ANNUAL RESEARCH REPORT 2019

ASME
SETTING THE STANDARD

engineering FOR CHANGE

IN THE 2019 ISSUE

a year's overview

RESEARCH COLLABORATIONS

Engineering for Change (E4C) Research Collaborations cut across geographies and sectors to deliver an ecosystem view of technology for good. 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.

E4C seeks partners for Research Collaborations who share our vision for sustainable community impact through technology that can improve the quality of life for underserved communities. By joining E4C in a leadership role, E4C partners have the opportunity to shape the E4C research agenda, advance the skills of early-career engineers through the E4C Research Fellowship, and provide tangible pathways for their leadership development in advancing the engineering profession to meet society's toughest problems.

In 2019, during the E4C Fellowship program, fifteen Fellows from ten countries conducted the ten Research Collaborations featured in this report.

The 2019 Research Collaborations range from analysis of digital identity solutions (page 5) to landscape analysis of the social entrepreneurship environment in Tunisia (page 9) and India (page 6).

Furthermore, Fellows developed a stakeholder and trend analysis of household water treatment technologies in Colombia (page 7) and a review of sustainability features in digital simulation tools to highlight opportunities for more sustainable design methods (page 11).

Fellows reviewed the state of Engineering for Global Development (EGD) academic programs and institutions in the USA, Canada, Australia, and New Zealand (page 4). A report based on expert interviews describes in detail the growth of the Humanitarian Engineering sector in Australia (page 9) and role of women in social innovation in the MENA region (page 8).

Full reports are available on the E4C platform on the Research Page in two versions: 1) summary and 2) full pdf. The investigations in this report represent the global perspectives of a unique combinations of future leaders in engineering for global development. To view full reports and to learn how to support this work, visit:

www.engineeringforchange.org/research

A global team

2019 E4C FELLOWS

engineering FOR CHANGE

Nishant Agarwal
India, Health Fellow

Grace Burleson
USA, Jr. Program Manager

Marilynn Holguín Clover
Colombia, Water Fellow

Senka Hadzic
South Africa, ICT Fellow

Joyce Hallak
Lebanon, Transport Fellow

Rhys Keogh
Australia, Energy Fellow

Kathleen Kirsch
USA, Sanitation Fellow

Carlos García Lanchares
Spain, ICT Fellow

Benson Maina
Kenya, Agriculture Fellow

Amartya Mukherjee
India, Energy Fellow

Pauline Mweu
Kenya, Junior Fellow

Charles Newman
USA, Expert Fellow

Mayarí Pérez Tay
Guatemala, Expert Fellow

Fernanda Petrus
Brazil, Habitat Fellow

Jennifer Ventrella
USA, Expert Fellow

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.

Access our platform: https://www.engineeringforchange.org/

- Global community of 1 million+ engineers, technologists and development practitionersCodified data on 1000+ essential technologies.
- Engineering insights about latest developments, best practices, opportunities and expert insights in EGD.
- Access research studies and field insights

Read full reports at:
https://www.engineeringforchange.org/research/

Read more about our Fellowship and Research Fellows:
https://www.engineeringforchange.org/e4c-fellowship/

To become a research partner, email:
partners@engineeringforchange.org

To learn more, email:
mariela@engineeringforchange.org

Engineering for Change
2019 Research Collaboration Partners

AUTODESK

Norwegian Red Cross

CAWST
Centre for Affordable Water and Sanitation Technology

1866 AUB
American University of Beirut
الجامعة الأميركية في بيروت

NORWEGIAN CHURCH AID

MIT D-Lab
designing for a more equitable world

NRC NORWEGIAN REFUGEE COUNCIL

IIT MADRAS

Think.iT

Innovation Norway

Save the Children

UTS
UNIVERSITY OF TECHNOLOGY, SYDNEY

State of Engineering for Global Development

global series

USA & CANADA

- 32 institutions with EGD-related curriculum & learning experiences
- 3 bachelors and 14 minors/certificates
- 8 graduate-level degree programs
- 28+ university research centers
- 160+ professors conducting EGD-related research

AUSTRALIA & NEW ZEALAND

- 27 institutions with EGD-related curriculum & learning experiences
- 2 diplomas/majors and 4 minors
- 14+ research and innovation centers
- 27 institutions with EWB events

Read the full EGD reports for USA & Canada and Australia & New Zealand.

