

An initiative of Economist Impact and The Nippon Foundation

PLASTICS MANAGEMENT INDEX

Evaluating effective management and sustainable use of plastics





About the report

Plastics Management Index: Evaluating effective management and sustainable use of plastics is a report from Back to Blue, an ocean health initiative of Economist Impact and The Nippon Foundation. The report was written by Economist Impact. The report is based on two global surveys^{1,2} and an index that ranks 25 countries across 44 indicators across three pillars (governance, systemic capacity and stakeholder engagement).

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Executive summary

The amount of plastic the world has manufactured since mass production started around 1950 is staggering: by 2015 that number was estimated at 8.3 billion tonnes, of which 2 billion was still in use.³ The remainder was waste, with nearly 80% of that sent to landfills or polluting the environment, including the oceans, where it will take centuries to degrade (and even then it will not disappear).

Plastic is not the world's only pollution challenge, but it is arguably the most prominent. When it comes to the ocean, for example, 60% of people say tackling plastic pollution is the top priority for restoring ocean health, ahead of dealing with chemical pollution and addressing climate change.⁴

Plastic is not the world's only pollution challenge, but it is arguably the most prominent.

The issue is unlikely to recede soon. The world makes and uses more plastic each year, with 367 million tonnes manufactured in 2020⁵—most of which is used in packaging and construction.⁶ With production forecast to double by 2040,⁷ and with externality costs estimated at US\$1,000 per tonne, the cost of plastics to society could by then exceed US\$700bn annually.⁸

By 2050, a century after mass production started, researchers predict the total amount of plastics made could have reached more than 25 billion tonnes.⁹ To put it another way, in the next 35 years we will produce twice as much plastic as we did in the first 65. Unless we change how we produce plastic and manage it as waste, as much as 12 billion tonnes of plastic waste could be in landfills or in the environment by that year.¹⁰

Continuing along this path is plainly unsustainable. Dumping plastics, large volumes of which end up in the ocean, is not just ecologically disastrous, but it has also become publicly unacceptable. Deciding how best to proceed, however, is less clear.

The Plastics Management Index

The scale of the challenge demands a new framework that covers the entire lifecycle of plastic products—from design to production to consumption to disposal and beyond. This report, which introduces the Plastics Management Index (PMI), aims to contribute to this goal by bringing attention to growing global concerns around the use of plastic and highlighting how its management can be made sustainable. And with 2021 marking the start of the UN's Decade of Ocean Science, the goal of which is science-based management of the oceans, the timing of this initiative is particularly apt.¹¹

The PMI, which is a project of Back to Blue, an initiative of Economist Impact and The Nippon Foundation, measures, compares and contrasts the efforts made by a selection of 25 countries at different stages of development in their management of plastics,¹² covering the entire lifecycle of plastic products. Its goal is to assess each country's capacity to minimise plastics mismanagement or leakages across the plastics lifecycle, while promoting the optimal production and use of plastic as a resource. In so doing, it views the issue through the lens of policy, regulation and business practice, while also incorporating consumer actions and perspectives.

Dumping plastics, large volumes of which end up in the ocean, is not just ecologically disastrous, but it has also become publicly unacceptable.

The PMI focuses on three categories for each of the 25 countries:

- Governance, which assesses a country's mix of laws, regulations and incentives for plastics management (36.36% weighting).
- Systemic capacity, which measures a country's scope to oversee, collect, sort and recycle plastic waste, and its investment in capacity-building efforts (36.36% weighting).
- Stakeholder engagement, which looks at international and national efforts by governments to combat plastic waste, along with the endeavours made by the private sector and consumers (27.26% weighting).

Each of these categories comprises data from four sub-categories, which contain between

two and six indicators. The resulting data are weighted according to importance after verification by Economist Impact analysts and consultation with independent experts to generate a score. The index also includes select data points from surveys of 1,800 consumers and nearly 770 executives in those countries. (See the Appendix of this paper for a full methodology.)

Research for the PMI reveals:

- Germany is the top performer overall in plastics management, scoring 87 points out of 100. It ranks 1st for governance and stakeholder engagement, and 3rd for systemic capacity. Among the reasons for its overall ranking are its recycling scheme, on which government and industry have worked to build a circular economy for plastics; its global leadership on plastics management that it couples with a proactive domestic approach; and a diverse approach to stakeholder engagement that feeds into government action.
- Europe leads in efforts to manage plastics, while Asia lags—despite producing half the world's plastics. Europe leads the overall ranking, in part because most European nations in the index are wealthy, but also thanks to the proactivity of the EU and its ability to fund innovation and research. Asia-Pacific countries largely comprise the middle of the table, followed by Latin American and African countries.

The 2021 Plastics Management Index

The Plastics Management Index ranks our selection of 25 countries across dozens of indicators, with those collated into three categories: governance, systemic capacity and stakeholder engagement.

OVEF	RALL SCORE		1) GO	VERNANCE		2) SY	STEMIC CAPAC	CITY	3) STA	KEHOLDER ENG	AGEMENT
1	Germany	87.4	1	Germany	96.9	1	The UK	85.4	1	Germany	77.9
2	Japan	84.5	2	Japan	94.3	2	Japan	85.2	2	Malaysia	75.7
3	France	78.9	3	France	89.8	3	Germany	85.0	3	Japan	70.6
4	The UK	77.6	4	The US	85.0	4	The US	84.4	4	Australia	69.6
5	The US	77.1	5	Sweden	82.3	5	France	80.6	5	Chile	69.3
6	Sweden	76.1	6	Finland	78.5	6	Finland	78.5	6	The UK	67.3
7	Australia	71.5	7	The UK	77.7	7	Sweden	78.1	7	Sweden	65.2
8	Finland	70.8	8	Chile	76.3	8	China	75.7	=8	France	62.2
9	Chile	68.7	9	Australia	71.1	9	Australia	73.3	=8	Indonesia	62.2
10	China	63.3	10	Vietnam	68.2	10	Thailand	64.1	10	Vietnam	58.8
11	Vietnam	60.1	11	Brazil	63.5	11	Chile	60.6	11	The US	56.9
12	Thailand	59.6	=12	China	61.7		AVERAGE	59.9	12	South Africa	55.4
13	Malaysia	59.0	=12	Thailand	61.7	12	Brazil	58.4		AVERAGE	53.7
	AVERAGE	56.6		AVERAGE	55.6	13	India	56.7	13	Thailand	50.7
14	Brazil	56.3	14	Malaysia	55.3	14	Ghana	54.2	14	Ghana	50.5
15	Ghana	52.4	15	Ghana	51.9	15	Egypt	54.1	15	Finland	50.3
16	Indonesia	46.7	16	Russia	44.8	16	Vietnam	52.9	16	China	49.1
=17	Russia	45.5	17	Indonesia	42.2	17	Russia	51.5	17	India	46.9
=17	South Africa	45.5	18	South Africa	40.3	18	Malaysia	50.2	18	Mexico	46.0
19	Argentina	42.1	19	Argentina	40.2	19	Argentina	49.9	19	Kenya	45.1
20	India	41.5	20	Jordan	27.3	20	Mexico	49.4	20	Brazil	43.7
21	Mexico	38.7	21	Mexico	22.6	21	South Africa	43.2	21	Russia	38.4
22	Egypt	34.4	22	India	22.2	22	Indonesia	39.7	22	Egypt	37.0
23	Kenya	28.8	23	Egypt	12.8	23	Kenya	34.0	23	Argentina	34.3
24	Jordan	28.0	24	Kenya	11.5	24	Jordan	27.4	24	Nigeria	30.9
25	Nigeria	21.4	25	Nigeria	11.1	25	Nigeria	24.5	25	Jordan	29.7

Source: Economist Impact's PMI

- China, the world's largest plastics producer, is developing the capacity to manage plastics but lags on stakeholder **engagement**. China's overall ranking (10th) is boosted by its 8th place in the systemic capacity category, helped by its efforts to improve domestic recycling capacity and collection. That offsets China's lower score (16th) for stakeholder engagement, where its strong showing for private sector commitments to reduce and promote plastics use is undercut by coming last place for responsible consumer actions and perceptions and ranking 13th for the national government-led approach to minimising plastics mismanagement.
- Most lower-middle-income countries struggle across the board—although Vietnam and Ghana outperformed.

Lower-middle-income countries¹³ face a range of governance, systemic capacity and stakeholder engagement challenges, but Vietnam (11th) and Ghana (15th) show that many of these can be tackled. Key systemic capacity issues for lower-middleincome countries are better oversight of management processes—particularly mechanisms to ensure accountability -and improved infrastructure to enable recycling. Kenya, a lower-middle-income country, shows that economies with limited means can succeed in some areas. Kenya, for example, outranks Germany in sub-category 3.3, which assesses private sector commitments about responsible plastic use.

- **Differences in stakeholder engagement** divide some over- and underperformers. Malaysia ranks 13th overall in the index but outperforms in the stakeholder engagement category, where it ranks 1st for responsible consumer actions and perceptions of plastic waste management—one of the four sub-categories—and 2nd overall in this category, behind Germany. Malaysia's relative outperformance was driven by media coverage of a plastic waste dumping scandal in 2018, which outraged the public and saw major changes implemented. Finland, conversely, ranks 15th for this category, dragged down by low scores for private sector efforts (lukewarm business commitments and practices, for example) and government action, including the lack of a comprehensive plastics waste management database and an absence of education on plastics waste in the school curriculum.
- Although signing international agreements is important, it is crucial that nations act domestically too. Implementing sound policies and practices at home is vital if countries are to improve plastics waste management. Here, there is much that nations can do. While 14 countries score maximum points for signing up to such instruments, just two (Germany and Japan) score the maximum for their national government-led approach (which, among other measures, assesses whether school curriculums focus on plastics).

