# Plastic Household Waste Valorization in Developing Countries:

critical design elements for a sustainable and circular business ecosystem

**Milou Derks[1,2,*], Henny Romijn[2]**

[1]Netherlands Organisation for Applied Scientific Research (TNO);
[2]University of Technology Eindhoven;

*milouderks@hotmail.com

## Keywords

Waste valorization; sustainable business models; ecosystem perspective; circular economy; bottom of the pyramid; informal sector; developing countries

## Extended abstract

Transitioning from a linear 'take-make-dispose' economy to a sustainable and circular economy focused on renewable resources and circular pathways, requires new business models valorizing what is currently considered as waste (Donner et al., 2021; Leder et al., 2020). Waste valorization does not only play an important role in the transition to a circular economy, it can also provide significant opportunities for improving livelihoods, generating jobs and improving living conditions in least-developed countries. As an example, Africa's urban population is expected to double from now until 2050. This growth would be mainly concentrated in informal settlements, which is already the home to about 63% of urban population in least-developed countries (Bauer, 2020). New business models focused on valorization of waste can stimulate both informal and private sector involvement, relieving the pressure on local authorities to provide basic services such as waste management, which is already quite challenging because of insufficient resources and lack of managed disposal sites (Godfrey et al., 2017).

Business models exist within (business) ecosystems. Stakeholders in the ecosystem have a large influence on an organization's business model and often determine an organization's success (Gradl & Jenkins, 2011). This study addresses the multifaceted problem of household plastic waste valorization in least-developed countries from a holistic ecosystem perspective. An ecosystem perspective is necessary to prevent partial solutions for waste valorization that do not address the root causes and to involve dynamics between actors in the ecosystem as an integral part. An ecosystem perspective on business models for the transition to are more circular waste management system has recently been applied by Kanda et al. (2021) who show that "ecosystems are a more appropriate concept to describe the high-level coordination between stakeholders

necessary to implement circular systems", increasing the suitability to analyze, plan and communicate circular systems on an organizational level. We extend this knowledge by deriving important design factors for such circular business ecosystems, therefore adding towards the practical use of the insights of Kanda et al. (2021), by analyzing two waste business ecosystems in least-developed countries.

The research objective is to derive important design factors that need to be taken into account to develop a socially and economically viable circular business ecosystem for *plastic* household waste valorization. To derive such design factors we build on business ecosystem research, which acknowledges several interconnected stakeholders, value networks, social and environmental issues as well as the local context (Peltola et al., 2016), to derive root causes for the current state of low waste valorization in least-developed countries and distill design elements for sustainable business models addressing plastic household waste valorization. To do this, we qualitatively examine the structure and process of plastic household waste value retention and capture in the current waste business ecosystems in urban areas in Malawi and Zambia. For each country extensive data collection consisting of questionnaires, interviews, focal group discussions, and stakeholder meetings, are conducted (many by the first author herself), to provide input for a thorough root cause analysis. Data collection is visualized in table 1. Qualitative data coding was used to analyze the data and to derive common themes and patterns to uncover root causes. The data could be grouped into four categories: infrastructural challenges, policy challenges, processor challenges and others. Malawi and Zambia were chosen, due to their close proximity, similar demographics (although Zambia is ahead in terms of economic development). Additionally, both have expressed their interest to work towards a circular waste management system and were willing to contribute in-kind to this study.

The root cause analysis showed that for both countries plastic waste valorization seems stuck due to three root causes. First, policy focuses on regulation, i.e. "sticks" such as prohibitions and limitations, limiting options for plastic remanufacturers and recyclers to develop a profitable business case, instead of providing "carrots", positive incentives throughout the value chain to stimulate plastic reduction, separation, collection and valorization. Second, it is challenging to secure sufficient volumes needed for profitability in remanufacturing or recycling. There is hardly any separation of waste in both countries, due to lack of incentives for households to separate, insufficient resources to engage in collection in general, let alone separated collection (in Malawi 20% of waste is collected in urban areas, in Zambia 45% is collected in urban areas, while in either country there is hardly any collection in rural areas), and most waste is dumped at open or illegal dumpsites. Plastics get contaminated at the households, during transport or at the dumpsite (mainly by decaying organics), decreasing their value, and plastics that still have value are buried quickly under new waste. Thus, at this moment, the only way that plastic waste can still be valorized is through collection by informal waste pickers at dumpsites, who account for 97% of all collected plastics. However, these only choose high-value easy-to-collect products and there is only a small collection window until the waste gets buried or contaminated beyond repair. Third, margins on recycled plastic products are low, due to high electricity prices, absence of available technology within the country and high cost of securing enough plastic waste (Dijkstra et al., 2020).

