Digital Approaches for the Circular Economy in Low and Middle Income Countries

This briefing gives an orientation on technology areas where digital approaches can contribute to the circular economy and sustainable waste management. This list represents a mixture of both high tech (industry 4.0) and simpler approaches that can be applied to address different actors in the value chain in low and middle income countries, from producers and recyclers through to municipalities and citizens. The areas and examples listed partially overlap and primarily aim to give an idea of the possibilities rather than an exhaustive overview of all providers and solutions (of which there are many!).

1. Tools for improving citizen engagement

- Reporting on quality of municipal services/ illegal dumping/pollution hotspots
- Raise awareness for recycling behaviours

Digital advantages » lower barrier for reporting, geolocation, public service accountability, possibility to incentivize positive recycling behaviour.
Technologies used » Mobile Apps, Interactive Games, GIS/Satellite Mapping, Drones, Social Media.
Examples » Dawar App Egypt, Litterati, Solagro – Serbia, 3D landfill model in Ukraine, #trashtag.

2. Improve operational efficiencies and compliance monitoring

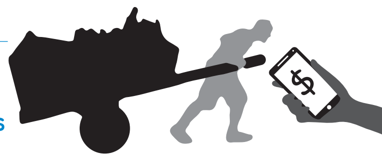
- Logistics and transport pathways, e.g. GPS tracking of garbage trucks to avoid dumping/optimize for traffic conditions, status monitoring
- Process and accounting management software in municipalities and authorities, remote control and monitoring systems for urban services, digital permit processes
- Environmental compliance software for increasingly complex global legal frameworks

Digital advantages » tracking and optimization of fleets/resources in real time, improve resource allocation, data collection & process standardization, facilitate compliance.
Technologies used » GPS, accounting/fleet management & data logging software, Internet of Things (IoT), sensors, compliance tools/databases in Producer Responsibility Schemes.
Examples » GPS Trackers in Algeria, digitalization of services/processes in NSWMP Egypt. See also » Digital Dividends in Plastic Recycling.

3. Resource marketplaces – connect buyers to sellers (collectors, recyclers, producers)

- Requests for waste collection or pickup from households/businesses for recycling
- Platforms for re-use/re-sale and refurbishing products for re-sale
- Find offtakers for recycling fractions where not known, also for uncommon fractions
- Provide some form of traceability and standards, transparent market pricing

Digital advantages » optimize recycling market, increase re-use of wastes, connect actors in value chain, remove middle-men pricing power dependencies.
Technologies used » mobile apps for collection requests, online buyer/seller platforms.
Examples » Mallsampah Indonesia, rebuy.de, cirplus, Excess Materials Exchange, HARIT organic city compost.
See also » Digital platforms as marketplaces for the circular economy.



4. Interface with and support informal waste collection networks

- Mobile payments can be used to pay waste pickers a financial incentive for collecting certain materials (better: pay for collection as a service)
- Traceability approaches necessary at collection centres/aggregators (e.g. take picture, weigh, classify materials)
- Option to support on tax obligations, trainings, social security and health insurance

Digital advantages » avoid double counting and large sums of cash on site, reduce reliance on unreliable middlemen, immediate payment, no bank account necessary.

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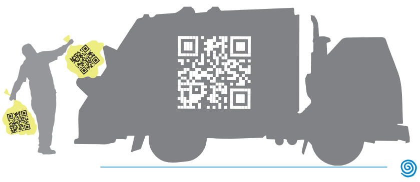
Technologies used » mobile payments, mobile apps, blockchain or approaches of photographing material, spreadsheet/logging software.
Examples » E-waste incentives Ghana, Empower, Kolekt App. See also » informal formal partnerships in the e-waste sector

5. Traceability of materials along (parts of) lifecycle

- Enable payments for e.g. environmentally sound recycling, financial incentives for collection.
- Product passport/history may enable better re-use/repurposing (e.g. electric vehicle batteries second life)
- Digital accompanying documents may support material flows in the circular economy e.g. transboundary movement notifications/customs regulations, EPR commitments.

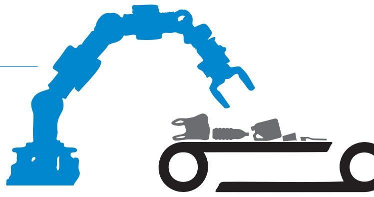
Digital advantages » such tracking is not possible for millions of products in analogue, reduce paperwork, generate mass flow and product lifetime data, avoid fraud, producer responsibility can be linked more strongly to end of life of products.
Technologies used » digital watermarks/UV markers, digital twin, 'product passport' through QR code or similar, blockchain or mass flow and inventory approaches, supply chain management software.
Examples » EU Battery Passport (in new regulatory proposals), Think Circular, Circularise.
See also » Blockchain in Waste Management.



6. Better data for improved planning and waste management interventions

- Reliable data on imports, recycling etc. are needed to manage EPR contributions, finance flows, estimate climate relevance and GHG emissions.
- Data can be in real-time (sensors, satellites) or data entry tools can support standardization and consolidation of data across operating locations.
- At product level information can travel with product via QR codes or similar, ultimately providing information on materials/components for recycling.

Digital advantage » better informed decisions, consolidation/automisation of data flows possible, standardize approaches in geologically separate locations, visualization.
Technologies used » data analytics, satellites, sensors/IoT, logging software, data entry (in websites or specific software), data visualization software.
Examples » CounterMEASURE, Waste Flow Diagram, Satellite data to track illegal dumpsites, Circular.Fashion circularity.ID for clothes.



7. Automation, Robotics and AI to optimize systems for circularity

- Advanced automated sorting/recycling processes use robotics combined with image recognition to enable increased throughput and recycling percentage.
- Distributed and additive manufacturing through 3D printing enables local repair, re-use of materials and sharing of design files, reduced waste in manufacturing.
- AI/Machine learning enables identification of substitute materials, better recyclability or modular designs, predictive maintenance, predictive end of life end-user behaviour, predict/autonomous identification of recycling options and locations, amounts of material available, supply constraints and suitable interventions etc.

Advantages » increase recycling, reduce waste in manufacturing, find new solutions, target resources to maximise positive impacts and reduce costs.
Technologies used » 3D printing, image recognition software, machine learning, IoT, self optimization and recycling algorithms, condition monitoring, impact analysis.
Examples » optimization software for sizing and fit of clothes in e-commerce by EyeFitU, dynamic pricing in marketplaces (stuffstr), accelerated metallurgy to find new alloys with same material performance (European Space Agency). See also » circular strategies framework for manufacturing companies, Artificial intelligence and the circular economy.

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