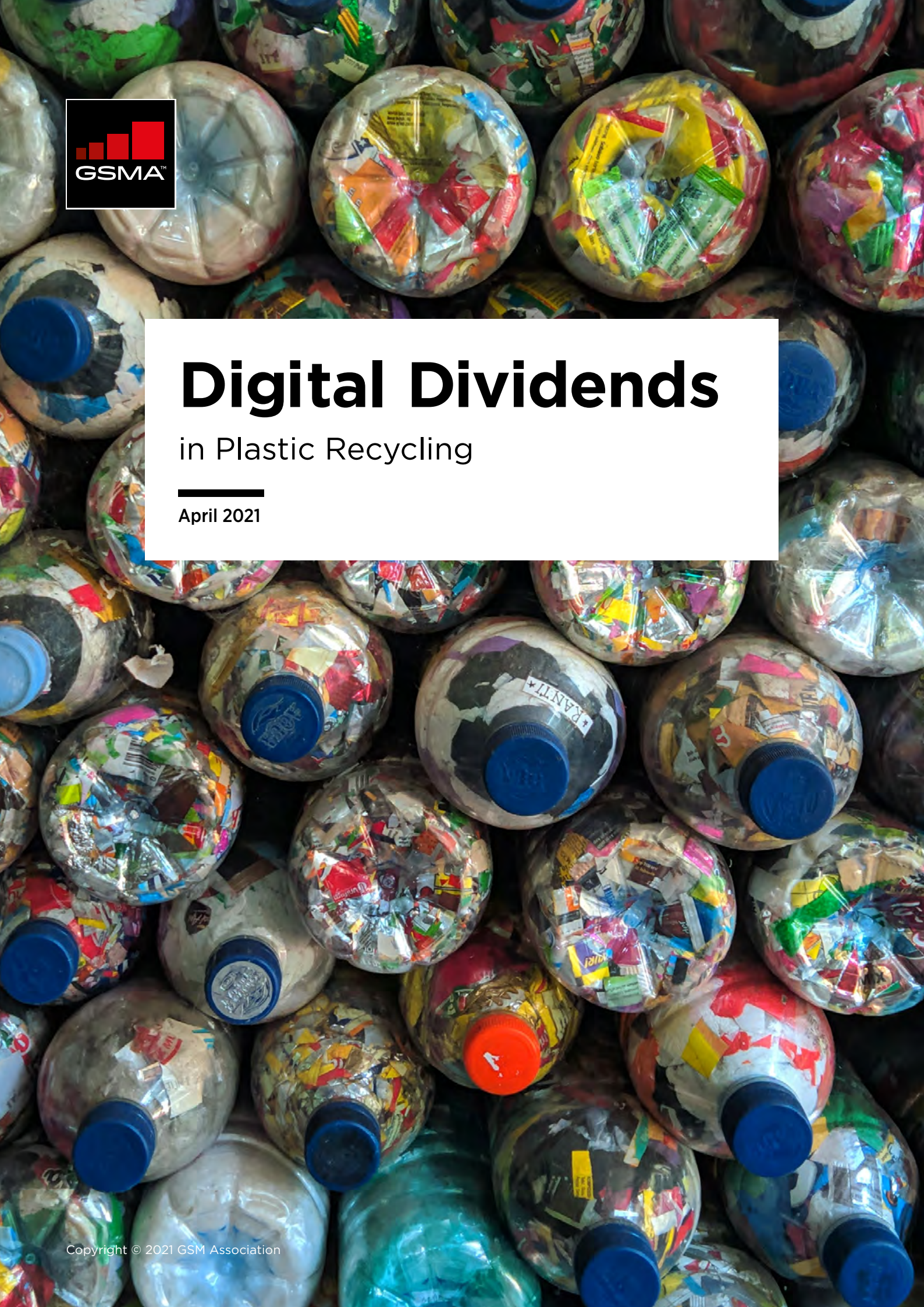

Digital Dividends

in Plastic Recycling

April 2021

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The programme is supported by the UK Foreign, Commonwealth & Development Office (FCDO).

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Executive summary

The mismanagement of plastic waste is a global challenge that must be ambitiously and urgently addressed if we are to achieve the Sustainable Development Goals (SDGs) or meet the targets set out in the 2015 Paris Agreement. The negative impacts of the plastic life cycle on the climate, the natural environment and the well-being of the world's poorest communities are well known. However, plastic production is on the rise, and globally less than 10 per cent of plastic waste is recycled. Unless substantial changes are made to how this material is used and reused, it is expected that over the next two to three decades, the amount of plastic produced every year will double,[1] the amount of plastic flowing into oceans will triple[2] and the plastics industry will account for 20 per cent of global oil consumption.[3]

Future increases in plastic pollution will largely be driven by the use of more plastic packaging in low- and middle-income countries (LMICs) in Africa and Asia. To complicate matters, many LMICs, particularly those in South and Southeast Asia, are adding to their plastic burden by importing waste from wealthier countries or becoming production sites of virgin plastics for domestic and international markets. In most LMICs, formal waste collection systems are underdeveloped or non-existent, and less than half of waste (by weight) is collected in cities. Low recycling rates and environmental leakage are symptomatic of a range of challenges related to waste collection, disposal and recycling.

1 World Economic Forum, Ellen MacArthur Foundation and McKinsey & Company. (2016). The New Plastics Economy: Rethinking the Future of Plastics.
2 Brogan, C. (24 July 2020). Ocean plastic set to triple by 2040, but immediate action could stem tide by 80%. Imperial College London.
3 Ibid. (p. 2 of Executive Summary).

However, nascent but very promising circular economy solutions are emerging in LMICs. In many countries, extensive networks of waste collectors, aggregators, transporters and processors from across the informal and formal sectors work in concert to collect and recycle vast amounts of plastic waste that might otherwise be burned or discarded in roads, open land or waterways. There is growing interest in using digital technology to improve the efficiency and effectiveness of these operations, as there is recognition that "downstream" innovations in plastic supply chains will help ensure that global and domestic brands have a consistent supply of high-quality recycled plastic, and enable "upstream" innovation in products that use less virgin plastic and are designed to be recycled.

In this report, we explore the specific benefits that plastics organisations (for-profit start-ups or social enterprises that manage plastic waste collection and recycling) in LMICs currently reap, or could eventually reap, from using digital tools or services or partnering with technology organisations, such as mobile network operators (MNOs). Through desk research and stakeholder interviews, we have captured and documented global trends and examples of best practice, and identified key value drivers that, alongside the use of digital tools, often enable plastics organisations to achieve scale and sustainability. The report also maps potential synergies between plastics and technology organisations that could become opportunities to collaborate and deliver environmental, social and commercial impact.

We have found that digital technologies, such as mobile apps, mobile payments, artificial intelligence (AI) and connected devices, have a critical role to play in improving citizen engagement in recycling, driving operational efficiencies and increasing transparency in the plastics supply chain. Mobile-enabled solutions can raise public awareness of why and how to recycle plastic waste, drive positive behavioural change, enable citizens to identify waste "hotspots" and increase plastics organisations' access to raw materials. Digital tools, such as mobile apps, can also help match the supply of plastic waste (e.g. from households or businesses) with waste pickers' and plastics organisations' demand for raw materials. Frontier technologies, such as AI and the Internet of Things (IoT) can improve collection and recycling activities, for instance, through bin monitoring and weighing or by automating plastic segregation.

Online portals and mobile-based tools are also being developed to connect all actors in the plastics supply chain, allowing plastics organisations to trace the flow of waste materials in real time, and to create digital marketplaces that ensure waste collectors receive fair prices for the plastic they sell. The high levels of transparency these solutions bring to the supply chain is an important requirement for global brands that want to increase their use of ethically sourced recycled plastics in their manufacturing processes. The ability of plastics organisations to trace the provenance, quality and flow of plastic – and to demonstrate the positive social and environmental impacts of their operations – will be critical to the development of the emerging socially responsible plastics sector.

The GSMA and its members can support ambitious responses to the plastics challenge. As part of their sustainability efforts, many MNOs and other technology organisations are already exploring how to reduce their plastic footprint, for instance by eliminating plastic packaging from their products or services, or by reducing the amount of plastic used in their day-to-day operations. While these initiatives are important, even greater impact can be achieved when MNOs and other technology organisations leverage their resources and technical expertise to make digital technologies more accessible to, and impactful for, a wide range of stakeholders. In doing so, GSMA members will find new opportunities to engage positively with their customers, grow their core revenue, develop new digital business models (e.g. in AI and IoT services), increase customer satisfaction and brand loyalty and source recycled plastic for new products.

Introduction

Plastic is an integral and valuable part of the global economy, and is used in thousands of products that add comfort, convenience and safety to our everyday lives. It supports innovation in medicine, lightens cars and airplanes (saving fuel and, therefore, emissions), extends the life of fresh food and delivers clean drinking water to billions of people living in poverty. In many ways, plastic makes modern life possible, but nearly half of what is produced today is designed to be disposed after just one use, within minutes of purchase. In low- and middle-income countries (LMICs) in particular, today's "throw-away culture" is contributing to climate change, damaging people's health and livelihoods, degrading natural environments and polluting waterways.

The global production of plastic materials has grown exponentially over the last seven decades, from 2.1 million tonnes in 1950 to over 400 million tonnes produced annually today.[4] Plastic production has increased so rapidly that it is estimated that over half of the plastic ever manufactured has been made in the past 15 years.[5] If business as usual is allowed to continue, over the next two decades annual plastic production will double again, largely driven by greater use of plastic packaging in the growing economies of Africa and Asia.

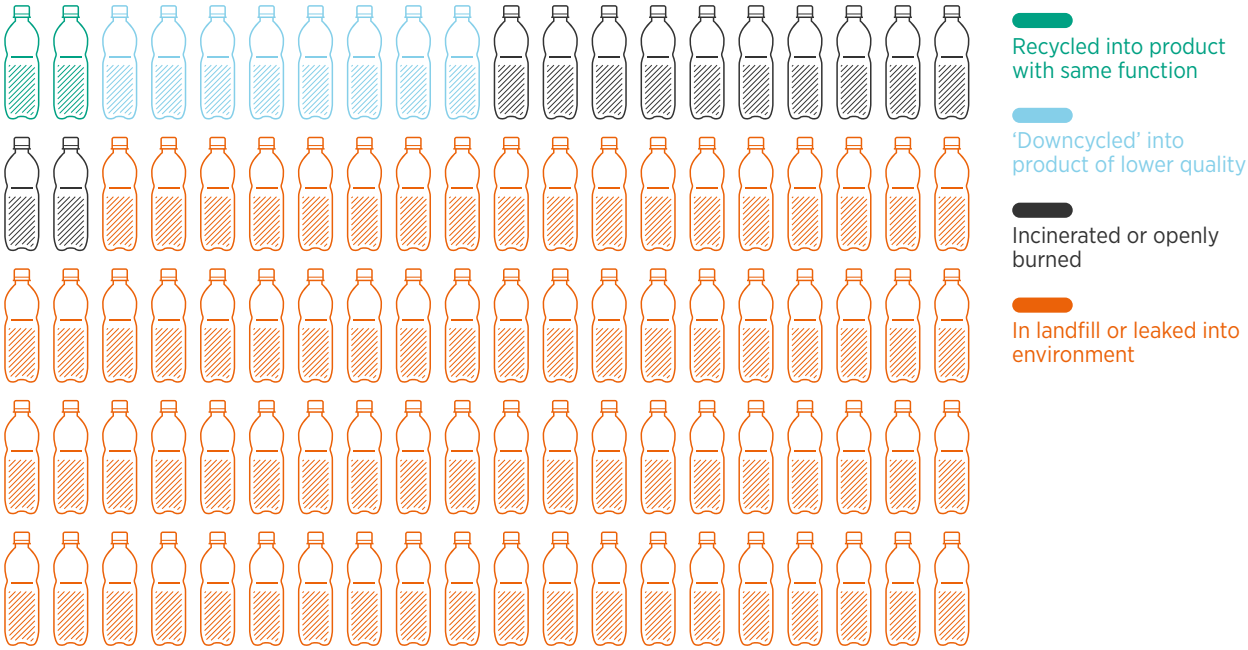
Data on global plastic waste management is scarce, but a study conducted in 2015 estimated that of the 8.3 billion metric tonnes of plastic ever produced, around 6.3 billion metric tonnes (about 75 per cent) had reached the end of its useful life and become waste.[6] As seen in Figure 1 (next page), almost 80 per cent of this discarded plastic had been buried in landfills or leaked into the environment where it is unlikely to completely biodegrade for hundreds, if not thousands, of years. Another 12 per cent of plastic waste had been destroyed through incineration, a process that releases toxic and heat-trapping gases into the atmosphere. Less than 10 per cent of plastic waste had been recycled and only two per cent had been reused in products with the same function, meaning it will remain in a circular economy. Most recycled plastic had been "downcycled" into something of lower quality, after which it cannot be (profitably) recycled again.

4 UNEP. (2018). Single-use plastics: a roadmap for sustainability.
5 Quest. (n.d.). The Plastic Pollution Epidemic.
6 Bureau of International Recycling. (2020). Recycling Plastics.

Figure 1

Where has our plastic waste gone?

(1 bottle = 1%)



Wealthier countries have historically found it to be most economical to export their plastic waste to LMICs, where formal waste collection systems are typically underdeveloped or non-existent, and lower labour costs and lenient environmental standards make it more cost-effective to recycle plastic into cheap household goods or clothing. In these countries, plastic waste is most often collected, sorted, shredded and melted by informal sector workers who typically discard unrecyclable and contaminated plastic waste into landfills or waterways, or burn it illegally. Half of the world's mismanaged plastic waste is found in five Asian countries – China, Indonesia, the Philippines, Vietnam and Sri Lanka[7] – and 90 per cent of all ocean-bound plastic waste flows through rivers in LMICs (eight in Asia and two in Africa).[8]

The negative impacts of mismanaged plastic waste on both people and the environment are increasingly apparent, and it is now widely accepted that plastic pollution is having a direct impact on the global community's ability to meet many of the UN Sustainable Development Goals (SDGs), including those related to poverty, hunger, health and well-being, inclusive and sustainable growth, sustainable consumption and production patterns and climate action. Despite this, plastic production is still not expected to peak for several more decades, and the flow of plastic waste into the oceans is likely to triple by 2040.[9] Without bold new ideas, policies and management strategies, current recycling rates will no longer be sustained and ambitious goals for future recycling growth will be impossible to achieve.

7 Ritchie, H. and Roser, M. (September 2018). Plastic Pollution. Our World in Data. Note that while this data is only available for 2010, projections of future global trends show a very similar distribution.
8 Gray, A. (8 June 2018). "90% of plastic polluting our oceans come from just 10 rivers". World Economic Forum Agenda.
9 Brogan, C. (24 July 2020). Ocean plastic set to triple by 2040, but immediate action could stem tide by 80%. Imperial College London.

