion tons of food are lost and wasted, and 22% of the word's total food loss is in low-income countries. If food loss and waste were a country, it would be the 3rd biggest emitter of greenhouse gas emissions. In Africa these figures are much higher than 22%

Efficient solutions for food loss

We need to have the right financial models to ensure development of cold chain. The return on investment is viable. But many communities have to find the initial funding and that would need government and other supports from NGOs.

However, we need to keep in mind that if it is less expensive to throw away unused food than investing into a cold room, why would the retailer/grocery shop spend money for the cold room? These problems need to be addressed and here we need dedicated finance models. Service-based models can be a solution as they avoid the upfront investment. Banks need to be part of the picture.

Also lack of awareness in Kenya is a main thing we need to tackle. Finally, the lack of local technical competence, we need to make sure these three fall in place. Currently these are the obstacles we see in developing a cold chain.

Doing more with less

Refrigeration has been around for more than 100 years and it's an evolving industry. We believe that Kenya does not need undergo the challenges that other countries faced. We can leapfrog the challenges faced by developed nations with CFC's and HCFC's.

As Danfoss we take pride in the fact that our business is sustainability. Danfoss contributes to combatting climate change with innovation and smart thinking allowing the world to get more from less. This mindset is built into all our technologies. No matter what we produce, the goal is always to optimize performance, increase efficiency, and minimize waste. And at the same time, Danfoss is supporting energy exploration efforts and a growing renewable energy market to help meet the growing demand. We would like to bring the energy efficiency mindset in Cold chain infrastructure.

The solutions are already available

The journey towards food security and minimized food wastage in Kenya is enabled by utilizing energy-efficient solutions already available and enhancing these with new technology. First step is to improve farming productivity to ensure an optimal yield. In the field, tractors and harvesters must be rightly equipped to optimize the harvest on the farms. It is estimated that by using precision agriculture technologies covering each production step could deliver up to 50% productivity improvement in farming by 2050. Precision agriculture is a modern farming management concept using digital techniques to monitor and optimize agriculture production processes. Precision farming combine sensors, robots, GPS, mapping tools and data-analytics software to customize the care that plants receive. Farmers receive the feedback in real time and then deliver water, pesticide or fertilizer in calibrated doses to only the areas that need it. The technology can also help farmers decide when to plant and harvest crops.

Next step is to get the food to the consumer. All along the way from farm to fork, food safety, freshness and hygiene must be secured with reliable as well as cost- and energy-efficient cold chain systems. From dairy and fishery products to farm produce such as vegetables and fruits, or processed foods such as bakery items, cold chains and storage are essential for efficient food distribution and minimized food loss. It is estimated that about one quarter of food production is lost due to a lack of or an incomplete cold chain in developing countries. The primary reason for these losses is the lack of systems, which connect all the different elements of a cold chain. So, an effective cold chain also needs a digital tracking and traceability system that allows the cold chain operators to monitor the temperature of the products at all times. Tracking the real-time temperature of products ensures that products remain at correct temperature and humidity, optimizing food safety and security.

This is what our products and solutions can do, and how we play a vital role throughout the entire journey: Helping to optimize the harvest on our farms, the efficiency in our food production and make high quality, refrigerated transportation and storage of food possible across the globe. We are part of Engineering Tomorrow's sustainable food supply for a growing world.

Danfoss in Kenya

With rich natural resources and a growing population in East Africa, Danfoss Climate Solutions, can provide sustainable cooling of fresh food and reduce the cost of living in megapolises. East Africa is also an indirect market for global key accounts and other clients such as OEMs, SIs, and contractors from North America, Europe, Australia, India, and China.

Research shows that 70-80% of tomatoes in Kenya are being wasted, not to mention other produce. The food processing companies moving to Kenya are seeing this as an opportunity. However, food loss, as one of the major issues in Kenya, can be easily solved by developing the right cold chain infrastructure. At Danfoss, we not only have innovative energy-efficient solutions but the right know-how.

