Using Appropriate Technology Principles in the Design of a Remediation Device for the Removal of Bacteria and Toxic Metals for Use in Rural Uganda

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Introduction

- **2.2 billion people** worldwide lack access to “safely managed” drinking water (World Health Organization, 2019).
- Only **7%** of the population of Uganda utilized **safely managed drinking water services** as of 2017 (UNICEF, 2019).
- **80%** of the population of **Uganda** lives in rural areas (Nayebare et al., 2014).
    - Poorest water quality due to reliance on groundwater and surface water sources (Nayebare et al., 2014).

What is Appropriate Technology?

A“***strategy***” for the developing world to achieve socioeconomic growth by “***meeting their basic needs***” *through* *“**developing their own skills***” and utilizing “*available resources in an **environmentally sustainable manner***”
(Murphy et al., 2009).

“*Technology with a **human face**, which, instead of making human hands and brains redundant, helps them to become **far more productive than they ever had before***”
(Schumacher, 1973, p. 112)

Technical Project Overview

Collect water from local source

Bind and remove toxic metals using a banana peel and activated carbon tea bag

Trap and eliminate bacteria using eucalyptus tree xylem

Obtain safe drinking water

Methods

- Assessment of the following appropriate technology considerations as they relate to the engineering design process (Sianipar et al., 2013a) :
  - Technical
  - Economic
  - Environmental
  - Socio-Cultural
- Evaluation of the extent to which the device encourages:
  - Sustainable development
  - “Community empowerment” (Sianipar et al., 2013b)

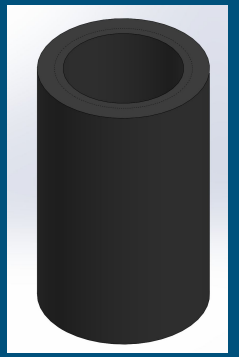
Results: Technical

- Banana-activated carbon tea bag capable of reducing concentration of manganese* (M. Klein, personal communication, September 23, 2019).
- Eucalyptus xylem is capable of removing all fecal coliforms
  - Confirmed through testing conducted in Uganda** (C. Kozlovsky, personal communication, January 29, 2020).
  - Uganda results validated through testing conducted through partnership with Azrieli College of Engineering Jerusalem*** (A. Shasha, personal communication, March 11, 2020).
- System can be used and maintained at household level

** Testing conducted by Molly Klein (Biochemistry)*
*** Testing conducted by Christina Kozlovsky (Mechanical Engineering)*
**** Testing conducted by Ariel Shasha and Liron Kanisberg (Mechanical Engineering)*

Results: Economic

- Goal for final design: $1.50/month per family
- Cost of prototype: $27 total
  - Durable and reusable
    - PVC pipe can last 25-40 years (Smith's Plumbing Services, 2019)
- Cost of prototype machined parts only: $8 total
  - If replaced every 6 months, $1.33/month
- Utilizes local materials
- Can engage local talent for manufacturing



1.

Results: Environmental

- Utilizes readily available materials
  - Banana peels
  - Eucalyptus tree branches
- No use of electrical power
- Reusable device
- Minimal waste generation

2.

3.

Results: Socio-Cultural

- Integration with daily routine
- Locally available materials
- Minimal education required for use and maintenance
- Acceptable for use by all
  - Women
  - Children

Discussion:
Sustainable Development & Community Empowerment

A "***strategy***" for the developing world to achieve socioeconomic growth by "***meeting their basic needs***"

Technical
- Produces quality drinking water
- Facilitates household-level filtration

Economic
- Affordable
- Discourages dependency through use of local resources

Environmental
- Requires no electric power
- Makes responsible use of local resources
- Generates minimal waste

Socio-Cultural
- Integrates with user's existing routine
- Requires minimal education to use and maintenance

Discussion:
Sustainable Development & Community Empowerment

*through "**developing their own skills**"* and utilizing "*available resources in an **environmentally sustainable manner***" (Murphy et al., 2009).

Sustainable Development

- Social Learning (Murphy et al., 2009)
- Ongoing partnership (Amadei et al., 2009)
- Local manufacturing

Discussion:
Sustainable Development & Community Empowerment

"*Technology with a **human face**, which,...helps them to become **far more productive than they ever had before***" (Schumacher, 1973, p. 112)

Community Empowerment

- Local responsibility for design, production, and ideation (Sianipar et al., 2013b)

Future Directions

- Ensure sustainable development
  - Mechanisms of social learning
  - Strengthening of partnerships
  - Scope of local manufacturing
- Encourage community empowerment
  - Potential for local businesses
  - Economic-social-political cohesion
- Conduct user testing (long-term)
- Begin community implementation (long-term)

Thank you!

Questions?

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