Pathways to a more sustainable and circular future are still within reach. In many LMICs, circular economy solutions are nascent, but promising. These solutions are based on traditions of separating waste at source, improved resource consciousness, and the emergence of innovative, small-scale plastic recycling initiatives. There is also growing evidence that digital technologies, such as satellite and drone imagery, AI and IoT – combined with the expansion of mobile coverage, smartphone penetration and mobile money adoption – can help address a range of challenges and inefficiencies faced by those responsible for locating, collecting, segregating, transporting and recycling plastic waste.

Our research has found that digital solutions can improve citizen engagement in recycling activities, drive operational efficiencies and increase transparency in the plastics supply chain. It is also clear from the case studies in this report that digital technology can help scale plastic recycling efforts in ways that support livelihoods and digital inclusion, and create value for all actors in the plastics supply chain. In parallel to exploring opportunities to reduce the use of virgin plastics in their own products and services, MNOs and other technology organisations have an opportunity to deploy digital technologies that enable plastics organisations in LMICs to provide a consistent and predictable supply of recycled plastic to consumer brands and other manufacturers, both domestically and internationally. Achieving this will ultimately reduce the production and use of virgin plastics upstream, and enable more products to be designed and optimised for reuse and recycling.

Box 1:

A note on Electronic Waste

Electronic waste (e-waste) is the fastest growing waste stream in the world, with 53.6 million tonnes produced annually (Global E-waste Monitor, 2020). Around 83 per cent of global e-waste is not documented, meaning that it is not recycled following international standards, or is disposed of in landfills or through incineration. Although our research did not specifically focus on opportunities for digital tools to support the collection and recycling of e-waste, stakeholders noted commonalities between this waste stream and plastics. New or impending Extended Producer Responsibility (EPR) policies are increasingly targeting both plastics and e-waste, and shifting responsibility for their collection and disposal back to the private sector. This has helped catalyse action from mobile operators, who currently support e-waste initiatives in at least 40 LMICs. We also identified examples of synergies between plastic and e-waste value chains. In Sri Lanka and India, for instance, many licensed e-waste collectors also collect plastic waste; and in many countries waste organisations collect multiple types of valuable recyclables, including e-waste, to help subsidise the collection and transport costs of lower value plastics. Plastic organisations engaged in our research noted that they would be interested in tailoring digital tools and processes to improve efficiencies in e-waste value chains.

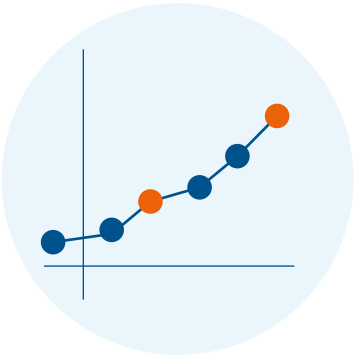
To learn more about what the GSMA and mobile operators are doing to support better management of e-waste, or to access information on e-waste policies from over 70 countries across Sub-Saharan Africa and Asia, visit:
www.gsma.com/mobilefordevelopment/climatetech/e-waste.

Research objectives and methodology

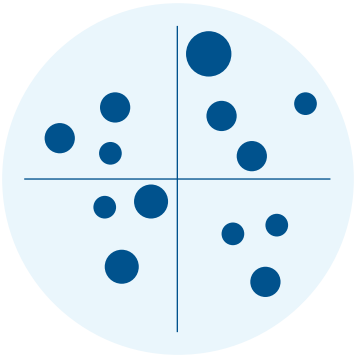
The use of digital technology in plastic recycling (and waste management more generally) has been less prevalent than in other sectors, such as agriculture, health and utility services, and plastic recycling innovations tend to be too fragmented and uncoordinated to have an impact at scale.[10] There is also a gap in understanding the potential role of the private sector, particularly MNOs and other technology organisations, in supporting plastics organisations and a range of recycling activities.

The objectives of our research were threefold: first, to capture and document global trends, innovations and examples of best practice in using digital technologies in plastic recycling; second, to understand the key factors (or "levers") that have allowed plastics organisations to achieve impact, sustainability and scale; and third, to explore the synergies between technology organisations and plastics organisations that could lead to mutually beneficial partnerships with environmental, social and commercial impact. "Plastics organisations" refers to a range of informal and formal businesses, from small social enterprises to larger corporate entities, that could be engaging across various stages of the plastic waste management value chain.

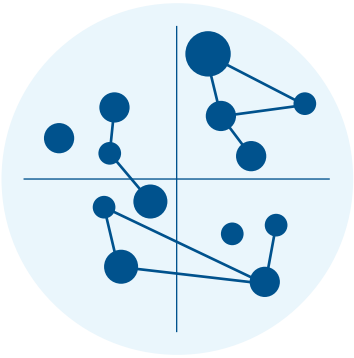
1 Global trends and best practices



2 Stakeholder insights



3 Opportunities for collaboration



In support of the research objectives, a review of publicly available literature was undertaken to compile an illustrative list of technology-enabled plastic recycling initiatives across Africa, South Asia and Southeast Asia. Based on the results of this desk research, interviews were conducted with stakeholders from the public and private sectors, including non-profit organisations, development agencies, plastics organisations and a broad range of technology organisations, including MNOs, handset and device makers and software companies. Additional details on the research methodology can be found in **Appendix 1**, and a list of the projects identified in the desk review is provided in **Appendix 2**.

The research was conducted remotely during the COVID-19 pandemic, which has greatly influenced the context of plastic recycling, both in terms of market conditions (low oil prices have made recycled plastics less competitive) and the ability of organisations to conduct business as usual. There was some indication that operating during lockdown fuelled interest among plastics organisations to adopt digital solutions, which are now accelerating quickly across many sectors in LMICs as a result of the pandemic. It is also worth noting that while the research aimed to identify organisations focused purely on plastic waste, many of these organisations provide services that address a wider range of recyclable materials. A complete list of the organisations that were engaged through the project can be found in **Appendix 3**.

10 World Economic Forum, Ellen MacArthur Foundation and McKinsey & Company. (2016). The New Plastics Economy: Rethinking the Future of Plastics.

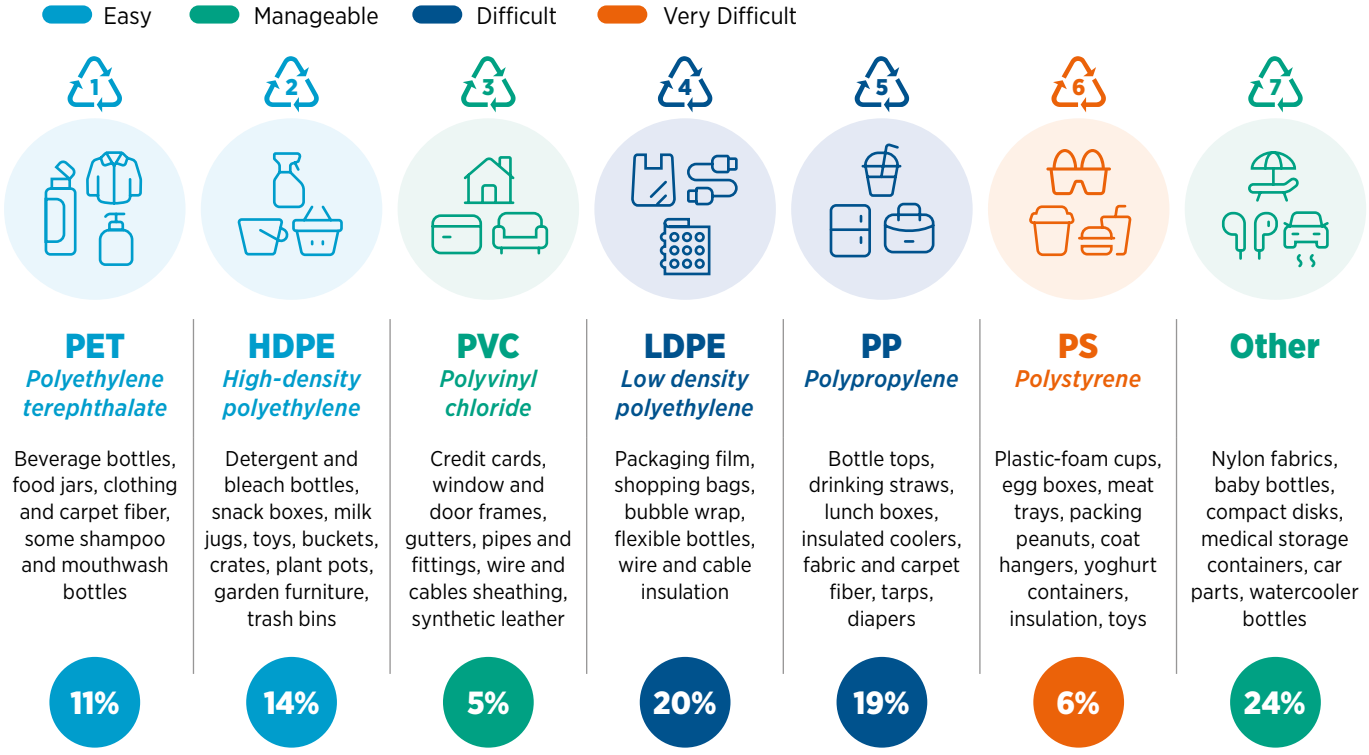
Section 1:
The plastic waste crisis in low- and middle-income countries

The world currently generates over two billion tonnes of municipal solid waste every year. This is expected to increase to 2.2 billion tonnes per year by 2025 and 3.4 billion tonnes by 2050, more than double the population growth over the same period, as per capita incomes and consumption rates increase in LMICs.[11] Today, plastic accounts for between seven and 12 per cent of all municipal waste by weight,[12] but this proportion will almost certainly increase given that the use of plastic products and packaging is on the rise.

Plastic is one of the most challenging materials to recycle. Many types of plastics can only be recycled a limited number of times, and each type requires a different recycling process. As explained by National Geographic, "Even the seven most common types of plastic used in consumer manufacturing... are replete with inconsistent resin composition, colour, transparency, weight, shape, and size that complicate and often rule out recycling."[13] While certain types of plastics, such as PET (*polyethylene terephthalate*) used in beverage bottles and clothing, are relatively easy to sort and recycle, thin plastics, contaminated plastics and multi-layer plastics are more challenging. For this reason, a number of LMICs, including Kenya, Rwanda and Sri Lanka, have approved or drafted laws to ban thin and single-use plastics, and Zimbabwe has introduced a ban on polystyrene food containers, with heavy fines levied at those who still use the material. Figure 2 shows the seven most common categories of plastic, their common applications and their ability to be recycled.

Figure 2

How easy is it to recycle the plastic we use?



Percentage of global plastic waste, 2015
Source: https://dirty70.eu

11 Ibid.
12 Kaza, S., Yao, L., Bhada-Tata, P. and Van Woerden, F. (2020). What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050. World Bank Group. Urban Development Series.
13 Parker, L. (16 November 2018). "China's ban on trash imports shifts waste crisis to Southeast Asia". National Geographic.

The impact of plastic on the environment

The life cycle of plastic is now considered to be a "planetary boundary threat", meaning that high levels of plastic pollution could eventually pass a critical threshold and have an irreversible global impact on vital climate processes, biodiversity levels and ecosystem functions.[14] Somewhere between 5.3 million and 14 million tonnes of plastic find its way into the ocean every year, mainly from coastal regions in Asia. Nearly 700 species are known to have been affected by plastic pollution in the ocean, and by 2050 it is expected that virtually every seabird species on the planet will be consuming plastic waste.[15] Floating plastic fragments has also been found to host harmful species of algae, viruses and microbial communities, and easily transport invasive species and harmful substances, altering ecosystems and changing genetic diversity. If urgent action is not taken, it is estimated that the amount of plastic flowing into the oceans every year will reach nearly 30 million metric tonnes by 2040.[16]

Furthermore, at present rates, the greenhouse gas (GHG) emissions from plastics value chains threaten the ability of the global community to meet carbon emissions targets. Over 99 per cent of plastics are produced from polluting and non-renewable sources, such as oil, natural gas and coal,[17] and the manufacturing process is both energy and emissions intensive, consuming between four and six per cent of oil and gas used worldwide every year. In 2019, the production and incineration of plastic produced over 850 million metric tonnes of GHGs, equal to the emissions from 189 coal power plants (500 MW).[18] Emissions figures are on a growth trajectory and if current trends continue, by 2050, the plastics industry could account for 20 per cent of the world's total oil consumption and reach the equivalent of 615 coal plants.[19]

The impact of plastic on people

When burnt in the open, many of the chemicals that give plastic their defining characteristics –plasticity, colour, malleability, durability and hardness – are released into the air, increasing the risk of heart disease and cancer, respiratory ailments, skin and eye diseases, nausea and headaches and damage to the reproductive and nervous systems.[20] Mismanaged waste, including plastics, also blocks waterways and drains, which causes flooding, waterborne diseases and breeding grounds for disease-carrying flies, mosquitoes and vermin. According to new research by Tearfund, between 400,000 and one million people die every year in LMICs from diseases related to mismanaged plastic and other solid waste.[21]

Plastic pollution also affects the economic development of LMICs by damaging livelihoods and curtailing growth in tourism. High concentrations of plastic in fishing areas threatens marine life and makes fishing much more difficult due to increased danger to boats, damaged fishing gear and poor quality of the catch. In Kenya, local fishermen have reported that their work must stop when plastic bottles and other waste gets entangled in fishing lines, and they have been forced to adapt by catching smaller fish or using different boats to go farther out to sea.[22] The United Nations Environment Programme (UNEP) has estimated that ocean-based consumer plastic pollution is costing fisheries, aquaculture and marine tourism $13 billion every year.[23] Plastic waste also damages livelihoods on land. Studies have found that up to a third of cattle and half the goat population in LMICs have consumed significant amounts of plastic, leading to bloating, a host of adverse health effects and eventually death by starvation.[24]

14 Villarrubia-Gómez, P., Cornell, S. and Fabres, J. (October 2018). "Marine plastic pollution as a planetary boundary threat: The drifting piece in the sustainability puzzle". Marine Policy, Volume 96, pp. 213–220.
15 Parker, L. (7 June 2019). "The world's plastic pollution crisis explained". *National Geographic*.
16 Parker, L. (24 July 2020). "Plastic rubbish flowing into the seas will nearly triple by 2040 without drastic action". National Geographic.
17 UNEP. (n.d.) "Our planet is drowning in pollution — it's time for change!"
18 Center for International Environmental Law. (15 May 2019). "Sweeping New Report on Global Environmental Impact of Plastics Reveals Severe Damage to Climate".
19 Ibid. (p. 2 of Executive Summary).
20 Verma, R., Vinoda, K.S., Papireddy, M. and Gowda, A.N.S. (2016). "Toxic Pollutants from Plastic Waste: A Review". Prosedia Environmental Sciences. Volume 35, pp. 701–708.
21 Tearfund, Fauna & Flora International, WasteAid and The Institute of Development Studies (IDS). (2019). No Time to Waste.
22 Safaricom. (28 June 2018). "Turning the tide: Why we must beat plastic pollution".
23 Tearfund, Fauna & Flora International, WasteAid and The Institute of Development Studies (IDS). (2019). No Time to Waste.
24 Ibid.