In 2022 Danfoss launched the "Eyes in Africa" internship project, where three Kenyan students were selected as Student Data Analysts and represented Danfoss on the ground. With this initiative, Danfoss wanted to understand the needs of the local population better and, with close collaboration with the University of Nairobi, to educate young minds on the importance of decarbonization and immediate action in response to climate change. One of the students is now a Danfoss full-time employee.

Students Voices

Internet of Things: The future of Engineering

The audience explored their imagination as Eng Erick Wanjala spurred to the 29th IEK convention audience what five years ago would have been termed as pseudo-science – the notion that a Civil Engineer could determine which side of the road is used most, or a resident of Budalang'i could be evacuated way before the banks of River Nzoia broke. 1st of December came and world's richest man Elon Musk announced that Neuralink was aiming to connect minds to the Internet to allow those without hands to control computers. Just a day later, the US Airforce unveiled its B-21 Raider, "that connects to other platforms sharing data seamlessly, increasing its effectiveness. It's the first of its kind, a 6th generation platform."

What could possibly be the enabler of all this? IOT. The Internet of Things is the ability of sensors to be connected to the Internet and leverage real-time data. This data, which is termed by many as the fuel of the future, can be instantly processed to influence decisions thousands of miles from where the actual sensor is. An example is incubators being connected to a phone app to remotely monitor the levels of critical parameters of patients.

Internet of Things will revolutionize how products are built, as optimizations to existing designs can be easily achieved when insightful real-time information is available. The technology represents a giant leap, but to be able to explore the immense capabilities that IOT offers, reskilling is required. Programming is a key component of such systems. There is also a need to use a software-first approach with less efficiencies to manual systems and embrace control by wire systems.

Isaac Masinde, Mechanical and Production Engineering Student, Moi University

Development of Telecommunications

Telecommunications engineering has inadvertently contributed to the technological transition of the global space. From the earliest days, telecommunication technology has enabled the development of communication infrastructure and services that have enabled the transmission of data and information across vast distances, creating a more connected world.

Recent advancements in telecommunications engineering include the Internet of Things (IoT) and 5G networks. IoT is a network of interconnected devices, like home appliances, cars, and wearable, which can be controlled and monitored remotely. 5G networks enable faster speeds, better bandwidth, and higher data rates than 4G networks. It has enabled us to access information, entertainment, and communication services more quickly and efficiently. Artificial Intelligence (AI) is the science of making machines do intelligent tasks. AI involves computer programming to make decisions and complete tasks without human intervention. AI can automate tasks, analyze large data sets, and make predictions. Machine Learning (ML) is a subfield of AI that entails creating algorithms that can learn from data and recognise patterns. ML algorithms are used to make decisions and predictions based on data and can be used to automate processes. ML algorithms are used in various areas, such as image recognition, natural language processing, and robotics.

In the years to come, telecommunications engineering will continue to evolve. It is expected that 5G networks will become more widespread and enable more advanced applications, such as autonomous driving and virtual reality. In addition, IoT devices will be connected to the network, allowing them to send and receive data. This progress will enable new applications and services, such as smart home and smart city solutions. Advances in artificial intelligence would be pivotal in developing new applications and services, such as virtual assistants, automated customer support, and predictive analytics. Machine learning will enable more efficient and intelligent networks.

Japheth Kiplagat 3rd Year Electrical & Telecommunications Engineering at Multimedia University of Kenya.

What Telecommunication Engineering Education entails

Telecommunication and Information Engineering involves studying the design and development of systems and networks for transmitting information over long distances and the design and development of systems and technologies for storing, processing and transmitting information.

These include telecommunication systems and networks as simple as a pair of radios or as complex as a global network of satellites, undersea cables and terrestrial transmission towers. Theses systems and networks are used for a wide range of purposes, including voice and data communication, broadcasting and internet connectivity.

To achieve transmission of information over long distances, we must consider factors like the type of information being transmitted, the distance it will travel and the available transmission technologies. The transmission of information over long distances often requires the use of specialised equipment such as amplifiers, repeaters and other devices.

At Dedan Kimathi University of Technology, we have been familiarized with all these devices and many other equipment used in Telecommunication Engineering due to their availability.