Shaping up: How the Plastics Management Index's lowest-ranked nations fared against the leader

The Plastics Management Index's **Overall score** findings within each category show where improvements are most needed. On the governance side, for example, Kenya and Jordan could do far more to promote responsible plastic production and consumption, while Nigeria needs improvements in most areas.



Indicator	GERMANY		KEN	KENYA		JORDAN		NIGERIA	
	Score	Rank	Score	Rank	Score	Rank	Score	Rank	
OVERALL SCORE	87.4	1	28.8	23	28.0	24	21.4	25	
1) GOVERNANCE	96.9	1	11.5	24	27.3	20	11.1	25	
1.1) Promoting responsible plastic production and consumption	100.0	=1	9.5	=24	9.5	=24	26.4	18	
1.2) Promoting safe and informed plastic usage	100.0	=1	0.0	=21	47.4	20	0.0	=21	
1.3) Plastic waste management	100.0	=1	15.5	=20	16.4	19	0.0	=22	
1.4) Operational enablers	86.5	=4	20.5	24	40.8	=17	17.9	25	
2) SYSTEMIC CAPACITY	85.0	3	34.0	23	27.4	24	24.5	25	
2.1) Oversight of management processes	100.0	=1	24.3	23	15.6	24	11.9	25	
2.2) Efficient collection and sorting channels	59.6	12	29.9	21	21.7	25	26.7	23	
2.3) Infrastructure to enable recycling	86.1	=6	50.0	25	61.1	20	52.8	=23	
2.4) Investment in capacity-building to ensure sustainability of systems	86.9	3	33.0	18	13.0	22	10.0	23	
3) STAKEHOLDER ENGAGEMENT	77.9	1	45.1	19	29.7	25	30.9	24	
3.1) National commitment through cooperation and adherence to international standards	100.0	=1	46.4	=16	46.4	=16	46.4	=16	
3.2) National government-led approach to minimising plastic mismanagement	100.0	=1	20.6	=13	0.0	=24	0.0	=24	
3.3) Private sector commitments on reduction and promoting responsible plastic use	52.2	14	59.1	8	26.8	22	37.1	=20	
3.4) Responsible consumer actions and perceptions	65.7	=4	53.5	14	48.3	18	42.6	21	
Source: Economist Impact, PMI data									

Foundations of effective plastics management

- Governance is strongly correlated with • better plastics waste management. Countries that enforce laws on plastics waste management do significantly better in the PMI. In other words, a high governance ranking implies that a country is proactive at legislating, monitoring and fairly enforcing transgressions of responsible plastics use and consumption. It also indicates that its waste management regime is underpinned by effective operational enablers. India, for example, could do better simply by putting in place mechanisms to monitor and enforce waste management regulations in urban and rural areas.
- When it comes to systemic capacity, robust oversight of waste management processes alone is insufficient.

Nations that perform well here exhibit strong oversight paired with more efficient collection and sorting channels, infrastructure to help recycling, and investments in capacity-building. Mexico, for example, scores well (7th) for oversight of waste management processes, but could raise its ranking by strengthening its collection and sorting channels (22nd) and investing in capacity-building to ensure sustainability of systems (25th). Malaysia, on the other hand, could do better by creating a single source of responsibility for plastics waste management to replace the existing division between local authorities and various ministries. Given that plastics pollution is a transboundary issue, countries that lead should share their knowledge and experiences with and help to fund improvements in —weaker nations.

Stakeholder engagement requires an across-the-board approach that includes government, business, media and consumers. The private sector, whether producing or using plastics, has a huge responsibility that it is ignoring in many countries, and that governments can influence through carrot and stick measures, as the EU has done. Consumers have some responsibility too. However, as they lack input into the pre-consumer stage (design, packaging, marketing), most can do so during and after purchasing. And consumers are further limited in terms of the available disposal solutions for plastics. Malaysia showcases the power of media to influence government and business to act responsibly. Meanwhile, Jordan and Nigeria—which finished 24th and 25th in the overall rankings and are the only countries to score zero from a possible four points for their national government's approach to minimising plastic mismanagement-show the importance of government action.

Plastics management policy and regulation

- There is far more to plastics waste management than simply managing the waste that is generated. One reason for Germany's lead is its lifecycle approach, including efforts to build a circular economy for plastics. Success goes far beyond providing most citizens with access to waste management and collection services. That said, such systems are an essential foundation. Consequently, countries need to put in place policies that are best suited to their needs as they seek to deal better with waste management and plastics.
- The lack of both an overarching framework and a single body to oversee plastics pollution is a major challenge for global plastics waste management.

The current patchwork of local regulations of varying scope, combined with about a dozen key global agreements on plastic pollution divided between three UN bodies, fragments and complicates a global approach to plastic pollution.¹⁴ At the international level, a global Paris Agreement-style treaty that deals with plastic waste throughout the lifecycle is needed to augment or even replace the existing mix of measures. There is growing support for such an initiative from governments (more than two-thirds of UN member states are willing to consider such an agreement¹⁵), non-government organisations (NGOs) and some of the

world's biggest plastics manufacturers and consumer brands.¹⁶ The UN Environment Assembly (UNEA), the leading global body on environmental policies and law, is scheduled to discuss whether and how to move ahead on that at its February 2022 meeting.¹⁷

Knowledge gaps hinder international action. The push for a Paris-style climate change deal for plastics comes as international momentum for improved plastics waste management has seen some success, with amendments agreed in 2019 now in effect for the Basel Convention that limit the international trade in recycled plastics. Yet successful actions require understanding the scale of the problem, and there are still significant knowledge gaps—not least an inability to measure plastics flows at the national and global level across the plastics lifecycle. Better tracking systems are needed to understand these flows within countries, across borders and into the environment, and would help policymakers devise better solutions.

Towards a circular plastics economy

 If the circular economy is to succeed, the perception of plastic waste must shift from valueless to valuable. Because it typically costs more to recycle plastics than it does to manufacture new plastics from virgin materials, countries need solutions to level the playing field. Plastic credits, extended producer responsibility (EPR) and other financial and non-financial measures (including for waste-pickers, who are crucial for plastics waste management in many countries) could all help.

- There are major constraints on what the world can do with plastic waste. While reusing and recycling are preferable to incineration or putting waste in landfills, reducing use and replacing with alternatives (paper, for example) where possible are essential. Recycling is not a panacea, and in recent years the conversation has shifted from a singular focus on recycling, whether mechanical or chemical, to an understanding of the need for a more comprehensive approach to limit production and use.
- Mechanical recycling faces inherent problems. This method sees plastics cleaned, processed and turned into plastic pellets, which are the feedstock for new plastic items. Limits of this solution include the fact that mechanical recycling is often more expensive than landfilling; many countries lack the infrastructure and/or secondary markets for recycled plastics; low-value items often aren't collected; sorting materials into different plastic types is costly; and recycled plastic feedstock is often inferior to, and more expensive than, virgin materials.
- Chemical recycling could allow far more plastics to stay in use. Greater use of this could boost the circular

economy and lower the amount of waste that is incinerated or sent to landfills. Although the technology is promising, it also has various limits. These include requiring extremely high temperatures, and therefore energy, which makes it costly; mixed outputs, which limit its uses; potential human health and environmental impacts; and the fact that its success requires finding buyers prepared to purchase what is produced. However, designing with chemical recycling in mind could result in plastics being recycled many times without a loss of quality.

Business and consumer action required

Businesses increasingly see the need for better plastics and waste management... Survey data suggest that more than four in five businesses encourage employees to segregate plastic waste from general waste, while a similar proportion are in favour of EPR and agree that businesses that produce or use plastic should be partly responsible for funding its collection and recycling. Three-quarters say the sustainable use of plastics is important or very important to their organisation's overall environmental sustainability plan, and two-thirds say that responsible production/use of plastics or plastics waste management is part of their overall corporate social responsibility (CSR) programme.

- ...but many have yet to turn intentions into action. The above still means a sizeable minority of businesses are doing far too little about plastics waste management. One simple step for more than 40% of businesses would be to join a grouping that is focused on reducing plastic use and waste. More than 30% of businesses could optimise their supply chain by taking action to reduce their use of plastic packaging and using substitutes for packaging. 60% could work on ensuring more sustainable product design.
- Many consumers are taking basic steps to aid recycling and cut plastic use... Survey data suggests two-fifths of consumers always segregate their waste, while a similar proportion say they sometimes do. Additionally, 70% say sustainable packaging and product design are effective at cutting plastic use, and nearly two-thirds believe that campaigns and activities to increase awareness about the issue are useful.
- ...but alternatives to plastic are often too expensive and inconvenient.
 More than a quarter of consumers do not know the benefits of recycling waste, which indicates that much could be achieved from raising awareness. Additionally, when asked to pick a barrier that prevents them from cutting their use of plastic, 43% say non-plastic alternatives are too expensive, while another 36% cite convenience.