Coming soon in 2020: State of EGD Latin America & State of EGD Asia

DIGNIFIED ID IN CASH ASSISTANCE IN EAST AFRICA

Fellows: Senka Hadzic (South Africa), Pauline Mweu (Kenya), Jen Ventrella (USA)
Contributors: Giulio Coppi (Norwegian Refugee Council)
Editors: Mariela Machado, Grace Burleson
Partners: Norwegian Refugee Council, Save the Children, Innovation Norway, Norwegian Church Aid, Norwegian Red Cross

With over 1 billion people worldwide lacking a form of legal identity, many individuals lack access to government and humanitarian services, financial, and mobile connectivity, particularly individuals in need of humanitarian assistance, such as refugees. Target 16.9 of the Sustainable Development Goals aims to address this need by providing institutionally-recognized identity for all by 2030. With the growing use of digital and mobile technologies worldwide, digital forms of legal identification could improve many populations' access to ID and other digital services.

However, implementing a large-scale digital service involves a variety of stakeholders, including the government, service providers, implementers, communities, and individuals. Digital interventions must be disseminated in enabling environments that allow the services to operate efficiently and ethically. Trends that enable successful digital ID solutions include (1) trust, (2) standards and policy, and (3) ICT infrastructure; in addition to overarching global initiatives and collaborations. And although providing an enabling environment is essential for successful implementation of a digital ID system, a strong contextual analysis regarding a digital ID system's user provision model is mandatory. We present a checklist to guide practitioners through the evaluation process required to design an appropriate user provision model, including integrating aspects of user value, local trust, convenience, standards, data security, and interoperability; among others.

Four key relationships are evaluated:

1. Government to implementing organization
2. Service providers to individuals
3. Service provider to service provider
4. Community to individual

16 PEACE, JUSTICE AND STRONG INSTITUTIONS

Read the full report on the E4C website.

AFFORDABLE HOUSING IN KENYA

Fellows: Fernanda Petrus (Brazil), Charles Newman (USA)
Contributors: Eddine Sarroukh (UN Habitat, Kenya)
Editors: Grace Burleson, Mariela Machado
Partner: UN Habitat

In response to the Kenyan government's goal to build 500,000 homes under the Affordable and Dignified Housing Plan by the year 2022, this report presents an analysis of construction methods and materials to guide and inform decision makers in the Kenyan government. Interviews were conducted with 12 construction professionals and manufacturers of relevant emerging construction technologies. Results are distilled into a graphic, comparable framework to assist Kenyan officials in understanding the benefits and limitations of the residential construction sector.

Read the full report on the E4C website.

SUSTAINABLE TECHNOLOGY IN INDIA

Fellows: Amartya Mukherjee (India), Nishant Agarwal (India), Charles Newman (USA)
Contributors: James Rajanayagam (IIT Madras)
Editors: Grace Burleson, Mariela Machado
Partner: Centre for Social Innovation and Entrepreneurship, IIT Madras

In India, the innovation and technology sector has grown immensely. However, it has been observed that many of the technical innovations are failing at various stages resulting in poor dissemination with impacts below the expected performance. To assess the barriers and challenges facing social innovations, interviews with stakeholders across India were used to identify twelve challenges and barriers.