Application of a business ecosystem perspective on the root cause analysis, results in the following design elements for a sustainable business ecosystem addressing plastic household waste valorization in developing countries: (i) the role of the informal sector should not be

underestimated and should be properly incorporated in the value chain, (ii) a new actor is needed between collection services and waste disposal sites in the form of collective facilities to arrange for separating, aggregating and transferring waste to the recycling industry (Barnes et al., 2021). Only waste that has insufficient value is then transferred to disposal sites. (iii) an open dialogue is needed between the private and public sector in which policy not only regulates but also stimulates the private sector via synergistic carrots and sticks, and (iv) upstream value chains should have a decentralized character, stimulating communities to invest in waste separation and collection.

Insights from this study show that an ecosystem perspective on circular waste valorization leads to meaningful results in least-developed countries and concrete implications for business model design to create circular ecosystems. Additionally, our insights can help entrepreneurs by defining and adapting their waste valorization strategies within the local context and help them shift from linear value chains to a circular system, it can also help policy makers in understanding barriers experienced with valorization in the sector, thus stimulating them to streamline policy with private sector needs. We conclude that individual businesses need to evolve towards a more dynamic and integrated business model in which separation, collection and valorization are closely connected.

TABLE 9: DATA COLLECTION METHODS FOR MALAWI AND ZAMBIA

| STAKEHOLDERS | Tools used | Malawi | Zambia |
|---|---|---|---|
| Local Authorities | Questionnaires and interviews | 10 | 2 |
| Government Departments/ Institutions | Interviews/ Questionnaires | 3 | 2 |
| NGOs | Interviews/ Questionnaires | 5 | 4 |
| Academia | Questionnaires | 3 | 0 |
| Companies + Business Council for Sustainable Development in Zimbabwe | Interviews/ Questionnaires | 15 | 10 |
| Household Waste Samples collected and characterized (* Used Data Collectors) | Sampling kits (e.g scales, gloves, waste bags) | 180 | 90 |
| Household questionnaires administered (*Used data collectors) | Questionnaires | 300 | 273 |
| Learning visits to companies active in waste valorization | Learning visits | 4 | 8 |
| Focal group discussions with companies active in waste valorization | Focal group discussion | 0 | 2 |
| Stakeholder meetings with 20+ private and public parties | Stakeholder meeting | 2 | 2 |
| TOTAL | | 522 | 393 |

# Acknowledgements

# References

Barnes, K., Blaauw, D., Schenck, R., & Pretorius, A. (2021). Buyback centres in Cape Town: the key integration

point between formal and informal sectors in the waste economy of the Western Cape. *GeoJournal*. https://doi.org/10.1007/s10708-020-10351-9

Bauer, G. K. (2020). Digital solutions to improve basic service provision to the urban poor. *Field Actions Science Report*, *2020*(Special Issue 22).

Dijkstra, H., van Beukering, P., & Brouwer, R. (2020). Business models and sustainable plastic management: A systematic review of the literature. *Journal of Cleaner Production*, *258*. https://doi.org/10.1016/j.jclepro.2020.120967

Donner, M., Verniquet, A., Broeze, J., Kayser, K., & De Vries, H. (2021). Critical success and risk factors for circular business models valorising agricultural waste and by-products. *Resources, Conservation and Recycling*, *165*. https://doi.org/10.1016/j.resconrec.2020.105236

Godfrey, L., Muswema, A., Strydom, W., Mamafa, T., & Mapako, M. (2017). Co-operatives as a development mechanism to support job creation and sustainable waste management in South Africa. *Sustainability Science*, *12*(5). https://doi.org/10.1007/s11625-017-0442-4

Gradl, C., & Jenkins, B. (2011). Tackling barriers to scale: From inclusive business models to inclusive business ecosystems. *CSR Initiative, Harvard Kennedy School, Cambridge MA*.

Kanda, W., Geissdoerfer, M., & Hjelm, O. (2021). From circular business models to circular business ecosystems. *Business Strategy and the Environment*, *30*(6). https://doi.org/10.1002/bse.2895

Leder, N., Kumar, M., & Rodrigues, V. S. (2020). Influential factors for value creation within the Circular Economy: Framework for Waste Valorisation. *Resources, Conservation and Recycling*, *158*. https://doi.org/10.1016/j.resconrec.2020.104804

Peltola, T., Aarikka-Stenroos, L., Viana, E., & Mäkinen, S. (2016). Value capture in business ecosystems for municipal solid waste management: Comparison between two local environments. *Journal of Cleaner Production*, *137*. https://doi.org/10.1016/j.jclepro.2016.07.168