The remaining respondents say it is too difficult to understand which materials are recyclable—highlighting the importance of awareness-raising.

The methodology for the Plastics Management Index (PMI)

The PMI assesses a country's capacity to minimise plastics mismanagement while promoting the optimal production and use of plastic as a resource.

It measures, compares and contrasts targeted efforts made by 25 countries, focusing on the plastics lifecycle through the lens of existing policies, regulations, infrastructure and systems, as well as business practices, consumer actions and perspectives.

The framework was based on a comprehensive literature review of academic studies and reports focused on plastics, as well as in-depth consultations through an Expert Panel and via interview.

It comprises three categories: the system of governance, existing systemic capacity and the engagement of key stakeholders involved in the plastics management process.

The framework consists of qualitative and quantitative indicators. A portion of the quantitative indicators were selected from consumer and executive surveys that were conducted between January and March 2021.

The PMI comprises 12 indicators and 44 individual sub-indicators.

Quantitative indicators: make up 20 of the 44 sub-indicators. For example, two indicators assess the corruption level and business environment in each country.

Qualitative indicators: are used for 24 of the 44 sub-indicators. These are based on a methodology decided upon by Economist Impact. For example, one indicator assesses the mechanisms in place for the management of single-use plastics in the country.

Each indicator and sub-indicator was then aggregated according to an assigned weighting to capture the importance of each category, indicator and sub-indicator, with the final aggregate scores and rankings based on these weights.

For a comprehensive assessment of the methodology, please see the Appendix.

1. Plastics: From innovative solution to intractable problem

1.1. State of play

Over the past 70 years, plastics have become a part of life for nearly everyone on the planet. In their various compounds, plastics keep our food safe, comprise parts of our homes, entertain us (toys, TVs and tablets, for example) and transport us—to name just a few uses.

Plastics dominate because they are cheap to make, durable and versatile. They have a high strength-to-weight ratio, are lighter than alternatives like glass and paper, can be shaped easily into different forms, and are impermeable to liquid. Unfortunately, the same things that give plastic its benefits mean they also lack value and don't degrade easily. Plastics are therefore omnipresent, from the Arctic Circle to the depths of the oceans to the peaks of the world's highest mountains.

The deleterious effects of their ubiquity are of widespread concern. Health experts worry about the effects on human, animal and plant health of chemical additives used in the production of certain plastics. The presence of microplastics and nanoplastics in the food chain is an additional worry, as are the economic and other effects of plastics escaping collection and entering the environment —known as leakage.

Plastics: A primer

Plastics are typically produced from fossil fuels like oil, natural gas and coal, or by synthesising the chemicals that those fossil fuels contain.¹⁸ Also known as polymers, most plastics are based on the carbon atom—with those atoms connecting to hydrogen, oxygen, nitrogen chlorine or sulphur to form the plastic.

Long chains of such connections of atoms are known as thermoplastics. Once shaped by heat, these can be melted again and reshaped. Most plastics fall into this category, including polyethylene (PE), polypropylene (PP), polyvinyl-chloride (PVC), polyethylene terephthalate (PET), polystyrene and polycarbonate.¹⁹

The other category of plastics is thermosets—as the name suggests, these set into a particular shape once heated, as their molecules undergo a chemical change to form a three-dimensional network. As they can't later be remelted or reformed, they constitute a much tougher recycling challenge. Examples include polyurethane (PUR), unsaturated polyesters, epoxy resins and silicone.²⁰

Moreover, plastics production is based on the use of virgin materials (oil, resin and the like, with recycled plastics still a minor contributor), while the industry generates sizeable CO2 emissions—around 400 million tons of greenhouse gases (GHG) in 2012, or 1% of the world's total.²¹ Collecting and disposing of plastic waste adds to this GHG toll.²²

Adding to this are significant external costs, estimated at US\$1,000 per ton, which stem from CO2 generation, increased health costs from air pollution, the expense of collecting and sorting plastics, and ocean clean-ups.²³ Based on that estimate, plastics cost the world about US\$367bn in 2020 alone.

Managing plastics, then, is a complex topic that involves a vast number of players—just about every business, government and consumer on the planet. Before we assess how the PMI's findings fit into this subject, the following section examines some crucial issues in the broader picture.

1.2. Plastics: The bigger picture

About 6.3 billion tonnes of plastic produced by 2015 was waste.²⁴ Around 12% of that was incinerated, 9% was recycled, and the rest (around 5 billion tonnes) went to landfills or has polluted the environment.²⁵

Since then, it is likely that about another 2 billion tonnes of plastic has been produced, with much of it used once and then dumped. Each year the world produces greater volumes of plastic although 2020 was a rare exception, with the covid-19 pandemic seeing global plastics production drop by 0.3%, to 367 million tons.²⁶



Global plastics waste generation in 2016

Although most plastics are produced in Asia, much is discarded in the rich world. The US generates more plastic waste than any other country, followed by the EU, India and China. The UK discards the second-highest amount of plastic waste per head, after the US

Table 1 Countries with the highest plastic waste generation in 2016.

Calculations using data reported in (18), with a refined estimate for the United States (bold text). EU-28 countries are reported collectively (italics).

	Plastic waste generation	Total waste generation	% Plastic in solid	2016 Population	Per capita plastic waste generation
Country	(metric tons)	(metric tons)	waste	(millions)	(kg/year)
The US	42,027,215	320,818,436	13.1	323.1	130.09
The US	34,020,748	263,726,732	12.9	323.1	105.30
EU-28	29,890,143	243,737,466	11.7	511.2	54.56
India	26,327,933	277,136,133	9.5	1,324.5	19.88
China	21,599,465	220,402,706	9.8	1,378.7	15.67
Brazil	10,675,989	79,081,401	13.5	206.2	51.78
Indonesia	9,128,000	65,200,000	14.0	261.6	34.90
Russia	8,467,156	59,585,899	14.2	144.3	58.66
Germany	6,683,412	51,410,863	13.0	82.3	81.16
The UK	6,471,650	32,037,871	20.2	65.6	98.66
Mexico	5,902,490	54,151,287	10.9	123.3	47.86
Japan	4,881,161	44,374,189	11.0	127.0	38.44
Thailand	4,796,494	27,268,302	17.6	69.0	69.54
South Korea	4,514,186	18,576,898	24.3	51.2	88.09
Italy	3,365,130	29,009,742	11.6	60.6	55.51
Egypt	3,037,675	23,366,729	13.0	94.4	32.16
France	2,929,042	32,544,914	9.0	66.9	43.81
Pakistan	2,731,768	30,352,981	9.0	203.6	13.42
Argentina	2,656,771	18,184,606	14.6	43.6	60.95
Algeria	2,092,007	12,378,740	16.9	40.6	51.59
Malaysia	2,058,501	13,723,342	15.0	30.7	67.09
Spain	1,832,533	20,361,483	9.0	46.5	39.42

Source: The United States' contribution of plastic waste to land and ocean, Law KL et al, Science Advances (2020).

Around half of all global plastics production takes place in Asia, which is the biggest plastics polluter by far. And most of this output is concentrated in China—in 2019 the country made 31% of the world's total, making it the world's largest producer (see graphic).²⁷ The NAFTA countries and Europe are also significant producers.

Although Asia produces more plastics than anywhere else, much of what is made there is discarded in wealthy countries. As the table below shows, the US and the EU generate the most plastics waste globally, ahead of India, China and Brazil.

Plastics are used in all manner of industries to meet myriad needs.

Plastics are used in all manner of industries to meet myriad needs. In 2019 in Europe, for instance, nearly 40% (some 20 million tons of the 50.7 million tons produced) was used in packaging.²⁸ About 10 million tons was accounted for by the construction industry, where plastics are used in windows, piping, insulation and roofing,²⁹ for example, while the car industry required about 5 million ton. The rest went to other segments like electrical and electronics, household, agriculture, medical and mechanical engineering.

Much of this doesn't end up as waste—or at least, not immediately. PlasticsEurope, the leading pan-European association for plastics manufacturers, reckons that 60% of plastic products and parts made in Europe are used for between one and 50 years.³⁰

But much, of course, is used once and discarded, including large volumes of personal protective equipment (PPE) like masks and gloves during the pandemic. Each year, vast amounts of plastics of various types (see box) enter the world's environment, a situation that constitutes, as the authors of a 2017 paper put it, "a singular uncontrolled experiment on a global scale, in which billions of metric tons of material will accumulate across all major terrestrial and aquatic ecosystems on the planet".³¹

That process is well under way. In 2016 alone 19-23 million tonnes of plastics ended up in aquatic ecosystems—the oceans, lakes and rivers—which totals about 11% of all plastic waste generated globally that year.³² Even if governments meet their targets to control the problem, the researchers warned, this number could reach 53 million tonnes annually by 2030.³³

Indeed, even the best-case scenario to alleviate this will see vast amounts of plastic waste end up in the environment. A recent paper modelled five scenarios of the flows of municipal waste and microplastics in 2016-40 to determine how effective different interventions might be in cutting plastic pollution.³⁴

It concluded that using every feasible intervention would reduce plastic pollution by 40% from its 2016 level, and by 78% by 2040 based on a "business-as-usual"

What a waste: From macro-plastics to microbeads

What constitutes plastic waste? Since the word plastic covers a range of polymers and additives with varying properties and purposes, from single-use items like plastic bags to bottles, food packaging, electronics, clothing and fishing nets, there is no simple answer.³⁵

Managing the waste is rendered more complex by its different categories. One way to categorise is by size:

- **Macroplastics**: pieces of plastic waste larger than 5mm, including bottles, bags, fishing gear, straws, cup lids and food packaging.
- **Microplastics**: measuring between 5mm and 1 micrometre (one thousandth of a millimetre).
- Nanoplastics: less than 1 micrometre.