We also focus on the design and development of systems and technologies for storing, processing and transmitting information. This includes development of databases, computer networks and other information systems, as well as development of algorithms and protocols for efficiently storing, processing and transmitting large amounts of data.

Telecommunication and Information Engineering plays a crucial role in our modern world by enabling the rapid and efficient transmission of information across long distances and providing the infrastructure for a wide range of important applications, from global communications and commerce to education and entertainment. This field is constantly evolving and new technologies and innovations are being developed, allowing us to transmit and process information in ways that were previously unimaginable.

It is evident that all the positive impacts have directly benefitted each and everyone of us.

Anthony Kaguu Wachira, student Telecommunication and Information Engineering at Dedan Kimathi University of Technology

My Journey has Just Begun

My journey has been quite interesting so far and I am looking forward to things getting even better. Studying for a degree in Telecommunications and Information Engineering, just like all other engineering disciplines, calls for a lot of hard work and dedication to be able to excel. I decided to venture into Telecommunications Engineering because of the role that the telecommunications industry plays in communication. The world has become a global village and communication is a huge part of that. The telecommunications industry is a male dominated field; hence, it is a good opportunity for me to get out of my comfort zone.

So far, keeping up with classes, lab work and social life has not been a challenge as I endeavour to manage my time properly. The lecturers are very diligent with their work and are supportive. The chairman of our department, for instance, normally urges us to participate in competitions and even introduced to us the Arduino microcontroller very early in the course so that we may grasp it better.

The highlight of my time as a student studying engineering in my university is the Tech Expo. This is an annual event where students come up with amazing innovations targeted at solving the problems in society. It is a good learning opportunity where I get to interact with some of the amazing brains and challenge myself to be in their place someday.

I cannot wait to be a registered engineer doing what I am passionate about and bringing about change in my society and the world at large.

Dalphine Momanyi, 2nd Year, Telecommunications and Information Engineering, JKUAT

Quality Assurance in Telecommunication Engineering

Telecommunications and Information Engineering (TIE) is a discipline that merges the concepts of computer science, electrical and electronics engineering and information technology.

Quality education means experience, exposure. It means having contacts with the right people in the right industry. This is precisely what the universities are focusing on by running course-oriented clubs that enable students to acquire practical skills alongside classwork. One such club is Google Developers Student Community (GDSC), which ensures that students in Telecommunications Engineering are at par with the current technology. Through this, they are able to interact with key role models in the industry during technological events in the institutions.

Teaching is given a practical approach as it is packed with lab training and workshops. The lecturer-student ratio is quite commendable, ensuring that each student is given maximum attention. Students are taken through a rigorous training on programming languages, which is crucial in their careers. Many graduates have attested to this, saying that the knowledge of programming has greatly differentiated them from other graduates in the job market.

Thanks to the Memorandum of Understanding (MoU) between the government and universities, they are able to provide students with immense exposure to top industry players through industrial visits and attachments. This has advanced the experience and skills, which the students apply in fields such as designing, servicing networks and computer networking.

As an emerging industry, it is expected to attract more students in the near future. The universities should therefore partner with organisations such as National Industrial Training Authority (NITA) for more internships and attachments. The current state of Telecommunications Engineering in the university is promising and the future is set to be better!

David Odhiambo, Telecommunications and Information Engineering, JKUAT

The Basis of Telecommunication Engineering Education at the University

Telecommunication Engineering focuses on the transmission of information across distances through the use of electronic or electromagnetic devices. This includes the design and development of systems for transmitting and receiving information, such as radio and television broadcasting, satellite communications, and telecommunications networks.

At the university level, Telecommunication Engineering programmes typically offer a combination of theoretical and practical coursework, providing students with a strong foundation in the principles of electronics, computer science, and electrical engineering. Students may also have the opportunity to specialise in a specific area of Telecommunication Engineering, such as wireless communications or network security. Students may take courses such as electronic circuits, signal processing, telecommunications networks, and wireless communications. They may also have the opportunity to gain hands-on experience through internships or laboratory courses.

