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BOOK OF ABSTRACTS

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DSAIL SOLVING REAL WORLD PROBLEMS

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Leveraging Science, Technology, Innovation and Entrepreneurship for Sustainable Development

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6. Smart Cities, Urban Innovation, and Building Technologies
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Convolutional Neural Networks for Automated Mammogram-Based Breast Cancer Screening in Kenya

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Abstract

Breast cancer remains a leading cause of mortality among women worldwide, with limited access to timely screening exacerbating outcomes in low-resource settings. This study presents an AI-powered breast cancer screening and detection system, developed using a convolutional neural network (CNN) architecture to enhance early diagnosis from mammograms. Mammogram datasets were collected from five hospitals across Kenya—Meru, Kerugoya, Nyeri, Outspan, and Embu Level 5 Hospitals—and supplemented with publicly available datasets to address data scarcity. Locally collected images were reserved for fine-tuning, validation, and accuracy testing within the Kenyan clinical context. Multiple deep learning models, including CapsNet, DenseNet, ResNet, EfficientNet, MobileNet, and Xception, were trained and benchmarked. Image pre-processing techniques such as Contrast Limited Adaptive Histogram Equalization (CLAHE) and cropping were applied to improve feature visibility. The system classifies mammograms into clinically relevant BI-RADS categories: Normal (BI-RADS 1–2) and Suspicious (BI-RADS 3–5). Evaluation demonstrated promising accuracy and robustness, highlighting its potential to support radiologists and extend access to quality diagnostic services. The model has been deployed as a web-based tool, enabling clinicians to upload mammograms in common formats (.jpg, .png, .dcm) and receive automated classification with confidence scores. This work demonstrates the feasibility of integrating AI-driven solutions into breast cancer screening workflows in Kenya, with potential for scalable deployment in similar low- and middle-income country contexts to improve early detection and patient outcomes.

Keywords: Breast cancer screening; Mammography; Convolutional Neural Networks (CNNs); Deep learning; Artificial intelligence in healthcare; Medical image analysis; Computer-aided diagnosis (CAD); Low-resource settings; Automated detection

Enhanced Machine Learning and Hybrid Ensemble Approaches for Coronary Heart Disease Prediction

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Abstract

Coronary heart disease (CHD) remains the leading cause of mortality worldwide, disproportionately affecting low- and middle-income countries where diagnostic resources are limited. Traditional statistical models often fail to deliver adequate predictive accuracy in complex, high dimensional, and imbalanced health datasets. This study developed and evaluated enhanced machine learning and hybrid ensemble models for CHD prediction, emphasizing diagnostic performance, interpretability, and applicability in resource constrained settings. Using a nationally representative dataset of 253,680 individuals from the Behavioral Risk Factor Surveillance System, preprocessing involved normalization and data balancing through the Synthetic Minority Oversampling Technique (SMOTE). The enhanced models, namely Adaptive Noise Resistant Decision Tree (ADNRT), Hybrid Imbalanced Random Forest (HIRF), Pruned Gradient Boosting Machine (PGBM), and Enhanced Support Vector Machine (ESVM), were designed to address noise, imbalance, and overfitting through adaptive pruning, cost sensitive weighting, and optimized hyperparameter tuning. Key predictive features included age, cholesterol levels, blood pressure, diabetes status, smoking behavior, and physical inactivity. Ensemble approaches including stacking, boosting, bagging, Bayesian model averaging, and majority voting were implemented and evaluated using accuracy, sensitivity, specificity, and area under the curve (AUC). PGBM achieved the highest sensitivity (90.8 percent), while HIRF provided the best overall calibration (AUC = 0.937). The stacking ensemble demonstrated superior overall performance with accuracy of 87.2 percent, sensitivity of 89.6 percent, specificity of 84.7 percent, and AUC of 0.94. Calibration and learning curve analyses confirmed strong generalizability and minimal overfitting. Feature importance and SHAP analyses enhanced model interpretability, while internal validation confirmed stability across subsamples. These findings highlight that hybrid ensemble learning models substantially outperform traditional classifiers, offering accurate, interpretable, and scalable frameworks for artificial intelligence driven CHD diagnosis in low resource healthcare environments.

Monitoring and prediction of fall armyworm pest on maize fields using machine learning approaches in the Central region, Ghana

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Abstract

Maize cultivation thrives in various agro-ecological zones in Ghana, primarily in the Central, Eastern, Ashanti, and Bono regions. In the Central region, smallholder farmers engage in maize farming. However, the fall armyworm (FAW), a pest that damages leaves, stalks, and cobs, poses a significant threat to maize production. This research aimed to monitor and predict the risk of fall armyworm in four districts within Central region namely Cape Coast, Abura, Mfatisman, and Komenda using machine learning techniques. Fall armyworm occurrence records from maize fields served as the target variable, while satellite-derived parameters, climatic and edaphic factors used as predictor variables. Random forest (RF), extreme gradient boosting (XGBoost), and deep neural network (DNN) models were trained to predict and map spatial risk, and validated model performance using a testing set. A weighted ensemble method combined the outputs of the individual models to enhance overall predictive performance. Precipitation and greenness were found to significantly influence FAW risk. The risk was elevated during periods of moderate rainfall but decreased when rainfall exceeded 270 mm. Additionally, an increase in greenness correlated with heightened FAW risk, which then plateaued. All models demonstrated strong predictive performance with Area Under the Curve (AUC) 0.92. The weighted risk output identified areas of very high risk (2.3%) and high risk (3.4%) in the Cape Coast and Komenda districts, particularly in the southwest of the study area, while 82% of the study area exhibited low risk. These findings provide a baseline for efficient, targeted, and precise pest control efforts in the region.

Keywords: fall armyworm, remote sensing, machine learning, risk.

The Paradox of Knowledge Management Systems: Competency Traps, AI, and Organizational Adaptability

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Abstract

Knowledge Management Systems (KMS) are widely adopted to capture organizational expertise and support decision-making. Yet, this systematic review reveals a paradox: instead of fostering adaptability, KMS can entrench outdated practices, trapping organizations in rigid routines. These "competency traps" often arise when AI-driven systems overemphasize established knowledge, thereby constraining innovation in rapidly changing environments. Drawing on 65 peer-reviewed studies published between 2019 and 2025, this review identifies seven mechanisms through which KMS reinforce outdated practices: codification bias, algorithmic reinforcement, rigid governance structures, performance-driven adherence, narrow classification, cultural legitimation, and temporal depreciation failure. These mechanisms span technical, procedural, and social dimensions, collectively creating barriers to knowledge renewal. The findings highlight environmental dynamism as a critical moderator. While KMS may function effectively in stable contexts, its limitations intensify in turbulent environments where rapid, unpredictable change is the norm. In addition, knowledge source diversity and unlearning protocols emerged as key mitigating factors that help organizations counter rigidity and sustain adaptability. Based on this synthesis, four intervention strategies are proposed: (1) temporal intelligence features such as scheduled reviews and knowledge age indicators, (2) algorithmic diversity requirements to disrupt self-reinforcing cycles, (3) governance recalibration to balance validation processes, and (4) challenger mechanisms that institutionalize constructive dissent. Collectively, these strategies constitute an adaptive design framework for building resilient knowledge systems. This study contributes to both theory and practice by linking KMS design, organizational learning, and sustainability. It underscores that KMS are not inherently beneficial or harmful; their impact depends on governance, contextual alignment, and continuous adaptation. For organizations leveraging artificial intelligence in dynamic environments, embedding adaptability into KMS is essential to prevent stagnation and enable sustainable growth.

Keywords: Knowledge Management Systems, Artificial Intelligence, Competency Traps, Organizational Learning, Sustainability

AI-Based Remote Health Monitoring and Emergency Response for Home- Based Care

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Abstract

Home-based healthcare for elderly and chronically ill patients is often limited by the lack of continuous, non-intrusive monitoring, leading to delayed responses during critical health events. Traditional approaches, such as wearable devices or manual supervision, can be uncomfortable, resource-intensive, and insufficient for detecting subtle physiological changes. This study presents an AI-based remote health monitoring system integrating a millimeter- wave (mmWave) radar sensor (C1001), an ESP32 microcontroller, to continuously track vital signs, body movements, and patient presence without physical contact. Data is processed at the edge and transmitted to Firebase cloud storage, enabling remote visualization through a web-based dashboard. A Retrieval-Augmented Generation (RAG) pipeline facilitates interactive querying of historical and real-time data, enhancing caregiver and clinician understanding of patient health trends. Real-time alerts via a buzzer enable timely interventions by providing alarms. The prototype demonstrates effective continuous monitoring of heart rate, breathing rate, and body movement, with minimal hardware complexity and ease of integration in home settings. By combining automated sensing, AI-driven analysis, cloud connectivity, and emergency alerts, the system provides a scalable, privacy-preserving solution for home-based care. This approach empowers caregivers and clinicians, improves patient safety, and supports timely medical decision-making, highlighting its potential for broader adoption in remote healthcare and telemonitoring environments.

Keywords: Remote patient monitoring, AI, millimeter-wave sensor (C1001), ESP32 microcontroller, RAG, cloud storage, home-based care.

AI-Powered Monitoring and Automation System for Greenhouse Farming

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Abstract

Meeting global food demand under climate variability requires greenhouse systems that optimize resource use while maintaining stable growing conditions. This paper presents the design and evaluation of an automated greenhouse platform that integrates Internet of Things (IoT) technology with edge-based machine learning for real-time environmental control. The system comprises three main components: sensors that measure temperature, humidity, and soil moisture, connected to an RP2040 microcontroller, responsible for data collection and actuating ventilation fans and irrigation pumps; a Raspberry Pi, linked to the RP2040, serving as the main controller, equipped with a camera for live image capture and running a lightweight TensorFlow Lite model for on-device plant health monitoring; and a cloud database with a web interface that provides access to real-time and historical data, notifications, and manual control from any internet-connected device. The platform is designed to operate continuously under variable environmental conditions, enabling early detection of plant stress and disease while minimizing water and energy usage. Expected outcomes include improved disease detection, more efficient resource management, and enhanced crop productivity through stable, data-driven environmental control. The results demonstrate that commercially available components can be combined into a reliable, scalable, and affordable greenhouse automation platform suitable for both research and commercial applications.

Keywords: Greenhouse automation, IoT-based environmental control, Plant health monitoring.

Insect Biodiversity Using Acoustic and Visual Records

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Abstract
Insect biodiversity plays a fundamental role in sustaining ecosystems and agriculture through pollination, pest regulation, and nutrient cycling [1]. However, traditional monitoring methods remain labor-intensive and geographically limited, leading to major knowledge gaps in sub- Saharan Africa. This study introduces a cross-modal framework that integrates acoustic and visual data to monitor insect diversity, focusing on pollinators and pest species of agricultural importance. Using low-cost, IoT-enabled recorders and cameras, insect sound and image data are collected across diverse habitats. Each observation is timestamped, georeferenced, and annotated with environmental metadata to ensure standardization. The data are processed using convolutional neural networks (CNNs) and spectrogram-based classifiers for automatic species identification. By linking these modalities, the framework improves detection accuracy and captures behavioral and ecological dynamics that single-sensor systems often miss [2]. This research aims to advance biodiversity informatics and strengthen data-driven agricultural management. The unified dataset will contribute to ecological modeling, pest outbreak prediction, and conservation planning. Additionally, the system promotes open science by aligning with global biodiversity data standards, making it compatible with repositories such as the Global Biodiversity Information Facility (GBIF). Ultimately, this study demonstrates how engineering innovation, through artificial intelligence and bioacoustic sensing, can bridge biodiversity science and technology, supporting sustainable agriculture and ecosystem monitoring in Africa.

Keywords: Bioacoustics, Biodiversity data, Pollinators, Machine learning, Data mobilization

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Determination of Bioactive Compounds, Antioxidant, and Sensory Properties of Naturally Fermented Drink made with Mulberry (*Morus nigra*), Yacon (*Smallanthus sonchifolius*), and Lemon (*Citrus limon*) Fruits

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Abstract

Increased consumption of functional foods has been linked with the prevention, management, and control of non-communicable diseases. Through the bioactive compounds, they provide physiological effects that lower the risk of non-communicable diseases. There is limited information on the effects of the biochemical and sensory properties of naturally fermented beverages of mulberry, yacon, and lemon fruits. This study aimed to determine the bioactive, antioxidant, and sensory properties of mulberry, yacon, and lemon fruit beverages taken at various stages of natural fermentation. Varying formulations of mulberry fruits, yacon root, and lemon fruits were applied in the ratios T0 (90:0:10), T1 (60:30:10), and T2 (30:60:10), respectively, fermented, and checked for the different parameters in 0, 5, 10, and 21 days. Flavonoids and phenolics were measured using the aluminium chloride colorimetric method and the Folin-Ciocalteu method, respectively. The antioxidants (FRAP and DPPH) were measured with the ferric reducing antioxidant power assay and 2,2-diphenyl-1-picrylhydrazyl radical scavenging assay, respectively. The sensory properties were assessed by ranking using the 9-point hedonic scale. The results indicated that total flavonoid concentration (TFC) ranged from 73.12 to 222.30 mg/LQE and the total phenolic concentration ranged from 193.94 to 297.27mg/L GE. The DPPH ranged from 49.94 to 81.26% and the FRAP ranged from 35.77 to 42.89 AAE. There was no significant difference between the different formulations, but a significant difference was observed between the different days of fermentation. The sensory properties showed variations between the different formulations, with treatment T0 giving significantly higher levels for most attributes than the other treatments. In conclusion, a combination of fruits with natural fermentation at 25^0C enhances bioactive and antioxidant properties that make it a suitable functional food.