Causes of plastic waste pollution in LMICs

Less than half of waste (by weight) is collected in LMIC cities, and this proportion drops drastically to 26 per cent outside urban areas where official waste collection systems rarely exist and local disposal methods, including burning, are most common.[25] Rapid population growth and urbanisation in many LMICs continue to add to the scale of the problem. By 2040, about four billion people globally are likely to be without organised waste collection services.[26] The vast majority of those without access to formal collection services will be living in LMICs in slum areas, small towns and villages.

A major challenge to improving recycling infrastructure in LMICs is cost. Publicly subsidised waste management models adopted by high-income countries are expensive and typically account for four per cent of municipal budgets.[27] Matching this level of expenditure in LMICs is often not possible, and most government expenditure goes towards street sweeping and bulk removal of waste from community collection points. The segregation and collection of waste, such as recyclable plastics, is extremely rare. For example, while South Africa has a more comprehensive waste management infrastructure than most LMICs, over 90 per cent of waste that could be recycled ends up in landfills.[28] Even when plastic waste is separated and collected at source, many countries lack the capacity to process, manage or dispose of their waste effectively, resulting in environmental leakage. In the Philippines, for instance, it is estimated that 74 per cent of the plastic waste entering the ocean had previously been collected.[29]

The inability of the public sector to finance effective waste management can act as a catalyst for more innovative circular economy models led by the private sector. However, a key constraint of private sector-led waste management is that waste collection contracts are often provided to planned areas containing a high proportion of higher income households. Even small-scale contractors tend to cherry-pick the most profitable clients who are most able or willing to pay for collection services.[30]

Customer apathy towards recycling is also a major barrier. Surveys conducted in South Africa at the end of 2019, for instance, revealed that there was a lack of motivation for recycling among consumers of all demographics and age groups. Those who were motivated did not know how to start, what to do with their recyclables, where to take them or whether recycling was worthwhile (i.e. they were unsure what actually happened to post-consumer recyclables).[31] In Kenya, poor recycling attitudes and behaviours have made it harder for plastics organisations to consistently collect the high volumes of plastic waste that make transporting, sorting and recycling plastic economical. When recycling volumes stagnate, plastics organisations must hope for subsidies to help incentivise collection and pay for labour-intensive processes, such as sorting. These funds often come from non-profit organisations or multinational brands like Coca-Cola, Nestlé and Unilever.[32]

Another common constraint is poorly developed or poorly implemented waste management policies and strategies. Although many countries have started to ban single-use plastics, implement policies requiring separation at source, or increase duties on plastic imports, they still lack the capacity to enforce these measures. Lack of data on plastic waste generation, types and flows is a key constraint to more effective and enforceable waste management policies, and limits the ability of municipal governments to plan and develop strategic partnerships with the private and public sectors.

Apart from poor waste management and recycling capacity, LMICs (particularly those in South and Southeast Asia) are also increasingly production sites of virgin plastic polymer and products, with ambitious targets to help meet demand in global and domestic markets. China leads in global production, while India, Bangladesh, Thailand, Pakistan and the Philippines have all seen increased investment in their plastic manufacturing sectors. Most LMICs are also experiencing a rapid increase in the use of single-use items, such as fast food packaging, which is adding significantly to plastic waste leakage, especially since they are often made with materials that cannot be profitably recycled.

25 Kaza, S., Yao L., Bhada-Tata, P. and Van Woerden, F. (2020). What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050. World Bank Group. Urban Development Series.
26 The Pew Charitable Trusts and SYSTEMIQ. (23 July 2020). "Breaking the Plastic Wave: A Comprehensive Assessment of Pathways Towards Stopping Ocean Plastic Pollution".
27 Kaza, S., Yao, L., Bhada-Tata, P. and Van Woerden, F. (2020). What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050. World Bank Group. Urban Development Series.
28 Stats SA. (5 September 2018). "Only 10% of waste recycled in South Africa".
29 WWF-Philippines. (October 2020). EPR Scheme Assessment for Plastic Packaging Waste in the Philippines.
30 DFID Knowledge and Research on Micro Enterprise in Low Income Countries from 2001 to 2005. This is a common practice in Dhaka, Lusaka and Nairobi.
31 PETCO. (2 December 2019). "New Survey Shows Majority of South Africans Apathetic to Recycling".
32 Ndiso, J. (9 August 2019). "Plastic, plastic everywhere but not for African recyclers". Reuters.

Section 2: **Plastic waste value chains and actors**

Although generally considered to be a public service, plastic waste management can also be viewed as a market system that has the potential to create value at each stage of the value chain in the form of fair and decent employment, sustainable revenue generation, and climate and environmental benefits. According to the Ellen MacArthur Foundation, about 95 per cent of the value of plastic packaging material, or $80 to $120 billion annually, is lost to the global economy when it is not recycled after its first use. This indicates there is a significant economic opportunity for recyclers in LMICs, even if only a fraction of this value is captured. Viewing discarded plastic as an opportunity for value creation is also an important step in LMICs' transition towards more circular economy models of material and resource use.

Plastic recycling value chains in LMICs are complex and involve a wide range of actors responsible for segregating, collecting, sorting, aggregating and recycling. An illustrative value chain, which assumes the absence of public waste collection services, is described in more detail on the following page, providing high-level insights into the types of actors and entities involved. Plastics organisations can engage across various stages of the value chain, for instance, by using digital technology to integrate waste pickers in more formal value chains, or by aggregating, recycling and selling recycled plastic waste in domestic or international markets (these digital solutions are explored in more detail in Section 4).

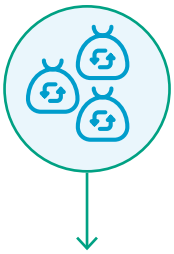
Informal actors in the plastics value chain, such as waste pickers and aggregators, often find profit in recycling ventures where their larger counterparts cannot. In their "invisible economy", these entities are not usually registered, do not pay tax and tend to informally use land that they do not pay for or lease. Even when working in extremely rudimentary conditions, the informal sector can often recycle considerable quantities of recyclables with little to no start-up or operational costs. However, the nature of their role means that many people operate without protection, recognition or social benefits. MNOs and other stakeholders, including formal plastics organisations, must learn to operate at the intersection of formal and informal markets, taking their social responsibility for the well-being of waste pickers and aggregators seriously. Enabling these actors to become formalised in the value chain, with the incentive of accommodating tax arrangements, could also lead to greater scale.

It is also worth noting that many value chain actors, both informal and formal, can often earn additional revenue by diversifying the types of materials they collect, aggregate and transport, often while working with many of the same value chain actors and utilising the same waste "hotspots" (e.g. shopping malls, hotels, waste transfer stations). Other valuable recyclables, such as metals, glass and electronic waste (e-waste), can help subsidise the collection and transport costs of PET, HDPE (high density polyethylene) and lower value plastics.

The plastics value chain

Local retailers put plastic materials from domestic and international brands, such as packaged food, water bottles or consumer goods, into the market. **Consumers** use the product or good and then discard the packaging. Most often, discarded plastic waste is not separated from other materials before it is disposed of in communal bins or collected from their home.

Waste pickers collect recyclable goods from households, businesses, public spaces and landfills. In 2016, informal waste pickers were responsible for approximately 60 per cent of global plastic recycling, and accounted for up to five per cent of jobs in cities in LMICs.[33] These workers typically receive very low returns on their collected waste, and lack basic protections and access to services (such as banking or mobile internet). There is widespread involvement of vulnerable persons, such as women and children, and much higher barriers for those with disabilities. A waste picker in an LMIC might receive between $0.03 and $0.04 for one kilogram of collected PET.[34]



Scrap shops and **aggregators** purchase and segregate raw recyclables from waste pickers. They generally lack formal training or education, but are capable of using cash flow and an understanding of market trends to take advantage of resale opportunities. They add minimal value to the materials themselves other than aggregating them into the minimum quantities required to attract the next actor in the supply chain, such as light or medium recyclers. Smaller scale recyclers typically require deliveries of one or two metric tonnes of plastic "feedstock" to operate their light machinery (balers and shredders) in a cost-effective way. Segregation and aggregation activities are often carried out on land that is rented or used informally, for example, by piling plastic on the side of a national road reserve or on the football pitch of a nearby school. These actors will often collect and aggregate other waste recyclables, in addition to plastic (e.g. paper, metals, glass).

Light and medium recyclers tend to add value to plastic waste by using simple technologies, largely to improve the volume efficiency of the waste so that it can be transported or shipped to domestic and international buyers. They seek to identify the cheapest source of plastic waste to maximise profits, and will most commonly sell their outputs to mega-aggregators or domestic buyers (since they do not have the capacity to process it further themselves or export it). These buyers will then resell the resource once more, either to a local manufacturer or large-scale recycling enterprise capable of processing and exporting in the international market. A light or medium recycler might receive between $0.13 and $0.14 for one kilogram of recycled PET.

Heavy and industrial recyclers are typically corporate, scaled entities with access to advanced recycling machinery. They typically source large volumes of raw or lightly processed material directly from light or medium recyclers or from larger scale aggregators. Because a heavy or industrial processor is capable of producing a high-quality, consistent and logistically efficient output, and has access to land and financial capital, they are in an ideal position to market their product domestically or in the international market. A heavy or industrial recycler might receive between $0.30 and $1.10 for one kilogram of recycled PET.

Brand owners and **consumer goods companies**, either from the international or domestic market, purchase recycled plastics for use in future products or services as an alternative to virgin plastics. Demand for recycled plastics is currently outpacing supply as more and more companies reduce their use of virgin plastic in response to consumer demand and Extended Producer Responsibility (EPR) policies. To address this shortfall, some companies are working with plastics organisations in LMICs to subsidise investments in new technologies and approaches. The ability of a plastics organisation to find a "legacy client" or consistent buyer for their product can often determine whether they can withstand market shocks (e.g. a drop in the price of crude oil or shipping delays). These contracts and partnerships, pegged to fair and consistent pricing structures for commodities traded, also provide recyclers with a rare, but highly valued, opportunity to scale their collection and recovery capacity.

33 UN-Habitat. (2010). Collection of Municipal Solid Waste in Developing Countries.

34 This is an estimated average across LMICs based on stakeholder interviews, and is the approximate price received by waste pickers in India before the Covid-19 pandemic (see footnote #39). Actual prices can vary greatly based on location and other factors.

Case study
Mr. Green Africa (Kenya)

The city of Nairobi produces around 2,400 tonnes of solid waste every day, roughly 60 per cent of which is collected and 10 per cent is recycled.[35] The sector relies heavily on socially marginalised, informal waste pickers to collect recyclables from dump sites and streets, which are then sold to informal scrap yards at a price that can change on a daily basis. From there, recyclables are sold to informal brokers and, finally, reintroduced into local manufacturing value chains. This system is largely ineffective and is characterised by high volatility and low levels of transparency.[36]

Mr. Green Africa, the first recycling company to be a Certified B Corporation on the African Continent, is a technology-driven, for-profit organisation with a mission to create sustainable, long-term social, environmental and economic impact through the collection, conversion and selling of post-consumer plastic waste. They aim to disrupt the current informal and exploitative plastic recycling sector in Kenya by integrating informal waste collectors (who are viewed as "farmers who harvest every day") in their value chain, leveraging technology to manage and streamline operations, and producing fairly sourced recycled materials for local and international markets. Their work has been supported by DOB Equity and by UK aid through the TRANSFORM programme[37] and by the Global Innovation Fund.[38]

Through their network of trading points throughout Nairobi, Mr. Green Africa can purchase recyclable plastic waste from waste pickers for a fixed premium price per kilogram. Whereas most waste pickers only collect and sell plastic waste when the market price is lucrative, those selling to Mr. Green Africa are guaranteed a stable and comparatively high selling price. This ensures that the company can maintain a consistent and predictable supply of raw material. Mr. Green Africa also has an app-based supplier loyalty programme, and provides a number of services to waste pickers, such as life and business skills, health assistance, access to microcredit, protective clothing and, in some cases, mobile phones.

35 Wiener, M., Gall, M. and de Oliviera, C.C. (September 2018). Circular Business Model Innovation: Insights from Mr. Green Africa.
36 Ibid.
37 See: https://www.transform.global/projects/mr-green-africa/members/all-members/
38 See: https://www.globalinnovation.fund/investments/mr-green-africa/

Premium prices can be offered to waste pickers, or sourcing agents, for their plastic because digital technology has allowed Mr. Green Africa to streamline the value chain and increase the end value of the recycled materials through high-quality processing. Their digital platforms track the flow of plastic waste through the entire value chain, provide an auditable payment trail, and create individual profiles on each of the waste pickers. This allows them to provide better support and mentoring, and to predict the quality, timing and volumes of plastic brought in by each agent.

Their processing equipment, housed at a factory in Nairobi, allows Mr. Green Africa to convert locally collected plastic waste into high-quality PCR (Post-Consumer Recyclates) that can be sold to Kenyan and regional partners as a competitively priced substitute for imported virgin plastics. To close the loop, Mr. Green Africa works closely with multinational companies across the entire plastic value chain (such as Unilever and Dow) and third-party plastics manufacturers, helping them realise their sustainable packaging goals by providing ethically sourced, locally produced PCR. While sustainability and social impact benefits are increasingly important for international corporations and fast-moving consumer good companies (which see positive marketing opportunities), customers also find the cost advantage of the recycled plastics over virgin resins to be very compelling.

Mr. Green Africa's focus on inclusivity, diversification (of types of plastics collected) and local supply chains has allowed them to maintain a consistent supply of raw materials during multiple shocks, including falls in oil prices, the plastic import ban in China (which distorted market prices) and, most recently, the COVID-19 pandemic. In fact, the organisation has doubled their collection volumes in the past year, from 90 to 100 tonnes per month in 2019 to 200 tonnes in 2020. The use of mobile apps and other digital technologies has provided operational efficiencies that are equally critical to their success, and without mobile money integration it would be much harder to manage internal processes, facilitate high volumes of small transactions (KSh 50 to 200) or prevent fraud.

Like many other plastics organisations, Mr. Green Africa contends that partnerships with MNOs would "bring their business to the next level" by allowing them to move to a more consumer-focused model whereby consumers could bring plastic, and possibly even e-waste, to collection locations and earn points that can be redeemed for goods, such as mobile airtime or data bundles. Partnering with MNOs would also enhance their ability to raise awareness of plastic recycling and incentivise behaviour change, such as booking collections and separating recyclables at source. As Mr. Green Africa continues to develop and innovate, they also plan to improve the way they measure their environmental (e.g. reduction in emissions or plastic kept out of the ocean) and social impact, and aim to scale the number of agents brought into their value chain.

