



2020 ANNUAL REPORT

Advancing the Decade of Action



A year's overview

RESEARCH COLLABORATIONS

E4C was founded by ASME as part of the Society's mission to advance engineering for the benefit of humanity. Engineering for Change (E4C) is powered by the American Society of Mechanical Engineers (ASME). E4C's mission is to prepare, educate and activate the international engineering workforce to improve the quality of life of underserved communities around the world. We are a Knowledge organization with global community of 1,000,000+ that believes engineering can change the world. Founded in 2009 by ASME, IEEE and EWB-USA.

Engineering for Change (E4C) Research Collaborations cut across geographies and sectors to deliver an ecosystem view of technology's role in achieving the UN's Sustainable Development Goals (SDGs). We investigate the relationship between engineering civil society impact, funding, and collective action. Through methods, such as participatory research and landscape mapping, we create actionable research for funders and international development organizations. Our targeted research is conducted by E4C staff and Research Fellows on behalf our partners and sponsors, and is delivered in the form of digestible reports that can be absorbed and implemented to address urgent global development challenges.



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State of Engineering for Global Development *global series*



ASIA

- 19 institutions in Bangladesh, Bhutan, India, Japan, Nepal, and South Korea
- 28 experiential learning opportunities

View the full summary:

https://www.engineeringforchange.org/wp-content/uploads/2020/12/E4C_State-of-EGD-Asia_December-2020.pdf



LATIN AMERICA

- 23 institutions with EGD-related curriculum & learning experiences
- 15+ experiential learning opportunities

View the full summary:

<https://www.engineeringforchange.org/wp-content/uploads/2020/12/Graphic-State-of-EGD-Latin-America-ENG-October-2020-2.1.pdf>



Also view State of EGD [Australia & New Zealand](#) and [United States & Canada](#)

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Landscape Analysis of Post-Harvest Technologies for Mango Production in East Africa

Mango cultivation is a major source of livelihood for many farmers in Kenya. However, it is estimated that about half of the mangoes produced are lost due to poor postharvest handling techniques. This research collaboration sought to investigate the actors in the Kenyan mango value chain, identify the points in the value chain where the losses occur, highlight the current technologies that are being used for mango processing and propose new technologies that can be adopted for improved efficiency in the processing of mangoes to reduce postharvest losses.

It was noted that the postharvest losses occur throughout the value chain, beginning right after harvesting, through transportation to the fresh mango markets and even during processing. The losses were found mainly to be the result of a lack of suitable technologies for the postharvest handling and production of a wider range of mango products. Additionally, a number of processing technologies were identified. These technologies are currently used mainly by small-scale processors, self-help groups and some farmers to make products such as mango juice, mango leather and dried mango slices.

Finally, it is proposed that the value chain actors consider the adoption of a circular economy to allow for the use of the by-products from mango processing for the production of other high value products like pectin and polyphenols. These can be used in other food and cosmetic applications, thereby creating new markets for the mangoes.

Read the full report here:

<https://www.engineeringforchange.org/research/landscape-analysis-post-harvest-technologies-mango-production-east-africa>



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www.ift.org/

Food Engineering and Sustainable Technologies (FEAST) Lab at
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www.feastlab.org/



Recommendations For Smart and Sustainable Agro-processing Manufacturing in Guyana

The crucial role of agriculture, and agricultural-related activities in the economic development of emerging economies has been widely acknowledged. The potential of the agricultural sector in boosting development not only resides on the economic aspects, but also the fact that it contributes to poverty reduction, food and nutrition security, and the sustainable use of natural resources. Agro-industries, which comprise all the post-harvest activities carried out for the transformation, preservation and preparation of agricultural production for intermediate or final consumption, play a major role in economic growth and poverty reduction by the generation and enhancement of value chains starting from the agricultural primary produce.

The aim of this Research Collaboration is to provide a general perspective of the current trends regarding sustainable development of agro-industries in emerging economies, with recommendations for applying these frameworks to the context of Guyana. This work, developed in partnership with the Guyana Economic Development Trust, explores in a broad manner the ecosystem of strategies and technologies available for supporting the growth of micro and small agro-processing entrepreneurs. The research is supported by detailed desk research on the agricultural sector, interviews with experts of varied backgrounds and interviews with micro and small entrepreneurs of the Guyanese agro-processing sector.