Keywords: natural fermentation, mulberry, yacon, bioactive, sensory, non-communicable diseases, and antioxidant

Development And Evaluation of Physicochemical Sensory and Microbial Stability Of Ready-To-Use Composite Porridge Flour

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Abstract

Protein-energy malnutrition is a major health concern among children in many African countries, largely due to poor complementary feeding practices from six months of age. Many communities rely on thin cereal-based porridges, which are low in essential amino acids such as leucine and lysine and high in fiber, leading to early satiety and inadequate nutrient intake. Cereals typically have low Protein Digestibility Corrected Amino Acid Scores (PDCAAS) ranging from 0.20 to 0.87, contributing to protein deficiency-related conditions (stunting and kwashiorkor). This study aimed to develop a composite porridge flour using pumpkin pulp, arrowroot, and sesame seed flours in four ratios: T1 (30:50:20), T2 (20:60:20), T3 (40:40:20), and T4 (50:30:20), with a control made from maize and sorghum (70:30). Samples were processed by extrusion and analyzed for proximate composition using standard AOAC methods. Water absorption capacity, oil absorption capacity, and bulk density were determined using approved procedures. pH was analysed using a pH meter, colour using a L*a*b* colourimeter. Beta-carotene content was measured using a UV-Vis spectrophotometer, total phenolics using the Folin-Ciocalteu reagent, and mineral content by atomic absorption spectroscopy. Samples were subjected to accelerated storage for 21 days (40^0C, humidity of 70%), then analysed for yeast and mould using the culture enumeration method. The moisture content ranged between 7.75% and 11.73%, with the control sample exhibiting the highest level. Significant differences were observed in the crude ash, crude fat, crude protein, carbohydrate content, beta-carotene, and total phenolic content among the treatments. WAC, OAC, and bulk density also showed significant variation across the samples. The pH values of the samples decreased during storage. Mineral analysis revealed significant differences in all minerals, except for iron. Sensory evaluation showed significant differences in aroma, texture, colour, and overall acceptability between the control and other treatments. Panellists generally preferred the control formulation. Samples T1, T2, T3 and T4 had no yeast and mould detected, while T0 had several CFU of yeast and moulds. In conclusion, incorporating arrowroot and pumpkin pulp flour improved the nutritional and functional properties of the composite porridge flour, making it suitable for use as a complementary food for young children

Keywords: Pumpkin pulp flour, arrowroot flour, defatted sesame seeds flour, extrusion, ready-to-use composite flour, malnutrition

Influence of fermentation vessels and Olive (*Olea africana)* ash on consumer acceptability and shelf life of spontaneously fermented milk

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Abstract

Spontaneously fermented milk is culturally significant in many communities and is also linked to health and nutritional benefits. Traditionally, it is known that milk has been fermented in gourds, but with the current scarcity of gourds, there is a need to explore other fermentation vessels that will guarantee the continuity of such practices. During the fermentation process, natural additives may be used to improve the overall quality. Besides contributing to the flavour of fermented milk, *Olea africana* ash (OAA) has phytochemicals and antimicrobial properties that could improve the shelf life. This study investigated the effect of incorporating OAA in spontaneously fermented milk, using gourd and PET plastic vessels for fermentation. The OAA was added to the milk at 0.05%, 0.10%, and 0.20% in both types of vessels before fermentation. Additionally, separate samples were also fermented in both gourd and plastic vessels without the addition of OAA. The subsequent samples were then subjected to sensory evaluation using panellists who were frequent consumers of fermented milk. The samples were stored at 4 °C, and their stability was monitored weekly for 28 days. They were analysed for the survival of Lactic acid bacteria (LAB), yeast, and moulds, as well as changes in pH, TTA, and syneresis during storage. The freshly fermented milk samples were generally accepted by the panellists up to 0.10% OAA in both gourds and plastic vessels. The LAB counts of gourd-fermented milk were high compared to plastic-fermented milk, and the counts reduced progressively during storage. Yeast and moulds increased significantly during storage, but their counts were significantly suppressed by the addition of OAA. Overall, all the fermented milk samples were within the acceptable limit of LAB, yeast, and moulds at the end of the storage period. PH and TTA were within the acceptable range until day 21 of storage. In conclusion, fermented milk in both gourds and plastic vessels containing 0.1% OAA was generally accepted by the consumers and significantly suppressed the growth of yeast and moulds.

Keywords: Milk, spontaneous fermentation, *Olea africana*, consumer acceptability, shelf life

Phytochemical Profile of Palm Olein Supplemented with Ginger (*Zingiber officinale*) Rhizome Extract and Correlation with Antioxidant Activity

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Abstract

Lipid oxidation is a major challenge, causing quality deterioration in edible oils. This necessitates the exploration of natural substitutes to synthetic antioxidants like butylated hydroxytoluene (BHT), which face concerns due to their thermal instability and potential toxicity. This study aimed to investigate the impact of ginger (*Zingiber officinale*) rhizome extract on the phytochemicals and antioxidant activity of palm olein, and establish a correlation between these properties. The extract was extracted from the ginger rhizomes using the maceration technique and ethanol and incorporated into palm olein free from additives at 200, 400, and 800 ppm, with a positive control of BHT at 200 ppm and an untreated negative control. Total phenolic content (TPC) was quantified using the Folin-Ciocalteu assay, and total flavonoid content (TFC) was quantified using the aluminium chloride colorimetric method. The antioxidant activity was measured using the DPPH free radical scavenging assay, and the results were expressed as the IC50 values (mg/mL). Pearson's correlation was used for the correlation between TPC / TFC and IC50. The ginger rhizome extract recorded a TPC and TFC of 136.27± 0.99 mg GAE/g and 439.41±0.67 mg QE/g, respectively. The antioxidant activity indicated that the antioxidant potential of ginger rhizome extract (IC50 = 0.12± 0.04 mg/mL) is comparable to that of quercetin (IC50 = 0.07± 0.02 mg/mL) but significantly better than that of BHT (IC50 = 0.29± 0.08 mg/mL). For the palm olein experimental groups, the ginger extract treatments demonstrated a concentration- dependent improvement in antioxidant activity, with the IC50 of palm olein supplemented with 800 ppm ginger rhizome extract not significantly different from that of the positive control, suggesting that the performance of ginger rhizome extract at higher concentrations may effectively compare with that of synthetic antioxidants. Correlational studies showed a strong negative correlation between the TPC/TFC and IC50, suggesting that enhanced antioxidant capacity is associated with higher phenolic and flavonoid levels; however, the observed correlation was not statistically significant. The findings demonstrate that ginger rhizome extract represents a promising natural antioxidant alternative to, or partial replacement for, synthetic antioxidants.

Keywords: Lipid oxidation, ginger rhizome, palm olein, phytochemicals, IC50

Change Point Analysis of the Time to Recurrence in Colon Cancer Patients

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Abstract

Change point analysis is essential in identifying shifts in disease progression, particularly in assessing recurrence risk in colon cancer patients. This study examined whether the risk of colon cancer recurrence remains constant over time or changes across follow-up. The likelihood ratio test with bootstrap resampling was applied to detect significant changes in the hazard function, and change points were estimated via maximum likelihood methods. Simulation studies demonstrated that the power of the likelihood ratio test was highest when the change point occurred near the middle of the follow-up period, and declined when located toward the extremes. The method was applied to a colon cancer dataset of 888 patients, of whom 446 experienced recurrences. Four covariates—treatment type, number of positive nodes, extent of local spread, and time to registration—exhibited significant change points. In the Cox Proportional Hazards model, treatment was associated with a marked reduction in recurrence risk after the change point, while the other covariates were linked to higher risk, with stronger effects post-change. Model adequacy was evaluated using Schoenfeld residuals for proportional hazards and Cox–Snell residuals for overall model fit, confirming that the Cox model with change points provided a reliable description of the data. These findings provide a basis for cancer surveillance agencies and public health programs to refine screening strategies and allocate resources more efficiently by focusing on high-risk periods of recurrence.

Keywords: change point, Cox proportional hazard, bootstrap resampling, colon cancer recurrence

A Review of Life Cycle Planning and Maintenance Management Strategies for Cancer Treatment Machines in Low and Middle-Income Countries (LMIC)

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Abstract

Studies have shown that 70% of cancer deaths occur in LMICs, with the World Health Organization projecting that in Africa, the disease is on an upward trajectory. The cancer incidences in Africa from 2020 to 2025 are expected to rise by +9.8%, while deaths will increase by +9.6%. There is therefore a high demand for radiotherapy machines, particularly in low- and middle-income countries (LMICs), as they are used by over 50% of cancer patients during treatment. The rising demand for cancer treatments has led low- and middle-income countries (LMICs) to prioritize the acquisition of capital-intensive machines, such as linear accelerators (LINACs). However, many overlook the critical need for maintenance planning, with annual maintenance costs ranging from 8% to 15% of the total acquisition cost. This negligence results in limited in-house capabilities, spare parts shortages, and insufficient funds for maintenance contracts, leading to poor machine performance, decreased equipment lifespan, treatment delays, and increased overall costs. This review addresses a significant gap in the literature on LINAC maintenance management. The review analyzes recent research trends and various maintenance strategies used during the operational phases of LINACs. The derived life cycle management conceptual framework, specific to LMICs, emphasizes careful planning and acquisition for effective maintenance. The review identified four intersecting focus areas: maintenance strategies, improvement approaches, spare parts management, and maintenance contracts. The study concludes with insights into future maintenance trends for LINACs, highlighting the urgent need to improve practices during the planning and acquisition stages.

Keywords: Maintenance, Life Cycle, Cancer, LINAC, low- and middle-income countries (LMICs)

Kenyan Sign Language Recognition Using Ensemble Method

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Abstract

The interaction between two or more people is called communication. It may be performed by word, by a written paper, by gestures like hand and head movements, by facial expression, by lips movement. Social inclusion heavily relies on communication, but there still exist severe obstacles to it as very little is known or translated to the Kenyan Sign Language (KSL). Unlike the American or Indian Sign Language, KSL has its own linguistic and cultural systems that cannot be identified by generic recognition systems. This work counters such issues by creating an ensemble machine-learning approach to KSL recognition that integrates the feature-extraction capability of Convolutional Neural Networks (CNN) with the classification strength of k-Nearest Neighbors (KNN). The model was preprocessed, augmented, and annotated using a curated dataset of 8,898 labeled KSL images obtained via Kaggle, in order to increase diversity and decrease noise. Gesture images were fed to the CNN component that extracted high-level spatial features, and then the KNN classifier used the same embeddings to make similarity-based decisions. In order to improve accuracy and reliability in relation to misclassification, a stacking ensemble method was used to combine the two models. Performance on the test set was evaluated using evaluation metrics such as precision, recall, F1-score and confusion matrices. The ensemble model was more accurate (70.32) than standalone classifiers and it was also found to have better recognition of the more complicated KSL gestures. These findings highlight how ensemble learning can be used to overcome communicative barriers between the Deaf and hearing populations in Kenya. The paper offers a technological solution to real-time KSL recognition, as well as provides a base to conduct further studies on larger and more varied datasets and gesture recognition in dynamic time. Finally, the work leads to the social inclusion process because it allows the use of convenient communication means that empower Deaf individuals and facilitate equal access to education, health, and everyday life.

Keywords: Kenyan Sign Language (KSL), Ensemble Learning, Convolutional Neural Network (CNN), K-Nearest Neighbors (KNN), Sign Language Recognition

Production Of Biochar Using a Locally Fabricated Semi-Auto Pilot Reactor for Agriculture and Environmental Applications

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Abstract

Agricultural activities produce large amounts of biomass waste that are valuable resources yet remain underutilized. The lack of locally adapted technologies for transformation of abundant agricultural residues is a major barrier towards sustainable biomass waste valorization within sub-Saharan Africa. This study aim was to design a locally made semi-autonomous pyrolysis reactor and produce biochar from agricultural residues for soil applications and climate change mitigation. A batch type fixed bed pyrolysis reactor with a capacity of 0.15m3 was fabricated and used to produce biochar from cotton stalks (CS) and cashew nutshells (CNS). The feedstocks were heated indirectly at temperatures between 600 and 700°C within 2-4 hours using biomass and recirculated pyrolysis gas. The biochar produced was analyzed for moisture content, ash content, fixed carbon, volatile matter, pH(water), X-ray diffraction analysis (XRD) and Fourier-transformation infrared spectroscopy (FTIR). A biochar yield of 22.92% and 29.98% for CS and CNS biochar respectively was achieved. The CS and CNS biochar had an alkaline pH (9.9±0.0 and 10.2±0.0), high fixed carbon (76.6 ± 0.3 and 71.6 ± 1.2), ash content (10.8 ± 0.1% and 14.1±1.4%). The high fixed carbon (>70%) show that the biochars have a high recalcitrant carbon that can last in soil for a long period, sequestrating carbon The XRD profiles revealed that the CS and CNS biochar have an amorphous carbon structure with predominant quartz (SiO2), sylvite (KCl) and calcite (CaCO3) crystalline mineral phases. The calcium and potassium minerals in the biochar structure occur in calcite and sylvite crystalline phases respectively which have high solubility. These results suggest that the produced biochar has high carbon sequestration potential, has bioavailable potassium and calcium nutrients and is suitable for ameliorating acidic tropical soils. This locally fabricated semi-auto pyrolysis reactor can be used by local farmers to transform agricultural residues into high quality biochar for improving soil health of tropical croplands and as climate change mitigation tool.

Keywords: pyrolysis, biochar, pyrolysis reactor, soil amendment, agricultural residues

Effect of biochar on sandy soil properties and lettuce yield: A strategy to mitigate vegetable drought stress in the Sahel region

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Abstract

Soil degradation and water scarcity are key constraints to agricultural productivity and food security in Sahel regions of West Africa. Improving soil health and enhancing crop resistance to water stress is critical for resilient vegetable production in arid sandy soils. This study evaluated the effect of cotton-stalk and cashew-nutshell biochars and their blend on sandy soil properties and lettuce (*Lactuca sativa L.*) productivity in Ouagadougou, Burkina Faso. Biochar was applied at 10 tons/ha to soil and lettuce cultivated between May and June 2025 under three irrigation regimes (100%, 80, 60% of crop water requirements) Biochar significantly improved soil porosity (by 5.8-10.9%, $p<0.001$), soil organic carbon (by 18.1%-53.2%) and reduced soil bulk density (by 7.2-13.3%, $p<0.001$) compared to soil without biochar. As a result, soil wilting point reduced by 16.6-26.5%, and field capacity increased by 19.9%-36.8% and plant available water content increased by 78.6%-125%. The biochar treated soils had significantly higher soil N (by 5.4-6.6g/kg, $p<0.001$) P (by 7.1-10.2g/kg, $p<0.001$), K (by 13.4-17.9 g/kg, $p<0.001$) compared to unamended soils. These improvement in soil organic carbon, available water content and porosity resulted to remarkable higher fresh lettuce marketable yields in biochar amended soils of 12.6–15.1 t ha^{-1} compared to control soils without biochar (6.8 t ha^{-1}) A blend of cotton stalk and cashew nutshell biochar performed the best with an optimal fresh average lettuce yield of 18.1 tons/ ha yield at 80% irrigation level of crop water demand. Even under 60% deficit irrigation biochar treated soils had an average 45% yields higher than soil without biochar at full irrigation. The impact of biochar on lettuce yield was optimum at moderate deficit irrigation (80% of full irrigation). These findings suggest that CS, CNS and their blend biochar buffer lettuce from water stress by improving soil porosity, organic carbon and plant available water content. These results demonstrate that cotton stalk and cashew nutshells derived biochars applied at 10 tons/ha can sustain acceptable lettuce yield with 20% reduction in irrigation water. The application of biochar can be a strategy to mitigate drought conditions and save irrigation water in vegetable production under hot Sahel climatic conditions.