For more information, see: www.mrgreenafrica.com

Section 3:
Value drivers in the plastics value chain

Demand for recycled plastic is driven by many factors. The single most significant one is the ability of international manufacturers to save costs by replacing virgin plastics with cheaper, recycled alternatives. Naturally, the economics of using recycled plastic in production is highly dependent on global oil prices and the corresponding price of virgin plastic. Falling oil prices during the COVID-19 pandemic have created serious challenges for waste pickers and plastic recyclers in LMICs, with lower demand for recycled plastic creating severe price shocks. Data from the city of Pune in India, for instance, shows that the price paid to waste pickers for PET has dropped to as little as 10 rupees ($0.01) per kilogram from 22 rupees before the pandemic.[39]

Without cost-effective access to the global recycled plastic market, plastics organisations involved in processing and/or selling recycled plastic to larger manufacturers rarely find a viable pathway to scale. Large cities or states with their own ports provide more favourable freight costs for plastic imports and exports, providing greater advantages in the global plastic recycling commodity market. However, landlocked countries facing high import costs for virgin plastic can also create demand for domestically sourced plastics, propping up local recycling value chains that are less dependent on global forces. Common examples of this trend include landlocked nations such as Uganda and Rwanda, which have relatively high demand for plastic from domestic manufacturers, and must also pay substantial premiums and navigate tedious procedures to import virgin plastic from Southeast Asia. In this sense, local processing and manufacturing solutions would be ideal and help to reduce both transport costs and emissions. However, this is far from the reality of many LMICs, particularly in Africa.

A second key driver is the rise of socially responsible plastic. To sustain their arduous labour inputs, informal waste pickers deserve decent and, more importantly, consistent pricing for the commodities they are collecting. However, severe shocks to the market have left many informal plastic recycling workers, particularly those in LMICs, without the cash flow or financial momentum to weather the next wave of market turbulence.[40] Socially responsible plastics mirror the scaled successes of the Fairtrade Foundation. Just as consumers are willing to pay more for bananas and coffee for the promise of decent working conditions for foreign farmers, consumers will also pay a premium to subsidise and support the work of informal waste workers overseas. Corporate suppliers and larger companies are taking notice and are increasingly financing and sourcing social plastics for manufacturing in response to this new pressure from socially conscious consumers.

39 The Economist. (16 December 2020). "Covid-19 has posed new challenges to the world's waste-pickers".
40 The Pew Charitable Trusts and SYSTEMIQ. (2020). (23 July 2020). "Breaking the Plastic Wave: A Comprehensive Assessment of Pathways Towards Stopping Ocean Plastic Pollution".

Recent initiatives by plastics organisations, such as **Plastic Bank**, **Thread** and **Plastics for Change**, are providing evidence of the potential of socially responsible plastic. While currently operating at relatively low volumes (compared with industrial polymer recycling activities), these organisations are quickly gaining momentum as conscious consumers demand fairer working conditions for the world's informal waste workers and attempt to mitigate the impacts of unmanaged plastic waste polluting land and marine environments. A novel idea, socially responsible plastic tests the willingness of consumers and/or MNOs to potentially pay higher prices for the same raw commodity in exchange for the peace of mind that the waste workers who sourced the plastic were paid decent wages and were not exploited.

A third key driver is the growing requirement for recycling driven by national Extended Producer Responsibility (EPR) regulations. EPR policies are often the best option available to national governments to promote waste reduction, recovery and recycling, and to lend greater support to value chains across the solid waste management and recycling sector. Seeking to delegate greater responsibility for waste management to waste producers and manufacturers (beyond the point of sale), public actors can help ensure recyclers receive a greater portion of high-value recyclables, while also limiting the risk of unsafe disposal, particularly for hazardous waste items, such as electronics. In LMICs, EPR policies are still in their infancy, going through slowly iterating draft designs in an often bureaucratic process. Generally, EPR mechanisms in these countries have often been poorly or too broadly designed, and not implemented successfully due to complications with enforcement and compliance.[41] Key challenges include:

- **EPR mechanisms often set ambitious targets (e.g. recycling rates, waste collection rates, banning of single-use plastics), but lack the basic corresponding fiscal instruments that lead to scalable shifts in business practice.** In their infancy, EPR mechanisms at the very least require public subsidies or favourable fiscal instruments. For instance, an EPR that seeks to promote plastic recycling can be coupled with an increase in tipping fees at landfills, tax waivers for recyclers based on increased volumes collected or the phased banning of single-use plastic products, such as plastic carrier bags.
- **EPR mechanisms are normally designed and legislated at a national level by national government actors, but then must be implemented by local municipal actors.** Waste management is inherently a municipal/local government function, and is ultimately governed by local, and often informal, public-private partnership (PPP) arrangements. Funding for waste management is often pegged to already stressed municipal revenue streams, and if national governments expect municipalities and local governors to implement new EPR mechanisms, they must complement such policies with additional funding and oversight.
- **EPR mechanisms are often non-specific, to the point that industries can easily exploit loopholes to avoid additional responsibility for the products they manufacture.** Effective EPR mechanisms are deliberately specific, targeting and almost singling out a small group of waste producers. An example of an effective EPR mechanism might include an EPR law that only governs the production of opaque PET plastics (e.g. singling out the small number of manufacturers that produce this non-recyclable and low-quality plastic).

In addition to these key value drivers, there are numerous other factors (or "levers") that influence whether a plastics organisation can achieve scale and sustainability. Scaling might include expanding a digital solution or service to more users in the same context or market (e.g. by targeting new customer segments or increasing marketing to attract new users), expanding to new markets or adding more functions to an existing service or solution to either increase value for current customers or attract new ones (including diversifying into new waste streams). The "Pathways to scale" table in **Appendix 5** summarises the key levers that plastics organisations report can act as barriers to scale, and matches them with potential tech and non-tech enablers. Some of these levers can be internal (e.g. access to data on waste hotspots, digital expertise) while others are external (e.g. enabling policy environment, access to users and buyers).

41 Gupt, Y. and Sahay, S. (July 2015). "Review of extended producer responsibility: A case study approach". Waste Management & Research. 33(7), pp. 595– 611.

Section 4: **Digital solutions in plastic waste management**

While there is great diversity in the structure and scale of plastic recycling initiatives, we have found that in almost all cases, plastics organisations are deploying digital technology in one or more of the following ways: to improve citizen engagement in recycling, to drive operational efficiencies or to increase transparency in the supply chain.

Tools for improving citizen engagement

Digital tools, games and campaigns can help raise public awareness of why and how one should recycle plastic waste, helping to drive behavioural change and increase plastics organisations' access to raw materials. Solutions can also enable citizens to identify sources or hotspots of plastic pollution, or report illegal dumping.

Common technologies used: Mobile apps, interactive content, mobile payments, satellite, drones, GIS mapping

Tools for driving operational efficiencies

Mobile-enabled solutions help match the supply of plastic waste (households, businesses) with demand for collection (waste pickers, plastics organisations). Frontier technologies, such as AI and IoT, are also being designed to improve collection and recycling activities, such as bin monitoring and weighing and the automation of plastic segregation.

Common technologies used: Mobile apps, mobile payments, AI (including machine learning), IoT

Tools for increasing transparency

Online portals and mobile-based tools help connect all actors in the value chain, helping plastics organisations to trace the flow of materials and create digital marketplaces. These solutions create high levels of transparency in the supply chain, which is an important requirement for global brands that want to increase their use of socially responsible recycled plastics in their manufacturing processes.

Common technologies used: Mobile apps, supply chain management software, blockchain, data visualisation software

Through our desk research, we compiled a list of just over 60 for-profit plastic recycling organisations that are leveraging digital technology across these three categories (see **Appendix 2**). The list is intended to be illustrative rather than exhaustive, and focuses predominantly on identifying digital trends among organisations that are active in priority countries in Sub-Saharan Africa (Kenya, Ghana, Nigeria, South Africa and Tanzania) and Asia (Bangladesh, India, Sri Lanka and Thailand). For more details on why these countries were selected, see **Appendix 1**.

The most innovative digital solutions identified through our research (i.e. those leveraging mobile apps, AI and other frontier technologies) tended to be deployed by start-ups and other small and medium enterprises (SMEs) rather than larger, established waste management companies. In many cases, these innovations are being driven by local, digitally savvy entrepreneurs who are on a mission to create profitable businesses that deliver value for both people and the planet. This mission is often supported, and sometimes subsidised, by global and domestic brands that have made commitments to reduce their plastic footprint and support sustainable development.

While mobile phone penetration and the uptake of technology in LMICs have grown exponentially over the past decade, and the use of digital services in other sectors is increasing rapidly, there has not been a similar level of innovation in the plastic recycling and waste management sector. Plastics organisations have described the digital landscape as "very fragmented" and "uncoordinated", and generally feel that examples of best practice were not well documented. To overcome this challenge, plastics organisations were highly motivated to showcase lessons from their own projects and to learn how to replicate the success of others.

Organisations from every stakeholder group in our study described the challenges they face identifying opportunities for cross-sector collaborations to address funding, skills and technology gaps. For plastics organisations, this was true whether they were seeking to develop new products or services or looking for opportunities to replicate or scale existing projects. In many of our interviews, we found that organisations were relatively unaware of the perceptions, motivations and needs of other stakeholder groups, and would welcome support to inform and facilitate conversations that could catalyse new partnerships. At the moment, there are relatively few examples of partnerships between MNOs and plastics organisations in LMICs, and this kind of cross-sector collaboration appears to be more common in Africa than in Asia. However, there was strong interest among MNOs and other technology companies in exploring new partnership models, which are seen as opportunities to deliver on sustainability commitments and to develop long-term commercial relationships.

The majority of digital solutions identified through the research could also be applied to the collection of broader solid waste recyclables, including e-waste. This is particularly true at the collection, segregation and aggregation stages where aggregator models can also be applied to glass, cardboard and other materials with reprocessing value. This could be particularly relevant in contexts where separation at source is increasing and positive recycling behaviours support these efforts.[42]

It is important to acknowledge that digital solutions also introduce the possibility of social exclusion in the plastics value chain, due to lack of access to a mobile phone or smartphone, expensive data rates, low levels of digital literacy and lack of access to charging points. However, these dynamics can be overcome with solutions that are designed with inclusion and accessibility in mind.

42 For example, in Thailand and Sri Lanka, separation at source are supportive practices and a key driver of the use of plastic collection organisations.

Tools for improving citizen engagement

KEY ADVANTAGES:

- More effective public and institutional outreach and awareness raising;
- Ability to incentivise positive recycling behaviours, such as booking collection services or segregating waste;
- Greater public service accountability;
- Crowdsourced data on plastic waste generation, hotspots and flows; and
- Increased efficiencies for waste collectors.

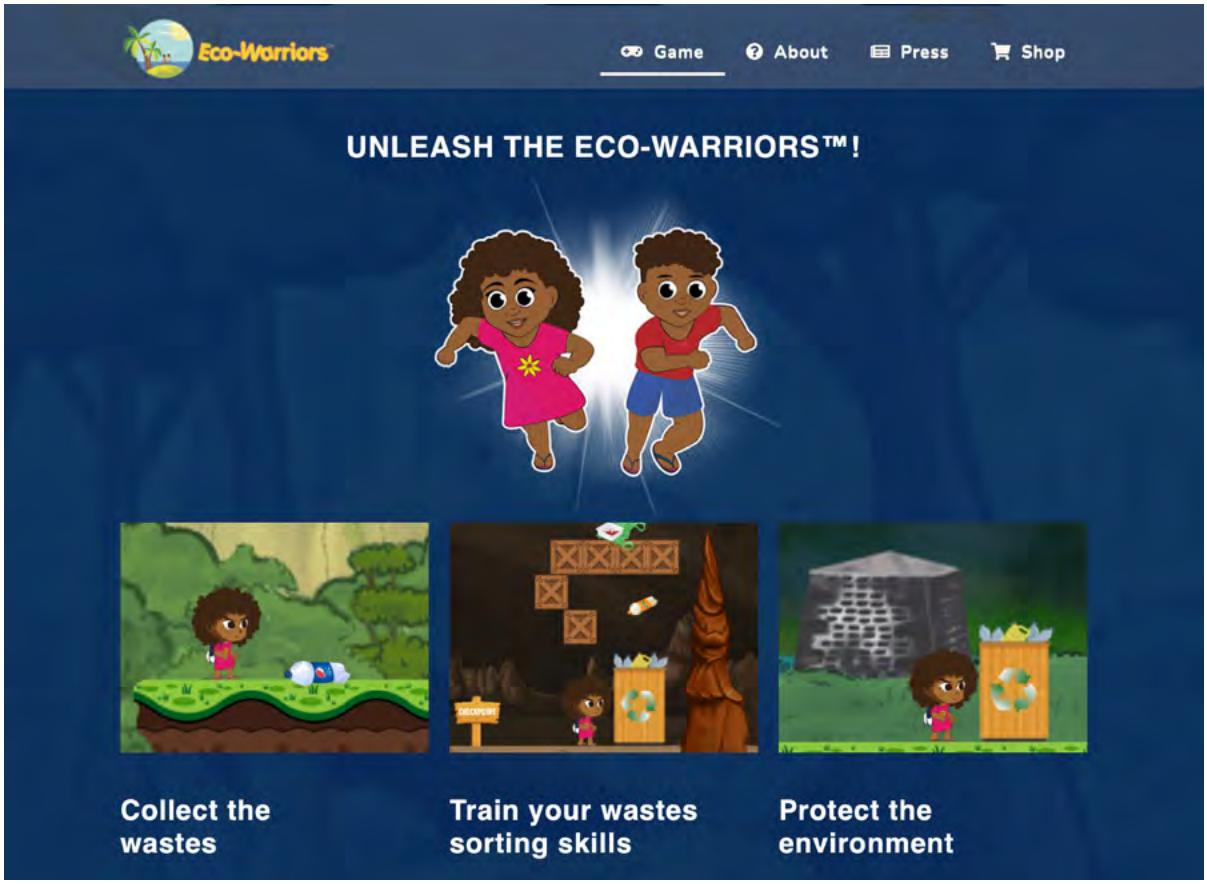
Many plastics organisations report that citizen apathy towards recycling, or simply a lack of information on how and where to recycle, are key barriers to sourcing a consistent and predictable supply of plastic waste. It is also widely recognised that improvements in recycling infrastructure or processes are unlikely to be sustainable if they are not accompanied by a change in recycling behaviour underpinned by widespread public awareness campaigns. For this reason, it is critical for plastics organisations to raise public and institutional awareness of the importance of plastic recycling, influence positive behaviour change (e.g. effective segregation of waste types or proactively booking a collection service) and leverage "citizen science" to identify waste hotpots and flows.