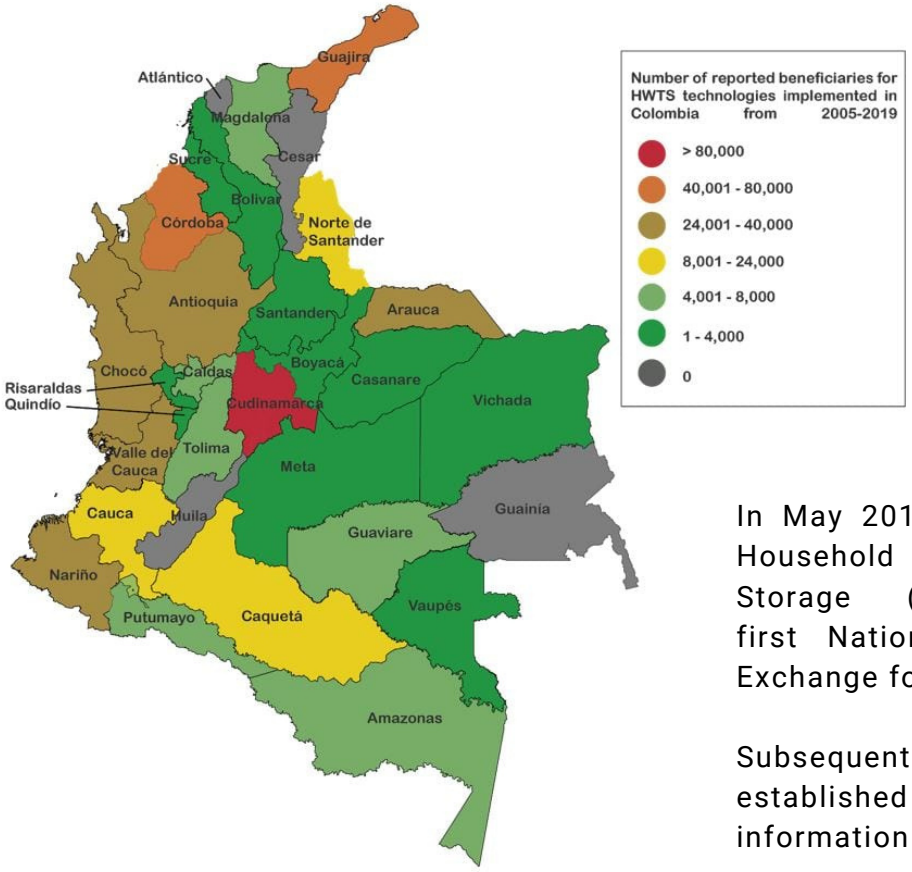
Challenges

Business knowledge	Time engagement
End-user knowledge	Capital force
Relevant team experts	Institutional motivation
End-user feedback	Personnel's availability
Institutional motivation	Academic sector
Funding	Underutilization of resources

Read the full report on the E4C website.

HWTS IN COLOMBIA: STAKEHOLDERS & TRENDS

Fellows: Marilynn Holguín Clover (Colombia), Mayari Perez (Guatemala)
Contributors: Eva Manzano (CAWST, Canada)
Editors: Grace Burleson
Partner: Centre for Affordable Water and Sanitation Technologies (CAWST)



In May 2019, organizations implementing Household Water Treatment and Safe Storage (HWTS) carried out the first National Learning and Experience Exchange for implementers in Colombia.

Subsequently, one of the priorities established was documenting specific information about HWTS implementation.

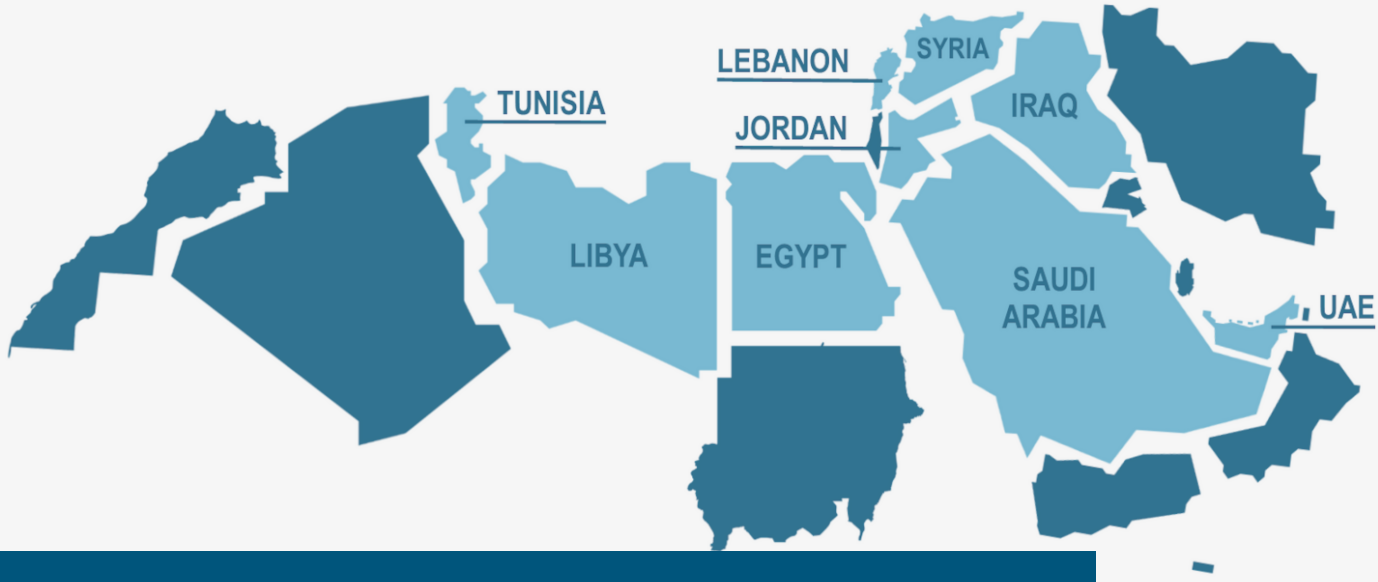
This research analyzed a curated database of HWTS interventions by 32 organizations in Colombia. Primary stakeholders and trends across Colombia are analyzed and implications are discussed.