Keywords: lettuce yield, deficit irrigation, biochar, soil health restoration

Proximate Composition, Bioactive Compounds, and Sensory Properties of Pumpkin Flour from Differently Blanched Pumpkin Parts

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Abstract

Pumpkin (*Cucurbita pepo*) is a climate resilient crop commonly grown in Kenya. However, its use has been narrowed down to complementary feeding utilizing only the pumpkin pulp and leaving out the nutrient dense peels and seeds during flour formulation. This study aimed to promote the use of all pumpkin parts in flour formulation by determining the effect of microwave blanching and water blanching on proximate composition, ascorbic acid, total carotenoids and sensory properties of flour from the peels, pulp and seeds. The pumpkin parts were prepared by water and microwave blanching before drying in the hot air oven at 60ºC and milling. The samples were analyzed for proximate composition (moisture and ash content) by muffle furnace method, ascorbic acid content and total carotenoid content by Ultraviolet-Visible Spectroscopy (UV-VIS) method. Sensory evaluation of pumpkin soup was determined by panelist using a 9- point hedonic scale. The sensory parameters of interest were color, taste, mouthfeel, consistency, and overall acceptability. The moisture content levels ranged from 4.95% to 9.64% while ash content ranged from 4.22% to 4.99% in the samples. The results indicate that moisture content was significantly lower for microwave blanched samples compared to the unblanched and water blanched samples. The ash content level was not significantly different between the unblanched and blanched samples for the different pumpkin parts. The unblanched pumpkin seeds contained the highest ascorbic acid content at 86.91±0.10mg/100g followed by pulp at 73.60±1.15mg/100g and peels at 68.34±3.71mg/100g. Ascorbic acid content reduced significantly with water blanching compared to microwave blanching. For carotenoid content the range was 30.80mg/100g to 35.73mg/100g, 25.11mg/100g to 33.51mg/100g, and 7.35mg/100g to 12.28mg/100g for the pulp, peels and seed samples respectively. The carotenoid content increased significantly with water blanching and microwave blanching for pumpkin peels and pulp. The sensory evaluation of the soup showed significant difference ($p<0.05$) between the microwave blanched and unblanched soup in taste, mouthfeel, consistency and overall acceptability. Therefore, blanching is recommended in value-added composite flour production to promote utilization of pumpkin peels, seeds and pulp providing a sustainable solution to reduce waste and increase consumption.

Keywords: ascorbic acid, carotenoids, sensory, pumpkin, peels, seeds, blanching

Modelling of the Murang'a Distribution Feeder and Grid-Tied Photovoltaic Integration at the MUT Spur

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Abstract

The integration of photovoltaic (PV) systems into weak, radial distribution feeders, typical of rural Kenya, raises concerns about voltage stability and renewable energy hosting capacity. This paper presents a detailed modelling and simulation study of the Murang'a distribution feeder, with a particular focus on the grid-tied PV system located at the Murang'a University of Technology (MUT) spur. A high-fidelity feeder model was developed and validated in the OpenDSS simulation environment using utility-provided topological and load data. Quasi-Static Time-Series (QSTS) simulations were performed to establish the feeder's baseline performance and quantify the effects of PV integration under varying penetration levels. The results highlight that uncoordinated PV generation leads to significant voltage excursions, with nodal voltages surpassing the statutory 1.05 p.u. limit during peak solar output. The findings provide a foundational, data-driven benchmark for future development of voltage regulation and hosting capacity enhancement strategies in rural Kenyan distribution networks.

Keywords: Distribution Networks, Photovoltaic (PV) Integration, Voltage Regulation, Smart Inverters, Volt- VAR Control, Hosting Capacity, OpenDSS

Mathematical Modeling of *Helicobacter pylori* Treatment and Transmission: Implications for Stomach Cancer Dynamics

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Abstract:

Deterministic mathematical model of the nonlinear first-order differential equation is proposed considering both direct and indirect contact transmission to capture some of the control measures such as treatment in limiting the infection. Six compartments are considered in the model that is; susceptible humans, exposed humans, infected humans with *H. pylori*, treated humans, infected humans with stomach cancer and the bacteria concentration from the environment. The qualitative behavior of the model was performed including, the existence of non-negative invariant solution, boundness region, equilibria (both disease-free as well as endemic) and stabilities of two-equilibrium points. Moreover, control reproduction number and bifurcation analysis were also studied. Sensitivity analysis of some parameters was also studied based on the control reproduction number. The simulation results show that increasing the *Helicobacter pylori* infections treatment rate, has a vital role in the reduction of infections and stomach cancer in the community. Therefore, we concluded that effective treatment rate and low contact rate are most significant to eradicate stomach cancer from the community.

Keywords: *Helicobacter pylori*, model analysis, treatment, sensitivity analysis, stomach cancer, numerical simulation.

Mathematical Modeling of Traditional Treatment against Long-COVID

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Abstract

Apart from the circulating SARS-CoV-2 variants around the world, the COVID-19 pandemic has left many individuals with a serious health burden known as long COVID. In this study, we first describe the underlying and complex mechanism of viral diseases, such as COVID-19, which is driven by inflammation and oxidative stress. We then develop and analyze an extended SEIR mathematical model to examine the transmission dynamics of COVID-19, progressing to the long COVID stage. With the growing number of research publications reporting that several herbal remedies prevent oxidative stress, a key feature of our model is the consideration of traditional medicine, which is widely used in Africa to treat both COVID-19 and long COVID. We demonstrate that the disease-free equilibrium (DFE) is globally asymptotically stable (GAS) whenever the basic reproduction number, R_0, is less than one. When R_0 is greater than one, the model has a unique endemic equilibrium (EE) that is locally asymptotically stable (LAS). We construct a nonstandard finite difference (NSFD) scheme, which is dynamically consistent with respect to the continuous model. Based on the uncertainty and sensitivity analysis of long COVID cases, we implement the NSFD scheme by generating numerical simulations that support the theory. They suggest that the basic reproduction number is a sharp threshold, thereby suggesting the improvement that the EE is GAS whenever R_0>1. They further show that post-recovery follow-up strategy and traditional medicine treatment are effective in managing symptoms of COVID-19. Results from this study goes a long way in informing policy for proper management of infectious diseases.

Keywords: mathematical modeling, post/long-COVID, herbal treatment, reproduction number, simulations.

Modelling the effects of environmental water stress on rice crop production in Mwea Constituency, Kenya using a multi-model machine learning approach

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Abstract

Rice is sensitive to soil water deficiency because rice cultivation has been historically cultivated under flood irrigation conditions. Rice flowering and maturity times are delayed as a result of water deficiencies resulting in low rice yields [1]. This research aimed to assess how environmental water stress affects rice production in Mwea Constituency over the period 1988 to 2023. The study used datasets such as normalized difference vegetation index (NDVI), land surface temperature, temperature condition index (TCI), vegetation condition index (VCI), standardized precipitation index (SPI), topographic wetness index (TWI), vegetation health index (VHI), tasseled cap wetness Index (TCWI), land use land cover (LULC), soil moisture index (SMI), precipitation condition index (PCI) and drainage density variables to simulate an environmental water stress index (EWSI) for the years under study, using multi-model ensemble machine learning approach to improve predictive robustness and minimize model bias. The input variables were subjected to Mann Kendall trend test where Tau values revealed both increasing and decreasing trends with $P < 0.05$ denoting a significant shift. Subsequently, variables were modeled using Artificial Neural Networks (ANN), Random Forest (RF) and XGBoost to generate Environmental Water Stress Index (EWSI) for years under study. Model performance was consistently high with R^2 values ranging from 0.9993 to 0.9999 reflecting the normalized scale (0–1) of the predictor and response variables which minimized absolute and squared errors (MAE = 0.0001 and RMSE = 0.0002). The ANN, RF, and XGBoost models demonstrated stable accuracy with only slight variations across years. The ANN, RF and XGBoost models were integrated using geometric mean to produce an aggregated EWSI which was reclassified following Kogan's (1995) approach [2] into five drought categories: no drought, mild, moderate, severe and extreme drought. Results revealed substantial inter- annual variability with 1988 and 2002 experiencing the highest water stress while 2016 exhibited the least drought conditions characterized by higher soil moisture and lower land surface temperatures. The extent of drought-free land increased to a maximum of 10,571 ha in 2016 representing a 58% increase compared to 1988 with 6,689 ha reflecting improved hydrological balance and irrigation efficiency. These findings highlight the strong influence of environmental water stress on rice production and demonstrate the value of ensemble modeling for drought risk assessment. Integrating EWSI outputs into irrigation scheduling and water allocation systems could enhance efficiency, reduce losses, and improve resilience to climate shocks. It provides critical insights for irrigation planning and water resource management to improve resilience under future climate variability.

Keywords: Environmental water stress, rice production, soil moisture.

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Mathematical modeling and analysis of childhood diarrhea dynamics in Nairobi County incorporating direct and indirect transmission

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Abstract

Diarrhea illness among children under the age of five years old is very prevalent in Nairobi County. Improper child waste disposal is one of the determinants of childhood diarrhea in the county. Limited studies have mathematically modeled childhood diarrhea dynamics in the region capturing environmental transmission. This study therefore developed a deterministic mathematical model incorporating both direct and indirect transmission pathways to better understand the dynamics of childhood diarrhea and suggest effective control strategies in the process. In the model analysis, we analytically established that the disease-free equilibrium is locally and globally stable when the control reproduction number is less than unity. Similarly, we showed that the endemic equilibrium is locally and globally asymptotically stable when the control reproduction number is greater than unity. From model sensitivity analysis, it was found out that the key critical model parameters are: the contact rate between susceptible and infected children, deposition rate of pathogens by carrier flies in the safe environment, ingestion rate of pathogens by susceptible children from safe environment, contact or ingestion rate of pathogens by susceptible flies from unsafe environment and contribution rates of pathogens to unsafe environment by infected children. From numerical simulations, it was validated through graphs that the disease-free is locally and globally asymptotically stable when the control reproduction number is below one, while the endemic equilibrium is locally and globally asymptotically stable when the control reproduction number is above one, which supported the analytical results. We concluded that improving environmental sanitation; promoting hygiene practices such as hand-washing, food safety, household water treatment, and household cleanliness; ensuring proper child waste disposal; and implementing household fly control are the most effective control strategies for the disease in the region. These interventions can help maintain the control reproduction number below unity, thereby leading to the elimination of the disease.

Keywords: Childhood diarrhea, environment, mathematical model, sensitivity analysis.

Transforming Capability and the Sustainability of Water Service Providers in Kenya: A Novel Analysis in a Regulated Utility Context

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Abstract
Transforming dynamic capability which refers to the ability of organizations to continuously reconfigure structures, processes and resources, has been widely acknowledged in strategic management theory, [1], [2], [3], [4]. However, it has been rarely quantified in regulated public utility contexts. This study seeks to fill this gap by providing one of the first empirical examinations of transforming capability as a distinct predictor of firm sustainability outcomes among Water Service Providers (WSPs) in Kenya. Using cross-sectional survey data from 75 WSPs (300 respondents), the study employed Linear Discriminant Analysis (LDA) to assess the influence of transforming capability on firm sustainability performance as defined by the Water Services Regulatory Board (WASREB), [5]. Indicators included Water Coverage, Water quality, Hours of Supply, Staff costs/Total Costs, Revenue Collection efficiency, Operations and maintenance costs coverage ratio, Non-Revenue Water, Staff Productivity Ratio and Metering Ratio. WASREB classifies the indicators into three categories. These are Service Quality, Economic Efficiency and Operational Sustainability, [5]. The researcher concluded that transforming capability has a statistically significant discriminating effect between "Not Acceptable," "Acceptable," and "Good" firm sustainability levels of the WSPs, with a 80.6% hit ratio. This accuracy level is lower than for sensing and seizing capabilities. This implies that while WSPs pursue organizational renewal, transformative leverage of such efforts is reduced by factors such as regulatory constraints, limited resources and institutional inertia. The study adds to the dynamic capabilities knowledge by explicitly quantifying transforming capability within a regulated Kenyan public utility sector, achieving application of theory beyond competitive markets. It also identified regulation as a double-edged boundary condition. While it enforces sustainability benchmarks, it can also stifle transforming efforts. For policymakers and managers, the findings underscore the necessity of investing in capacity building, adaptive processes, benchmarking and innovation initiatives which strengthens transformation. This research offers a novel evidence-based lens for enhancing the resilience and sustainability of water utilities in emerging economies by linking transforming capability to regulatory benchmarking. Hence providing a technology informed framework for improving water utility performance, thereby contributing to sustainable urban development and achievement of SDG 6 on Clean Water and Sanitation [6].

Keywords: Transforming capability, dynamic capabilities, water utilities, sustainability, regulation.