Microplastics can be categorised based on their origin:³⁶

- **Primary microplastics**: these are often added to products like cosmetics in the form of microbeads (which are now banned in some countries) or from the wear and tear of car tyres or clothing made from synthetic materials.
- **Secondary microplastics**: these result from macroplastics breaking down in the natural environment.

While public awareness of how some products contribute to plastic waste, like single-use bags and cartons, is growing, many products that are not commonly associated with the issue are major contributors.

Car tyres, for example, are about 24% synthetic rubber, which is a plastic polymer.³⁷ A recent study estimated that tyre wear globally amounts to 288,000 tons of microplastics annually, with about 100,000 tons of that washed into the oceans.³⁸ Earlier studies estimate that tyres account for 10-28% of ocean microplastic waste.³⁹ approach. But even the best-case scenario would see 710 million tonnes of plastic waste pollute the land and the ocean in that time.⁴⁰

It is little wonder that the issue has increased in political importance.

It is little wonder that the issue has increased in political importance. In July 2021, for example, the G20 said it recognised "the serious impact of marine litter and in particular marine plastic litter" and reiterated its support for solutions including "developing a new global agreement".⁴¹

The grouping also called for action to tackle so-called ghost gear, discarded or lost fishing nets and other equipment. An estimated one million tonnes of this ends up in the ocean each year—at least 10% of all marine litter.⁴²

And it wants more done to increase public awareness of single-use plastics, while noting "the positive impacts that the national implementation of extended producer responsibility schemes has had in some of our jurisdictions".⁴³

1.3. The rise and rise of plastic packaging

The most significant use of plastics is in packaging.⁴⁴ Plastic packaging is cheap,

lightweight (especially compared with glass) and has barrier properties that keep food fresh for longer than, say, paper or cardboard.

All of this has driven plastic's share as a percentage of global packaging volumes from 17% in 2000 to 25% by 2015.⁴⁵ That volume is projected to increase fourfold from 2015 to 2050, by which time the world will be producing 318 million tons annually.⁴⁶

A key driver of the problem worldwide is that no value is placed on plastic packaging. The World Economic Forum (WEF) says as much as 95% of its value is lost after being used just once, totalling US\$80bn-120bn a year.⁴⁷

The WEF arrived at that number after calculating that just 14% of plastic packaging is collected for recycling—yet ultimately only 5% of its value is retained for use when accounting for post-collection value losses. It also notes that the recycling rate for plastics generally is even lower than that for plastics packaging, both of which are already far below the global recycling rates for iron and steel (between 70-90%) and paper (an estimated 58%).⁴⁸

In addition, plastic packaging pollution has significant externalities—costs to society that the UN Environment Programme (UNEP) conservatively estimates costs US\$40bn a year, and which itself totals more than the profit made by the plastics packaging industry.⁴⁹



The main plastic resin types—and how they are used in packaging

Source: The New Plastics Economy: Rethinking the future of plastics, World Economic Forum (2016). See: https://www.weforum.org/reports/the-new-plastics-economy-rethinking-the-future-of-plastics

This combination of zero-value and omnipresence means much plastic packaging gets dumped. In 2016, when the WEF report came out, there were estimated to be around 150 million tons of all types of plastics in the oceans, with 8 million tons entering the seas each year equivalent to one garbage truck dumping plastic into the ocean every minute.⁵⁰ By 2050, should nothing be done, that rate would have risen to one every 15 seconds, with packaging constituting the largest proportion.

1.4. Coming soon: More plastic

What's clear is that over the next 30 years, and likely well beyond that, the world will produce far greater volumes of plastics. Dealing with that reality has become urgent.

What's clear is that over the next 30 years, and likely well beyond that, the world will produce far greater volumes of plastics.

The Pew Charitable Trusts' Dr Winnie Lau, a senior manager who works on strategies to prevent ocean plastics pollution, says the conversation has shifted in recent years from "it's all about recycling" to an understanding that the world needs to take a more comprehensive approach. That starts, she says, by understanding the four most important drivers of global plastics pollution:

- The dramatic rise in plastics production in recent decades.
- That much of what is produced is harder to recycle and problematic, like flexible and multi-layer plastics, which curbs recycling as a solution.
- The vast collection gap in the developing world.
- That virgin plastics are cheaper than recycled plastics, which further restricts recycling as a solution, even as significant sums are still being invested into oil and gas, and far less into solutions for plastics pollution.

Those drivers make the following solutions logical, Dr Lau says:

- The most impactful is to **reduce the production** of plastics:
 - Step 1: if you don't make it, you don't have to deal with it later, which means using plastics only where necessary.
 (Do brands need to wrap t-shirts in plastic? Do vegetables need to be plastic-wrapped?)
 - **Step 2:** use reuse-and-refill systems for household items, for example.
 - **Step 3:** design packaging to use as little plastic as possible.

- Where packaging is required, **substitute** where possible with materials that are reusable, recyclable, biodegradable, sustainable and compostable. In many cases that will be paper, which currently has far higher recycling rates. Where refill-and-reuse systems are in operation, other reusable materials might be more appropriate.
- Recycle, but bearing in mind that this isn't a silver bullet (see box). This is because plastics must be collected, sorted, cleaned and then turned back into plastic pellets. And improving recycling requires that plastics be designed with that in mind. This includes not using chemical additives that complicate the process; eliminating hard-to-recycle elements; and putting in place measures that close the loop by incentivising the use of recycled plastics over virgin inputs.
- Finally, properly manage the waste that remains by eliminating leakage as far as possible (for example, by eliminating dumpsites) and ensuring that what is captured is used to best advantage.
 Additionally, some plastics will inevitably leak, which reinforces the importance of designing them with biodegradability in mind, otherwise they will break down into microplastics and nanoplastics, polluting the environment and the food chain.

This approach, which was the subject of a report that Dr Lau's organisation co-authored, could cut 80% of plastic pollution by 2040, saving governments US\$70bn relative to a business-as-usual approach, lowering projected annual GHG emissions from the plastics lifecycle by 25% and reducing demand for virgin plastics by 55%.⁵¹

This scenario would see a 30% cut in plastics consumed by 2040—partly through elimination and partly via reuse-and-refill systems—with another 17% substituted. Increased recycling would account for 20%, leaving 23% of plastics needing to be disposed of safely. The remaining 10% would require significant innovation across all sectors to get to near-zero plastic pollution.

Continuing on a business-as-usual path, on the other hand, would "jeopardise our ability to mitigate climate change, and is incompatible with the goals of the Paris Agreement", the report notes.⁵² Should nothing be done, it estimates that lifecycle plastic-related emissions would double between 2016 and 2040, reaching 2.1 gigatons of equivalent CO2. That would see it account for 19% of the total annual emissions budget by then, versus 3% currently, assuming that global heating was limited to 1.5 degrees Celsius above preindustrial levels.⁵³

Limitations of mechanical recycling

Mechanical recycling is the process whereby used plastics are cleaned and turned back into plastic pellets, which can be used as feedstock to make new plastic items.

Although it's often viewed positively, the reality is more nuanced. That's because mechanical recycling has many shortcomings, including:⁵⁴

- It is often more expensive than landfilling.
- Countries (particularly those that are less developed) lack recycling facilities and/or secondary markets for recycled plastics.
- There is leakage between collection and processing.
- Many items don't get collected by waste-pickers, as they are low-value.
- Contamination means further losses.
- Plastic can be recycled only a limited number of times—often just once or twice.
- It is complicated and costly to sort materials into different plastic types.
- It is not possible to recover all resources used, while what is recovered is often inferior to virgin plastics.
- Virgin materials are often cheaper than recycled plastics.

Mechanical recycling can be open-loop (where the plastic is downcycled from, say, a PET bottle to fibre) or closed-loop, where the plastic is recycled back into a similar product, with the recycling process in theory able to be done indefinitely without the plastics degrading.

Open-loop recycling, then, postpones disposal, whereas closed-loop recycling is more sustainable.

"You might ask: why can't we increase the recycling amount to 50%?" Dr Lau says. "This is where the economics and the hard-to-recycle plastic come in, because so much of what is put on the market today—in fact 80%—is economically unrecyclable since you have to collect the plastic, sort it, clean it and then you turn it back into the recyclable pellets. That's all extremely costly."

And, she adds, the final problem is that virgin plastics are cheaper, so from a financial perspective companies prefer that over recycled plastic.

"It's a whole system connection—if you don't commit to buying the recycled plastic, even if it's more expensive than virgin, you can't close this loop," says Dr Lau.