The total impact of implementations from 2005-2019 comprises an estimate of over 660,000 beneficiaries. Filtration technologies were the technology of choice by implementers, with each organization implementing a single solution, rather than multiple options. To improve both adoption and suitability of technologies, a multi barrier approach is recommended once the context has been sufficiently analyzed and feasible technology has been selected.

Este informe también está disponible en Español.

Read the full report on the E4C website.

6 CLEAN WATER AND SANITATION



WOMEN IN TECH: SOCIAL INNOVATION IN MENA

Fellows: Joyce Hallak (Lebanon), Jennifer Ventrella (USA)
Contributors: Hala Ghattas, Imad Elhajj (American University of Beirut)
Editors: Grace Burleson, Mariela Machado

In recent decades, changes in the Middle East and North African (MENA) region have spurred a socio-technical entrepreneurial spirit in the region. Increasingly, women are playing an important role in the design and implementation of these innovations.

We reviewed 39 technological social innovations and interviewed five social innovators in the MENA region designed for or by women. Innovations included technology education platforms, fintech, blockchain, ecommerce, and more.

Success factors

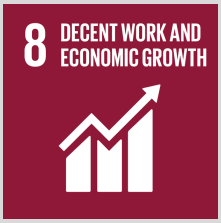
- Increased awareness & support from local government
- Higher education
- Understanding the community the founder is serving
- Personal drive and work ethic
- Supportive personal network

Challenges

- Slow bureaucratic registration processes and political instability
- Limited access to startup funding
- Need sufficient expertise across the team
- Maintaining a sustainable cash flow during the beginning
- Outreach programs, particularly to rural areas

Gaps & Opportunities

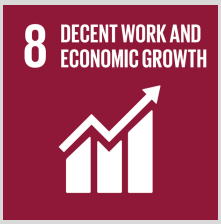
- Business development support and guidance
- Ways to better communicate social impact to investors
- Pathways to find a relevant mentor
- Training for investors to improve their decision-making



Read the full report on the E4C website.

SOCIAL INNOVATION IN TUNISIA

Fellows: Kathleen Kirsch (USA)
Contributors: Mehemed Bougsea (Think-it, Tunisia)
Editors: Jennifer Ventrella, Grace Burleson, Mariela Machado
Sponsor: Think-it (Tunisia)



Emerging social enterprises work towards the development of effective solutions to challenging social and environmental problems. Through desk research and interviews with startup founders, incubators, and investors in Tunisia, this report presents a landscape of the social innovation sector, and potential gaps and opportunities for development. Ultimately, the social innovation sector in Tunisia is emerging and thriving, but there remain challenges and opportunities to ensure innovators have growing and resilient social enterprises.

Read the full report on the E4C website.

HUMANITARIAN ENGINEERING IN AUSTRALIA & NEW ZEALAND

Fellows: Rhys Keogh (Australia)
Contributors: Eva Cheng (University of Technology, Sydney)
Editors: Grace Burleson, Mariela Machado, Charles Newman
Sponsor: University of Technology, Sydney

Humanitarian engineering (HumEng) in Australia and New Zealand has rapidly grown in the last five years, with new programs, courses, and experiential opportunities, such as EWB-Australia.