Examples of digital solutions that support awareness raising include public sector-led educational campaigns that target specific cities, regions or countries, as well as mobile-based games and resources that seek to incentivise individuals to act more responsibly. Our research suggests that mobile technology is particularly well placed to raise awareness of environmental issues by gamifying plastic recycling activities that could contribute to positive behaviour change, support fundraising efforts and provide research benefits.[43] For example, the Ocean Conservancy's Clean Swell app encourages concerned citizens to pick up waste around beaches and waterways, and then use the platform to record every item collected. Clean-up results can then be shared with family and friends, and analysed to allow users to see the personal impact they have had on making the ocean a cleaner and healthier ecosystem. Individual data is automatically uploaded to the Ocean Conservancy's database, producing a global snapshot of ocean trash and providing researchers and policymakers with actionable insights.[44] The gamification of plastic recycling can also help raise consumer awareness of "social plastics", encouraging households to support organisations and waste collection initiatives that enhance the livelihoods of waste pickers.

43 GSMA. (2020). Digital Dividends in Natural Resource Management.
44 Ocean Conservancy. (11 July 2017). Fighting for Trash Free Seas.

Changing local perceptions of plastic waste: Eco Warrier (Mauritius)

In 2019, the Prime Minister of Mauritius announced the launch of Moris Nou Zoli Pei, a campaign aimed at promoting the reduction, reuse and recycling of waste. To support the initiative, the digital game Eco-Warriors was designed to provide citizens, particularly children, with access to information about recycling and to promote a sense of civic duty. The game encourages young players to learn more about their country's geo-historical heritage as they guide digital characters who collect trash from beaches, oceans and forests. Children can get a free copy of an Eco-Warriors comic book by exchanging five kilograms of household recyclable waste, such as plastic, paper, glass or metal cans. This call to action not only helps gamers put into practice what they learned in the app, but also helps to track waste patterns. A monthly report on waste tracking and carbon emissions is sent to regional manufacturers to help them understand the indirect emissions of their products and reduce their carbon taxes. Eco-Warriors is the first mobile game to receive backing from UNESCO, and the United Nations has praised the app's combination of technology and entertainment, describing Eco-Warriors as a "next-generation solution" that will have a global impact on our perspective on sustainable development.[45]



45 UNESCO. (31 July 2019). "Eco-Warriors™: The first ever ecological game to be launched under UNESCO's patronage across Africa".

Digital solutions can also be used by citizens to help plastics organisations and other authorities identify plastic pollution hotspots or to report illegal waste dumping activities. Several mobile-enabled data collection tools have been developed to harness the reach of the public and provide an easy way for them to share information on plastic waste types and locations. The data generated from these activities is helping to deepen municipalities' understanding of waste flows, build momentum for new plastic-related policies and inform more targeted responses to clean-up activities.

For example, the **Dawar** app in Egypt was created by waste management solutions company Environ-Adapt in collaboration with the Ministry of Environment of Egypt and GIZ. The mobile app is designed to help citizens report waste placed in streets by facilitating communication between concerned entities, including the Waste Management Authority, relevant district offices and the Ministry of Environment, so that they can jointly manage waste recovery. Users of the app report the waste and its location, and soon after receive a photo proving that the waste has been removed.

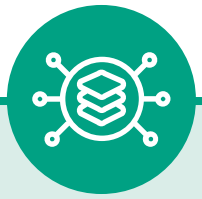
There are also several examples of organisations using satellite images, drone footage, AI-based image recognition and analysis, and GIS-based spatial mapping to interrogate data and identify plastic waste hotspots and flows. In addition to creating engaging content for consumers, this data can inform better strategies for tackling plastic waste and help plastics organisations source higher volumes of raw material.

Educating the world to drive change: Ellipsis Earth (global)

Ellipsis Earth specialises in detecting, categorising and tracking plastic waste that has been leaked into the environment, particularly along coastlines, oceans, rivers, cities, railways and road networks. They work with waste management companies, local and national governments around the world, as well as academia and non-profits to provide scientifically robust, globally comparable data on plastic waste provenance and movement. Drones are used to scan and capture images of polluted areas, and Ellipsis' custom machine learning algorithm analyses the images to identify plastic with 93 per cent accuracy. Their software can then classify what the plastic is (e.g. a plastic bottle, fishing net or toothbrush), the type of plastic, and even the brand. This data is used to create detailed heatmaps of waste hotspots, and to advise partners on the best approaches to tackle and prevent future plastic pollution. Through their media arm, Ellipsis uses this content to produce engaging and thought-provoking content for environmental education.

Visualising plastic waste: Trashmap (Tanzania)

In 2019, OpenMap Development Tanzania created an interactive map of informal dumpsites and waste hotspots along seven of Dar es Salaam's polluting rivers, as well as in informal settlements across the city. The map, and the tools that it produced, were sourced from over 35 drone flights, coupled with extensive in-house spatial analysis. The resulting TrashMap provided a comprehensive overview of the dumpsites responsible for clogging rivers and waterways, and magnifying flood risks across the city. Robust spatial data showed crude dumping practices across the city, quantifying volumes, characterising waste typologies and linking data to baseline census and socio-political variables. The map is interactive and user friendly, tailored to a local Tanzanian profile while also aligned with international best practice through QGIS, UMap and Humanitarian OpenStreetMap. Following initial pilots supported by the UK Foreign, Commonwealth & Development Office (FCDO) and The World Bank, several local plastic waste collection companies, including The Recycler, Green Waste Pro and Tirima Enterprises Ltd., independently contracted the creators of TrashMap, recognising that their spatial data could help them develop more efficient and profitable plastic recycling and recovery operations.



Tools for driving operational efficiencies

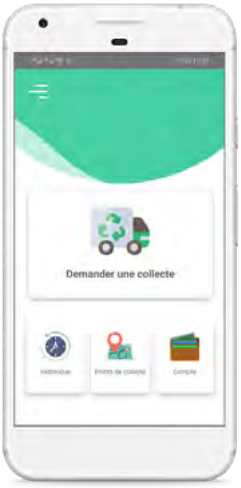
KEY ADVANTAGES:

- Greater ability to match supply and demand for plastic waste;
- Improved experience for plastics organisations' customers;
- More efficient sourcing of plastic waste and lower transport and storage costs; and
- More effective waste collection and sorting processes.

Sixty per cent of the digital solutions in our research sample are used to match households, businesses and other entities that generate waste with waste collectors and recyclers. It is most common for organisations to use a mobile app, often supported by a website or messaging service like WhatsApp, to enable customers to report the types of waste they have available and book collection services. The data generated by these apps can be used by plastics organisations to better plan collection routes and timetables, to share recycling information and advice with their customers and to encourage them to use the service more regularly.

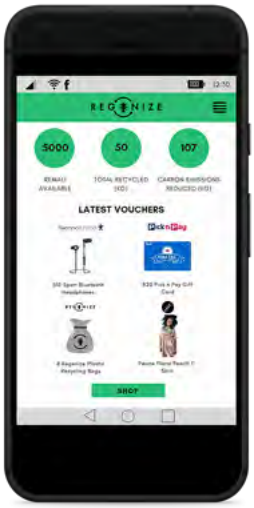
While some plastics organisations pay their customers for plastic waste with cash or other incentives, others charge households and businesses a fee for their collection service. Those that offer their customers value in exchange for plastic waste, such as **Coliba** or **Mr. Green Africa**, can rapidly expand their customer base with the promise of payment. The more traditional model of charging customers for a collection service, used by organisations such as **Yo-Waste** in Uganda, enables income to be earned from obtaining the separated plastic waste and from selling it to the next actor in the value chain, leading to more lucrative margins. However, the customer base for fee-for-service organisations is likely to be more limited.

Creating value from waste: Coliba (Côte d'Ivoire)



Coliba offers plastic recovery, collection and recycling services by connecting Coliba Rangers (waste pickers) to homes, institutions and communities through their mobile app (see right). Coliba launched operations in Côte d'Ivoire in 2017. Waste pickers who are formally employed by the start-up collect plastic bottles from businesses and households in exchange for points that are sent through the app or SMS. After being cleaned, the plastic waste is turned into pellets in Coliba's local factory and resold to local or international companies to produce repurposed and recycled products. In 2018, Coliba received a grant from the GSMA Ecosystem Accelerator Innovation Fund (supported by UK aid) to develop its mobile app and deploy its door-to-door plastic bottle collection service in 10 districts across Abidjan. Through this collaboration, Coliba recognised that using mobile money platforms to facilitate payments was an opportunity to create value for both their own organisation and an MNO partner. After showing a local MNO, MTN, the volume of transactions the service would drive, a partnership was formed. Coliba and MTN Côte d'Ivoire now have a commercial and co-branding partnership that enables Coliba users to exchange reward points they earn in the app for MTN data credit. In 2020, the GSMA continued their support to Coliba by designing a kisok-based model and "behaviour trigger" plan aimed at helping Coliba understand how to get consumers to regularly recycle their plastic and increase the amount of plastic Coliba collects from households.[46]

Accessible, inclusive and rewarding: Regenize (South Africa)



Regenize provides residential recycling collection services using a mobile app (see right) that allows customers to either pay a small monthly fee for door-to-door collection services, or to drop their recycling at collection points free of charge. They also partner with waste pickers who use the app to connect with customers, and who are provided with uniforms, recycling tricycles and smartphones. All residents who recycle through Regenize are rewarded with Remali, or "Recycling Imali" ("money" in Xhosa), a virtual currency that encourages and rewards environmentally sustainable behaviour. The currency can be used to purchase supermarket gift cards or data and airtime from MNOs, such as MTN, Vodacom, Telkom Mobile and Cell C.

46 GSMA. (2021). Five key insights from evaluating Coliba: a recycling start-up in Côte d'Ivoire.

Mobile devices and GPS trackers are being used by plastics organisations, such as **TakaTaka Solutions** in Kenya and **Tirima Enterprises** in Tanzania, to improve the management of collection vehicles and reduce transportation costs. There are also examples of frontier technologies being used to improve vehicle fleet management and other operational efficiencies, such as collection, billing and segregation. For instance, connected devices placed in bins enable plastics organisations to monitor their weight and contents in real time, allowing them to automatically invoice customers or ensure that collection vehicles are only routed to pass bins that need to be emptied. In Bangladesh, MNO **Robi Axiata** provided 500 sensors to the Dhaka City Corporation to help the city continuously monitor the status of waste inside the public bins and to inform authorities when to collect the waste. The digital system proved to be much more efficient than any other conventional waste management system, as it reduces labour, prevents spill over of waste, saves time and is more economical.[47]

AI also has the potential to improve how plastic waste is segregated. This could be deployed at the household level, for instance, **Gringgo Tech** in Indonesia is developing an AI-powered app that will help households identify and sort plastic waste.[48] It could also be used in material recovery facilities and plastic processing factories.

Smart waste solutions: Ishitva Robotics (India)

Launched in India in 2018, Ishitva Robotics Systems builds efficient waste management solutions using frontier technology. The start-up deploys AI, robotics and machine learning to decipher the composition of waste brought to recycling centres, and sorts them into various categories using recyclable and non-recyclable labels. The process is automated by their proprietary algorithm ishitvAI, which has improved both the quantity and quality of sorting processes. Manual sorting is a slow and inaccurate process that increases the chances of more waste being dumped and some waste not making its way into the recycling ecosystem. The company also uses smart bins in urban areas to collect data on the kind of waste being generated, which Ishitva says will be useful for understanding and identifying waste disposal trends, resulting in better management. The data collected remotely by the bins populate an online dashboard that authorities can use to monitor contents in real time, and automatically sends SMS alerts when a collection is required.

47 Sohag, M.U. and Podder, A.K. (July 2020). "Smart Garbage Management System for a Sustainable Urban Life: An IoT Based Application". Internet of Things, Volume 11.
48 See: https://www.gringgo.co/gringgo-google-ai

Tools for increasing transparency

KEY ADVANTAGES:

- Better integration of informal and small-scale operations with more formal, large-scale recyclers and big brands;
- Access to market information to ensure all actors receive fair and decent prices for plastic waste;
- Provide brands with assurance that they are purchasing high-quality, ethically sourced recycled plastics and fulfilling EPR requirements; and
- Ability to establish an auditable trail of financial transactions and to measure environmental and social impact.

Supply chain management platforms are designed to help plastics organisations guarantee a reliably consistent flow of plastic waste into their processing factory. These solutions often deploy mobile devices and online portals to link informal actors to a digital supply chain, and which collect vast amounts of data at every stage. This might include the location, volumes and types of plastic materials being collected, prices being paid for raw materials, payment methods, aggregator stock levels and recycling rates. This information can be monitored in real time to inform management decisions or respond to incidents, or it can be analysed over time to identify trends and make predictions about future waste flows.

Supply chain management solutions often go hand in hand with digital marketplaces, which provide all actors in the value chain, particularly waste pickers, with up-to-date information on the market prices they should expect for their plastic waste. Examples of innovative supply chain and marketplace solutions include **Jumeni Technologies' Dispose Green** app in Ghana, and the **Recykal Marketplace** in India. **SAP** is also preparing to pilot a supply chain management solution for plastic waste in Ghana based on their successful agriculture-focused Rural Sourcing Management Tool.[49]

49 Meyerhoff, R. (29 October 2020). "Ghana's Ambitious Plan to Minimize Plastic Waste". SAP.

Case study
Banyan Nation (India)

India recovers around 70 per cent of plastic waste through informal recyclers, but almost all this material is downcycled in an unscientific manner. As a result, brands in India shy away from using recycled plastic from domestic recyclers despite making global commitments to use less virgin plastics in their products and services. Layers of complex informal recycling networks (through which plastic waste is passed from roaming collectors, to stationary scrap shops, to aggregators and, finally, to small-scale recyclers), manual segregation processes and a lack of recycling and cleaning technology all contribute to this challenge.

Banyan Nation is an innovative, technology-driven plastic recycling and waste management company with a mission to build India's first vertically integrated formal recycling business. Their innovation lies in efforts to address the three key challenges in plastics recycling: using digital networks to address the "last mile" of informal plastic waste aggregation; developing a cost-efficient strategy for sorting, cleaning and recycling waste into pellets that are comparable in quality to virgin plastic; and partnering with domestic companies and multinational corporations that use the recycled waste in new products and packaging.

Banyan Nation's mobile and cloud-based data intelligence platform, deployed in various cities across India, collects crucial data on plastic waste by developing individual profiles of thousands of waste collectors and aggregators, integrating them in a formal, responsible supply chain. Using an interactive dashboard, the organisation maps the location of each aggregator, their personal details and contact number, their level in the value chain, the prices they are paying to waste collectors and the types and volumes of plastic materials they collect. By creating a "birds-eye view" of plastic waste flows, they are able to track large volumes of high-value plastic collected

throughout a city, as well as the low-value and unrecyclable plastics that are likely to be discarded in landfills or waterways. In addition to creating operational efficiencies, this data is helping to track the flows of e-waste in Hyderabad, all solid waste in Warangal, ocean-bound plastics in Chennai and the flow of plastic in the Ganges River in Varanasi.