Read the full report here:

<https://www.engineeringforchange.org/research/recommendations-smart-sustainable-agro-processing-manufacturing-guyana>



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COVID-19: Affordable Testing Solutions

This work was prepared for the "High Level Panel Discussion on COVID-19 Testing" at the UN's virtual COVID-19 Innovation and Investment Forum on June 17, 2020.

<https://www.uneca.org/aiif2020>

Polymerase chain reaction (PCR) and Reverse transcription-polymerase chain reaction (RT-PCR) are widely considered the 'gold standard' for medical diagnostics. However, PCR and RT-PCR testing requires a fully functioning lab, a strong supply chain, long wait times, and trained technicians, which may be lacking in some resource-constrained testing locations. Rapid testing has been studied as a quicker and easier diagnostic method for low-resource settings, especially for diseases with high transmission rates such as COVID-19. Tracking of infected individuals for early detection using Information & Communication Technologies (ICT) solutions, and lung ultrasound are increasingly used in resource-constrained settings.

This report reviews affordable rapid testing techniques, including antibody testing and antigen testing. Further, the shortage of nasopharyngeal swabs needed to carry out PCR testing or antigen testing in conjunction with the widespread use of digital modeling and manufacturing technologies, have pushed hospitals to resort to locally and rapidly manufactured nasal swabs to supply the demand. Lastly, Information and Communications Technologies (ICT), including 'big data' and artificial intelligence (AI) allowing the use of research resources on global online platforms, can help companies develop diagnostic solutions faster and more efficiently. This report reviews examples of ICT solutions that support COVID-19 testing and diagnosis.

Read the full report here:

<https://www.engineeringforchange.org/research/covid-19-affordable-testing-solutions/>



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COVID-19: Innovation and Investment in Medical Devices and PPE

This work was prepared for the "High Level Panel Discussion on Innovation and Investing in medical Devices and PPEs" at the UN's virtual COVID-19 Innovation and Investment Forum on June 17, 2020.

<https://www.uneca.org/aiif2020>

During the COVID-19 pandemic there have been worldwide shortages of critical personal protective equipment (PPE) and medical devices, primarily ventilators and oxygen therapy devices. In response to the increased demand for these technologies during the pandemic, the U.S FDA enacted Emergency Use Authorizations (EUA) during the COVID-19 crisis to expand the availability of PPE, ventilators, and other critical medical equipment. EUAs intend to increase the availability of PPEs and medical devices to respond to the COVID-19 crisis by allowing flexibility for manufacturers to make appropriate modifications to the design of these devices to address current supply shortages. These special authorizations have led to the development of innovative design and manufacturing approaches for PPE and ventilator technologies. Although the increased need for these technologies has sparked the development of open source and locally and rapidly manufactured solutions, there are many design and manufacturing standards that must be followed to uphold quality.

This report reviews common PPE types, including masks, respirators, face shields, protective goggles, gowns, aprons, and gloves. Further, ventilator technology and rapid development initiatives are reviewed. Lastly, manufacturing innovations for medical devices and PPE are presented.

Read the full report here:

<https://www.engineeringforchange.org/research/covid-19-innovation-investment-medical-devices-ppe/>



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Engineering Response to COVID-19: A Reference List for Low-Resource Settings

Engineering response to the novel coronavirus (COVID-19) pandemic is pivotal in devising new technologies and solutions to mitigate negative health outcomes worldwide. In low-resource settings, the availability and suitability of technology and engineered solutions are especially pressing. In this report, we categorize and identify best practices, standards, guidelines, and insights related to technology use during the COVID-19 response in low-resource settings. The document is intended to serve as a reference for technologists in current and future pandemic responses.

In the full report, over 170 resources are categorized into 21 tables, which are organized under six overarching areas:

1. Standards for all medical devices
2. Transmission mitigation
3. Diagnostic technologies
4. Management and treatment technologies
5. Maintenance and optimization of existing technologies
6. Environmental health and safety.

In the full report, each resource is categorized by name, publisher, type, audience, and purpose.