This report examines the state of HumEng in Australia and New Zealand, developed through desktop research and interviews. It catalogues the various educational offerings offered by universities and outlines the current and future challenges to the ecosystem as identified through interviews with key academics.

Key opportunities and challenges in the region include the need for consistent terminology, integration with industry, and increased professional recognition for the discipline. Recommendations and pathways forward are outlined in the report.

Read the full report on the E4C website.

EVAPORATIVE COOLING TECHNOLOGIES IN KENYA

Fellows: Benson Maina (Kenya)
Contributors: Eric Verploegen (MIT D-Lab, USA)
Editors: Mayari Perez, Grace Burleson, Mariela Machado
Sponsored by: MIT D-Lab (USA)

The project report addresses the awareness, use, and barriers to adoption of Evaporative Cooling Technologies (ECTs) in the Embu and Machakos Counties of Kenya. Evaporative Cooling Technologies (ECTs), such as a charcoal and brick cooling chambers or Zeer-pots, have been shown to be affordable to construct and operate; however, adoption of these technologies has not been widespread. This study sought to determine both the reasons for use and factors which hinder adoption of ECTs. Data were collected through a structured questionnaire administered to 81 mango farmers in two contrasting agroecological zones.

Among the farmers that participated in this study, 73% are aware of ECTs, and among this group 56% use at least one ECT. A majority of the respondents (58%) in this study belonged to a farmer group or cooperative. Membership to a farming group was the greatest determinant of awareness and usage of ECTs. All of the respondents in this study that are users of ECTs are members of a farming group, and the ECTs used were located at central locations and owned collectively by the farming groups. Having access to agricultural extension services and attending trainings related to mango farming was strongly correlated with farmers adopting ECTs.

Among the non-users who were aware of ECTs, the reasons attributed to lack of adoption included high cost of acquisition and maintenance, lack of information, lack of access to ECTs, and a lack of need for storage to extend shelf life. None of the respondents individually owned an ECT, and the ECTs being used in both study areas were built with the help of government and non-government agencies, which is indicative of the cost barriers that must be overcome. Despite the barriers to ECT adoption, farmer groups who owned ECTs indicated that they benefited from their use, improving shelf life and reducing losses, increasing the time to look for markets, and increasing prices for their produce.

Recommendations for effective use of ECTs:

- Improve ECT designs to enhance their performance, lower the cost, and better meet users' needs.
- Inform farmers of the benefits of ECTs and provide training.
- Leverage farming groups as pathways for disseminating ECTs.
- Increase access to extension services to improve availability of agricultural recommended practices and information.

Read the full report on the E4C website.

SUSTAINABILITY IN DESIGN AND MANUFACTURING

Fellows: Carlos García Lanchares (Spain)
Contributors: Zoé Bezpalko (Autodesk, USA)
Editors: Grace Burleson, Mariela Machado, Jennifer Ventrella
Sponsored by: Autodesk

Trends show that design and manufacturing firms are increasingly working towards more sustainability initiatives. The UN 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. Design and manufacturing simulation products (CAD, CAE, etc.) offer engineers the ability to improve the sustainability of their designs based on the three core elements: Profit, Planet, and People.

Profit

"Profit" is the current driver of most of simulation software capabilities. Services and technology are designed to improve the efficiency of design, save manufacturers time, and improve the overall quality of steps in the process. Examples of features include finite element analysis (FEA), additive manufacturing (AM) optimization, and model-based definition (MBD).

Planet

Simulation tools can reduce the number of physical prototypes required and improve quality control, reducing material and scrap waste. With the development of Lifecycle Analysis (LCA) and sustainable material selection tools, capabilities in improving the ecological impact of products and manufacturing processes are on the rise.

People

Simulation tools that track employee wellness in office spaces, worker health in manufacturing lines, and human-computer interaction can improve the well-being of people engaging with technology in various ways. These tools, such as human factor analysis, thermal control simulations, and workforce development software are on the rise.

Overall, simulation tools for improving the efficiency and profit margins of design are predominately available and used. However, these features can also have great impact on product sustainability, such as saving materials and milling machine time and energy. Further, there is great opportunity to increase simulation functionalities that can improve product design and manufacturing sustainability, such as improved material selection, waste reduction, compliance, and corporate social responsibility (CSR) reporting; among others.

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