After studies, graduates of Telecommunication Engineering expect to find employment in a variety of industries, including telecommunications, broadcasting, and computer networking. They may work for telecommunications companies, government agencies, or consulting firms, and may be involved in the design, implementation, and maintenance of telecommunications systems. A degree in Telecommunication Engineering can also provide a strong foundation for graduate study in a related field, such as electrical engineering or computer science. As the field of Telecommunication Engineering continues to evolve, the demand for qualified professionals with specialised knowledge and skills is expected to increase.

Overall, Telecommunication Engineering is a challenging and rewarding field that plays a vital role in modern society, enabling people to communicate and access information from anywhere in the world.

Leila Akinyi Otieno, Telecommunications and Information Engineering, JKUAT

5G as an Enabler of Digital Technologies

By Lawrence Nangabo

SINCE the launch of the first generation commercial cellular network in Japan by Nippon Telegraph and Telephone in 1979, telecommunication standards for cellular networks have evolved over the years, becoming better in terms of data transfer rate, decreasing latency, and increasing network capacity. This has increased reliability and efficiency of the networks, thus facilitating quick access to information. The development of 5G is a critical milestone that can be leveraged as an enabler of digital technologies.

But what is 5G?

5G is a fifth-generation telecommunication standard for cellular networks. The third Generation Partnership Project defines 5G standards and specifications in collaboration with the International Telecommunication Union and the Internet Engineering Task Force, among others. It iterates upon the previous standard, 4G. It is designed to increase data transmission rates, minimize latency, provide reliable connectivity, reduce wireless network response time and increase the capacity of the network to handle multiple devices. This enhances the efficiency of the network.

Previous cellular networks relied on low-band (600-900MHz) and mid-band (1.7-4.7GHz) frequencies. 5G networks rely on low-band, mid-band, and higher-band frequency radio waves. The additional high-band frequency radio waves or millimeter wave frequencies in the range of 24-54 GHz aids in increasing the rate of data transfer. 5G can be implemented in the millimeter wave band up to 100GHz.

According to the International Mobile Telecommunications 2020 standard by the International Telecommunication Union Radiocommunication Sector, in ideal conditions, *the peak downlink data rates for 5G networks will be about 20 Gb/s and peak uplink data rates about 10 Gb/s.* 5G radio network latency is expected to be one millisecond, throughput 10 Mbps/m^2 area, and one million Internet of Things (IoT) devices are to be connected per square kilometer. The peak downlink data rate for 5G is much higher than for 4G's 100Mbps.

According to the Global System for Mobile Communications, 5G is expected to account for around a quarter of the total mobile connections by the end of 2025. More than two in five people worldwide can access a 5G network. In October 2022, Safaricom launched 5G trials for individual and enterprise customers in Nairobi, Kisumu, Kisii, Mombasa and Kakamega with plans to expand the number of 5G sites to more than 200 across the country by March this year.

What does this mean for digital technologies? Due to 5G's higher rate of data transfer, lower latency, more network capacity than 4G networks, its ability to support edge computing, Vehicle-to-Everything communication, and network slicing, and higher reliability, 5G will impact digital technologies in the following ways:

Internet of Things; there will be more connected IoT devices on the network that can communicate seamlessly and quickly in real-time. This will promote the development of new IoT applications for smart cities.

Artificial Intelligence and Machine Learning; AI systems will be more efficient and faster, thus responding more quickly. Higher reliability and network capacity will also ensure that Autonomous Vehicles operate safely.

Virtual and augmented reality; the higher bandwidth and lower latency will ensure VR/AR applications work more effectively and are easily accessed by more mobile devices providing near-real-time experiences.

Big data; 5G network's high capacity makes it possible for multiple IoT devices to connect to the network while facilitating high data transfer rates. It will be, therefore, likely to collect and analyze large data sets in real-time to ensure fast and informed decision-making by organizations.

Cloud computing; a higher rate of data transfer and network capacity will enable individuals and organizations to access large data sets from the cloud quickly, thus facilitating sharing of information and promoting the development of cloud-based applications to access cloud-based services quickly and efficiently.