Read the full report here:

<https://www.engineeringforchange.org/research/covid-19-engineering-response-kit-low-resource-settings/>



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Engineers Respond to COVID-19: Case Studies Around the Globe

In 2020 the engineering community responded to the urgent need for medical equipment to combat the novel coronavirus (COVID-19) pandemic. Demand for personal protective equipment (PPE) skyrocketed as healthcare providers rushed to the front lines and governments began mandating the use of face coverings in public spaces. Furthermore, ventilators, essential medical devices for treating patients with severe COVID-19 symptoms, were in shortage around the world. Symptom tracking and contact tracing technologies were developed to prevent the spread of the virus. This report highlights just a few of the global engineering community's collective efforts to combat the pandemic and improve safety and well-being of healthcare workers and the public. The report includes detailed reviews of the following engineering initiatives:

- **Canada:** PPE by the Canadian Shield
- **Colombia:** Ventilators by InnspiraMED
- **Ghana:** PPE by the Ghana Society of Biomedical Engineers, Impact Hub Accra, Kumasi Hive, and Ghana Tech Lab
- **India:** Contact Tracing by Aarogya Setu
- **India:** Ventilator Design by Nocca Robotics
- **Lebanon:** PPE by Lebanon Response Teams
- **Netherlands:** Ventilators by Project Inspiration
- **Panama:** Humidifiers at the Technological University of Panama
- **South Korea:** Contact Tracing and Smart City Project
- **USA:** Ventilators by General Electric and Ford Motor Company

Read the full report here:

<https://www.engineeringforchange.org/research/engineers-respond-covid-19-case-studies-around-globe>



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Sanitation in Challenging Environments: Appropriate Sanitation Solutions for Hard Rock Areas in Rural Cambodia

To meet Cambodia's target of 100% improved sanitation coverage by 2025, pour flush pit latrines are the recommended sanitation solution. However, challenging environments make conventional latrines difficult to construct and increase the likelihood of contaminating the surrounding environment.

The purpose of this research is to evaluate technologies that could enable sanitation access in areas of rural Cambodia where hard rock is present while ruling out established approaches such as pit latrines. While hard rock is a less common challenging environment in Cambodia, hard clays and soils present similar challenges. Suitable sanitation solutions for hard ground profiles are above the hard ground profile and are watertight to prevent contamination into the environment from leaching. This report presents a number of sanitation solutions that fit these categories.

The successful uptake and scaling of technically viable solutions can be affected by a number of drivers. These include behaviour change from open defecation and conducting faecal sludge management through community engagement, financial subsidies from public and private partnerships, making use of existing capacity and supply chains, household considerations such as affordability and privacy that make improved sanitation an aspirational product, and monitoring and evaluation, to ensure solutions are sustainable and to improve the uptake process.

Read the full report here:

<https://www.engineeringforchange.org/research/sanitation-challenging-environments-cambodia-appropriate-sanitation-solutions-hard-rock-areas-rural-cambodia/>



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Engineers Without Borders - Australia

www.ewb.org.au/r



Investigating Factors for Consideration in Decision-Making Frameworks for Household Water Treatment in Southeast Asia & the Pacific

Household water treatment (HWT) is an effective measure for improving the safety of water, if centralized water security measures fail. However, HWT technology selection and implementation is a complex area to address, as a number of factors need to be considered within the process. Selection of appropriate technology is often aided or justified by decision-making frameworks, of which have unique contextual categories for consideration. The need for support for the decision-making process has resulted in the development of numerous tools within the Water, Sanitation, and Hygiene, (WaSH) sector. However, of these tools for selection of “most appropriate technology/approach/system”, there does not exist a singular decision-making framework for selection of household water treatment technology. The reason for this may be that HWT is not a priority in most contexts, it is a stop-gap, most countries are more focused on wider spread solutions of which do not have the complexity of individual considerations.

To gain understanding of the factors and considerations in HWT technology selection and implementation, we investigated practices in countries in Southeast Asia and the Pacific. Interviews with experts provided insight into technology procurement, provision, and sustainability of solutions. These data assist in identifying key factors for consideration in selection of HWT options.

Read the full report here:

<https://www.engineeringforchange.org/research/investigating-factors-consideration-decision-making-frameworks-household-water-treatment-southeast-asia-pacific/>



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Water-Energy-Food Nexus Innovations in MENA: Bringing Hope Amid Challenges

The Middle East and North Africa (MENA) region is currently facing multiple challenges related to the Water, Energy and Food sectors, such as water scarcity, drought, population growth, urbanization and political instability. These challenges cause negative health impacts including malnutrition, water related diseases, and pollution due to use of fossil fuel energies.