1.5 Key players

1.5.1 Industry

Much of what's needed, in other words, requires action from the plastics production industry and from brands that use plastics. There is much that they can do. Take industry: recent research shows that just 20 firms produce 55% of the world's plastic packaging waste—with ExxonMobil, Dow, Sinopec, Indorama Ventures and Saudi Aramco alone accounting for more than a quarter of all single-use plastics manufactured globally.⁵⁵

The report found that just 2% of single-use plastics were made from recycled polymers in

2019, and that 54 of the 100-largest polymer producers attained the lowest-possible grade for circularity, "indicating a complete lack of policies, commitments or targets".⁵⁶

Much of what's needed, in other words, requires action from the plastics production industry and from brands that use plastics.

Another 26 had the second-lowest grade, including industry giant ExxonMobil from the US, where the oil and gas industry has a credibility gap to overcome. In 2020 leaked documents showed that the US oil and gas industry had known for decades that large-scale recycling would likely never be economical, yet had spent millions of dollars promoting the opposite message.⁵⁷

The former head of the Society of the Plastics Industry (SPI), the industry's lobby group, told US media that the pro-recycling strategy was undertaken simply to ensure the industry kept making plastic products.

"The feeling was the plastics industry was under fire, we got to do what it takes to take the heat off," said Larry Thomas, who led the SPI for a decade until 2000. "If the public thinks the recycling is working, then they're not going to be as concerned about the environment."58

Chemical recycling: Promising, but not there yet⁵⁹

Promising though chemical recycling is, it is not yet a panacea. Two of the most common processes for chemical recycling, pyrolysis and hydrothermal cracking, require extremely high temperatures (350-700 degrees Celsius), and therefore consume a lot of energy.

Other shortcomings also hinder its commercial viability. Pyrolysis typically creates a mixture of outputs, which makes it most useful for producing fuel from waste plastics. Hydrothermal cracking has a similar output—a mixture of products—which means only some of what is generated can be recycled into plastic.

Those difficulties have to date hindered the technology's real-world application. A recent investigation found that three such projects in the Netherlands, Indonesia and the US, which were backed by large firms, had effectively been shelved, as they were not commercially viable.⁶⁰

All 30 projects examined—most of them deals between small chemical recycling firms and large petrochemical or consumer brands—were "operating on a modest scale or have closed down", with most of the surviving projects years behind schedule. In large part, this was due to the same difficulties that face traditional recycling operations: the cost and difficulty of collecting, sorting and cleaning plastic waste.

That said, chemical recycling does hold potential. With the right design processes factored in at the front-end of the lifecycle, it could see plastics recycled numerous times without degradation.

Success, though, is contingent upon a range of factors, including further research to solve some of its most pressing problems, as well as issues at the design stage of the plastics lifecycle—for example, ensuring any additives used don't undermine the chemical recycling process. And, as with mechanical recycling, it requires buyers willing to purchase the output.

In addition, says the Centre for International Environmental Law (CIEL), a legal research and advocacy body, although research on chemical recycling is taking place, "many unknowns remain around the toxicity of fugitive emissions from high temperature treatment, management of solvents, affordability of processes, and the efficiency of catalysts".⁶¹

And, CIEL adds, when chemical recycling involves turning plastic into fuel via combustion, including pyrolysis, it "poses the same environmental health concerns as waste incineration", including significant human health impacts.⁶²

Today, however, the industry in the US says that it does want to solve the issue⁶³—and indeed firms like ExxonMobil and Dow have begun to take steps to boost the use of recycled plastics.⁶⁴ That is also the case for the industry in Europe, where, for PlasticsEurope, the circular economy is a key focus. Whereas in a linear economy people make products, use them and dispose of them,⁶⁵ in a circular economy producers and users seek to keep resources for as long as possible, extracting the maximum value from them during their useful life and recovering what's possible at the end.

That is part of PlasticsEurope's goal for the EU of attaining 60% reuse and recycling in plastics packaging by 2030, and 100% reuse, recycling and/or recovery by 2040.

Virginia Janssens, managing director of PlasticsEurope, says the scale-up of chemical recycling will allow far more plastic to stay in use globally, providing a crucial boost to the circular plastics economy, and giving developed and lessdeveloped countries the ability to deploy the technology to increase their recycling rates and the amount of recycled content used in products.

Ms Janssens says chemical recycling could reduce the amount of plastic waste that is incinerated in the EU (about 12 million tonnes annually) or that goes to landfill (7 million tonnes), with the numbers showing "the clear untapped potential for more collection and sorting of plastic waste for recycling". "[Our members] are planning investments of €2.6bn in 2025 and €7.2 billion by 2030—that's 44 planned projects in 13 EU countries provided the right enabling conditions are in place in terms of EU regulation to adequately scale up this technology at the right speed," Ms Janssens says.

The industry's investment in chemical recycling, she says, shows its determination to address plastic waste "and supports the EU Green Deal's climate and sustainability ambitions". Should those investment targets be reached, Ms Janssens projects the production of chemically recycled plastics will increase to 1.2 million tons in 2025 and to 3.4 million tons in 2030. That would move the bloc's Circular Plastics Alliance closer to its goal of 10 million tons of recycled plastics by 2025,⁶⁶ more than twice 2016's level of 4 million tons.⁶⁷

1.5.2. Governments

While Europe leads the world on plastics management, success requires action from other regions too. It has been estimated that as much as 12.7 million tonnes of plastics leaks into the marine environment each year,⁶⁸ with Asian countries by some estimates contributing over half this total.^{69,70}

While tackling pollution in those countries is an obvious step, the underlying situation is more nuanced than might first appear, says Dr Trisia Farrelly, co-director of Massey University's Political Ecology Research Centre in New Zealand, and a member of UNEP's Expert Group on Marine Litter and Microplastics.

Out of sight, out of mind

For decades, China imported about half of the world's plastic recyclables, including from many of the G20 nations. Among these are the countries that lead the Plastics Management Index. For instance, Japan, the US, Germany and the UK were among the top ten exporters of plastic waste to China in 2017.⁷¹

However, China slammed that door shut in 2018. The result? Lacking capacity at home, countries sent their waste elsewhere—including to South-east Asian countries like Malaysia, Thailand⁷² and Indonesia.⁷³ Given that in 2016 around 50% of plastic waste collected for recycling globally was traded internationally,⁷⁴ those volumes were large.

Then, as those overwhelmed countries began to reject plastic waste, countries like the US sent shipments to poorer nations, including Bangladesh, Laos, Ethiopia and Senegal, where labour is cheap and environmental regulations are limited.⁷⁵

The movement of plastics is subject to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, a global treaty that entered into force in 1992 that is meant to protect people and the environment throughout the plastics lifecycle. (The US, which signed the convention in 1990, is the only country included in the Plastics Management Index that has not ratified it.⁷⁶)

At the beginning of 2021, amendments to the convention came into force that subject the transnational movement of plastics waste deemed to be hazardous to the prior informed consent (PIC) requirement.⁷⁷

The amendments are designed to ensure that plastic waste cannot be dumped easily and that shipments go through proper procedures. It won't eliminate illegal traffic, but it does mean far more plastic waste is accountable than was the case previously.

Dr Trisia Farrelly, co-director of Massey University's Political Ecology Research Centre, says the amendments should resolve some of the problems of waste-dumping, provided developing countries can stand up to powerful nations that wish to continue past habits.

The amendments subject the transboundary movement of all plastic waste to PIC. However, she notes, that does not apply to mixtures of plastics with materials needing to be separately recycled in an environmentally sound manner and that are almost free of contamination. Dr Farrelly says this creates a loophole, with countries potentially feeling pressured to give PIC and accept a wider range of plastics than they have the capacity to take. Linked to this is that receiving countries set their own contamination rate, which exporting countries must not exceed.

"However, they are not bound to set contamination rates, or they may feel pressure to set their contamination rates at a higher level than they would like," she says.

"New Zealand, for example, has decided not to set a contamination rate for its plastics waste exports ... and could make the decision to export to a receiving country with high or no contamination rates and higher willingness to give PIC over others with stricter import rules," says Dr Farrelly.

The difficulties do not end there, she says, because the rules exclude some plastic waste exports from PICs "if they are effectively going to be recycled". That creates an enforcement challenge, because irresponsible actors can falsify what is in their shipment simply to get around the PIC requirement. Additionally, some polymers and resins on the exclusion list are "ones that we know cannot be recycled", including certain cured resins and fluorinated polymers.

The only way to determine whether shipments met the rules would be to check them.

"Most exporting countries do not have this kind of system in place," she says. "They may have laws that make it illegal, but they may not have systematic controls in place and, in reality, they have little interest in enforcing this. And for receiving countries, it's an almost impossible task—or at least it requires serious resources—to control everything that comes in."

"This makes it so much more important that exporters in more economically powerful countries ensure they have robust legislation in place, along with monitoring and enforcement to ensure that only high-value, clean, sorted plastics are exported, and that they can confirm that these exports will be responsibly and safely recycled at the destination," says Dr Farrelly.

Dr Farrelly says that while it is accurate to say these countries have the most pollutants leaching into the marine environment, it's important to ask why. The reason, she says, is a form of colonialism.

"The problem is not the developing countries' alone," Dr Farrelly says. "It has for a long time been waste-dumpers—where big producers are offloading what they can't deal with in their own territories on to developing countries, who they know can't deal with it either."

Just over half of the 3.9 million tonnes that was collected in the US for recycling in 2016 was exported, for example, with 88% of that going to countries that already struggle to deal with plastics, and with as much as 25% of that exported amount considered lowvalue or contaminated, meaning it could not be recycled.⁷⁸ (US exports of plastic waste dropped by two-thirds in 2019 following China's decision to close its door to most of the world's recycled plastics [see box]).