Through their mobile app, scrap shops and aggregators in Banyan Nation's network can send data and geotagged images of waste and details on when it would be ready for delivery. This allows Banyan Nation to optimise the supply chain in real time, predict how long it will take the raw materials to arrive at their recycling facility and notify buyers when the recycled material will be ready to ship. This is a huge advantage given that brands and plastics manufacturers do not have very flexible production schedules.

Once the plastic is ready to be recycled, Banyan Nation's proprietary plastic cleaning technology converts collected post-consumer and post-industrial plastic waste into high-quality recycled granules that is comparable in quality and performance to virgin plastic. They currently focus on "bottle-to-bottle" circular economy applications in which material traceability and quality are key requirements for major fast-moving consumer goods (FMCG) brands aiming to replace virgin plastic. Unilever and Reckitt Benckiser, Shell and Castrol are among their primary partners. While most current contracts and sales are in India, there is growing demand for Banyan's recycled granules in the Middle East and Southeast Asia where Banyan has begun exporting their material.

Banyan Nation understands that people are at the centre of sustainable production, and has consciously built systems that ensure all stakeholders in their supply chain and production systems are treated fairly and with dignity. They recognise that millions of poor households in India rely on waste collection for their livelihood. Instead of displacing these livelihoods, they work to integrate informal workers – who have tremendous last-mile access – to form the most resource-efficient recyclables supply chain in the world. They also regularly train the scrap collectors in their network to help them add more value to their scrap through better segregation. Anecdotal evidence suggests that many of the scrap dealers in Banyan Nation's supply chain have benefited financially (through better income, reliability and stability) from their association with the company.

MNOs can help proliferate Banyan's outreach and impact and reap commercial benefits through strategic partnerships. First, MNOs could leverage their mobile money platforms to facilitate digital payments to thousands of suppliers while also offering incentives for segregation, such as free talk time or data. MNOs could also help raise consumer awareness of recycling, and its benefits to the environment and circular economy, by supporting targeted messaging campaigns. Finally, Banyan Nation hopes that MNOs or other technology companies could leverage their digital platforms or technical expertise to support their data collection efforts, for instance, by co-developing tools that would give them better insights into waste flows and volumes.

For more information, see: www.banyannation.com

One of the key drivers of a more circular economy is the willingness of manufacturers and brands to increase the use of recycled or social plastic in their products and packaging, either as a cost-effective alternative to virgin plastics or to meet EPR requirements. The ability of plastics organisations to trace the provenance, quality and flow of plastic through the value chain – and to demonstrate the positive social and environmental impact of their operations – will be critical to the development of this new sector. Organisations like **Plastic Bank** (Haiti, Brazil, Indonesia, the Philippines and Egypt), **Plastic for Change** (India) and **Empower** (active in 15 LMICs), are innovators in this space, and have established collection centres where informal waste pickers and others can trade plastic waste for cash, mobile credit or other vouchers. The procurement process and mobile platforms (some of which use blockchain technology) builds transparency and accountability into the supply chain and enables the organisations to certify quality at every stage.

Responsible and fair supply chains: Plastics for Change (India)

Plastic for Change's ethical sourcing platform connects informal waste collectors to global markets, ensuring that brand partners receive a consistent supply of high-quality recycled plastic through their responsible and transparent supply chains. The organisation has adopted strategies from fair trade agriculture and applied them to the informal recycling economy in LMICs. In addition to providing urban waste pickers with access to fair market prices, Plastic for Change's mobile platform enables the organisation to create an auditable trail of every transaction and trace the provenance of collected plastic waste. Operating in Bangalore, and now expanding to coastal communities across Southeast India to reduce ocean plastic, the platform enables global corporate clients, such as The Body Shop, to improve their social and environmental impacts and meet India's EPR requirements by purchasing ethically sourced recycled plastic. Plastic for Change is the first recycler to be verified by the World Fair Trade Organization, and one of the first to be certified as an Ocean Bound Plastic Collection Organisation.

Become plastic positive: Empower (Global)

Empower was founded in January 2018 with a vision to enable people to create a cleaner and better world. Empower has created a fund to finance plastic waste clean-ups using donations from individuals and companies aiming to become "plastic positive". They have set up collection points in 15 LMICs around the world, together with partners that then issue financial rewards in return for the deposit of plastic. Empower issues EMP Tokens worth $1 that are paid out for each batch of waste deposited at a collection point. Payment is made into an e-wallet via a mobile app. Blockchain makes it possible to distribute tokens anywhere in the world, securely and without any intermediaries, and with the guarantee of transparency and traceability. It is therefore possible for the sponsor who made each waste deposit possible to be kept informed of their impact.

Section 5:
A role for MNOs and technology organisations

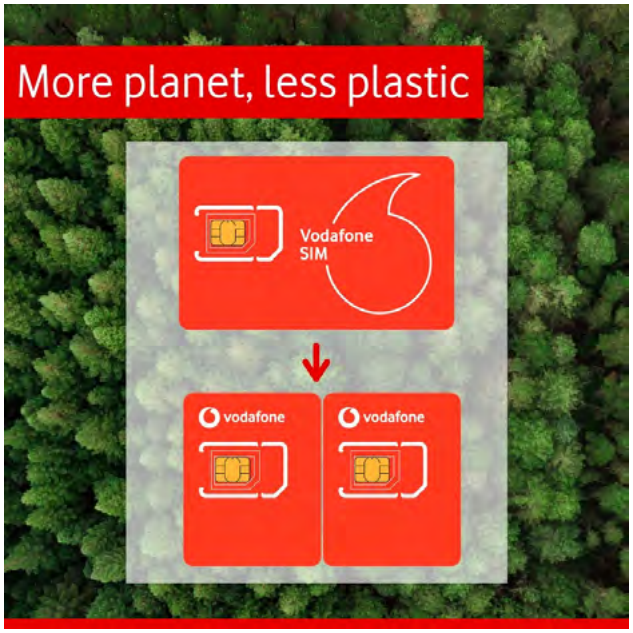
As part of their sustainability efforts, many MNOs and other technology organisations are exploring how to reduce the plastic footprint of their operations, such as eliminating plastic packaging from their goods or services or reducing the amount of plastic used in their day-to-day operations. Beyond these activities, our research revealed that digital and mobile-enabled solutions have clear potential to improve the effectiveness, transparency and fairness of plastic waste value chains in LMICs. There are many opportunities for MNOs and other technology organisations to leverage their resources and technical expertise to make emerging technologies more accessible to, and impactful for, a wide range of stakeholders.

Actions by MNOs to reduce their own plastic footprint

MNO stakeholders participating in our research highlighted that they are already taking steps to reduce their use of plastic, noting that key contributors of plastic waste include bags at retail outlets, SIM card packaging, as well as water bottles and food packaging used in their offices. **Safaricom** in Kenya has developed reusable solutions to eliminate the use of polythene bags in their retail shops and have a three-year plan, culminating in 2021, to eliminate all single-use plastics from their business operations. In 2019, **Globe Philippines** instituted a ban on single-use plastics at its headquarters while also conducting an employee campaign called WASSUP ("Wag Sa Single Use Plastic") that aimed to tackle the impacts of plastic on the environment. The campaign explored innovative ways to address the country's plastic problem (starting with Globe's employees and partners), to improve Globe's recycling infrastructure and to reduce or stop the use of non-recyclable plastics altogether. The responsible disposal of plastic waste is also a key consideration for MNOs. For example, **MTN Côte d'Ivoire** segregates recyclable plastic in their offices and shops and channels it to **Coliba**, which processes it for export to manufacturers.

Becoming a plastic-free organisation: Safaricom (Kenya)

Safaricom is dedicated to becoming a plastic-free environment by eliminating all single-use plastic at their facilities and minimising the plastic used in their retail packaging. This effort began by reducing plastic in Safaricom offices: single-use plastic has been phased out in all cafeterias across the country, staff are encouraged to carry reusable water bottles and single-use plastic tumblers for visitors have been replaced with reusable glasses. In 2019, Safaricom began measuring the progress of their integrated waste management programme, and through a partnership with local waste management company TakaTaka Solutions, they now separate all their waste for recycling. Over 97 per cent of all waste from their main facilities is now either reused, repurposed or recycled. Furthermore, environmental consciousness and waste reduction play a key role in supplier selection, and partners that do not have environmental compliance certifications are disqualified.



MNOs have also recognised opportunities to reduce plastic waste associated with SIM cards. In 2019, as part of a wider strategy to minimise their use of all non-essential plastics, **Vodafone** announced that it would replace their standard credit card-sized SIM holder with a smaller format that reduced the amount of plastic by 50 per cent. Efforts to cut the amount of plastics used in SIM cards are being explored in LMICs, as well. In Kenya, **Safaricom** has halved the amount of plastic used in SIM card packaging, and estimates that this effort has removed 2.52 tonnes of plastic from their organisation and saved KSh 46.8 million ($430,000) in costs.[50]

Designing products with circularity in mind is also reducing plastic use among device sellers and manufacturers. For example, under their Planet First initiative, **Samsung** collects e-waste and reuses the recycled plastic in new products. The ethical, reliable and sustainable **Fairphone 3** smartphone is also now available in five Vodafone markets (Germany, Italy, UK, Spain and Ireland) as part of a strategic partnership between the two companies. Fairphone 3 is sold with sustainable and reusable packaging, and manufactured from responsibly sourced, conflict-free tin and tungsten, recycled copper and plastics, and gold sourced by Fairtrade. **Vodafone** stores also offer customers a range of eco-friendly accessories under the label "Red Loves Green", including fully biodegradable or recyclable phone cases made from, for example, reused ocean plastic, plus charging banks and docks made from sustainable materials and plastic-free packaging. Stakeholders interviewed for our research stated that device manufacturers would support using even more recycled plastic in their products, but are constrained by a lack of standards on quality and traceability. This highlights the important role that improved recycling processes can play in supporting "upstream" innovation.

Green design: Huawei (Global)

Huawei takes a proactive approach to the sustainability of their products and services, and makes extensive use of Lifecycle Assessment (LCA) and design thinking to use more environmentally friendly methods and materials. They use bio-based plastics where possible, and apply a green packaging strategy with the principles of: Right Packaging, Reduce, Returnable, Reuse, Recycle, Recovery and Degradable (6R1D). For example, Huawei's P40 model uses 17 per cent less packaging material compared to their previous devices with similar specifications. The company is also committed to recovering and recycling plastics and e-waste. By the end of 2019, Huawei was running nearly 1,300 recycling stations in 48 countries and regions around the world. Through a paid recycling programme, Huawei's service centres took back over 300,000 used spare parts (totalling 60 tonnes) every month in 2019.[51]

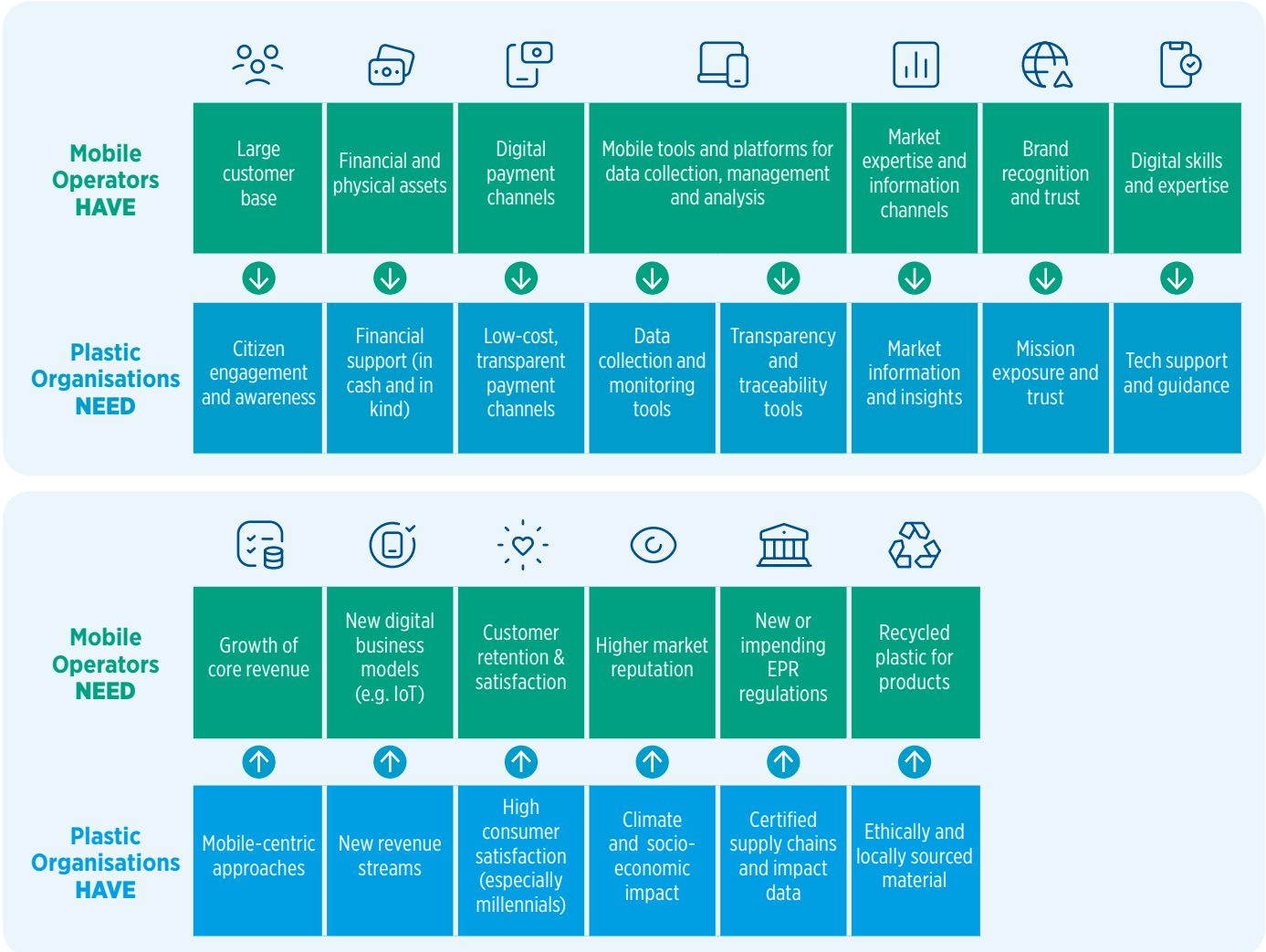
50 Safaricom. (2019). "Environmental Stewardship". Sustainability Report 2019.
51 Huawei. (2019). 2019 Sustainability Report.

Partnerships with plastics organisations

There are several potential synergies between MNOs and plastics organisations that could lead to mutually beneficial partnerships. Plastics organisations could provide private-sector organisations an opportunity to grow their core revenue, develop new digital business models (e.g. around AI and IoT services), increase customer satisfaction and brand loyalty and source recycled plastic for new products. At the same time, technology organisations, including MNOs, could help plastics organisations in LMICs achieve greater impact, sustainability and scale by leveraging their digital platforms, services and expertise, as well as raising awareness among potential users. These synergies, as described by stakeholders themselves, are laid out in Figure 3.