However, social innovation and entrepreneurship has been growing steadily in the region, with initiatives aiming to support achievement of the SDGs, such as reducing energy and water usage in agriculture, improving drinking water security, food security, and more. This report reviews the ecosystem of innovation within the water-energy-food nexus by identifying enabling factors and barriers that innovators encounter in the region.

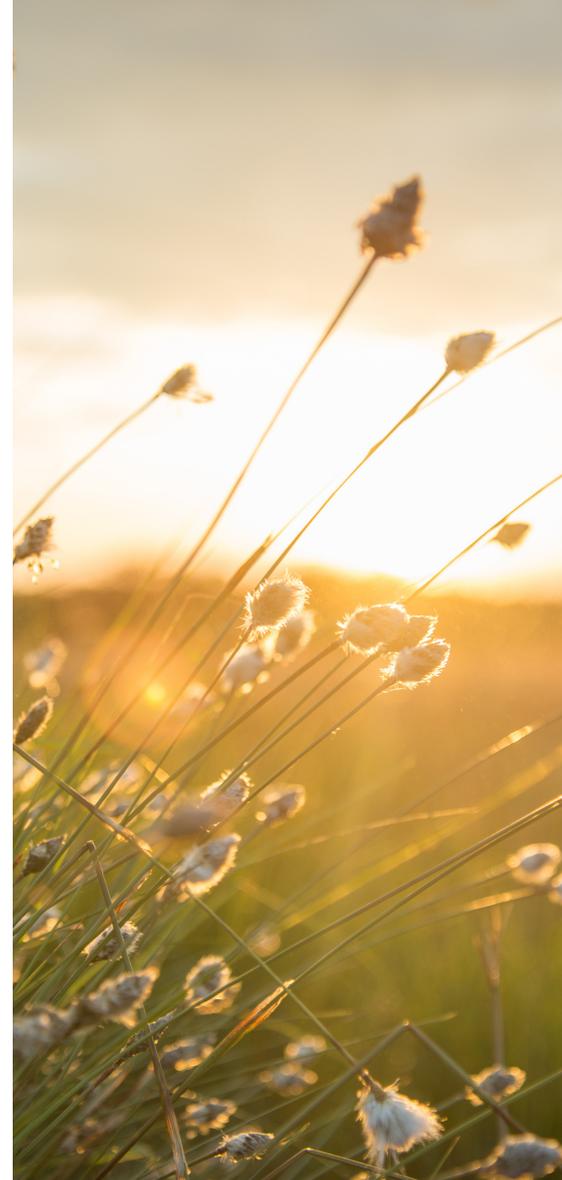
Recommendations for improving innovation in the water-energy-food nexus in the MENA region are presented. For example, R&D should be promoted by policy-makers and universities to support innovation, bureaucracy and administrative burdens should be made leaner and friendlier towards innovators, improved access to finances and markets should be made possible for entrepreneurs, social innovation should be encouraged and innovators properly recognized in their home countries, proper education and awareness about sustainability issues should be promoted and spread in the region, and policies supporting entrepreneurship should be developed and further implemented.

Read the full report here:

<https://www.engineeringforchange.org/research/water-energy-food-innovations-mena-bringing-hope-amid-challenges/>



**Humanitarian
Engineering
Initiative**



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9 INDUSTRY, INNOVATION
AND INFRASTRUCTURE