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Regret Bias and Investment Decision by Investors at Nairobi Security Exchange, Kenya

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Abstract

Investor often makes incorrect decisions often due to and not limited to inadequate technical expertise, regret and desire for faster returns. Researchers have however proved that due to the market inefficiencies, the standard finance models employed by market practitioners have failed to account for the market anomalies. There is a gap in relevant literature in developing markets particularly Kenya which is an emerging security market. The objective of the study was to establish the effect of regret bias on investment decision. The period of study is 10 years that is 2014 to 2023. The study adopted causal research design. This research design was suited because it enabled the researcher to collect data from different investors for the purpose of determining the existence and extent of a phenomenon as well as established the relationship between variables and the cause and effect of variables. The study units of study were listed companies trading at Nairobi security exchange. Currently NSE has 62 listed companies. Secondary data collection schedule was utilized to collect data needed for the research. The study entailed descriptive and inferential statistics data and it was collected coded and analyzed using quantitative analysis method. Panel data revealed a significant positive effect between between regret bias and investment decision of NSE investors in Kenya where the p value is equal to 0.003 which is less than 0.05, R square of 0.1832 Therefore, the study concluded that regret biases significantly affect investment decision and therefore the study recommends that the Investors at NSE should minimize blames centered on regret for the past but take them as a lesson for future, the implication of this study is that financial advisors should incorporate behavioral coaching when advising clients so that they help in minimizing regret bias while making investment decision therefore aid in making better strategic decision . It is recommended that furthers studies be done on different types of investors and others types of biases as this would expand studies on behavioral biases.

Regret bias, Investment decision, Nairobi Security Exchange, Utility for Profit/losses, portfolio Return on Investment

Financial Technology, Fund Size and Financial Performance of Mutual Funds in Kenya.
Digital Portfolio Management

Abstract

The integration of Financial Technology (FinTech) into the investment landscape has transformed traditional portfolio management practices both regionally and globally. In Kenya, the mutual funds sector is increasingly embracing digital portfolio management tools to enhance efficiency, transparency, and investor engagement. As the business world navigates the highly dynamic economic and technological environment, the need for building a sustainable financial ecosystem. The Kenyan mutual sector plays a pivotal role in fostering economic growth and stability through the key roles of capital mobilization and resource allocation as a financial intermediary on the financial markets. This study looks at the effect of FinTech adoption, specifically digital portfolio management, on the financial performance of mutual funds in Kenya. Using a mixed- methods approach, for robustness and credibility of the outcome, the study used purposive sampling and integrated primary data from fund key personnel with secondary data from audited financial statements covering the period from 2014–2023. Data analysis was conducted using SPSS and STATA. The findings reveal that use of digital platforms and solutions in portfolio management contributes to improved fund performance through real-time data analytics, automated asset allocation, enhanced returns and lower operational costs. The study underscores the need for a robust regulatory framework to encourage inclusivity and targeted capacity building to fully leverage FinTech in optimizing mutual fund performance. The findings demonstrates that FinTech adoption is significantly critical, emphasizing the role of fintech in promoting operational efficiency to improve performance. The study highlights the strategic need for digital transformation in a highly evolving financial ecosystem. These implications are relevant for policymakers, fund managers, and technology providers seeking to foster a more inclusive and efficient financial ecosystem in Kenya. This study aligns with the conference theme by presenting research-based insights that promote innovation-driven resilience and long-term sustainability in the financial services industry. It positions FinTech not only as a performance enabler but also as a catalyst for sustainable financial performance.

Keywords: Financial Technology, Digital Portfolio Management, Mutual Funds, Financial Performance.

Financing Mechanism in Advancing Open Innovation Among Science and Technology Parks in Africa

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Abstract

Open innovation advances sustainable development and fosters collaboration and partnerships among key stakeholders. However, open innovation appears to be a phenomenon of developed economies with emerging and developing economies significantly lagging behind. This study examined the government financing mechanism in predicting the level of innovation among Science and Technology Parks (STPs) in Africa. Using a cross-sectional descriptive research design and targeting 70 managers from 14 Science and Technology Parks, primary data was collected using a structured email questionnaire. The tool was evaluated for internal consistency, content validity and construct validity. The data was tested for univariate normality, collinearity, pairwise linearity, absence of outliers and autocorrelation. Linear discriminant analysis was used for testing the null hypothesis. The study found that linear discriminant analysis model had an associated canonical correlation of 0.888, Wilks' Lambda of 0.212, Chi-square coefficient of 10.853 with an associate p-value of 0.004, with well differentiated functions at group centroids of (1.342), (.204) and 2.373 for each of the different categories of innovation. Further, the study found that government financing mechanism explained approximately 78.85% of the variations in open innovation classifications among Science and Technology Parks in Africa and achieved a hit ratio of 80% in the confusion matrix and 70% in the Jack-Knief classifications. The study concluded that government financing mechanism is a statistically significant discriminant of open innovation among STPs in Africa. The findings underscore the strategic role of government-led financing mechanisms in fostering innovation ecosystems that support research and development, infrastructure development and innovation diffusion across sectors. The study recommends that governments in Africa could deliberately endeavor for tax incentives for investors in the Science and Technology Park, directed access to venture capital and seed funding for startups, early-stage companies, clear policy on funding public research, and explore mechanisms for facilitating foreign direct investment which can enhance inflows into the Science and Technology Park(s).

Keywords: open innovation, financing mechanism, science and technology park

The Effect of Equity Financing on Financial Performance of Licensed Microfinance Institutions in Kenya

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Abstract

This study examined the effects of equity on financial performance of Licensed Microfinance Institutions in Kenya. Over the past few decades, microfinance has emerged as one of the effective sources of finance for socio-economic development in the world and is recognized as an essential tool of financial inclusion. However, the magnitude and the real socio-economic impact of MFIs are still debatable. A significant body of empirical research has questioned the ability of MFIs in the alleviation of poverty and reported their limited impacts on the ownership of assets and consumption. The theories used in this study were Stakeholder Theory and Capital Structure Theory. This study adopted both descriptive research design and correlational research design. The target population comprised of 13 LMFIs. Out of 192 targeted population 52 respondents were selected. Stratified and purposive sampling techniques were used to sample out. Primary data was obtained directly from respondents using a closed and open- ended questionnaire. This data was then analyzed using descriptive and inferential statistics (Pearson correlations and regression analyses). Reliability was measured by Cronbach's alpha test at a minimum threshold of 0.7. This data was analyzed using multiple regression models. Statistical Package for Social Sciences Statistics version 27 was used in analyzing correlations amongst the variables. Based on the findings of the study, it was concluded that equity financing significantly influenced financial sustainability of Licensed Microfinance Institutions in Kenya. Therefore, this study recommends that for Licensed Microfinance Institutions to remain sustainable Kenya Association of MFIs should formulate policies that would ensure all MFIs firms have sound system of sourcing for their smooth running. This study further recommends that Licensed Microfinance Institutions should have alternative measures to stem any financial risks which would sabotage their smooth running. Kenya Association of MFIs should encourage all microfinance firms to embrace diversified sources of equity funding.

Key Words: Equity Financing, Financial Performance, Microfinance Institutions

Digital Bureaucracy and Youth Dissent: A Governance and Participation Perspective

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Abstract

Digital bureaucracies in Africa are increasingly positioned as instruments of transparency and service delivery. Yet, paradoxically, they are also being deployed to suppress youth dissent and reconfigure civic space. This paper interrogates that duality through a critical integrative review of over 60 peer-reviewed articles, policy reports, and digital governance frameworks, selected via targeted searches across Scopus, JSTOR, and regional repositories. Anchored in Bacchi's "What's the Problem Represented to Be?" (WPR) framework and Foucault's governmentality lens, the analysis explores how algorithmic systems, biometric registries, and predictive analytics are reshaping state–citizen relations. Drawing on case studies such as #EndSARS (Nigeria), #FeesMustFall (South Africa), and #RejectFinanceBill2024 (Kenya), the paper maps the tension between youth-led democratic innovation and institutional exclusion. It introduces two monitoring tools—the Dissent Responsiveness Score and the Participation Diversity Index—to assess how digital bureaucracies respond to civic engagement. The findings reveal that while digital platforms offer new avenues for participation, they also embed surveillance logics, algorithmic bias, and data asymmetries that disproportionately affect youth. The paper concludes with normative recommendations for inclusive digital governance, emphasizing co-creation, transparency audits, and youth-responsive policy design. It calls for a reimagining of digital public administration that centers equity, dissent tolerance, and democratic renewal.

Keywords: Digital Bureaucracy, Youth Dissent**,** Digital Governance, Governmentality, Democratic Innovation

Effect of Corporate Governance Practices on Performance of Commercial State-Owned Enterprises in Kenya

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Abstract

State owned enterprises (SOEs) play a significant role in most global economies, serving as key drivers of economic growth, industrial development, and creating employment. They also support the government broader agenda of improving the citizens quality of live across the key domains of United Nations 17 Sustainable development goals (SDGs), Africa Agenda 2063 for the "prosperous Africa that we want", Kenya Vision 2030 "transforming the County in key Social, economic and Political spheres", and the 2022-2030 government agenda focusing on "five priority areas of social economic transformation of Kenya by 2030. However, approximately 70% of these commercial SOEs are loss making entities despite being in key sectors of the thriving economy. The objective this study was to examine the effect of corporate governance practices on SOE's performance in Kenya. The study applied a post- positivism research philosophy and a cross-section approach to descriptive research design. The sampling frame and unit of analysis was the 41 commercial state-owned enterprises in Kenya. The unit of response was 205 managers of these 41 commercial SOEs. A closed ended questionnaire was used to collect primary data for the predictor and a secondary data collection sheet for the target variable. A pre-test for the questionnaire was carried out using managers of three non- commercial SOEs in Nairobi, Kenya. Kaiser-Meyer-Olkin (KMO) coefficient and Bartlett's Chi- Square from Confirmatory Factor Analysis were used to enhance construct validity. Ordinary Least Squares- simple linear regression was used for inferential analysis after testing the data for Gaussian distribution, linearity and autocorrelation. The study found that 28.2% of the variations in SOEs performance could be explained by corporate governance practices and that there is a statistically significance influence of these practices on SOEs performance. These findings imply that departing from best practices in corporate governance practices can have a significant effect on SOE performance. The study found that board structure and board transparently and accountability had relatively favourable measures and hence recommends that the same should be sustained to progressively drive better performance among the commercial state-owned enterprises. This study recommends that these SOE's should consider a harmonization of best practices among them. This study further, recommends a focussed approach to the review and harmonization of policy/ies driving these corporate governance practices at entity level and attention to utilisation of technology in risk approaches so as to drive strategic performance.

Keywords: Corporate governance practices, organizational performance, state -owned-enterprises

The Effect of Human Capital on Performance Dairy Farmers' Cooperatives

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Abstract

The purpose of the study was to examine the effect of human capital as a core competence on the performance of Dairy Farmers' Cooperatives. The study adopted descriptive and causal research designs and targeted County Cooperative Commissioners, lead farmers, and CEOs of Dairy Farmers' Cooperatives. Data were collected using closed-ended questionnaires from 210 sampled respondents and interviews with County Cooperative Commissioners for qualitative insights. Reliability was tested using Cronbach's alpha, while validity was assessed through content, construct, and criterion validity. Stratified and simple random sampling techniques were employed to select respondents. Quantitative data were analyzed using descriptive and inferential statistics. The findings revealed that human capital significantly influences cooperative performance (B = 0.85; P = 0.000). The study concluded that Dairy Farmers' Cooperatives should always provide a free recruitment process that will bring on board a workforce that is well set through skills. Human resource expertise, training and recruitment of a well-set team would improve productivity and, in the long run, cooperative performance.

Key words: Human capital, Core Competence, Dairy Farmers' Cooperatives, Performance

Effect Of Employee Involvement in Change Process on Employee Change Acceptance: A Survey of Commercial Banks in Nakuru City

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Abstract

Employee involvement in the change process is essential for fostering ownership and reducing resistance in dynamic sectors like banking. This study assesses the effect of employee involvement encompassing participation in decision-making, recognition of input, and encouragement of creativity on employee change acceptance in commercial banks in Nakuru City, Kenya. Anchored in Social Exchange Theory, the research adopted an explanatory quantitative design, targeting 118 frontline leaders (Branch Managers, Chief Operations Managers, Human Resource Managers, Sales & Marketing Managers, Credit Managers, and Service Administration Managers) across 28 commercial banks, selected via a census approach to ensure comprehensive representation. Data was collected via structured questionnaires, validated through expert review and pilot testing (Cronbach's $\alpha > 0.7$), and analyzed using descriptive statistics, Pearson correlation, and multiple linear regression in SPSS. Results indicated moderate perceptions of involvement (mean = 2.81, SD = 1.296), a strong positive correlation ($r = 0.675$, $p < 0.001$), and significant effect ($\beta = 0.247$, $p = 0.003$). The study concludes that greater involvement boosts change acceptance by promoting reciprocity and commitment. The study concludes that greater involvement boosts change acceptance by promoting reciprocity and commitment. Recommendations include establishing participatory forums and feedback mechanisms to enhance engagement. Future research should explore longitudinal effects and comparative regional analyses. These insights guide banking leaders in Nakuru to optimize change initiatives for adaptability.

Keywords: Employee involvement, Change process, Employee change acceptance, Commercial banks, Nakuru City

Modeling Dependence in Financial Markets using Multivariate GARCH-Vine Copula approach

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Abstract

The global financial landscape is increasingly becoming interconnected, with financial markets exhibiting complex interdependencies. This increases the possibility of market risk spreading from one market to another, as market shocks often propagate across asset classes especially during periods of economic uncertainty. Failure to adequately capture the characteristics of univariate return series and the dependence structure between them, may lead to significant underestimation of the market risk forecasts. The standard multivariate Generalized Autore- gressive Conditional Heteroskedasticity models assume that financial data follow a normal dis- tribution, an assumption that fails to capture the heavy tails, skewness, and non-linear depen- dencies commonly observed in asset returns. Thus, this study models the dependency structures among a portfolio of financial asset classes using multivariate Generalized Autoregressive Conditional Heteroskedasticity Vine Copula approach. The multivariate GARCH model captures the dynamic volatilities and conditional correlations among assets, then vine copulas are used to model the remaining non-linear and tail dependence relationships between the standardized residuals. Dependence was modelled across three sub-periods: pre-, during and post-COVID- 19 pandemic. The empirical results indicated that the financial return series exhibit complex dependence patterns that vary across asset classes and evolve over time, reflecting the diverse behaviors of financial markets under varying economic conditions. Dynamic conditional cor- relation drawable vine copulas (DCC-DVine) was the best-fit dependence model in the pre- pandemic period, while constant conditional correlation structures with drawable vine copula (CCC-DVine) and regular vine copula (CCC-Rvine) were the best-fit models during and post- COVID 19 pandemic, respectively. The findings highlight the erosion of diversification benefits during systemic crises and underscore the importance of incorporating flexible dependence structures in financial risk modeling, offering valuable insights for academics, practitioners, and regulators concerned with market risk and portfolio resilience.