Cyber security; increased network capacity means more devices can simultaneously connect to the network. This increases the cyber threat level and makes network security management complex. 5G is also built upon Network Function Virtualisation and Software Defined Networking, which makes it vulnerable to cyber threats such as Man in Middle Attacks (MitM), Denial of Service (DoS), and Distributed Denial of Service (DDoS). There is a need to incorporate enhanced security features such as end-end encryption in 5G networks. Network security managers should also be proactive in mitigating and responding to cyber threats quickly to enhance the security of these networks.

In conclusion, the adoption of 5G coupled with digital technologies will facilitate easier sharing of information. This will drive innovation, increase efficiency, improve productivity, and promote the growth and development of the digital economy.

Lawrence Nangabo is a graduate engineer (Electrical & Electronics), GMIEK, at the State Department for Public Works.

Artificial Intelligence is the Future we Cannot Ignore

By Sharon Akinyi Odhiambo

Introduction

WHAT we considered science fiction a few years back has since become reality. A reality that is fast paced and keeps on changing and it is sometimes difficult to see the future. Yet it is important that we adequately prepare for this future. And this begs the question, how do we adequately prepare for the unkown? If our ancestors woke up today to experience the massive range of technological advancement we have had over the years, they would think of us as gods. Creating robots and having them perform our tasks in a matter of seconds would be a wild imagination for them and this is Artificial Intelligence, also known as AI. Artificial Intelligence is a field of computer science and engineering focused on the creation of intelligent machines that can think and act like humans. The development of AI involves creating algorithms and systems that can process and analyse large amounts of data, recognise patterns, and make decisions based on that analysis.

With AI we are beginning a far-reaching and fast paced journey, one that will lead us to a radically different lifestyle. I don't think AI is a tad, rather these technologies will provide a significant gamechanger in every aspect of life from engineering manufacturing to environment, agriculture, healthcare, telecommunication and, sadly so, warfare. These technologies are spread through a vast area of machine learning, natural language processing, robotics, and computer vision, among other technologies.

Is AI good or bad for us?

AI is definitely going to bring a lot of changes in our lives, a change that is guaranteed to impact us in a way, either positively or negatively. The popular question from most people on AI is its impact on our society, hence the reluctance on adoption of its use by most folks. My grandmother doesn't understand how a robot vacuum cleaner will clean her space for her, says it is spying on her, and there are so many consiparacy theories around them too.

With the world shifting to electric vehicles, self driven vehicles is the next epitome of the transport industry. It is more efficient and less susceptible to human errors made on the road. If we reduced the number of accidents on the road and made transportation safer, our expressway would make more sense for us Kenyans.

> AI in healthcare has assisted doctors make more informed and accurate diagnosis and are able to predict patient outcomes and suggest treatment options. Look at the most recent Covid predicament.

Manufacturing production can be optimised through the use of AI improving production processes and efficiency just to mention but a few.

However, the development and use of AI also raises ethical concerns, such as the potential for increased unemployment and the need to ensure that AI systems are transparent and accountable and address the privacy risks.

Conclusion

AI has the potential to revolutionise many industries and improve the efficiency and effectiveness of many processes by trying to create systems that can perform tasks that would normally require human intelligence, such as learning, problem solving and decision making. IT experts need to implement the cutting-edge technologies and safety protocols required to power AI. Overall, AI and related technologies have the potential to bring about significant advancements and improvements in many areas, but it is important to carefully consider the potential impacts and address any concerns to ensure that these technologies are used responsibly and ethically. As for robots replacing humans, because of their close relationships with their patients and students, robots will never be able to replace human healthcare professionals or educators.

Sharon Akinyi Odhiambo is a Network Design Graduate Engineer at Konza Technopolis

29th IEK Convention: A Platform to Discuss how Best to Engineer a Sustainable World

By Maureen Mwangi

THE Institution Engineers of Kenya (IEK) in conjunction with Engineers Board of Kenya co-hosted the 29th IEK International Convention on November 21 to 25, 2022 in Diani Reef Beach Resort and Spa in Kwale County, Kenya.