The ICT Landscape in Northern Kenya: Challenges and Opportunities

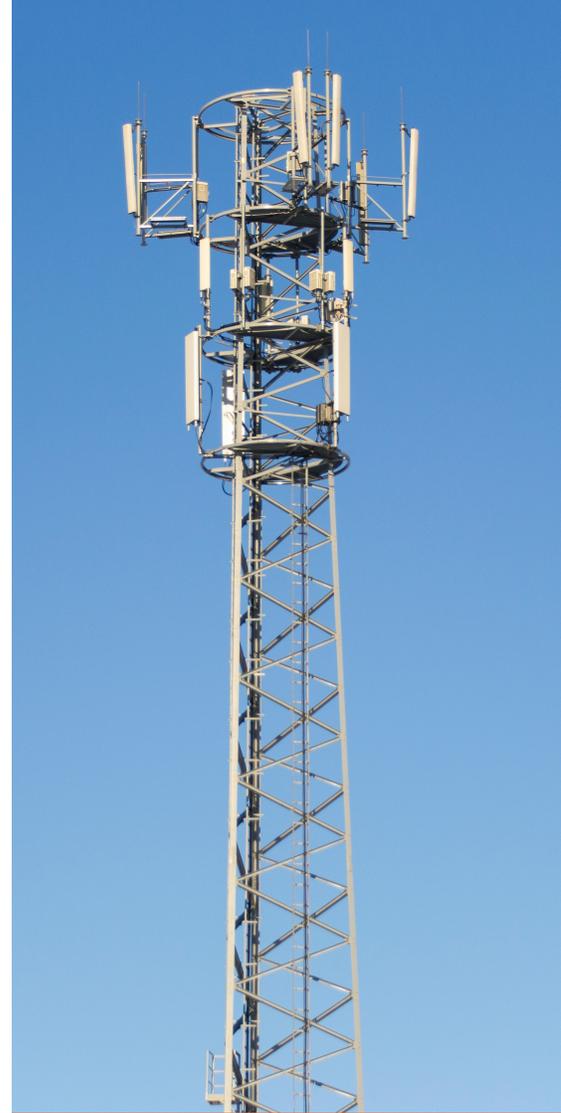
Although Kenya is an African leader in ICTs and technology in cities, such as Nairobi and Mombasa, the northern region has limited network coverage and where available, is limited to 2G level. Poverty levels are also higher in Northern Kenya, further increasing barriers to technology implementation. This research sought to investigate the ICT landscape in Northern Kenya and investigate opportunities for digital technologies in the region, majorly in the fields of Education, Agriculture, Health and Jobs.

The challenges that the region faces include less developed infrastructure, low levels of education and limited exposure to opportunities that digital technologies can offer. There are limited solutions targeting the region and innovators venturing into the region have to overcome several cultural barriers. However, there are a few digital solutions that have been successfully deployed in the region and there are several positive trends that promote investment and innovations that target Northern Kenya.

Innovators working in Northern Kenya should tailor their solutions to be suitable by making them less power intensive or taking advantage of solar power, making them simple for use with basic phones, allowing them work offline and also understanding the complex social factors that may affect the adoption of their solutions. There were also various trends that promote innovation in the region, including the devolved governments, favorable policies and collaboration between different stakeholders in the region.

Read the full report here:

<https://www.engineeringforchange.org/research/ict-landscape-northern-kenya-challenges-opportunities/>



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Social Innovation in the USA: A Landscape Analysis of Social Enterprise Incubators

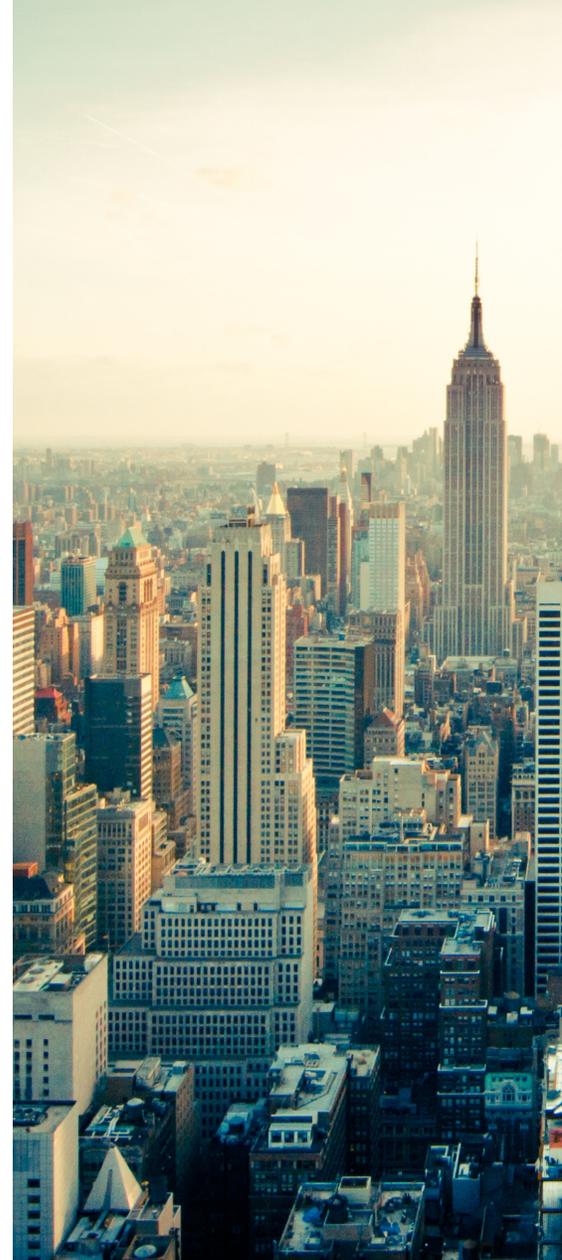
Social Enterprise Incubators (SEIs) help socially-focused businesses achieve their central mission and scale by providing support including mentorship, networking opportunities, and access to funding. SEIs differ from traditional business incubators in their scope and approach focusing on addressing social issues and the unique challenges that early stage social enterprises face.