Obviously enough, governments have a key role to play. Brands need to get involved too.

Obviously enough, governments have a key role to play. Brands need to get involved too. As noted by the Ellen MacArthur Foundation, a UK-based charity focused on developing the circular economy, although consumer-facing firms like Danone, L'Oréal, Molson, PepsiCo, Coca-Cola, H&M, ColgatePalmolive and Unilever have begun to act, brands need to do much more.⁷⁹

What's needed from business, the foundation said, is bolder action on packaging that cannot be recycled and ambitious targets to reduce packaging. The foundation has also called on governments to ensure recycling can scale, not least by putting in place EPR schemes.

The foundation has also asked governments to act through the UNEA to craft an international framework for action, ahead of the UNEA's February 2022 meeting that is likely to take up the issue.⁸⁰

1.5.3. Consumers

And then there are consumers. Although they are an important part of the solution, there is limited desire in key regions to change habits. A 2020 report covering five key polluting countries in South-east Asia, for example, found that while 91% of consumers were concerned about plastic waste issues, many weren't changing their habits with regard to purchasing decisions or recycling and reuse.⁸¹

Dr Farrelly says it is also the case that consumers have the least power of those involved to act. Much plastic packaging, she says, is driven by marketing, not functionality, which places the onus squarely on the brands.

Research shows that marketing and sales are the main drivers of product design rather than end-of-life sustainability, with globalised supply chains of consumer goods not taking into consideration waste management conditions in local markets.⁸² Dr Farrelly adds that it is unreasonable to expect parents on a limited budget to avoid plastic where safe and affordable plastic-free alternatives do not exist.

"Everybody needs to do something, but then my question is: Who's got the most power to make the most significant change? It's not consumers," she says. "A lot of people would dearly love to avoid plastics in their life, knowing the health hazards associated with them—if nothing else—but really struggle to do so." "So, my response to corporations would be: make it easier for us to avoid the stuff, and do better," Dr Farrelly says.

1.6. The many challenges of plastics management

As we've seen, there is no shortage of challenges when it comes to plastics management, although perhaps the most important is that there is no one framework and no single body that oversees plastics pollution.

Freshwater ecosystems: The "largely ignored" conveyor belt

Dr Emmanuel Olusegun Akindele, a freshwater ecologist and conservationist at Obafemi Awolowo University in south-west Nigeria, says the world must focus far more than it does on plastics pollution in freshwaters like rivers, lakes and inland waterways.

"All of these freshwaters are interconnected, and ultimately they all flow to the ocean —they serve as the conveyor belts for plastics from the terrestrial environment to the ocean," he says.

"For example, the Atlantic Ocean is about 200 km away from where I am in Nigeria," he says, "but whatever happens here ultimately affects the Atlantic Ocean in the Gulf of Guinea—even upstream from where I collect my samples."

Despite their importance, says Dr Akindele, freshwater ecosystems are "largely ignored compared with terrestrial and marine ecosystems".

"When we talk about conservation, people always talk about forest and ocean. Freshwater ecosystems are not given their due attention, yet we need them for our existence and for biodiversity," he says.

The solution? Policymakers worldwide "should give as much attention to freshwater plastic pollution as they do for marine plastic pollution".

Instead, a patchwork of regulations, directives and voluntary commitments, some national or regional, others international, cover some, although not all, of what's needed. And at least a dozen key global agreements on plastic pollution are divided between three UN bodies.⁸³

Another challenge is that users are constrained in what can be done with plastics.

Another challenge is that users are constrained in what can be done with plastics. Reusing and recycling are preferable to incinerating and putting waste in landfills, yet all solutions have their limitations. And plastics that leak from formal collection systems (and in many countries such systems don't exist or can't cope with existing levels of waste) are burned on open fires or dumped illegally, leading to other challenges (see box).

Another challenge is the petrochemical industry's massive investment in infrastructure to manufacture more plastics and chemicals, as demand for fossil fuels is predicted to slow in the coming decades due in part to government-enforced measures to mitigate climate change. One estimate is that the industry is planning to spend US\$400bn to build another 80 million tonnes of capacity.⁸⁴

This move by the petrochemical industry to plastics production, including single-use plastics production, "is one big reason why we're not seeing a drop-off in the production of single-use plastics," says Dr Farrelly.

"In 2019 368 million metric tons of newly made—or virgin—plastics were produced, with some reports estimating that 50% of that is for single-use purposes," she says, adding that, "it is estimated that we will see a 40% increase in plastics production by 2040".

1.7. Ocean plastics pollution

With images of a seahorse riding on a plastic earbud, seabirds, turtles and dolphins drowned in plastic fishing nets, and mounds of plastic bottles on beaches, it's hardly surprising that plastics pollution in the oceans is of particular concern to the public.

Part of the problem is a lack of responsibility for plastics pollution in international waters. Another is the issue of richer nations dumping their plastic waste in poorer countries, which often lack the capacity to deal with it, and where it pollutes waterways and the oceans.

On top of that, there are only estimates of how much plastic is flowing into the oceans. It's thought that five trillion plastic items, most of them microplastics, are circulating in the oceans' surface layers,⁸⁵ with a further 14 million tons of microplastic conservatively estimated to be on the ocean floor.⁸⁶

Measurement remains an important gap, with major gaps in knowledge and capacitybuilding, too. And while perceptions of ocean pollution are often limited to plastics, the subject in fact is far wider, including the

What's driving plastic leakage into oceans: A five-country analysis

Research shows that more than 80% of plastics in the oceans originates from land-based sources, and that's due to poor waste management. Of that total, in 2015 it was estimated that 55-60% came from five nations—China, Indonesia, the Philippines, Thailand and Vietnam—as demand for plastics outstripped local waste-management infrastructure. Subsequent research shows that not only was dumping by rich nations at least in part to blame, but also that these five countries have improved their waste management practices and infrastructure, as have a number of developing nations.⁸⁷ Waste generation in China, for instance, was down by a reported 60%, with inadequately managed waste halved—largely due to the country's efforts to build more incinerators.

A lack of formal recycling systems and a lack of value in plastics products are also driving the problem. Most of what leaks is waste that is not collected in the first place, since it is worth too little for waste-pickers. Additionally, more than 25% of leakage is from outside Asia, making any effort to combat ocean plastics a global challenge.



% contribution to ocean plastic, by driver

Source: Stemming the Tide: Land-based strategies for a plastic-free ocean, Ocean Conservancy (2015).

presence of persistent organic pollutants in plastics (which undermine the drive towards implementing a circular economy) and other toxins.⁸⁸

The five countries in the Ocean Conservancy study typically rely on informal systems predominantly waste-pickers—to collect plastics and sell them to recyclers. As they are paid by weight, it is logical that wastepickers focus on higher-value plastics that are easier to collect, plastic bottles rather than plastic bags, for example. This explains why much of what leaks into the oceans is low value.

The researchers found that only about 20% of municipal waste fits this higher-value parameter. This is one reason why those looking to solve the problem of plastics management say that including waste-pickers, who are often from vulnerable, marginalised communities, and improving their lives is crucial.

And while the public is often appalled at images of dead and dying marine life or mounds of plastic waste on beaches, it's estimated that only 5% of the plastic that enters the oceans ends up on beaches or in the Great Pacific Garbage Patch, as the North Pacific gyre is known.⁸⁹ The remaining 95% is below the surface where it cannot be extracted. Logically, then, the focus must be on tackling plastics pollution on land.

1.8. Land-based problems require land-based solutions

The premise is simple: if every piece of used plastic could be contained before entering the environment, then the problem of plastic pollution wouldn't exist.

The premise is simple: if every piece of used plastic could be contained before entering the environment, then the problem of plastic pollution wouldn't exist.

Broadly, that's the focus of Project STOP, an initiative started by Borealis, a chemical company, and SYSTEMIQ, an advisory firm. Project STOP builds sustainable, circular waste management systems in South-east Asia using what it calls a "system enabler" approach, where teams of experts in a range of disciplines help cities to design and implement formal, low-cost waste-management systems that provide collection for every household and business, ensuring that plastics stay out of the environment.

Joi Danielson, an environmentalist and former consultant with McKinsey, is a partner at SYSTEMIQ and co-founder of Project STOP. In recent years, Ms Danielson says, people have moved away from talking about ocean plastics specifically and are instead looking at the broader topic of environmental waste pollution. Critical areas for focus are places with very low levels of waste collection, higher pollution levels and numerous river systems and islands.

Ms Danielson says that although the challenges differ by country, they typically involve two elements: how well governed a country's formal waste management systems are; and how much funding is available either to run what's already there or to set up and run what's needed.

Take governance, she says. Countries with the highest levels of waste pollution tend to have different formal waste systems between rural and urban areas, with the latter more organised, institutionalised and scaled. Rural areas, on the other hand, tend to be ad hoc and community-led, which means they rely on the enthusiasm of local leaders. In a country like Indonesia, she says, with 75,000 villages in rural areas, it is unrealistic to identify 75,000 leaders who will be motivated and have the skills to drive a formal waste management system.

What is required is a transition from smallscale waste management systems that are dependent on local leaders to a system that is more institutionally coordinated and no longer tied to local politics.