Figure 3

Synergies between plastics organisations and MNOs[52]



52 This has been adapted from the MNO synergies diagram developed for: GSMA Intelligence. (2019). The Mobile Economy: Asia Pacific 2019.

Stakeholders engaged in our research identified several ways in which cross-sector collaboration could lead to mutually beneficial (or "shared value") partnerships with environmental, social and commercial impact. Some of these opportunities draw on the success of digital tools deployed in partnership with MNOs and technology companies in other sectors, such as agriculture, sustainable fishing or natural resources management.

Awareness and education

Many plastics organisations have objectives related to empowering local communities, from understanding the negative impacts of plastic waste to identifying locally relevant ways to manage excess material, to supporting positive behaviour change. Plastics organisations in both Africa and Asia have reported that they need support from MNOs to achieve these objectives and to raise their profile among consumers and businesses. At the same time, MNOs clearly stated that the most immediate value of plastics organisations for their business is enhancing their market reputation as a business that has a positive climate and socio-economic impact. In response to pressure from customers, policymakers and internal sustainability commitments, MNOs are very interested in supporting sustainability initiatives and showcasing efforts to reduce their own plastic footprint.

The COVID-19 pandemic has highlighted how MNO platforms and communication channels can be leveraged to keep citizens up to date with the latest advice while also preventing the spread of disinformation. In many LMICs, MNOs have been working with governments to deliver timely information directly to mobile devices. In a similar way, MNO platforms can be used to promote plastic recycling initiatives and awareness campaigns. Kenyan start-up **Eneza Education** provides a comparable example, as they use low-cost mobile technology to deliver educational lessons and assessments to users via SMS, web and Android platforms. Eneza has partnered with Safaricom in Kenya and MTN and AirtelTigo in Ghana, and now has nearly four million users on its platform in both countries.

It is also imperative that people have the tools to manage waste in a low-tech and low-cost way. In 2017, the ***WasteAid Toolkit: Making Waste Work*** was launched, providing a free online guide to waste management for communities in LMICs. The toolkit provides non-technical background knowledge for people to organise waste management on a community level, as well as a series of step-by-step illustrated guides to turning common waste materials into useful products. It is written in plain English without jargon and unnecessarily complex terms, is fully illustrated and available in desktop and mobile formats.[53] To date, the toolkit has been viewed by over 150,000 people from 218 countries, and downloaded nearly 30,000 times. Because most of WasteAid's beneficiaries view the internet on their phones, more people are accessing the toolkit from smartphones than from desktop computers.

53 See: https://wasteaid.org/toolkit/

Data collection and logistics

It is important for all actors in the supply chain to have up-to-date information on where to find plastic, where to sell it and how much they can sell it for. As with the sharing economy that has produced ride-sharing, car-sharing, bike-sharing and other exchange activities, mobile apps can also find new local buyers for recycled goods by allowing them to notify social enterprises or waste pickers when they are ready for collection. Mobile apps could help waste pickers digitally log their plastic collections in real time or relay their locations back to customers, social enterprises or cooperatives to help manage the timing of pick-ups and other logistics. Once this data is uploaded to a central database, or even a blockchain-enabled decentralised database, it can be analysed to inform waste management decisions, provide traceability to the plastic supply chain and ultimately lead to more sustainable recycling practices.

In other sectors, such as agriculture and sustainable fishing, apps designed by MNOs (see for instance, the **mFish initiative supported by XL Axiata in Indonesia**[54]) not only capture data, but also aggregate and distribute useful content to relevant users around the world to help them become more sustainable and profitable in their methods. Most of these apps are designed for low-income users with limited access to broadband data and who use either a basic smartphone (at best) or feature phone to access content.

Plastics organisations will benefit from partnering with MNOs and other technology organisations to find inclusive and low-cost connectivity solutions that enable them to transmit data and access platforms that provide a suite of data collection, data storage and data analysis (including AI) services and applications. This could help drive more sustainable business models, build lower cost IoT ecosystems and create marketplaces that allow multiple parties to access the data being generated across the sector. With connectivity becoming increasingly commoditised, MNOs are also looking to expand their role in this spacce, from providing essential tools and capabilities for ecosystem partners to build IoT solutions, to becoming end-to-end IoT solution providers themselves.[55]

Digital payment platforms

Plastics organisations often deal with high volumes of small-value financial transactions with a number of stakeholders. Enhanced digital payments support from MNOs, in the form of APIs, lower transaction rates or other incentives, will make the work of plastics organisations easier. Mobile money services, including those linked to blockchain payment platforms, could provide a more convenient, cost-effective and transparent way for organisations to transfer payments to waste collectors and other actors in the value chain. Mobile money platforms could also be a convenient way for plastics organisations to create and sustain rewards (such as vouchers) for both waste pickers and consumers who are separating at source. High uptake of mobile money services in LMICs, particularly among those who work in the informal sector, suggests that collaboration with MNOs would be valuable.

For MNOs in LMICs, digital payments and broader financial services provide an opportunity to diversify beyond connectivity, offset stagnating core revenues and grow their presence in the digital ecosystem.[56] The GSMA Mobile Money programme has also advocated that enabling third parties to integrate with mobile money services is key to driving ecosystem growth, increasing value for end users and creating new revenue streams for mobile money providers.[57] As seen in Figure 4, the benefits of digitising payments across value chains can be both direct and indirect.

54 See: https://mfish.co/about/
55 GSMA Intelligence. (2019). The Mobile Economy 2019.
56 GSMA Intelligence. (2020). The Mobile Economy: Sub-Saharan Africa 2019.
57 Pathy, V. (27 October 2020). "What value do open APIs bring to the mobile money landscape?" Mobile for Development Blog.

Figure 4

Benefits to mobile money providers from digitising payments in LMICs

Direct benefits of digitisation	Indirect benefits of digitisation
Revenue from payment transaction fees	Higher use among existing mobile money users
New mobile money customers in rural areas	Mobile money ecosystem use by new customers
New mobile network service users	Increased network use (SMS, calls, data)
Increased loyalty or stickiness of existing users	Increased agent activity – ecosystem development
Licences for payment platforms and management systems	Uptake of adjacent products (loans and insurance)

Source: GSMA. (2020). Digitising payments in agricultural value chains: The revenue opportunity to 2025.

Improving transparency and traceability

To support their business models, many organisations sell plastic waste to global brands and manufacturers to be packaged as socially responsible plastic – an ethical alternative to virgin plastics in which traceability is critical. **Plastic Bank**, for example, offers access to an auditable and traceable supply chain of quality recovered plastic feedstock. Their proprietary blockchain technology, powered by GSMA member IBM, allows for a transparent and traceable supply chain, and auditable, real-time impact tracking. Their platform can also collect real-time data to measure partnering brands' progress with the Sustainable Development Goals (SDGs).

A comparable example from the mobile industry is **Mezzanine**, a Vodafone-owned company specialising in digital enterprise solutions. Mezzanine sees mobile technology as a major enabler for creating productive societies and delivering last-mile mobile, IoT and digitally enabled solutions that cut costs, increase efficiency, improve risk management and provide unrivalled access to customers across Africa. They have developed a farmer management solution that allows agribusinesses to digitise operations for farmer registration, input management, communication and mobile money payments. The solution has a track-and-trace component that improves visibility into last-mile operations.

Technical support and guidance

AI provides organisations with the ability to analyse and derive insights from immense datasets, but the algorithms used by AI tools must be bespoke, designed for a narrowly focused problem and fed with vast amounts of very specific data. The GSMA has found that, at present, the resources and technical expertise required to develop and apply AI algorithms are a significant barrier for many organisations.[58] The ability of technology organisations to provide access to technical skills, resources and digital expertise to fill this skills gap can be more valuable than project funding. **Microsoft's AI for Earth** programme , for instance, helps put Microsoft cloud and AI tools in the hands of organisations addressing a wide range of environmental challenges. While these types of projects are still difficult to implement if organisations need immediate commercial returns, private-sector stakeholders have told the GSMA that the development of new AI applications – even when incubated by sustainability or CSR functions – may eventually provide long-term commercial value, and could also drive the development of "bridging technologies" that will help them realise the full promise of IoT solutions.

58 GSMA. (2020). Digital Dividends in Natural Resource Management.

Case study
Econet Zimbabwe

While Zimbabwe's capital city faced a waste collection shortfall for several years, many residents first became aware of the severity of the problem during a 2018 cholera outbreak, which the World Health Organization (WHO) estimates cost the lives of at least 50 people. While the official cause of the outbreak was determined to be burst sewer pipes that contaminated the city's drinking water, it was recognised that waste piling up around the city was exacerbating the health crisis.

A team from Zimbabwe's largest MNO, Econet Wireless, joined other volunteers in trying to curb the outbreak by sweeping streets, cleaning drains and picking up rubbish, but once these efforts were finished it became clear that the city did not have the capacity to dispose of all the waste they had collected. In response, an Econet subsidiary, Cassava Smartech, created Clean City Africa. The ultimate aim of Clean City is to provide waste collection and disposal services that divert recyclable waste away from landfills and prevent leakage into the environment by helping to connect various actors in the value chain.

At the time of the initiative's launch, most existing waste management contractors were small operations that focused their activities in wealthier neighbourhoods, resulting in fragmented initiatives that did not have the capacity or resources to collect from more than 500 homes per week, let alone provide a city-wide solution. In response, Econet helped to build the capacity of these organisations, carefully selecting around 20 waste collection companies and turning them into franchisees assigned a specific geographic area. Clean City provides training and equipment to expand their operations, monitors their work and supports collection through the provision of vehicles, marketing and facilitating payment collection.

Through the Vaya Clean City mobile app, households and businesses that are generating waste are easily matched to waste collectors and aggregators. The app collects each customer's personal details, their location and their estimated amount of waste. This information is used to estimate a collection charge, which the customer can pay through Econet's mobile money interface, EcoCash. To accommodate households that cannot afford to pay for household waste collection, Clean City created community collection points where people can simply drop off their waste for a token fee. To ensure that everyone in the value chain was benefiting from Clean City's operations, Econet proposed a model whereby fees are shared between collectors, franchisees, the City of Harare and Clean City. Furthermore, five per cent of the revenue goes to a Community Environmental Service (CES) fund, which covers the cost of cleaning streets and public places. Over 500 people are deployed through CES to clean public spaces every day.

Today, there are over 40 franchisee waste collectors in Clean City's network that have collectively created over 5,000 jobs. Many of these jobs are at material recovery centres where each franchisee must sort and segregate various types of recyclables, including organic waste, plastics, glass, metals and e-waste. Much of this work is done by individuals who previously worked as waste pickers. Working with local authorities and its franchises, Clean City franchisees now cover over 500,000 households in Harare and its suburbs (300,000 of which are regular customers), and over 50 illegal dump sites have been shut down across Harare since the company launched. Furthermore, the service has led to over 10,000 households separating materials at source.

Although the initiative was initially driven by Econet's sustainability and corporate responsibility ambitions, Econet believes that the commercial benefits will increase as the project scales and becomes self-sustaining. New commercial partnerships with global brands, such as Coca Cola, and efforts to drive behaviour change (around waste disposal and segregation, and the acceptance of paying for services using the mobile app) will be key.

For more information, see: www.cleancityafrica.com

Section 6: **Recommendations**

Our analysis of existing projects and conversations with stakeholders suggests there is potential for new cross-sector partnerships and dialogue to catalyse new action. With this in mind, we have developed the following recommendations for four key stakeholder groups.

Recommendations for MNOs

Rationale for action #1:

MNOs can benefit from supporting initiatives that strengthen their reputation as responsible and sustainable companies.

- **Recommendation 1a:** Explore opportunities to work in partnership with plastic waste management organisations, including supporting the creation of digital solutions and providing discounted airtime or data credit to reimburse users for segregating and recycling their plastic waste.
- **Recommendation 1b:** Support governments, NGOs, plastics organisations and other entities to raise public awareness of the importance of plastic recycling and best practice in their local context.
- **Recommendation 1c:** Conduct a cost-benefit analysis of additional investments in socially responsible plastic for in-house products, benchmarking the premium that could be paid for scaled investments in recycled plastic against other sustainability efforts.

Rationale for action #2:

Plastic recycling initiatives could contribute to future revenue streams, for instance, through mobile money transactions or data revenue from increased use of mobile apps or connected devices.

- **Recommendation 2a:** Consider setting up a national or city-wide digital marketplace to better connect actors in the plastic recycling value chains. This could be an effective way to support more efficient and transparent recycling practices, and could also generate income through transactions made on the platform.
- **Recommendation 2b:** Support innovative initiatives through partnerships, accelerators or mentoring entrepreneurs that draw on emerging digital technologies, such as IoT (smart bins or illegal dumping sensors), AI (identifying plastic types) and digital payments (traceability of plastics for due diligence purposes).

To help inform future partnerships, we have created a simple tool to assist MNOs in evaluating whether a plastics organisation is sustainable, viable and scalable. The assessment, found in **Appendix 4**, can help determine whether an organisation mirrors best practice, and if the proposed digital tools or innovations are likely to help achieve scale and sustainable operations.

Rational for action #3:

MNOs must be prepared to comply with future regulations, such as EPR mechanisms. Helping to shape robust EPR policy could also be advantageous if efforts are made to maximise environmental responsibility, which can also be shared with customers to increase brand loyalty.

- **Recommendation 3a:** Take action to understand and measure the use of plastics in products and packaging, and explore ways in which waste plastic from products would be recovered through, for example, a deposit and return scheme on the in-house sale and return of a mobile phone.
- **Recommendation 3b:** Help shape the development of EPR regulations in the local policy environment, with MNOs taking a fair share of responsibility for plastic waste management.

Recommendations for plastics organisations and digital innovators

- Consider how digital solutions can be developed and applied in local contexts to enable more effective and efficient plastic waste management.
- Seek partnership opportunities with MNOs or other tech companies, to enable a range of scale levers, such as increased access to data, user awareness and trust, technical mentoring and digital payment interfaces.
- Aim to meet and be able to prove appropriate standards of quality for processed plastic waste and social due diligence in relation to waste collectors and other downstream value chain actors. This should be considered in relation to the specific needs of a potential client or client type that can integrate recycled plastic into their manufacturing processes.
- Consider how digital tools could exacerbate inequality between waste pickers/collectors and mitigate this, where possible. This includes access to smartphones or charging points. Collaborate with MNOs to design inclusive solutions for all.
- Where relevant, create solutions to enable waste collectors, who are out and about for long periods of time, to recharge their phones during shifts, making digital solutions more practical for them. (See the example of Chanja Datti, Nigeria, which has installed solar-powered phone recharging centres at their collection hubs.)