This research report provides a landscape analysis of SEI in the United States (U.S.). To accomplish this, a comprehensive list of U.S.-based SEI was compiled into a database that included information on the organization type (academic, network, independent), technology or people focused, and sector of focus. Additional information regarding aspects of the organizations such as size, location, revenue, and contact was added as possible. For this study, SEIs include any organization that mentors, funds, connects and/or supports enterprises that have a socially-driven mission. Sixteen experts from SEIs across a range of sectors, geographic locations, and organizational structures participated in 30-60 minutes semi-structured interviews. Data collected from desk research and interviews were then synthesized, the results of which are presented in this report.

Overarching trends identified in this report include 1.) lack of alignment in sector identity, 2.) challenges with funding and organizational capacity, and 3.) need for productive networking and collaboration amongst sector stakeholders.

Read the full report here:

<https://www.engineeringforchange.org/research/social-innovation-usa-landscape-analysis-social-enterprise-incubators/>



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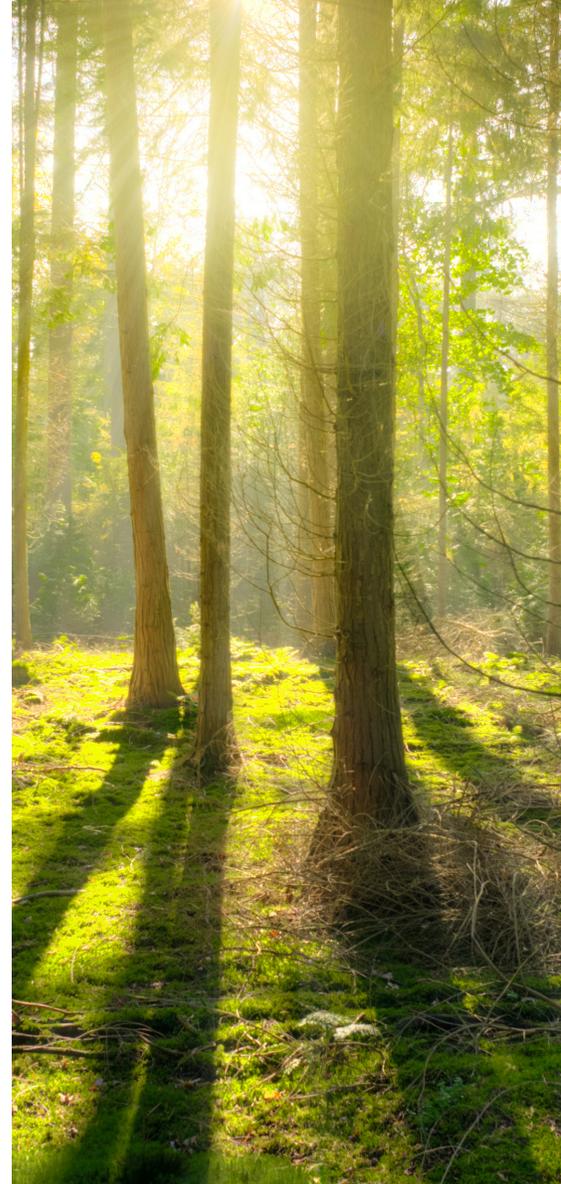
The Role of Industry Sustainability Standards in Design & Manufacturing

The United Nations defines sustainable development as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” This approach requires three core elements of sustainability: economic growth, social inclusion, and environmental protection. There are ample applications and opportunities for design and manufacturing (D&M) solutions in each of these core sustainability elements. D&M simulation tools, such as computer-aided design (CAD) are designed to improve the efficiency of manufacturing, saving time, energy, and reducing material usage and waste.