Keywords: Portfolio market risk, dependency modeling, multivariate GARCH, Constant Conditional Correlation, Dynamic Conditional Correlation, Regular vine, D-vine, C-vine, S-vine

Effect of the Strategic Planning Process on the Performance of Dairy Agribusiness SMEs in Murang'a County, Kenya

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Abstract

Kenya's dairy agribusiness sector remains a cornerstone of rural livelihoods, yet most small and medium enterprises (SMEs) continue to face persistent constraints of low productivity, fluctuating prices, and weak managerial systems. Strategic planning therefore presents a practical mechanism through which firms can set clear goals, align resources, and respond more effectively to market and environmental pressures. Guided by the Resource-Based View and Contingency Theory, this study examined how the strategic planning process influences the performance of dairy agribusiness SMEs in Murang'a County. The specific objectives were to assess the effect of an organization's vision statement and the use of documented strategic plans on the performance of dairy agribusiness SMEs in Murang'a County. A descriptive cross-sectional design was applied to 143 enterprises registered with the Kenya Dairy Board. Data collected through structured questionnaires were analyzed using descriptive statistics, Pearson correlation, and simple regression models. Descriptive results showed that dairy agribusiness SMEs in Murang'a County engaged only moderately in strategic planning, with mean scores ranging between 2.98 and 3.06 (SD = 0.73–0.79). Most respondents (about 49–51%) held neutral views on whether their firms clearly defined goals, analyzed markets, or planned for the long term, suggesting partial but uneven adoption of formal planning practices. Correlation analysis revealed a positive association between strategic planning and firm performance, indicating that better planning corresponded with improved operational outcomes. The bivariate regression model confirmed this relationship, $F(1,141) = 6.99$, $p = .009$, explaining 4.7% of the variance in performance ($R^2 = 0.047$). Strategic planning was a significant positive predictor ($\beta = 0.25$, SE = 0.09, $t = 2.64$, 95% CI [0.06, 0.43]), implying that a one-unit increase in planning effort raised performance scores by 0.25 units. These findings show that even incremental improvements in structured planning, through clearer goal setting, market analysis, and resource alignment, can yield measurable gains in the productivity and competitiveness of dairy SMEs. The study concludes that structured and participatory strategic planning enhances both financial and non-financial performance dimensions of dairy SMEs. It recommends that county authorities and sector stakeholders strengthen training and mentorship programs to build managerial planning capacity and integrate data-driven planning tools that sustain competitiveness and growth in Kenya's dairy value chain.

Keywords: strategic planning; dairy agribusiness; SMEs; performance.

Effect of the Strategic Planning Process on the Performance of Dairy Agribusiness SMEs in Murang'a County, Kenya

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Abstract

Kenya's dairy agribusiness sector remains a cornerstone of rural livelihoods, yet most small and medium enterprises (SMEs) continue to face persistent constraints of low productivity, fluctuating prices, and weak managerial systems. Strategic planning therefore presents a practical mechanism through which firms can set clear goals, align resources, and respond more effectively to market and environmental pressures. Guided by the Resource-Based View and Contingency Theory, this study examined how the strategic planning process influences the performance of dairy agribusiness SMEs in Murang'a County. The specific objectives were to assess the effect of an organization's vision statement and the use of documented strategic plans on the performance of dairy agribusiness SMEs in Murang'a County. A descriptive cross-sectional design was applied to 143 enterprises registered with the Kenya Dairy Board. Data collected through structured questionnaires were analyzed using descriptive statistics, Pearson correlation, and simple regression models. Descriptive results showed that dairy agribusiness SMEs in Murang'a County engaged only moderately in strategic planning, with mean scores ranging between 2.98 and 3.06 (SD = 0.73–0.79). Most respondents (about 49–51%) held neutral views on whether their firms clearly defined goals, analyzed markets, or planned for the long term, suggesting partial but uneven adoption of formal planning practices. Correlation analysis revealed a positive association between strategic planning and firm performance, indicating that better planning corresponded with improved operational outcomes. The bivariate regression model confirmed this relationship, $F(1,141) = 6.99$, $p = .009$, explaining 4.7% of the variance in performance ($R^2 = 0.047$). Strategic planning was a significant positive predictor ($\beta = 0.25$, SE = 0.09, $t = 2.64$, 95% CI [0.06, 0.43]), implying that a one-unit increase in planning effort raised performance scores by 0.25 units. These findings show that even incremental improvements in structured planning, through clearer goal setting, market analysis, and resource alignment, can yield measurable gains in the productivity and competitiveness of dairy SMEs. The study concludes that structured and participatory strategic planning enhances both financial and non-financial performance dimensions of dairy SMEs. It recommends that county authorities and sector stakeholders strengthen training and mentorship programs to build managerial planning capacity and integrate data-driven planning tools that sustain competitiveness and growth in Kenya's dairy value chain.

Keywords: strategic planning; dairy agribusiness; SMEs; performance.

Synthesis and Characterization of Modified Alginate Biopolymer Sorbent for Removal of Methylene Blue Hydrate and Cobalt II from Aqueous Solution

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Abstract

The increasing discharge of synthetic dyes and heavy metals into aquatic systems poses serious environmental and health risks. Adsorption using biopolymer-based sorbents offers a sustainable alternative to conventional treatment methods. In this study, alginate hydrogels were modified by crosslinking with barium ions and reinforcing with polyvinyl alcohol (PVA) to form an interpenetrating polymer network. The materials were characterized using Fourier Transform Infrared Spectroscopy (FTIR), Scanning Electron Microscopy (SEM), and Thermogravimetric Analysis (TGA). FTIR confirmed the successful incorporation of PVA and barium crosslinks, as evidenced by shifts in hydroxyl and carboxyl functional groups. -COO- asymmetric stretching shifted from 1592cm^{-1} (CA) to 1589cm^{-1} (BA), -COO- symmetric stretching from 1413cm^{-1} (CA) to 1410 cm^{-1} (BA). C-O and C – C stretching was recorded between 1081cm^{-1} (CA) and 1079cm^{-1} (BA). Ca-O and Ba-O vibrations was recorded 817cm^{-1} and 814cm^{-1}, respectively. SEM revealed a highly porous surface morphology with improved structural integrity compared to conventional calcium alginate. TGA demonstrated enhanced thermal stability of the modified hydrogels, indicating improved suitability for practical applications. CA lost more weight in all decomposition phases compared to BA. Both materials degrade entirely at 850^{0}C, with CA residue left at 11% and BA at 48%. These results suggest that the barium–PVA reinforced alginate sorbent has promising potential for wastewater remediation and lays the foundation for further adsorption performance studies.

Key Words: Alginate hydrogel. PVA. Adsorption. FTIR. Barium. TGA.
Note: CA is Calcium Alginate, **BA** is Barium Alginate

Physical and Chemical Variables of River Water Quality in River Thanantu Sub-Catchment

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Abstract

Agrochemicals are widely used to boost agricultural productivity, yet their intensive and often indiscriminate application has become a major contributor to water pollution, threatening aquatic ecosystems, public health, and sustainable resource use. In Kenya, rivers traversing agricultural landscapes are increasingly vulnerable to contamination from pesticides and fertilizers. This study evaluates the physical and chemical variables of river water quality in the river Thanantu sub- catchment, in Tharaka Nithi County, Kenya. The study employed an experimental research design. Water samples were collected from three sites upstream, tributary, and confluence, identified using Geographic Information System (GIS) tools. Sampling was carried out in both wet and dry seasons to capture seasonal variations. Duplicate water samples were collected and subjected to standard laboratory procedures for analyzing turbidity, total suspended solids (TSS), temperature, pH, nitrates, and total phosphorus. Agricultural practices within the sub-catchment were also assessed through questionnaires administered to farmers, key informant interviews with agricultural officers and community leaders, and transect walks for field observations. Data were analyzed using descriptive statistics, one-way ANOVA, and regression analysis to test for spatial and seasonal differences. Water quality analysis showed significant seasonal variation, with higher turbidity values (14.1 NTU upstream, 22.6 NTU tributary, and 30.9 NTU downstream) and elevated TSS levels (65.72 mg/L in the dry season and 111.23 mg/L in the wet season). Nutrient concentrations also differed significantly across seasons, with total nitrogen ($p = 0.008$) and total phosphorus ($p = 0.038$) being higher during the wet season due to increased surface runoff. The study concluded that intensive agrochemical use is a key driver of water quality degradation in the Thanantu sub-catchment, with impacts exacerbated during the wet season. Current river pollution management strategies are inadequate to address the problem. It is recommended that the County Government, in collaboration with national agencies, implement integrated agrochemical management programs, strengthen enforcement of environmental regulations, and promote farmer awareness on sustainable practices. Longitudinal monitoring of pesticide residues in water, sediments, and aquatic organisms is also necessary to track cumulative impacts and inform evidence-based interventions.

Keywords: physical variables, chemical variables, river water quality, River Thanantu sub- catchment

Spiraling and Spiral-release of Protein Filaments Propelled by Biomolecular Motors

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Abstract

Cytoskeletal protein filaments, such as microtubules (MTs), are propelled by biomolecular motors in synthetic environments and function as active polymers with potential use in biosensors and nanodevices. When gliding over kinesin-coated surfaces, MTs are actively driven far from equilibrium, giving rise to emergent dynamics such as buckled conformations and flagella-like beating conformations. In particular, when their leading ends become pinned, MTs may buckle and form spirals [1],[2]. Such spirals may persist or, under certain conditions, release from the pinned end through a process of depinning (spiral-release) [3]. These transitions alter filament trajectories and can reduce the efficiency and reliability of directed transport. Understanding the physical origins of these behaviors and how filament mechanics influence spiraling and spiral-release is therefore essential both for fundamental biophysics and for designing and improving the controllability of protein-based active transport systems. Here, we investigate the role of bending rigidity in spiral-release dynamics of MTs driven by kinesin motors. Our simulation method is a build-up of our previous work [2], which we modify by introducing a spiral- release threshold. In the course of our study, we recognized that the mechanical properties of MTs critically influence whether spiral formation occurs prior to spiral- release. Figure 1 shows time series of simulated MT trajectories before and after pinning at their leading ends, under different bending rigidities. For MTs of bending rigidity 22.0 $pN \cdot \mu m^2$, spiral-release typically occurs while the filament remains nearly straight, resulting in only minor changes in direction. Figure 1: Time series of movements of microtubules (orange) driven by bound kinesin motors (green dots) before and after pinning of their leading ends, for MT with bending rigidities; 22.0 $pN \cdot \mu m^2$ (a), and 2.5 $pN \cdot \mu m^2$(b). The white dots represent randomly distributed kinesin motors. Scale bar = 2 μm. However, MTs of bending rigidity 2.5 $pN \cdot \mu m^2$ undergo spiral formation prior to spiral-release, and release is followed by marked unwinding and deflection. These findings provide important insights into the mechanical regulation of MT transport and have implications for optimizing their applicability in biosensors and nanodevices. Future work will extend this model to include more realistic mechanical features and experimental validation.

Keywords: Protein filament, Biomolecular motors, Microtubule, Kinesins, Spiraling, Spiral-release.

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Spontaneous Beating of a Clamped Protein Filament Driven by Biomolecular Motors

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Abstract

Cilia are ubiquitous, hair-like appendages on cells that contribute to vital functions such as fluid transport and microbial propulsion. Due to their intricate architecture, the fundamental mechanisms of ciliary motion remain difficult to study directly. Theoretical models based on the follower force framework, have suggested that sufficient active force and biomolecular motors binding–unbinding can drive spontaneous oscillations [1], [2]. However, these approaches overlooked the detailed mechanics of biomolecular motors themselves. We simulated the beating conformation of a protein filament, the cytoskeletal microtubule (MT) to be specific, clamped at its plus ends and driven by immobilized kinesin biomolecular motors in a gliding-assay format using the overdamped equations of motion and explicitly included the mechanics of kinesin motors proteins. We observed two distinct MT conformations over the course of time: Fig 1 (a) stuck and (b) beating MT with emergence of spontaneous travelling waves along the filament from clamped end to free end. Figure 1: MT conformation as a function of time. MT is shown in red, binding motors in green and unbound motors are white. Time lapse images of a (a) stuck MT where MT length is 10 μm and surface motor density is 20 motors μm^{-2}, and (b) beating MT with length 10 μm and surface motor density is 40 μm^{-2}. The beating phenomenon was observed to depend on MT length and surface motor density. In addition, the MTs were observed to oscillate with a frequency in 30-60 mHz range. The frequency scaled with surface motor density with an exponent of approximately 1/4, distinct from the predicted scaling of 4/3 from models that do not explicitly include the mechanics of motor proteins. Our results show the critical role the mechanics of motor proteins play in determining the spontaneous beating of MTs. The results also provide insights into the beating phenomena and can be useful in the design of micro- and nanoscale devices for fluid manipulation, mixing and pumping, with broader implications in biotechnology.

Keywords: Cilia, microtubule, kinesin

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Unity 3d Simulation of Robot Arm Control Using EOG/EMG Signals

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Abstract

This project involves the development of a Unity 3D simulation of a robotic arm controlled using electrooculography (EOG) and electromyography (EMG) signals. These bioelectrical signals, which originate from human muscle activity and eye movements, provide an intuitive and non-invasive means of controlling robotic systems. The simulation provides a virtual environment that enables the testing and refinement of bioelectrical signal–based control algorithms, offering a cost-effective and safe alternative to physical hardware testing. By minimizing the risks associated with hardware prototyping, the platform enables continuous experimentation while reducing cost and resource requirements. Furthermore, it serves as a research and training tool for students and professionals working on assistive technologies, human–machine interaction, and rehabilitation robotics. The main objectives of this project were to design and implement a Unity 3D simulation environment for a robotic arm, integrate real-time EOG/EMG signal data for motion control, validate the simulation against actual robotic arm movements, and enable flexible customization of tasks such as object manipulation and rehabilitation training. To achieve this, the project utilized Arduino-based acquisition of EMG signals, a TCP communication link between Python and Unity, and forward kinematic modeling for robotic arm motion. The simulation successfully demonstrated the feasibility and potential of using bioelectrical signals to control robotic arms with a high level of responsiveness and adaptability. The outcomes of the project include a Unity 3D robotic arm simulation, a real-time interface for EOG/EMG input, a comparison between virtual and physical control performance, and interactive training modules for end-user engagement. In addition, the project highlights the role of simulation in advancing inclusive technology design, particularly for individuals with physical impairments who may benefit from brain–computer and muscle–computer interfaces. This work contributes toward bridging human bio-signals with virtual robotic systems, enhancing accessibility, rehabilitation, and future applications in assistive robotics.

