Plastic waste bricks implementation deck

EcoWorld
Plastic Recycling

Impact Analysis

Why?
In the coastal resort of Watamu in Kenya, plastic waste pollution threatens the tourism industry, the marine environment and human well-being. EcoWorld Recycling has taken on this challenge by creating dynamic plastic waste value chains, involving local communities, the hotels industry and businesses. The EcoWorld vision is 'Leading change and igniting the plastic waste circular economy in coast province Kenya'. A current major goal is to upcycle plastic waste into building materials. These products will create new and independent SME opportunities, and bring added value to plastic waste.

What?
The first product design is the interlocking building brick. The cost of housing in Kenya is high, and the use of natural building materials like quarry coral is expensive, and it has a negative impact on the environment.. Mud-and-wood houses pose different challenges such as degradation and cracking. Shelter is, together with food and clothes, considered a basic need in Kenya. Upcycled plastic building bricks will create win-win benefits by providing access to affordable housing and community buildings, and reducing the impacts of plastic pollution. This initiative has the potential to unleash livelihoods in coastal Kenya, and create a perpetual plastic waste circular economy.

Impact
Analysis of the brick on the social, environmental and economic impacts:

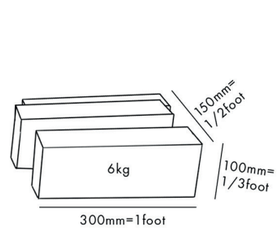
The brick is easy to use and cheaper than the locally made coral block, thus more accessible. Sales distribution of the bricks will be done by trained and empowered women and youth groups, who also act as the plastic suppliers and recyclers, and are the drivers of the plastic circular economy.

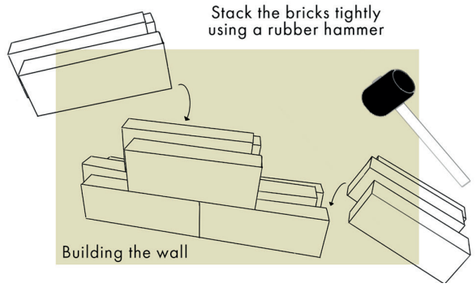
The PP plastic content of the brick, is a low-value plastic that is a problematic environmental pollutant, and the brick will offer a useful and valuable solution. The production of a plastic waste bricks requires less energy than a coral block, 0.82Kwh compared to 5.55 Kwh. When using the brick, no cement is needed, and the brick can be reused due to its interlocking features.

For EcoWorld, a new income stream will be created, and local communities will benefit from jobs and SME opportunities, as the EcoWorld slogan says by "Turning Trash into Cash".

Technical specifications

The brick
The brick geometrics are co-designed locally to find the right shape, size and weight. The brick has interlocking features resulting in reduction of building costs due to reduced requirement for skilled labour, saving construction time and reduced requirement of costly material like cement. Research shows the interlocking technique is 24% cheaper per m2 than using conventional bricks (Tyas, 2018).





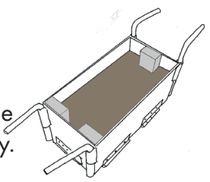
A standard school building of 15x5x3 metres needs 1334 bricks, 4003 kg of recycled PP plastic

The mixture
The mixture composition of the block is **3 kg's** of recycled plastic and **3 kg's** of finesand (sand particles of maximum 1 mm^2). The required energy to melt that composition is **0.31 Kwh** and it takes 4 minutes until solidification. The final brick is tested on compressive strength, with a result of **16.6 MPa**. The plastic waste brick is therefore stronger than the current coral block with a compressive strength of **12.9 MPa**.

The production process
Melting
The process starts with melting the mixture composition. There are multiple heat sources that can be used like a fire, a heat mixing bowl, an oven or an extruder. Though co-design it was found that using an extruder is the preferred option because it allows mixing while melting, hazardous fumes are contained and the temperature can be carefully controlled. An example of a plastic-sand extruder that costs 8.500 USD is:

Parameter description	Nominal value
Production capacity, kg/h	150
Nominal drive capacity, kW	**5,5**
Nominal electric heaters capacity, kW	**15**
Mix temperature at the exit, ºC	150-200
Maximum temperature in heating zones, ºC	350

Moulding and compacting
A locally co-designed mould is used to produce the bricks. The mould is closed, filled and opened manually. When the molten mixture is insight the mould pressure is added using a hand press with a capacity of **14.7 kN** compressive force. Then the composition has to remain in the mould under pressure for 20-30 minutes to solidify. The last step is opening the mould and letting the brick cool completely.



Mould and hand press

Cost
The material cost of the composition is **46.8 Ksh**, and with the labour and required energy the total cost of the brick is **128.2 Ksh**. The plastic waste brick is therefore cheaper than the current coral block equivalent of **138 Ksh.** Due to the downtime of the mould while cooling only 2 bricks can be made per hour, making the brick more expensive. The next step in the production line development should be researching how to increase the moulding capacity. The extruder explained above has the capacity of mixing and melting the material for 25 bricks per hour, so that is the maximum production potential decreasing the total cost significantly (128.2Ksh to 77.6Ksh).

Implementation roadmap

Time	2023		2024		2025
Focus	 **Go/No-go** Acquired 100.000 USD funding for entire research and development phase  Research	Investing	 **Go/No-go** Acquired standardized building material test results on the final bricks  **Go/No-go** Successful systematic implementation of bricks in Watamu Pilot production line	Start operations	 Expanding operations
Internal	Create an EcoWorld task force Research on required machinery Research on leaching of micro-plastics and mitigation through surface sealants available on the market	Procure the required machinery Hire a remanufacturing operator	Install the machinery and organize production space Machinery operation trainings Perform certified tests on final bricks	Test different construction methods and specifications like load bearing properties Evaluate on the implementation, is the plan working or does it need changing? Is the brick locally accepted? Use the "Tripple bottom line" framework	Hire more operators and expand production
Develop	Expand PP plastic supply chain working with Women and youth groups Expand the material recovery facility to make space for the production line and storage	Create a quality control protocol Create an ambassadors program with Women and Youth gourps	Set-up the logistics of a selling network Create marketing, sales and business plan	Built a showroom and demo sights in Watamu where people can see and use the bricks Set-up educational awareness project as part of a training center at EcoWorld Watamu	Testing other products that can be made with the set-up production line
External	Find 100.000 USD funding for research, procurement and implementation trough CSR investors, plastic manufacturing companies and other organizations like USAID Research legislation on building material development	Find organizations that want to buy the bricks like UNHabitat	Work together with Women and youth groups and SME's for the selling network Find a partnership with a research facility like university for testing the final bricks Set-up partnerships with building developers and builders as clients	Set up partnerships with universities to further investigate upcycling opportunities Make buying agreements with clients such as UN Habitat Involve Women and youth groups in a trainings center to set-up the educational project and train to use and sell the brick	Expand operations to other material recovery facilities in coastal cities and towns Information sharing with other not commercial/for profit organizations such as NGO and non-profit creating a community of plastic waste brick producers Create media exposure about the implementation of the brick in Watamu