The 2022 convention theme was *'Sustainable Engineering in the Era of Climate Change'*. This convention came just after the 27th Conference of the Parties of the United Nations Framework Convention on Climate Change (COP27) in Sharma El-Sheikh, Egypt, which concluded on November 20.

The Chief Guest – Water, Sanitation and Irrigation Cabinet Secretary Alice Wahome – officially opened the conference.

Ms Wahome noted the importance and the role Engineers play in the ministry. She promised to support and embrace recommendations from the Institution of Engineers of Kenya (IEK) and work collaboratively with it.

IEK President Eng Eric Ohaga noted the importance of deepening collaboration between the institution and the government to contribute to economic development.

"We are aware of your priorities in the water, sanitation and irrigation docket and as engineers we are at the centre of supporting you to undertake the implementation of these programmes in order to meet your set targets," Eng Ohaga told the CS.

> The president emphasised the need to have more professional Engineers in county governments to eradicate shoddy workmanship in development projects.

"The County Governments require approximately 1,500 additional engineers and these need to be recruited urgently as there are a number of shoddy and dangerous infrastructure developments in the counties. It is urgent that the government hires trained, experienced, registered and licensed engineers to be in-charge of all engineering works in Counties and National Government," he said.

16 - Paper Presentations
3 - Panel Sessions
23 - Keynote Speeches
8 - Exhibitions

The convention gave presenters and delegates an opportunity to reflect on ways to mitigate climate change and means to adapt to the rapid changes. It was noted that engineers are the forerunners in climate change solutions, adaption strategies and sustainability. Engineers have a big role to play in mitigating climate change impacts.

The five-day convention attracted delegates from around the globe, with an attendance of over 3,000 engineers physically and virtually. Those in attendance included government representatives, educationists, students, Engineering practitioners, international engineering organisations and the private sector.

The 2022 convention undeniably recorded the highest number of attendees. The sessions comprised 16 paper presentations, three panel sessions, 23 keynote speeches and 38 exhibitions.

The convention was structured into the following sub-themes;

- Building resilient infrastructure
- Harnessing emerging technologies for sustainable development
- Innovation
- Mitigation measures against climate change
- Climate Adaption
- Climate Change Impact & Engineering
- Artificial Intelligence
- Energy Transition
- Role of Nuclear and renewable Energy in Combating Climate Change
- Role of Green Financing and Green Economy

The convention kicked off with three concurrent events; the 1st Future Leaders Summit, 1st Men Engineers Summit, and 5th Women Engineers Summit. The Future Leaders Summit themed, "Back to Basics", was chaperoned by Future Leaders/Young Engineers' Committee Chairperson Eng Lilian Kilatya and gave a platform to the young Engineers to engage and develop short and long-term resolutions.

"Young aspiring engineers, graduate engineers and young corporate members should be involved in discussions relating to engineering as they influence their welfare and sustainability when it comes to opportunities and resources," said Eng Kilatya.

The Men Engineers Convention spearheaded by Eng Paul Ochola focused on 're-invention towards a sustainable future'.

Engineers Board of Kenya (EBK) Chairman, Eng. Erastus Mwongera, applauded men for holding their first summit ever. He asked them to hold more sessions like their women counterparts to share ideas, network and build solutions.

Finally, the Women Engineers Summit themed, '360 degrees Women Engineers: A catalyst for Change', focused on diversity and inclusivity, career progression and mentorship, and mental health and wellness.

Women Engineers Committee (WEC) Chairperson Eng Florah Kamanja said they are planning to launch the 'She for She' programme whose major aim is to grow women membership at the Institution of Engineers of Kenya (IEK) from 12.7% to 30% by 2024. The aim of the programme is to pair up young female Engineers with experienced Engineers for mentorship, coaching and guidance.

"It is the responsibility of every female Engineer to empower another female Engineer," said Eng Kamanja.

The summits touched on professional ethics, planned urbanisation, building resilient infrastructure, investment entrepreneurship opportunities, diversity and inclusivity, career progression and mentorship, mental health and awareness at work and learning institutions, harnessing emerging technologies for sustainable development innovation, mitigation measures against climate change, climate adoption and climate change impact.