Keywords: Unity 3D, EMG signals, EOG signals, robotic arm, simulation, assistive technology

Development of Low-Cost Experimental Techniques for Combustion Study

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Abstract

Combustion is a subject in multiple engineering fields including mechanical and chemical engineering. The subject falls within the wider Thermofluids field in which instructors often grapple with delivery due to the involved technical concepts and mathematical rigor. Towards effectively delivering these technical concepts, laboratory experiments have been found useful. Unfortunately, the high cost of experimental equipment poses a challenge especially in under-resourced engineering training institutions. In response to this challenge, research efforts have been directed towards developing low-cost techniques to improve experimental access. Examples of low-cost techniques developed for thermofluids study include pipe flow, venturi nozzle, particle image velocimetry (PIV), Newtonian/non-Newtonian fluids, pitot tubes amongst others. This study presents the development of two low-cost experimental techniques focused on the combustion sub-field. One of the techniques allows measurement of laminar flame speed from images of conical Bunsen flames. The other technique developed is low-cost particle streak velocimetry (PSV) which allows flow velocity profile measurement using imaging of tracer particles seeded into a flow. Low-cost components have been used to develop the low-cost techniques from their standard forms. These components include a low-power laser for illumination, mobile phone for imaging and open-source software for image processing. The developed laminar flame speed measurement technique has been tested on premixed LPG-air flames and has yielded results that fall within the range of literature. The low-cost PSV technique has been tested by using it to measure flow velocities in Bunsen burner flames and validating against theoretically computed velocities

Keywords: engineering pedagogy; combustion; particle streak velocimetry; low-cost technique; phone-based technique.

Construction and evaluation of an institutional rocket stove for improved thermal efficiency and carbon emission reduction

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Abstract

Increased greenhouse gas emissions generated from daily human activities have led to climate change and global warming. The effects of these challenges are being compounded by the overdependence on biomass fuel and utilization of inefficient cookstoves by approximately 3 billion people globally. Efforts are being made to promote clean cooking in domestic setup. However, learning institutions are sidelined. It is estimated that primary, junior secondary, and senior secondary schools in Kenya consume approximately 1.3 million tonnes of firewood, translating to approximately 1.456 million tonnes of CO_2 emitted annually. This makes schools significant contributors to the overall emissions generated. To counter the prevailing avoidable climate change effects, various mitigation measures have been developed and are being adopted – Improved Cookstoves, in particular, the Institutional Rocket Stove (IRS). This improvement aims to accelerate clean cooking in learning institutions by reducing the amount of fuel consumed directly, impacting on emissions generated. Upon successful construction, testing, and everyday use for fourteen months, the Institutional Rocket Stove has proven to be an efficient, environmentally friendly, and economical means of cooking compared to other conventional methods such as the three stone method and traditional cookstoves like bellevue. This paper details the construction of an institutional sized rocket cookstove; the paper covers the construction of the cookstove and performance analysis to determine insulation capacity, thermal efficiency, fuel consumption, and smoke emissions which were found to be 0.26 W/m^2K, 43%, 44g/L, and little to no emissions respectively. The project was carried out in Dedan Kimathi University of Technology (DeKUT) who sort to shift from stainless steel institutional cookstoves due to their dilapidated state. Overall, the project serves to promote clean and efficient cooking which will consequently alleviate the contribution of poor cooking methods in environmental degradation, global warming, health degradation, and inefficient cooking practices.

Keywords: Improved Cookstoves (ICs), rocket stove, carbon emission, fuel consumptions, thermal efficiency

Assessment Of Climatic and Biophysical Factors That Influence Maize Crop Health and Yield: A Case Study of Muringato Catchment in Kenya.

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Abstract

Small holder agriculture serves as the backbone of food security in most societies in addition to supplementing family incomes. Increasing weather variability presents a major challenge, as smallholder farmers lack reliable climate information. Their limited farm size often excludes them from government initiatives, and traditional forecasting methods are proving increasingly inadequate to predict these severe environmental changes in regards to health. This attest to the need of evaluating the changes of weather patterns which aids in identifying when the crop is affected at different phenological stages. The area of study was the Muringato Catchment area which is part of Upper Tana River Basin situated in Nyeri county, in Kenya where significant changes in weather patterns have been experienced leading to shortage of yield production in small scale holders' farmers. This research aimed to evaluate and characterize the climatic and biophysical variables that influence the maize crop health and yields from the year 2019 to 2025. The various datasets were evaluated from remote sensed data and ground in situ data. The input variables were climatic variables such as rainfall and temperature, biophysical variables such as topographic wetness index (TWI), slope, aspect, enhanced vegetation index (EVI), bareness index (BI), normalized difference vegetation index (NDVI), normalized difference red edge (NDRE), leaf area index (LAI), soil moisture index (SMI), normalized difference water index (NDWI), land surface temperature (LST) and anthropogenic variables. The Google earth engine as a cloud platform to fetch data was utilized as a tool that leveraged utilization of remote sensed data. The evaluation enabled the farmers to understand the linkages between the weather patterns and how they influence the vegetation health condition of maize crop at different phenological stages which leads to effects to yields and affect the food security of the catchment. The results indicated that changes in weather patterns largely contributed to changes in vegetation health influence which led to low yield production. The relationship between rainfall, soil moisture index and vegetation index showed great relationships during the growing season. The rainfall showed variation from 2019 to 2025 as 70,149,130, 65,152 and 125mm respectively. The soil moisture correlation coefficient (r^2) of 0.72 depicting strong relationships between the in situ and remote sensed data in relation to vegetation variables. This would benefit the small holder farmers, have a great understanding in regard to weather parameters variation and its effect on their Maize crop. The finding will enable stakeholders to rapidly implement policies that support food security and contribute to the Sustainable Development Goal of Zero Hunger.

Keywords: *weather, Maize crop, vegetation health, soil moisture, small holder farmers*

The Quest for Exponential Construction Project Labour Productivity (CPLP) Growth in Industrial 4.0; Panacea or Sinking Sand?

Abstract

Adopting innovations of the 4IR is beneficial to the effectiveness and efficiency of Construction Project Labour Productivity (CPLP). Several theories exist regarding the impact of the Fourth Industrial Revolution (4IR) on the construction industry. The study aimed to serve as a predictor of the effects of 4IR on Construction Project Labour Productivity (CPLP). Using the dichotomy of panacea versus sinking sand, the critique of the portended relationship was evaluated in this exploratory research. The conclusion was that either situation – panacea or sinking sand – will occur based on the maturity and strategic foresight of the implementation.

Key words: Labour, Productivity, 4IR, panacea, sinking sand.

Toward a Smarter Nairobi: Unpacking the city's transitional challenges

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Abstract

Smart cities use digital technologies and data-driven solutions to enhance the quality of life for residents, improve sustainability, and optimize city operations. Nairobi's policy of integration of smart cities is evolving through a multi-layered framework that aligns local priorities with national and global development agendas (CIDP, 2023-2027). The policy outlines Nairobi's smart growth strategy that includes six dimensions: people, living, mobility, economy, governance, and environment through integration of intelligent systems to create more efficient, livable, and resilient environments. This paper is a desk top analysis to unpack the challenges in Nairobi's Smart City journey. It will identify the key features of smart cities from digital infrastructure, smart transportation energy efficiency, data driven governance, public safety and citizen engagement. It will document progress that has been made towards making the city smart, for example in high-speed internet, widespread WIFI, energy efficient buildings, smart grids, digitization of services, and e-payments, among others. It will identify the challenges experienced along the way such as fragmented planning, limited digital access, weak inter-agency coordination, and uneven service delivery, while exploring opportunities that can be leveraged to make Nairobi a smart city. Smart cities are not just about technology, they are about using innovation to solve urban challenges and create inclusive, future-ready communities.

Keywords: Smart City, Nairobi, Smart features, challenges, opportunities

Influence of Workplace Environment on Housekeepers' Well-Being in the Hotels Industry

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Abstract

In recent years, researchers and organizations have increasingly focused on understanding how various aspects of the work environment affect employees' well-being, acknowledging its critical influence on organizational performance and employee satisfaction. The hotel sector represents a relevant source of employment for the tourism industry. Within hotels, housekeepers are a numerically large occupational group and play a crucial role in maintaining the cleanliness and aesthetic of the rooms. These are two factors that significantly affect guest satisfaction. Although hotels require great performance from housekeepers, their job is of the lowest quality within the industry as it involves poor working conditions, low wages and relative job insecurity. As housekeeping work processes are characterized by repetitive, strenuous and fast-paced tasks, workers are exposed to physical, psychological, biological and chemical hazards. This study reviewed and analyzed literature from ten (10) articles on the effects of the workplace environment on housekeepers' well-being. The study employed analytical reviews of the related articles to justify the influences of the physical workplace environment on housekeepers' well-being. Content analysis was used to analyse the literature framework of the study. The literature so far reviewed had applied quantitative, qualitative and mixed methodologies. The review shows that extant literature pays attention to the physical and social dimensions of workplace environment, organizational job characteristics, intrinsic job factors, and employees' perspectives on their roles. The well-being concept in the literature largely involved job performance, employee satisfaction and achievement, health, and productivity in the housekeeping department. Some of studies showed that hotel housekeepers worked under great time pressures, endured excessive workloads, did not have enough time to rest and recover, and often skipped or shortened lunch breaks. Some of the house-keepers believed that their employers valued work productivity more than their safety and health. The findings indicate that enhancing the housekeepers' workplace conditions and relationships can positively affect their well-being. This in turn has broader implications for organizational productivity and employee retention. These findings are aligned with the Job Demands-Resources Theory, which posits that workplace resources mitigate job demands, leading to higher employee well-being and retention. In recommendation, there is need for a comprehensive approach to workplace design, integrating physical and social elements to promote higher levels of employee engagement. Housekeepers' health and safety should be enhanced through initiatives like regular health check-ups, ergonomic adjustments, and proper safety training. Additionally, enhancing workplace conditions coupled with strong organizational support, can significantly improve employee well-being, particularly in the housekeeping sector with high physical and cognitive demands.

Keywords: Employee satisfaction, Hotels, Housekeepers' well-being, Organizational performance, Physical work environment, Workplace conditions

Bridging The Gap: Assessing Skills, Training, And Competencies for Curriculum Development in Sustainable Tourism

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Abstract

Tourism plays a critical role in Kenya's economy, contributing approximately 7.9% to the national GDP and supporting around 1.6 million jobs. However, the sector faces mounting challenges including environmental degradation, sociocultural disruptions, and the impacts of climate change, necessitating a shift toward sustainable tourism practices. Despite the growing global emphasis on sustainability, there remains a significant gap in the knowledge and skills required by tourism professionals in Kenya to align with international sustainability standards. This study aimed to bridge this gap by: (1) identifying the knowledge and skill deficits among tourism professionals; (2) evaluating the extent to which sustainability principles are integrated into current training programs; (3) outlining essential competencies for sustainable tourism; and (4) assessing the effectiveness of current training methods in developing these competencies. A qualitative, descriptive survey design was employed. A purposive sample of 60 respondents was drawn from a target population of 75 professionals across diverse tourism sub-sectors using Yamane's formula to ensure broad representation. Data collection involved curriculum reviews, policy document analysis, semi-structured questionnaires, and key informant interviews. Quantitative data were analyzed using SPSS, and qualitative data were thematically examined using NVivo. Cronbach's Alpha (≥ 0.7) confirmed instrument reliability. Findings indicated underrepresentation of frontline actors such as tour guides (8.3%) and community tourism leaders (3.3%) in training programs, while educators comprised the majority (55%). Regression analysis ($B = 0.451$, $p = 0.019$), correlation ($r = 0.632$, $p < 0.001$), and ANOVA ($F = 8.808$, $p < 0.001$) all underscored the significant impact of experiential, hands-on learning on competency development. Qualitative insights emphasized the importance of digital literacy, community engagement, and practical skills. The study concludes that for Kenya to advance sustainable tourism aligned with its development agenda, training programs must become more inclusive, practice-oriented, and sustainability-focused.

Keywords: sustainable tourism, training gaps, tourism professionals, Kenya, competencies

Physico-Chemical and Microbial Qualities of Yacon (Smallanthus Sonchifolius)-Based Oatmeal Energy Bar

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Abstract

Yacon is a sweet tasting Andean tuber considered a functional food due to its bioactive compounds. It has been used to formulate various baked products but there's limited research on its use in energy bars. The aim of this study was to evaluate the physico-chemical and microbial qualities of yacon based oatmeal energy bar. Energy bars were made using four oats to yacon powder mixtures in the following proportions: 100:00 (control), 95:5, 85:15, 75:25 and 60:40. A completely randomized design with three replicates was used and data analyzed using one way analysis of variance and significant differences determined by Fisher's Least Significant Difference. Proximate analysis was done using Association of Official Analytical Chemists Methods (AOAC). For physical analysis, color was analyzed using hunter lab color difference meter, texture analyzed using texture analyzer and water activity using Hygropalm-HP23-AW-A-portable water activity analyzer. With substitution of yacon powder, there was no significant difference in ash and fiber ranging 1.93%-2.95% and 0.70%-1.14% respectively. The carbohydrate content significantly increased 74.79%-82.72%. With substitution of yacon powder, there was significant decrease in moisture, protein and fat 7.90%-4.70%, 11.90%-7.57%, 2.79%-0.91% respectively. There was 40% significant decrease in total energy (1555.88kJ-1545.40kJ) with addition of 40% yacon powder. Texture (6.52N-2.44N) and pH (5.85-5.72) significantly decreased while water activity (0.62-0.68) and bulk density ($1.26g/cm^3$-$1.41g/cm^3$) increased, low pH guarantees long shelf-life. Yeast and molds were detected after 30-day storage at room temperature; the count remained within safe limits (yeasts/molds <100CFU/g). Moisture content over the 30 days was also analyzed, there were no major differences over time since the bars were packed in airtight plastic zip-lock bags.