Recommendations for governments in LMICs

- Take action to improve data collection and analysis on solid waste management, including sources and types of plastic waste, current recycling services and plastic generation and waste streams.
- Share data on waste generation and flows on an open source platform to enable local innovators or MNOs to use it to support solutions that help improve plastic waste management.
- Consider partnerships with MNOs to conduct joint public awareness campaigns about the threats of plastic pollution and that encourage behaviour change around the segregation of waste and recycling plastic waste in particular.
- Proactively prepare and implement new EPR mechanisms, levying fines or extra fees on larger polluters while lifting fees and providing subsidies to those who act more progressively and in line with the aspirations of new EPR policies. Guidance on best practice for EPR policy is available at oecd.org.
- Consider implementing tax incentives for recyclers, which can be an effective way to promote a healthy and vibrant recycling sector. Despite the important strategic role in public service provision and environmental welfare, private-sector recycling companies are levied with a host of taxes that hinder their ability to turn a profit.

Recommendations for donors

- Ensure that investments in improved solid waste management include components on waste reduction, recycling and plastic recycling, specifically.
- Encourage circularity by fostering collaboration and collective action between organisations involved in all stages of the value chain, from the local plastics organisations and actors engaged in plastic collection, sorting and recycling,to global plastic mannufacturers. Donor networks can be leveraged to reduce the use of the most difficult to recycle plastics, improve public awareness about recycling and build support for more effective EPR policies.
- Unite private-sector companies, governments and development partners that are committed to identifying locally appropriate solutions that enable LMICs to solve the plastic challenges unique to their context. Support them with the resources and expertise they need to innovate, develop new business models, scale successful solutions and replicate success in new contexts or markets (e.g. by expanding from urban to rural areas, or to new countries).
- Act as an ecosystem accelerator by promoting win-win partnerships between plastic waste innovators and MNOs. Provide plastics organisations with access to funding to test or scale digital innovations, and promote and showcase best practice.

With the UN estimating that the global community has just one decade left to change direction, ambitious and urgent action, and a renewed commitment to working in partnership, will be critical to achieving the 2030 climate agenda and protecting decades of development progress. The inspiring examples of "best practice" plastics organisations throughout this report indicate that as the plastic pollution crisis becomes even more complex and far-reaching, we should expect to see even greater integration between digital technology and recycling activities in LMICs.

Our research has helped create a more comprehensive picture of global trends and innovation in the plastic waste management sector, as well as the benefits reaped by organisations that deploy digital technology. We are excited to see that as this sector matures, there will be many opportunities for MNOs and other technology organisations to reduce their own plastic footprint, and to leverage their resources and technical expertise to ensure that digital technology delivers value to a wide range of stakeholders. In doing so, they will help scale solutions to climate action, reduce environmental degradation and bring long-term value to their organisation.

The GSMA's ClimateTech programme is committed to furthering these efforts and is actively working to help our members and development partners identify opportunities for innovation. Through this work we aim to foster cross-sector collaborations, generate new insights on the size of the commercial opportunity for MNOs and other technology organisations, and help document and replicate best-practice models.

Appendix

Appendix 1:
Detailed research methodology

The research was conducted over a five-month period between October 2020 and February 2021, and included multiple components. First, desk research and a literature review enabled the team to identify specific cases of digital innovation in plastic waste management across Africa, South Asia and Southeast Asia.

To ensure that desk research (and eventually the stakeholder interviews) identified specific and locally relevant contextual factors, rather than just high-level global trends, more focused research was conducted on nine priority countries identified at the proposal stage. This "deep dive" explored how plastic and other solid waste is currently managed, the key actors in the value chains (from waste collection up to large off-takers of recycled plastics) and an assessment of the opportunities and constraints for digital solutions to make plastic waste management more effective.

The countries included in the deep dive were Kenya, Ghana, Nigeria, South Africa, Tanzania, Bangladesh, India, Sri Lanka and Thailand. These countries were selected because they have large coastal cities or cities located on large rivers, which offer the scale of plastic recycling opportunities necessary to support innovative partnerships between plastics companies and tech companies. This approach also brings forward environmental considerations arising from the adverse impacts of waste plastic disposal or leakage into rivers and oceans. These countries not only produce a major proportion of plastic waste, but also contribute significantly to the national and international trade of plastic waste. They offer the scale of economy and critical mass to support both community-based and corporate business modelling across solid waste collection and waste recycling and recovery value chains. They also participate in, and are more realistic candidate to support, the rise of social and fair trade plastic movements. Finally, the priority countries represent a range of levels of maturity in the digital economy (higher in Bangladesh, India, Nigeria, South Africa and Thailand) and a range of mobile data costs (much lower in Tanzania than South Africa, for example), which are likely to affect the viability and popularity of digital solutions. All countries have high mobile phone penetration rates.

Stakeholder interviews were conducted with over 30 plastics organisations (concurrently with the desk research). While there was a focus on the selected countries above, interviews were also conducted with innovative organisations from other LMICs where it was felt that learning from best practice solutions would contribute to the research. The research included plastics organisations at varying stages of maturity/scale, as well as various business and partnership models. While the research aimed to identify organisations that focus solely on plastic waste, many of these organisations provide services that address a wider range of recyclable material. We prioritised both commercial organisations and social for-profit enterprises, but also considered the role of local NGOs and donors in catalysing and providing key supply chain services to for-profit plastic entities.

Following the completion of interviews with plastics organisations, interviews were conducted with MNOs and technology companies. Notable examples of MNOs that are proactively involved in plastic waste initiatives include EcoNet in Zimbabwe and MTN in Côte d'Ivoire and Ghana. This round of interviews provided insights into the awareness levels and actions of MNOs in this area, as well as areas for synergy and partnership with plastics organisations or other actors, such as government or NGOs.

Appendix 2:
List of digital innovations

The 63 plastics organisations identified through our desk research are listed below. This is not intended to be an exhaustive record of all digital technology-enabled projects currently in operation in LMICs. However, the projects identified are illustrative of current trends in digital approaches to plastic recycling.

Innovation categories:

1	Identification, reporting and data collection
2	Plastic waste collection: matching supply with demand
3	Digital solutions to connect and manage supply chains
4	Improving efficiency in waste management operations
5	Traceability of recycled plastic
6	Public awareness and communications

Organisation	Country	Innovation category	Website
Appcyclers	Ghana	2	Link
BD Waste	Ghana	2	Link
Coliba	Ghana	2	Link
Jekora Ventures	Ghana	2	Link
Jumeni Technologies	Ghana	3	Link
Zoomlion Ghana	Ghana	4	Link
Mr. Green Africa	Kenya	2	Link
Taka Taka Solutions	Kenya	4	Link
Chanja Datti	Nigeria	2	Link
EcoFuture	Nigeria	2	Link
eTrash2Cash	Nigeria	2	Link
Let's Do It Nigeria	Nigeria	1	Link
OkwuEco	Nigeria	2	Link
WeCyclers	Nigeria	2	Link

Organisation	Country	Innovation category	Website
Recyclan	Nigeria	2	Link
WasteCoin	Nigeria	2	Link
EnviroServe	South Africa	4	Link
Kudoti	South Africa	3	Link
Packa-Ching	South Africa	2	Link
Regenize	South Africa	2	Link
Waste Plan	South Africa	4	Link
Eco Friends	Sri Lanka	2	Link
Sevanatha Urban Resource Centre	Sri Lanka	1	Link
Green Waste Pro	Tanzania	4	Link
Tirima Enterprises	Tanzania	4	Link
The Recycler	Tanzania	1	Link
GEPP me	Thailand	2	Link
GooGreen	Thailand	2	Link
Koomkah	Thailand	2	Link
Recycle Day	Thailand	2	Link
Ellipsis Earth	Global	1	Link
Rubicon	Global	3	Link
Blue Planet Environmental Solutions	Multi-country: active across Asia	3	Link
Plastic Bank	Multi-country: Philippines, Haiti, Indonesia, Egypt and Brazil	5	Link
Empower	Multi-country: active in 15 countries	5	Link
Tianjin City Mine	China	3	Link
Coliba	Côte d'Ivoire	2	Link
Bekia	Egypt	2	Link

Organisation	Country	Innovation category	Website
Dawar	Egypt	1	Link
Banyan Nation	India	3	Link
Bintix	India	2	Link
Citizengage	India	2	Link
Encashea	India	2	Link
Ishitva Robotics System (IRS)	India	4	Link
Kabadiwalla Connect	India	3	Link
Let's Recycle	India	2	Link
Paperman	India	2	Link
Plastics for Change	India	5	Link
PomPom	India	2	Link
Rethink+	India	2	Link
Recykal	India	2	Link
Swach Co-Op	India	2	Link
Waste Ventures	India	2	Link
Gringgo Waste Tech	Indonesia	4	Link
Rekosistem	Indonesia	3	Link
Klean	Malaysia	2	Link
Panda & Wolf Holdings – Eco-Warriors	Mauritius	6	Link
RecyGlo	Myanmar	2	Link
Solu	Philippines	2	Link
Evreka	Turkey	4	Link
Yo-Waste	Uganda	2	Link
RecycleBot	Zambia	2	Link
Ulubuto	Zambia	2	Link

Appendix 3:
Stakeholder list

The GSMA would like to acknowledge the numerous organisations that have contributed to this research by sharing their insights, experiences and perspectives with our team:

- Appcyclers, Ghana
- Bangladesh Petrochemical Co. Ltd. (BCPL), Bangladesh
- Banyan Nation, India
- BD Waste, Ghana
- Ceylon Chambers of Commerce, Sri Lanka
- Chanja Datti, Nigeria
- Coliba, Côte d'Ivoire
- Dialog Axiata PLC, Sri Lanka
- Eco-Spindles, Sri Lanka
- Econet, Zimbabwe
- EcoSpear, Bangladesh
- Environment and Social Development Organisation (ESDO), Bangladesh
- Goo Green, Thailand
- Grameen Phone, Bangladesh
- Green Waste Pro, Tanzania
- Huawei, China
- Indorama, Thailand
- Kabadiwalla Connect, India
- Kudoti Network, South Africa
- Mr. Green Africa, Kenya
- Nelplast, Ghana
- NETFUND, Kenya
- Recycle Day, Thailand
- Robi Axiata, Bangladesh
- Safaricom, Kenya
- SAP, UK
- Smart, Cambodia
- The Recycler, Tanzania
- Trash Monger, Nigeria
- UNDP Regional Innovation Centre, Thailand
- WasteAid
- WasteCoin, Nigeria
- WEIGO, Global Alliance of Waste Collectors
- World Wide Fund for Nature (WWF)
- Yo-Waste, Uganda
- Zaidi Recyclers and Zanrec, Tanzania
- Zero Trash Waste, Sri Lanka

Appendix 4:
Assessment criteria and best practices

Assessment criteria	Best practices organisations would demonstrate:
How mature is the organisation (concept stage, pre-launch, launch, scaling, etc.)?	• At least two years of stable and/or growing operation • Volume of plastic collected and processed has stabilised or increased year-on-year
Does the current scale of plastic collection/processing operations demonstrate potential to scale?	• Average quantities of collected and processed plastic have increased year-on-year • Number of current jobs (entity has a core team of permanent staff and does not rely excessively on ad hoc or informal labour) • Access to crushing and extrusion technology: horizontal baler, crusher, hot wash, dryer, extruder
How will they create value for MNOs?	• Good understanding of value recognised by MNOs, such as revenue for data or brand recognition on sustainability issues
Are they partnering with local/ global brands to sell recycled plastic?	• Long-term commitment from off-takers for collected or lightly processed plastics • Contracts with large brands that purchase recycled plastic (e.g. Unilever or The Body Shop).
Who do they see as their addressable market?	• Target number of subscribers/users of the digital solution • Catchment area, number of target households and target tonnes of plastic

Assessment criteria	Best practices organisations would demonstrate:
What are their environmental, climate and social targets, and how will they measure these?	• Efficient and low-carbon operations • Sustainable plan for "reject plastics" • KPIs on energy efficiency and water reuse at plant • Complying with relevant ISO standards on environment, health and safety, etc. • Fair wages and health and safety for waste collection workers • Solutions can be accessed by the poorest, including those without a smartphone • Fair payments to supply chain
What difference will a financial investment make? Over what period?	• Clarity of value addition from financial support • Time frame of the project funded by the grant • Sustainability post-grant project period
What business value will MNO support bring (e.g. increase in collection volumes, reduced operating costs, improved customer journey, positive consumer behaviour change, etc.)?	• Specific targets to achieve • Number of households • Catchment area/number of neighbourhoods/number of cities • Tonnes of plastic waste
What social and environmental/ climate value will MNO support bring?	• Support would allow increased levels of community outreach, advocacy and training • Employment (number of jobs created) • Improved incomes • Less plastic leakage • Emissions saved

Appendix 5:
Pathways to scale

INTERNAL

Lever as a barrier	Scale lever	Lever as an enabler
Lack of data on plastic waste sources, flows, and types.	**Data and insights**	Digital solutions can provide insights into plastic generation, hotspots and pathways, enabling more robust public sector policy development and commercial opportunities for plastic innovators.
Lack of data (or the deliberate concealing of data) relating to market and index pricing for commonly traded plastic recyclables.	**Data and insights**	Digital solutions can democratise access to commodity prices and indices across global markets, including for the informal sector.
Quality of processed plastic is not high enough without access to more advanced machinery and consistent sources of plastic waste.	**Capacity and resources**	Digital solutions allow more efficient and accurate sourcing and segregation of the target plastic types being marketed, leading to less contamination and mixtures of plastic waste at the point of trade.
Lack of knowledge or capacity to develop effective digital solutions.	**Quality of solution**	MNOs and other technology organisations can provide technical expertise and form new partnerships that leverage their existing digital platforms.

EXTERNAL

Lever as a barrier	Scale lever	Lever as an enabler
Inability to demonstrate the quality of processed plastic, or aspects such as fair prices paid to suppliers and absence of child labour, are constraints to selling a processed product to manufacturers that require high auditable standards.	**Users, buyers and partners**	Supply chain management solutions and other technologies that support traceability in the value chain can help plastics organisations meet the demands of large manufacturers and brands.
Inability to pay users for segregated plastic waste within the tight margins of the business. However, business models that rely on payment by users for the collection service are unlikely to be widely adopted in LMICs.	**Users, buyers and partners**	Digital payment platforms and support from MNOs on airtime or data credit at discounted prices can help incentivise more users participate in plastic waste segregation and collection for recycling.
Heavy taxes and environmental levies on waste management operators turn away prospective investors.	**Enabling environment**	Government-led tax incentives, subsidies and waivers help establish a conducive investment climate for waste management and recycling entrepreneurship.
A landlocked city or state lacks access to deep-berth ports for the efficient trade of plastic commodities.	**Infrastructure and resources**	Reverse logistics and preferential haulage rates (for recyclers) help aggregators and plastic processors to get their products to a port of sale/global commodities market.

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