IEK News briefs

By Maria Monayo

Nigerian Society of Engineers holds 55th National Engineers Conference

The Nigerian Society of Engineers held its 55th National Engineers Conference on November 14-18, 2022 at the International Conference Centre in Abuja. The theme of the Conference was *Advancing the Frontiers of Communication and Digital Economy in Nigeria.* Institution of Engineers of Kenya (IEK) president Eng Erick Ohaga together with 1st VP Eng Grace Kagondu and Council member Eng Paul Ochola represented the institution.

13th Institution of Engineers of Tanzania (IET) International Conference 2022

The Institution of Engineers of Tanzania held its 13th International Conference on December 1-3, 2022 in Arusha. The conference under the theme, *Advancing UN sustainable Development Goals through Engineering Technology in the framework of climate change adaptation approaches,* was graced by the European Union Head of Delegation to Tanzania, Amb Manfredo Fanti. The conference was attended by delegates from African states, including Rwanda, Ghana, Nigeria, Ethiopia and Kenya. The Future Leaders Committee Chair, Eng Lilian Kilatya, represented the IEK.

Uganda Institution of Professional Engineering 25th National Technology Conference and Exhibition

Institution of Engineers of Kenya (IEK) President, Eng Eric Ohaga, and Eng Hannah Njeri (Council Member, IEK) represented the Institution at the official opening of the Uganda Institution of Professional Engineering (UIPE) 25th National Technology Conference and Exhibition in Kampala. The conference took place on December 8 and 9, 2022 at the Royal Suites Hotel in Kampala. The event was presided over by the Uganda Minister of Disaster Management, Eng Hilary Onek. The National Technology Conference is an annual event by UIPE for dissemination and sharing of engineering knowledge, innovations, solutions, and promotion of science in Uganda.

IEK Membership Report

The IEK membership committee meets every month to consider applications for membership of the various classes received at the secretariat. The IEK Council in 2022 recruited the following members under various membership categories as shown below;

MEMBERS RECRUITED IN THE YEAR 2022

Membership Class	487th 26th Jan	488th 28th Feb	492nd 7th April	499th 2nd June	500th 1st July	501st 29th July	502nd 9th Sept	503rd 29th Sept	504th 28th Oct	505th 16th Dec	TOTAL
Fellow	-	2	3	1	-	2	1	-	-	-	9
Corporate	24	36	27	9	43	73	14	7	11	6	250
Graduate	75	95	85	92	67	126	77	76	134	108	935
Graduate Engineering Technologist	2	4	4	1	-	5	4	-	7	6	33
Graduate Engineering Technician	-	3	4	1	1	8	7	4	2	6	36
Student	1	30	3	36	4	14	17	2	6	21	134
TOTAL	**102**	**170**	**126**	**140**	**115**	**228**	**120**	**89**	**160**	**147**	**1397**

Gender Data

Class	Male	Female	Percentage (Male)	Percentage (Female)
Fellow	6	3	66.7%	33.3%
Corporate	226	24	90.4%	9.6%
Graduate	798	137	85.3%	14.7%
Graduate Engineering Technologist	30	3	90.9%	9.1%
Graduate Engineering Technician	35	1	97.2%	2.8%
Student	93	41	69.4%	30.6%
TOTAL	**1188**	**209**	**85%**	**15%**

Summary

Gender	No	Percentage
Male	1188	85%
Female	209	15%
TOTAL	**1397**	**100%**

The Council invites Engineers and affiliate firms to apply for membership in the various membership classes, kindly follow the link **Membership Classes (iekenya.org)** for a list of classes available.

Graduate and Corporate members are encouraged to apply for transfer of class to Corporate and Fellow class respectively. Members can check eligibility and how to apply on our website using the following link: **https://iekenya.org/web/register_as_member**

The IEK condoles with family and friends of our members who have passed away in the recent past. May their souls rest in peace.

"Death is not extinguishing the light . It is putting out the lamp because the dawn has come."

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