In conclusion, making the energy bars with oats and yacon powder can be a great alternative use of the Andean tuber. It offers nutritional benefits and is microbiologically safe within 30 days of storage at room temperature. This research advances technology and development by increasing knowledge on yacon and promoting the formulation of diverse products from it. These diverse products may include: yacon energy bars, yacon syrup, yacon flakes, yacon cakes, yacon biscuits and many others. This may lead to farmers growing more yacon thus creating income.

Keywords: Energy bar, fructooligosaccharides, Oats, Yacon

Developing the components of a low-cost atomic force microscope

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Abstract

The Atomic Force Microscope (AFM) is a critical tool for measuring forces and characterizing surfaces at the nanoscale, with applications spanning biology, chemistry, materials science, and micro-/nano-electronics. However, the cost of commercial AFM systems—ranging from tens of thousands to over half a million dollars—often places them out of reach for researchers in poorly resourced institutions and developing countries. For basic models, the high cost is largely driven by specialized opto-electro-mechanical components and electronic controllers. In this ongoing project, we are developing a low-cost AFM by addressing these expensive components. We are leveraging salvaged opto-electronics from common consumer devices (such as CD, DVD, or Blu-ray drives) and 3D printing the instrument's opto-mechanical parts. We are also partially developing custom electronics for optical control and monitoring, and creating custom data acquisition software using LabVIEW. We are currently integrating these opto-electro-mechanical and data acquisition components and performing initial imaging tests using a commercial cantilever and lateral nano-positioner. Future work will involve developing a fully custom, open-source platform for data acquisition and control using freely available development tools, along with custom nano-positioners. Upon completion, we anticipate our approach will provide an affordable, accessible nanoscale characterization tool for the local research community and other AFM practitioners. This will enhance our collective capacity to analyse samples and drive innovation across numerous engineering and scientific disciplines. Sub-theme: Nanotechnology and Material Science

Keywords: nanotechnology, instrumentation, surface characterization, atomic force microscopy

A nano-scale optical displacement measurement sensor using an optical pickup

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Abstract

High-resolution displacement measurement is critical for nanoscale applications, enabling the precise manipulation and characterization of matter. However, the specialized sensors typically required for this task are often prohibitively costly. In this ongoing work, we present an effort to develop an affordable displacement sensor by repurposing an Optical Pickup Unit (OPU) – the laser-based component found in CD/DVD/Blu-ray drives – to measure nanoscale displacements. We have developed custom electronic circuitry and software to effectively monitor and control the instrument's operation. We are currently assembling these components to carry out preliminary displacement measurement tests. Retrofitting commercial optical pickups offers a cheaper and viable alternative to expensive, purpose-built sensors. Future work will focus on comprehensively characterizing the instrument's resolution and bandwidth using a commercial displacement sensor to validate its performance. This approach promises to democratize access to high-precision metrology for researchers and engineers.
Sub-theme: Nanotechnology and Material Science

Keywords: nanotechnology, measurement, instrumentation, displacement measurement

Remaining Useful Life (RUL) Prediction of Lithium-Iron-Phosphate Batteries based on LSTMs

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Abstract

Lithium iron phosphate batteries have gained increasing adoption in electric vehicles (EVs) and grid energy storage systems due to their safety, longevity and cost advantages. For these two use cases, ensuring long-term reliability is critical for user confidence and large-scale adoption. A major problem when assessing battery reliability emanates from the inherent uncertainty of the capacity within the Coulomb Counting equation, this degradation is brought about by incremental reduction in capacity. Estimation of Remaining Useful Life (RUL) and State of Health (SoH) is crucial for planning and avoiding unexpected failure. RUL of lithium-ion batteries predicts how many cycles are left such that the battery would be usable. Usability is defined by what percentage of the initial battery capacity is regarded as the lowest acceptable limit, for most applications 80% is the considered threshold. Since battery degradation depends on operational and usage patterns, temporal deep learning models such as Long Short-Term Memory (LSTM) networks can leverage time-series data to predict SoH and RUL. This study develops and evaluates LSTM-based models for battery health prediction, demonstrating their potential to accurately capture degradation trends and enhance reliability forecasting for LFP batteries.

Keywords: Battery health estimation; Remaining Useful Life; Lithium-ion batteries; State of Health, State of Charge, Coulomb Counting Equation.

A Framework for Enhancing Human-robot Collaborative Through Mixed Reality-Enabled Digital Twins

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Abstract

Human-robot collaboration is a significant research area in the context of flexible and complex manufacturing systems. However, challenges still exist that prevents synergistic cooperation between humans and robots in Industry 4.0. Research has explored the use of virtual environments to augment interaction but does not have a focus on the augmentation of human perception of the robot's state and motion plan during collaboration. In this research, a new approach for enhancing human–robot collaboration for collaborative assembly tasks with the aid of integration of mixed reality (MR) and digital twin (DT) technology is employed. The system provides visual feedback to human operators in the form of robot status, task completion, and motion paths with low latency. The approach was validated on a gear mechanism assembly case study to assess the system's effectiveness through task completion time. The users within the case study were assigned an interface type, MR versus screen- based interface and were tasked to complete the collaborative assembly task. The results showed that the mixed reality interface had a 39.16% improvement in completion time and reduced error rate compared to the screen-based interface. Users also reported high levels of satisfaction from the administered usability study while suggesting potential areas of improvement. The findings confirm the applicability of the proposed framework to interactive and immersive HRC environments. It is a contribution to the research on human- robot collaboration in showing the potential benefit of digital twins and mixed reality to offer scalable solutions in industrial settings.

Keywords: Digital Twin (DT), Mixed Reality (MR), Human-Robot Teams (HRTs), Collaborative Robotics (Cobots), Industry 4.0 (I4.0), Extended Reality (XR)

Practical Works on MicroElectronics and Nanotechnology at AIME

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Abstract

Since its emergence few decades ago, nanotechnology has been shown to be a perfect example of a crossroad between different fundamentals sciences. In the last 10 years, the continuous progress of classical topdown lithography and the use of alternative bottom-up elaboration methods has allowed new and smaller components to be created. Their combination has led to very complex and innovative architectures. At the same time, flexible, low-cost, and low-ecological footprint devices have emerged. Thus, the diversity and multidisciplinary features present challenges in addressing these issues in educational programs. Practical works are essential for students, to assimilate the complex theoretical concepts and acquire associated skills. Here, we share our experience of introducing nanotechnologies to university students through practical work. For more than 40 years, we have proposed microelectronic-based device- fabrication training that seeks to realize devices in a clean room that is mainly dedicated to educational purposes. In this presentation, we will present our pedagogical approach based on practical training in the field of CMOS technology, sensor technologies (gas), energy harvesting with solar cells, or integrated on-chip energy storage. Also, we will share our starting experience in our new platform dedicated to quantum technologies. We will focus on the peculiar interest of some practical work. The authors thank the GIP-CNFM (Coordination Nationale de Formation en Micro- électronique et Nanotechnologies), the graduate school of research NanoX n°ANR-17- EURE-0009, as well as the projects 22-CMAS-0001 QuanTEdu-France, ANR-23- CMAS-0024 INFORISM, in the framework of France 2030 program.

Keywords: Integrated electronics, Sensors, Quantum technology, Education

Effectiveness Of Marketing Communication Strategies on Awareness of Health Care Services in Public Hospitals in Nakuru County

Reitz Mureithi

Abstract

Although Nakuru County's Department of Health employs certain communication and marketing strategies, there are still information gaps that hinder awareness of health services in public hospitals. This study examined the effectiveness of marketing communication strategies on awareness health services in public hospitals in Nakuru county. The research was guided by four objectives namely; to establish the effectiveness of crisis communication on awareness of health services in public hospitals in Nakuru County, to determine the effectiveness of social media on awareness of health services in public hospitals in Nakuru County, to examine the effectiveness of advertising on awareness of health services in public hospitals in Nakuru County, and to establish the effectiveness of public relations on awareness of health services in public hospitals in Nakuru County. The research was also guided by diffusion of innovation and framing theories. The study adopted correlational research design. The research targeted 11 public health facilities in Nakuru County including 10 level 4 hospitals and 1 level 5 hospital. 52 respondents filled the questionnaires out of a targeted 71. They included core members of the public health emergency operations center, medical superintendents, nurses in-charge, head accountants, public relations officers, public health officers and health promotion officers. The study found that advertising and social media are the most effective marketing communication strategies that raise awareness of health services in public hospitals in Nakuru county. It also found that there is no written organizational communication policy and that the hospital staff are not aware of the protocols to follow in case of an emergency requiring crisis communication.

Key words: *awareness, crisis communication, advertising, social media, public relations, health services, public hospitals.*

RFID-Based Smart Speed Advisory System for Enhanced Road Safety

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Abstract

Road safety remains a significant challenge in Kenya, with over speeding contributing to a large proportion of road accidents, especially in areas such as school zones and residential roads. This project presents the design and implementation of an RFID and GPS-Based Smart Speed Advisory System aimed at enhancing driver awareness and compliance with speed limits through real-time alerts. The system utilizes an ESP32 TTGO microcontroller interfaced with an MFRC522 RFID reader, NEO-6M GPS module, and DFPlayer Mini audio unit to deliver bilingual (English–Swahili) voice alerts to drivers upon entering or leaving speed-restricted zones. RFID tags are installed at the start and end of each zone to identify speed limits, while the GPS module continuously tracks the vehicle's location to provide redundancy in case an RFID tag is missed. When over speeding occurs, the system triggers a voice alert through the DFPlayer Mini and logs the violation in the Blynk IoT console, which serves as the central monitoring platform for authorities. The project further integrates Bluetooth communication for system diagnostics and updates, ensuring smooth operation and flexibility. The developed system offers a cost-effective and scalable approach to improving road safety, particularly within Kenyan road conditions. It combines the strengths of RFID and GPS for robust detection and employs real-time voice and cloud-based alerts to support both drivers and traffic authorities. The prototype demonstrates how low-cost IoT solutions can contribute meaningfully toward accident reduction, policy enforcement, and the realization of smarter, safer transport infrastructure.

Advancing Speech and Language Technologies for Local Languages: A Machine Translation and ASR Approach

David Muriithi, Michelle Gesare, Shelton Ombachi and Joseph Muguro

Abstract

A High-performance speech and translation model that promotes digital equity and preserves local languages linguistic and cultural heritage within modern AI systems. This project fine-tunes existing state-of- the- art speech and translation models using culturally rich datasets from local languages. The adapted models improve transcription and translation accuracy while creating reusable datasets and scalable fine-tuning methods for other African languages

A Secure Authentication model for Enhancing Single Sign-On security Against credential compromise.

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Abstract
Single Sign-On (SSO) systems are vulnerable to phishing and credential theft, highlighting the need for stronger authentication mechanisms. This study proposes a biometric-enhanced SSO model to improve security and usability. A systematic literature review identified key weaknesses in existing SSO systems, while design thinking guided the model's user-centered development. Implemented using WebAuthn, the model enables secure, password-less authentication through public–private key cryptography. Validation employed real and sample biometric data, including mobile fingerprint and facial recognition, and Fingerprint Verification Competition datasets. Using Goal-Based Evaluation methodology, the study confirmed that integrating biometric authentication into SSO significantly mitigates credential-related vulnerabilities.

Keywords: single sign-on, biometric authentication, security

Innovative Strategic Practices and Competitive Positioning in Kenya's Agribusiness Sector: A Case of Animal Feeds Firms in Nakuru City

Judith Chepkemoi

Abstract

Animal feeds firms are vital engines of growth in Kenya's agribusiness sector. While these firms continue to support livestock production and contribute significantly to agricultural GDP, they face numerous challenges that hamper their competitive positioning. Animal feeds firms are hindered by intense competition, fluctuating raw material costs, limited access to modern technology, inadequate innovation capacity, and rapid changes in market demands. Unfavorable business environments and weak strategic management practices present other bottlenecks to this vital segment of the agribusiness sector. The aim of this paper was to examine the relationship between innovative strategic practices and competitive positioning of animal feeds firms in Nakuru City. The specific objectives were to identify the innovative strategic practices employed by animal feeds firms; to assess the competitive positioning of these firms; and to determine the influence of innovative practices on competitive positioning. The study adopted a desktop review approach where critical literature review was conducted to identify key themes. The study findings indicated that product innovation, process innovation, and marketing innovation remain the most critical practices affecting competitive positioning of firms in the sector. The study concludes that adoption of innovative strategic practices significantly influences the competitive positioning of animal feeds firms. The study recommends increased innovation capacity and competitiveness by strengthening animal feeds firms through financial incentives, technical assistance programs, technology transfer initiatives, and capacity building support.

Keywords: *Innovation, Strategic Practices, Competitive Positioning, Agribusiness, Animal Feeds, Nakuru City, Kenya*

Harmonizing Cross - Border IP Policies for STI Governance in East Africa

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Abstract

Science, Technology, and Innovation (STI) are critical drivers of socio-economic transformation across Africa. However, fragmented intellectual property (IP) policies among African nations continue to impede seamless regional integration, technology transfer, and innovation-led trade. This paper examines the fragmentation of intellectual property (IP) policies within the East African Community (EAC) and how continental frameworks like the African Continental Free Trade Area (AfCFTA) can foster harmonization. We review recent developments – including Kenya's rising innovation activity, the EAC Treaty's explicit IP harmonization mandate, and new EAC regional IP policy efforts – to highlight governance gaps. The analysis discusses how overlapping national and sub-regional IP regimes cross- border trade and innovation. Drawing on peer-reviewed studies and policy reports, the paper assesses challenges in legal interoperability, enforcement and institutional coordination. We then propose tailored solutions: strengthening the EAC's regional IP policy, actively shaping the AfCFTA IP protocol, leveraging existing regional systems (e.g. ARIPO membership), and building new inter-state cooperation mechanisms. These recommendations aim for policy coherence and institutional innovation that support science, technology and innovation (STI) across Kenya and the broader EAC, while aligning with continental development goals. Ultimately, this paper highlights the critical role of harmonized IP governance in advancing Africa's STI agenda, promoting equitable access to technologies, and enhancing the continent's competitiveness in the global knowledge economy.