Plastic credits: Turning waste into value

Joi Danielson, Project STOP's co-founder, says plastic credits are a nascent, yet interesting, financing mechanism that projects could borrow against in order to set up new waste infrastructure, and with which they could pay off loans.

It works like this: Project STOP is starting a new programme for 1.4 million people, with some funding raised via grants and some that it is looking to get in loans—which it will repay by selling plastic credits into the market.

If the programme collects 25,000 tons of plastic annually, it can sell, say, 7-10 years' worth of future plastic credits. In this way, the programme can obtain the net present value of that ten-year commitment, which provides the working capital needed for funding waste infrastructure.

Ms Danielson says the plastic credits market is a decade behind the carbon credit market, "so no one really knows what the price of credits will become, how the taxation works it's kind of like the Wild West".

But, she says, working with an estimate of US\$150/ton would see around half of the cost of the infrastructure funded through plastic credits alone.

"That doesn't mean that the community can't own pieces of the waste system at all—it just means that it's co-ordinated from a more centralised level generally so there are no gaps in collection coverage across different areas. And then we see a big change in waste collection levels," Ms Danielson says.

Enforcing penalties for dumping or burning waste is another crucial governance area, she says. And good governance is also a prerequisite on the funding side, where money is needed for operating costs and infrastructure.

Tying local government funds to the waste system is a useful solution

Where should that come from? Developed countries usually fund both through taxation, she says, but in many parts of the world that have localised waste collection systems, operating costs are often collected via small monthly cash payments from those willing to pay for waste services. That is far less efficient and less comprehensive, because not all households will be prepared to pay with their waste often dumped or burned.

Although household waste fees typically provide the main pool of funding for a waste system (with material sales from, for example, recyclable waste or processing organic waste into compost), what's charged is generally enough only for a linear waste collection system. Circular waste systems, where materials are sorted and sold, are more expensive. Tying local government funds to the waste system is a useful solution, as is private sector co-funding—including plastic credits (see box) and EPR schemes, which impose waste management and clean-up obligations on producers.

Governance and funding are crucial, as is behaviour change, says Ms Danielson, and that can be achieved faster and more efficiently by targeting government bodies and companies through regulation than by trying to reach millions of people.

There is also a problem of scale—the significant gap between the sums of loan-based funding available for waste management projects and the capacity of governments and their partners to carry out such projects and repay those loans.

"We talked to one country government fund whose minimum spend is US\$100m," she says. "Until recently, we were the largest project in Indonesia that is rolling out these waste management systems, but to spend that amount, you'd need to do multiple regions and cities at the same time, and very few organisations can manage that not even us."

1.9. Reasons for optimism

While there is no shortage of challenges, many interviewees felt there are reasons for optimism.
Source-reduction: Sustainability and materials design

In recent years, more attention has been paid to the front-end of the plastics lifecycle. This includes the need to move away from petrochemicals, with its extraction causing pollution, and instead use materials from more sustainable sources (including recycled plastics and biological solutions); and for plastics to be designed with the circular economy in mind.⁹⁰

Virginia Janssens, managing director of PlasticsEurope, says designing for reuse and recycling is a top priority for the association's members and their partners in the value chain as they seek to build a fully circular plastics lifecycle. Such an approach, she says, is having a significant effect on plastics recycling performance, innovation and investment.

"The circular economy is about more than just recycling," she says. "It's about new ways of doing business with interconnectedness and interdependencies in our value chains. It's also about keeping the value of products and materials for as long as possible in the economy through, for example, a lifecycle approach to identify the optimal sustainable design of products, increasing the lifespan of products, and reusing products—without compromising plastics' functionalities."

One risk in designing for recycling is that it is often done only with existing technologies in mind, says Dr Patricia Vangheluwe, a chemist who heads PlasticsEurope's end-of-life and circularity team.

"You also have to look with the future in mind, and many people don't do that. When I design for recycling with my scientific mindset, I do it with both existing and future technologies in mind, so that you don't waste resources," she says, adding that this includes factoring in chemical recycling considerations, for example.

"So, let's also think with future creative technologies in mind that our industry can deliver and that we have to deliver—otherwise we'll not reach the circular economy," she says.

Dr Vangheluwe cites CEFLEX, a European industry-wide initiative with a goal of making all flexible packaging in Europe circular by 2025.⁹¹

CEFLEX has put redesign at the heart of its approach, aiming to ensure that, where possible, multi-material flexible packaging is redesigned to use mono-materials so that it will better fit existing recycling streams.⁹²

Other key plastics value-chain initiatives, she says, include VinylPlus, Styrenics Circular Solutions, the Polyolefin Circular Economy Platform and PETCORE Europe.

First, there is far greater political awareness of the importance of plastics management, with nations, NGOs and companies seeking a comprehensive framework, and with the EU showing leadership with a range of regulations. At the same time, and linked to this, many stakeholders want improvements. As Malaysia shows, public outrage can drive change quickly.

Far more is also becoming known about the dangers of plastics and the steps needed to mitigate those dangers, particularly at the design stage (see box). And yet, as the PMI shows, much more is needed in a range of areas. Far more is also becoming known about the dangers of plastics, and about the steps needed to mitigate those dangers

2. The Plastics Management Index: Overall results

The PMI is built on three categories governance, systemic capacity and stakeholder engagement—that each consist of four sub-categories, scores for which are derived in turn from indicator scores that are based on hard data and systematic assessments of a country's performance by Economist Impact analysts, as well as survey responses. In this section we assess the overall results; subsequent sections will delve into each category in more detail.

The overall score attained by each country is comprised of the weighted sum of the scores for three categories, where governance and systemic capacity have weights of 36.36% each, with stakeholder engagement at 27.26%.

On that basis, Germany is ranked 1st, Japan 2nd and France 3rd, followed by the UK, the US and Sweden (see chart). All score more than 75 points, placing them in the "very high" performance category.

A further nine countries score higher than 50 points, placing them in the "high" performance category, including the world's biggest plastics producer (China), and two lower-middle-income countries (Vietnam and Ghana).

Another nine score between 25 and 50 points, placing them in the "medium" performance category. Of these, Jordan is the lowestranked upper-middle-income nation, coming in at 24th. Finally, Nigeria is the only country to attain a "low" ranking, with 21.4 points, dragged down by its governance score. In general, countries that outperform on plastics management on an overall basis score better thanks to:

The overall score attained by each country is comprised of the weighted sum of the scores for three categories

- A high governance ranking, which implies proactivity: for instance, that a country promotes responsible plastics use and consumption, safe and informed plastics usage, and that it has a robust plastics waste management regime underpinned by effective operational enablers.
- Outperformance on systemic capacity, which stems from aspects like superior oversight of waste management processes, more efficient collection and sorting channels, and the presence of infrastructure to help recycling.
- Better stakeholder engagement, with countries doing well if they adhere to international standards, their governments push formalised approaches to minimising plastic mismanagement, and the private sector and consumers fulfil their roles.

Although there is a strong correlation to show that wealthier countries outperform lesswealthy nations on an overall basis, that is not always the case. (Wealth is measured in terms of GDP per head, which when plotted against the overall ranking has a positive correlation of 0.80.)

Overall rankings: How the PMI's 25 countries fared

Overall, Germany was ranked 1st and Nigeria last. The two biggest producers of plastics, the US and China, were ranked 5th and 10th respectively. The higher a country's score, the greater its capacity for plastics waste management.

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20	India					41.5			
21	Mexic	0				38.7			
22	Egypt	:				34.4			
23	Kenya	а				28.8			
24	Jorda	n				28.0			
25	Niger	ia				21.4			

Three reasons for Germany's position as global leader

Dr Aleke Stöfen-O'Brien, a lawyer and policy expert at the WMU-Sasakawa Global Ocean Institute at the World Maritime University in Sweden, highlights three elements that could have contributed to Germany's leading ranking.

The first is its *Der Grüne Punkt* recycling scheme,⁹³ which underpins Germany's approach to creating a circular economy. Instead of imposing outright bans on certain plastic products, as some other countries have done, the government instead reached an agreement with industry that has, among other consequences, "allowed for a huge amount of recycling".

"It's quite industry-friendly," Dr Stöfen-O'Brien says of the approach. "And the industry in exchange, in my opinion, has answered with a lot of voluntary measures and voluntary initiatives. It's a question of whether you decide to go with the 'top-down, binding, legal, stick route' or with the carrot route, and then the industry follows —as Germany has done to a certain degree within available regulatory options."

The second is that Germany has committed itself to the issue globally (as have some other nations). That includes its lead on the G20 and G7 plans to combat marine litter, with funds provided to help implement the plans worldwide, along with knowledge exchange and technology transfer.

That links to Germany's approach committing itself "to very strong international rules, and there's a very strong push to implement these and to really try for change," Dr Stöfen-O'Brien says.

The third, which feeds into the stakeholder engagement category, is the Roundtable on Marine Litter, a platform that brings together a diverse range of participants including representatives from industry, government, non-government organisations, and even philosophers and artists to discuss key issues.⁹⁴

"The Ministry of Environment, the Environment Agency and the State of Lower Saxony are then responsible to make sure that what is agreed for implementation is implemented and pushed forward," says Dr Stöfen-O'Brien.

Despite leading the index, Germany can improve in several areas—for example, it ranks just 12th on the efficiency of its collection and sorting channels, which is a key component of the systemic capacity category.