Traditionally, D&M solutions emphasized saving companies time and money, however there is an increasing emphasis on their role with sustainability goals. With increasing pressure from consumers and government, the D&M industries are currently experiencing considerable market shifts. There is an emphasis on producing more, with less negative impact in order to meet market demands while mitigating emissions and pollution levels and meeting the goals of sustainable development. This research collaboration between Engineering for Change and Autodesk aimed to assess the main drivers for industry interest in improving product sustainability, which identified as: social movements and values, regulations, customers and consumers, CEOs and management roles, sustainability functions, and engineers and designers.

Read the full report here:

<https://www.engineeringforchange.org/research/role-industry-sustainability-standards-design-manufacturing/>



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Resilient Affordable Housing for Flood Risk Reduction: A Review of Interventions in Four Cities in East Africa

East African countries are highly susceptible to floods caused by extreme weather events and sea-level rise. Both historical precedents and recent events of widespread flooding and climate change related risks accelerate the need to implement disaster risk reduction strategies. The need is urgent especially in low-income settlements placed in flood-prone urban areas around Lake Victoria and cities on the coast of the Indian Ocean. The population is expected to rapidly increase in the next three decades in these regions, which are considered to be at high-risk for flooding and sea-level rise.

This report presents an overview of four selected East African cities (Mombasa, Dar es Salam, Kisumu, and Nairobi), highlighting key geographic features, current socio economic situation, and present challenges related to flood-impact in urban areas. Furthermore, the report presents and describes a list of different solutions/measures addressing the physical vulnerability of houses to floods. These actions are organized by intervention level including strategies applied by households to build more resistant houses or to repair their houses after floods, building materials characteristics, and other more enduring solutions such as public infrastructure provision and relocation. The report concludes highlighting systemic challenges and different issues faced at the building materials level, urban design and housing design level, planning and policy.

Read the full report here:

<https://www.engineeringforchange.org/research/resilient-affordable-housing-flood-risk-reduction-review-interventions-four-cities-east-africa/>



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13 CLIMATE ACTION



Understanding Technologies in Context: A Case Study for Ecological Resilience in the Mt. Elgon Region of Eastern Uganda

In 2020, MAPLE Microdevelopment founded the Mbale Center for Innovation and Design (MCID) with the aim to empower creative design thinking and community action related to environmental preservation and economic agency in the Mt. Elgon region of Eastern Uganda. With the increasing threat of climate change, MCID aims to bridge the gap between local community traditions and grassroots design for ecological and economic resilience. Especially considering the historical legacy of problematic technology implementation that neglects community values, needs, and resources.

This report emphasizes the importance of incorporating principles of ecological resilience, ancestral knowledge, and historical context of technologies into design methodologies by providing a high-level review of these considerations within the context of the Mt. Elgon region and its peoples. This report concludes with recommendations for contextualizing technologies by emphasizing community engagement. Five specific recommendations are given: (1) enable community voice and power, (2) center ecological and social values, (3) deprioritize Western knowledge, (4) consider historical context, (5) emphasize rights of nature, and (6) engage in active reflection.

Read the full report here:

<https://www.engineeringforchange.org/research/understanding-technologies-context-case-study-ecological-resilience-mt-elgon-region>



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ICT for Development (ICT): An analysis of terminologies and paths forward

Information and Communication Technologies and Development (ICTD) is a young interdisciplinary field that encompasses both the practices and experiences of using ICT, that is computers and similar technologies, for development purposes, that is improving people's lives at different levels; as well as the study and analysis of such practices and experiences, from a professional and academic research perspective. To gain an insight on the current state of affairs in ICTD, Engineering for Change partnered with the School of Information at the University of Michigan to hold interviews with ICTD experts from academia, and public and private sectors using an online card sorting activity as a means to guide conversation. When we began to analyze the findings from these interviews, we found a wide wide range of opinions regarding relevant terminology, direction for the sector, and an overall lack of agreement on a shared agenda.

This report outlines the history of how the field has evolved, highlight the challenges that have arisen as a result of the growth over the past 10 years, and recommendations for what can be done to steer a course to create a shared vision and unify the field in the coming decade.

Read the full report here:

<https://www.engineeringforchange.org/research/ict-development-ict-analysis-terminologies-paths-forward>

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