Keywords: intellectual property (IP), harmonization, fragmented, integration, innovation, technology transfer

Mapping Spatial Variabilities of Vegetation Phenology in the Muringato Catchment Area Using Fused MODIS-Landsat Time Series

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Abstract

Understanding vegetation phenology is critical for assessing ecosystem responses to environmental changes especially in semi-arid regions. This study investigated spatial patterns and temporal trends of key phenological stages in the Muringato Catchment, Nyeri County, Kenya, from 2000 to 2024, using fused remote sensing time series data. The March-August cropping seasons were considered. The objectives were to characterize climatic, topographic and edaphic factors influencing vegetation phenology; model the relationship between the environmental factors and phenology using Random Forest model; then quantify the relative influence of the environmental drivers. Surface reflectance data from MODIS and Landsat 7, 8, and 9 were fused to produce gap-filled time series, from which EVI was derived. Phenological metrics were extracted from EVI for 1000 randomly sampled points. Results revealed earlier SOS and prolonged growing seasons from 1684 to 1856 meters above sea level and in areas with higher precipitation. Temporal trends indicated SOS advancement by 2 to 5 days per decade in warmer regions, associated with increasing temperatures and variable rainfall. The Random Forest model identified elevation (0.28), temperature (0.22), and precipitation (0.19) as primary drivers, explaining 65-78% of POS and EOS variability. These findings underscore the influence of topography and climate on seasonal vegetation patterns, providing insights for adaptive agricultural and forest resource strategies in the face of environmental change.

Keywords: Vegetation Phenology, Data Fusion, Muringato Catchment, Environmental Drivers

Quantifying Transforming Capability: A Linear Discriminant Analysis of Firm Sustainability Outcomes in Regulated Kenyan Water Utilities.

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Abstract

Sustainability of water and sanitation services is a global challenge. Further, it is projected that rising water scarcity will cost an estimated 6% of the Gross Domestic Product (GDP) in Kenya by 2050. Transforming dynamic capability which refers to the ability of organizations to continuously reconfigure structures, processes and resources, has been widely acknowledged in strategic management theory, [1], [2], [3], [4]. However, it has been rarely quantified in regulated public utility contexts. This study seeks to fill this gap by providing one of the first empirical examinations of transforming capability as a distinct predictor of firm sustainability outcomes among Water Service Providers (WSPs) in Kenya. Using cross-sectional survey data from 75 WSPs (300 respondents), the study employed Linear Discriminant Analysis (LDA) to assess the influence of transforming capability on firm sustainability performance as defined by the Water Services Regulatory Board (WASREB) [5]. Indicators included Water Coverage, Water quality, Hours of Supply, Staff costs/Total Costs, Revenue Collection efficiency, Operations and maintenance costs coverage ratio, Non-Revenue Water, Staff Productivity Ratio and Metering Ratio. WASREB classifies the indicators into three categories. These are Service Quality, Economic Efficiency and Operational Sustainability, [5]. The researcher concluded that transforming capability has a statistically significant discriminating effect between "Not Acceptable," "Acceptable," and "Good" firm sustainability levels of the WSPs, with a 80.6% hit ratio. This implies that while WSPs pursue organizational renewal, transformative leverage of such efforts is reduced by factors such as regulatory constraints, limited resources and institutional inertia. The study adds to the dynamic capabilities knowledge by explicitly quantifying transforming capability within a regulated Kenyan public utility sector, achieving application of theory beyond competitive markets. It also identified regulation as a double-edged boundary condition. While it enforces sustainability benchmarks, it can also stifle transforming efforts. For policymakers and managers, the findings underscore the necessity of investing in capacity building, adaptive processes, benchmarking and innovation initiatives which strengthens transformation. This research offers a novel evidence-based lens for enhancing the resilience and sustainability of water utilities in emerging economies by linking transforming capability to regulatory benchmarking. Hence providing a technology informed framework for improving water utility performance, thereby contributing to sustainable urban development and achievement of SDG 6 on Clean Water and Sanitation [6].

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Large Scale Forest Monitoring: Tree Clustering on Drone Images

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Abstract

Forests are vital ecosystems that regulate climate, store carbon, and sustain biodiversity. Accurate and timely monitoring of forest dynamics is essential for sustainable resource management, yet traditional field-based methods remain limited in scale and frequency. This study presents a large-scale forest monitoring framework that leverages drone imagery and the Segment Anything Model (SAM) to automate tree canopy segmentation and area estimation across different seasons. The SAM-generated masks are analyzed to quantify changes in canopy coverage and detect temporal growth patterns. To further assess species-level variability, unsupervised clustering algorithms such K-means are applied to seasonal growth metrics, enabling differentiation of tree species. This approach highlights the potential of integrating foundation models like SAM with drone-based monitoring to support scalable, data- driven forest management and ecological research.

Keywords: Drone images, Segment Anything Model, clustering

The Moderation Effect of Strategic Decision-Making on the Relationship between Entrepreneurial Orientation and the Performance of Community Pharmacies in Kenya

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Abstract

Entrepreneurial orientation (EO) has become a force in entrepreneurial ventures by informing the necessary efforts for value creation. This study investigated the moderating effect of strategic decision-making (SDM) on the relationship between EO and the performance of community pharmacies in Kenya. The research was theoretically based on the Entrepreneurial Personality System for addressing decision-maker traits. Using a quantitative cross-sectional design, data were collected from pharmacy operators ($N = 222$, response rate: 59.04%) via a structured questionnaire. The study demonstrated strong internal consistency (Cronbach's $\alpha \geq 0.823$) and established content validity through pilot testing. Multiple linear regression and hierarchical moderation analysis with HC3-robust standard errors were employed to test the hypothesis. Results showed that SDM has a marginal direct significant effect on firm performance ($\beta = 0.197$, $p = 0.065$), with no statistically significant moderation effect (Proact × SDM: $\beta = 0.114$, $p = 0.598$; Risk × SDM: $\beta = -0.397$, $p = 0.087$). The study found that SDM cannot moderate the EO-performance relationship if the strategic EO mindset required to do so is absent among pharmacy entrepreneurs. Entrepreneurs in the local pharmaceutical sector exhibit strategic inertia by prioritizing operational functions over growth strategies. This inertia hinders enterprise scalability. This study encourages pharmacy owners and entrepreneurs and policymakers to prioritize strategic planning for expansion to translate entrepreneurial capability into persistent growth.

Keywords: Entrepreneurial orientation, community pharmacy, risk-taking, innovative, proactive, performance.

Smart Inverter Control for Mitigating Reverse Power Flow in Rural Feeders with High PV Penetration

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Abstract

The integration of renewable energy sources into existing power grids is essential for sustainable development, yet presents significant technical challenges, particularly for rural distribution networks. This paper investigates the cumulative impact of multiple, grid connected Photovoltaic (PV) systems on a representative rural feeder in Kenya. While individual PV installations may comply with national grid code export limits, their combined effect during periods of high solar irradiance can lead to significant reverse power flow, threatening the stability and safety of upstream network equipment. This study utilizes a validated OpenDSS model of the 69 km 11kV feeder to simulate a high-penetration scenario, comprising three distinct 1 MW PV systems. The uncontrolled baseline simulation quantifies a severe reverse power flow problem, with a peak of approximately 0.93 MW back into the substation. A key finding is that the feeder's high electrical stiffness renders generic Volt-Watt controls ineffective, as local voltages do not rise sufficiently to trigger curtailment. Consequently, a more sensitive, coordinated smart inverter control strategy, employing both Volt-VAR and Volt-Watt functions, is designed and simulated. The results demonstrate that this advanced strategy is highly effective, successfully mitigating the peak reverse power flow by 62.3% down to 0.35 MW. This is achieved at the cost of approximately 1,500 kWh of curtailed energy per day, quantifying the critical trade-off between grid safety and renewable energy utilization. This work validates a practical methodology for enabling high-penetration PV on rural feeders and highlights the necessity of feeder-specific, optimized control strategies over generic solutions.

Keywords: Reverse Power Flow, Photovoltaic (PV) Integration, Smart Inverter, Coordinated Control, High R/X Feeder, OpenDSS.

Adapting LLaMA Model for the Kikuyu Language: Bridging the Language Gap through Machine Translation

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Abstract

This study focuses on machine translation for Kikuyu language, a low-resource Bantu language with limited representation in natural language processing. We adapted the pretrained LLaMA 3.2 (3B) model to enhance its performance on English–Kikuyu translation tasks. A curated dataset of 30,000 English–Kikuyu sentence pairs was extracted from a larger corpus covering domains such as news, healthcare, agriculture, and digital services. Data preprocessing involved correcting of Kikuyu diacritical marks (ĩ and ũ), removal of inconsistent and duplicate and tokenization. Fine-tuning was performed using Parameter-Efficient Fine-Tuning (PEFT) techniques, enabling efficient adaptation without full retraining. Experimental results demonstrate consistent improvements in translation quality, with the Bilingual Evaluation Study (BLEU) score of 25.21. These findings highlight the potential of transfer learning through fine tuning large language models trained with high resource language to low-resource languages, despite data scarcity constraints.

Keywords: Large Language Model, low-resource language, transfer learning.

Integrating Machine Learning, Computer Vision and Sensor Analytics for Source-Level Wastewater Segregation in Institutional Water Management

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Abstract

Kenya faces severe water scarcity, with renewable freshwater availability of only about 500 m^3 per person annually, far below the global threshold of 1,000 m^3. The challenge is caused by climate change, rapid population growth, pollution and aging infrastructure, while inefficient water management practices in institutions such as schools and hospitals result in the direct discharge of reusable greywater. This greywater, typically from handwashing and cleaning, contains minimal contaminants and holds great potential for non-potable applications such as flushing, irrigation and surface cleaning. However, in the absence of on-site segregation systems, it is often mixed with blackwater and released into the sewer system, wasting valuable freshwater resources and overloading treatment facilities. This project proposes an AI-enhanced wastewater segregation system that integrates visual and chemical data to automatically classify and direct wastewater at the point of generation. The system uses a high-resolution camera to capture real-time images of wastewater while pH and Total Dissolved Solids (TDS) sensors measure its chemical properties. The image data are processed using a Convolutional Neural Network (CNN) to extract visual features such as turbidity, color and particulate concentration. Simultaneously, sensor data are analyzed using a supervised machine learning model, such as a Support Vector Machine (SVM) or Random Forest, to interpret water quality parameters. The two data streams are fused at the decision layer, producing a robust classification output that categorizes wastewater into Reuse, Treat or Repurpose classes. The prototype is implemented using a Raspberry Pi microcontroller, which manages image capture, sensor data acquisition and control logic. Based on the classification output, solenoid valves are automatically actuated to direct water to the appropriate outlet either for direct reuse, treatment or repurposing. The hybrid integration of computer vision, sensor analysis and embedded automation provides a low-cost, efficient and scalable solution for decentralized wastewater management in institutional environments. By promoting intelligent greywater segregation, the system reduces freshwater consumption, minimizes pollution and supports sustainable water reuse practices. It directly contributes to Kenya's Vision 2030 objectives on sustainable resource management and aligns with the United Nations Sustainable Development Goal 6 (Clean Water and Sanitation). Beyond institutional deployment, the system demonstrates the potential of artificial intelligence in addressing environmental challenges.

Keywords: Wastewater segregation, Greywater, Machine Learning, CNN, Sensor integration, Sustainable water management

P300 Event-Related Potential Interface and 3D SLAM-Based Remote-Control Mobile Robot System

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Abstract

This paper presents a brain–computer interface (BCI) system that integrates the P300 event-related potential with a 3D-SLAM (Simultaneous Localization and Mapping) autonomous mobile robot. The proposed system enables a user to remotely operate a robot by detecting brainwave responses associated with visual attention. The robot performs environmental mapping, self-localization, and autonomous navigation based on LiDAR sensing and SLAM technology. The proposed approach aims to assist individuals with motor disabilities by providing a non-contact control method using brain activity. Experiments confirmed reliable P300 detection, precise localization, and successful robot navigation toward the target location.

Keywords: P300, Event-Related Potential, Brain–Computer Interface, 3D-SLAM, Autonomous Mobile Robot, EEG Control

Adsorption Of Methyl Red from Textile Dyeing Wastewater Using Coffee Husks Biochar

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Abstract

Contamination of water has become a global problem in the twenty-first century due to the entry of both organic and inorganic toxins into the water system. Enormous amounts of wastewater are discharged into the environment from the dyeing processes. Because of their great chemical stability, industrial effluent from textile production combined with insufficient dye degradation results in significant water contamination. Dye-contaminated wastewater poses major health concerns, including cancer, as well as problems for the aquatic environment. A common azo dye used in textile manufacture and as an antibiotic is methyl red dye (MRD) which finds its way into the water system when directly released or stray during the dyeing process. It is known to be poisonous, carcinogenic, teratogenic, mutagenic, and cause respiratory issues. Therefore, it is crucial to keep an eye on the quality of water. There is a need therefore to remove these toxins from the environment and water. Coffee husks biochar (CHB) was produced by gentle pyrolysis of coffee husks at 350 °C followed by characterization using XRD, FT-IR, and SEM. Analysis using FT-IR revealed the vanishing of the O-H group in the coffee husks and the emergence of C=C, C=O, and C-O in the CHB indicating the conversion of husks to biochar. Besides, the SEM investigation demonstrated a change in the surface morphology of the CHB. In batch investigations, the impacts of CHB dose (0.2-1.2 g), medium pH (1-12), time of contact (5-60) minutes, and initial dye concentration (20-150 mgL^{-1}) were investigated. Coffee husks biochar demonstrated remarkable efficacy in eliminating MRD with an impressive removal efficiency of up to 96.56% at optimum conditions. At pH 2 and 0.6 g of CHB, an adsorption equilibrium capacity of 10.42 mg g^{-1} was reached in 25 minutes. Langmuir isotherm proved to be the appropriate model for describing the MRD adsorption onto CHB, assuming a chemisorption mechanism.

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