Vietnam, for instance, which is a lowermiddle-income country and an outlier when measured this way, ranks 11th overall, outperforming every upper-middle-income country bar China. A country's performance, in other words, is not as limited by its per-head GDP as one might assume—as the example of 15th-ranked Ghana, also a lower-middleincome country, shows too. Another outlier is the US, for which its 5th-place ranking belies its position as the wealthiest nation in the PMI.

A country's performance, in other words, is not as limited by its perhead GDP as one might assume

Interestingly, there is a very low positive correlation (0.10) between a country's overall score and the percentage of plastic in its waste stream, and a strongly negative correlation when comparing the overall score against the percentage of inadequately managed waste (-0.65). This indicates that it is not the proportion of plastic waste each nation produces that counts, but how it handles waste overall.

Analysis of the results also finds positive correlations between a country's overall score and its ranking in the UN's Human Development Index (0.83) and its literacy rate (0.67), and a strongly negative correlation when compared against their Gender Inequality Index score (-0.86). All of which is to say that nations are likely to do better if their citizens are healthier, happier, better educated and fairly treated.

2.1. Regional variations

Examining the results on a regional basis, Europe leads the overall ranking. That is in part because five of the six European countries in the research are relatively wealthy and do well on a range of development measures, but it is also due to regulatory action by the EU in recent years. Russia is the exception. It ranks 17th overall (equal with South Africa), with below-average scores for all three categories.

Most of the eight Asia-Pacific countries take up the middle of the table, bounded by Japan in 2nd place and India in 20th. Asia-Pacific countries perform best in stakeholder engagement, with Malaysia, Japan and Australia taking three of the top four positions behind Germany, and with Indonesia and Vietnam also in the top ten. China's 8th place for systemic capacity is another highlight, where it scores well for three of the four components: efficient collection and sorting channels; infrastructure to enable recycling; and investment in capacity-building to ensure sustainability of systems.

The four Latin American countries in the study (Chile, Brazil, Argentina and Mexico) rank in the middle to lower end of the index. As a group, they are weakest in the stakeholder engagement category although Chile, the only high-income country in this group, is the exception (ranked 5th) versus Mexico (18th), Brazil (20th) and Argentina (23rd). The Middle East and Africa nations are weakest overall, with four of the six taking the last places (Egypt, Kenya, Jordan and Nigeria). Ghana is the strongest performer, ranked 15th overall, just ahead of South Africa at 17th.

The Middle East and Africa nations are weakest overall

Finally, the sole nation from North America included in the study is the US, for which its 11th place for stakeholder engagement undermines stronger performances for governance and systemic capacity.

Dr Aleke Stöfen-O'Brien of the World Maritime University in Sweden says Europe's lead stems from the EU's position as the world's most proactive party on the issue. The EU's policies and regulations that address plastics in a crosssectoral manner are one factor, as is the bloc's ability to leverage its vast resources to target innovation and research.

"It's the powerhouse of knowledge. The amount of research on plastic—and not just material science, but philosophical questions, societal issues, gender," Dr Stöfen-O'Brien says. "It's really holistic and broad."

Another factor is the EU's focus on transparency—for instance, about the chemicals used in plastics, and the potential health impacts of which are a concern. A third advantage relates to enforcement, with the European Court of Justice able to hand down judgements for breaches. Additionally, Dr Stöfen-O'Brien says, the EU's risk-based approach means countries have an obligation under the 2008 Marine Strategy Framework Directive to monitor the marine environment—and increasingly the freshwater environment through the Water Framework Directive—for human impacts like plastics and chemical pollution.⁹⁵

"This knowledge is then linked and communicated to decision-makers that deal with plastics so that they can have concrete, evidence-based knowledge on which plastic they should target," Dr Stöfen-O'Brien says. "I don't know any country or bloc in the world that has a similar, comprehensive monitoring set and that links it to measures."

Another directive is the 2019 measure that targets the ten most-polluting single-use plastics found in the marine environment, such as cutlery, cups, straws and certain sanitary products.⁹⁶ It bars listed items from being placed on the EU market if sustainable alternatives are easily available and affordable, and limits the use of the rest, including through design and labelling requirements.

A key aspect of the single-use plastics directive is an EPR scheme, which envisages waste management and clean-up obligations for producers, says Dr Stöfen-O'Brien. Although EPR is "difficult on so many levels in a legal sense, and in terms of follow-up and enforcement, the idea behind it is extremely important."

China: Key steps forward

China's overall ranking of 10th puts it ahead of every other non-high-income nation in the survey, helped by coming 8th for systemic capacity.

Doug Woodring, who founded and leads Ocean Recovery Alliance, which works to improve ocean health, says China has taken several important steps in recent years.

"The first thing is that it stopped the importation of plastic waste from the West," he says. "That caused a shock that needed to happen to wake up the world systems—it created a big effect globally, which is still being felt."

China's decision highlighted the fact that many countries, including the US, Australia and Japan, were offshoring their waste problem, and had not invested in value-added processing at home.

"And then domestically, as China did that, it tried to improve its domestic recycling capacity and collections, particularly at the consumer level," he says.

Mr Woodring says China is also working to rid the country of single-use plastic utensils, "which will drive demand for different designs" that might be reusable, easier to recover and recycle, or that will be truly compostable—provided there are facilities to support composting.

On the other hand, says Mr Woodring, domestic collection still lags China's ambition, even in its tier 1 cities, "where they've tried to paint a good picture of change, and a working, modern recycling system".

"I would say the recovery of consumer materials, of post-consumer waste, still has a way to go to be better across all of the tiered cities," he says. "And rural is even harder, because the farther away you get, the harder it is to get plastic waste into the recycling system."

Japan: Strong overall, but some important shortcomings

While Japan performs well in terms of overall governance and systemic capacity, it does less well when it comes to the third category: stakeholder engagement.

Its overall third-placed ranking for this category is dragged down by its 24th place in the sub-category of responsible consumer actions and perceptions (consumer perceptions of the Japanese government's actions were the lowest of any country surveyed, with just 15 percent of respondents having a positive view), and its 16th place for private sector commitments to reduce plastics waste and promote responsible plastic use – with business practices a particular problem.

The survey also highlights weak points within the governance category, with Japan ranked seventh in terms of operational enablers.

Lastly, Japan – like Germany – underperforms in terms of efficient collection and sorting channels, where it was ranked seventh, which dragged down its overall score for the systemic capacity category.

3. Governance

As a country's overall score is highly positively correlated (0.97) to its governance score, it is little surprise that nine of the top ten countries overall are in the top ten in terms of governance. The exception is China, which ranks 12th.

The outlier is India, which is ranked 22nd for governance with 22.2 points, undermining far stronger scores for systemic capacity (13th with 56.7 points) and stakeholder engagement (17th with 46.9 points).

India's particular weakness is in plastics waste management (where it scores zero in two of the three indicators) coupled with a failure to score any points in another five of the remaining 11 governance indicators—like promoting safe product use and safe product design, promoting green public procurement, and regulating

Outlining the governance category

The governance category assesses the enabling governing environment for the optimal production, consumption and end-use of plastics.

This includes mechanisms like policies, regulations, legal frameworks and voluntary initiatives across the plastics value chain, and corresponding funding mechanisms to ensure enforcement.

The four sub-categories and indicators that comprise this category are:

- **1. Promoting responsible plastic production and consumption:** six indicators measure: regulation of single-use plastics; regulation of microplastics; incentives to use sustainable plastic inputs; penalising irresponsible business action; promoting green public procurement; and whether the private sector must report its plastic footprint.
- 2. Promoting safe and informed plastic usage: based on two indicators: safe product use and safe product design constituting.
- **3. Plastic waste management:** measures the presence of a comprehensive waste management framework; whether labelling is mandatory; and whether violations of waste management laws are penalised.
- **4. Operational enablers:** includes indicators for the business environment, corruption and government effectiveness.

microplastics. That undermines areas where it does perform well, like incentivising the use of sustainable plastic inputs.

Dr Suneel Pandey is the Director of the Environment & Waste Management Division of The Energy and Resources Institute (TERI), a research body headquartered in New Delhi. He says India's poor governance rating is due in part to a lack of monitoring mechanisms for general waste management regulations in urban and rural areas.

"Rules are good, but there is no monitoring mechanism as a follow-up. And if there are violations, how to tackle those violations, and if there are penalties to be levied, how can those penalties be levied?" Dr Pandey says, adding that India's waste management won't improve in the absence of monitoring.

Clean India Mission

Although India scored poorly on governance, Dr Suneel Pandey, the director of the Environment & Waste Management Division of The Energy and Resources Institute, says cities are working to improve the collection of plastic waste through the government's Swachh Bharat Mission (Clean India Mission). This is a cleanliness competition that started in 2014 in which cities compete to improve their ranking on sanitation and waste management issues.

"Now it has become prestigious for cities to do improve their ranking year on year," Dr Pandey says, explaining that scores are based on actions taken by cities, and how residents view their effectiveness.

However, there are grey areas on the regulation side, particularly as regards extended producer responsibility (EPR). To date, he says, there has been no agreement between manufacturers, brand-owners and government on a viable way to implement EPR, especially the role of city authorities.

"Manufacturers say some city governments are not providing proper waste management services, so their product gets littered. City governments say it's the responsibility of manufacturers or brand-owners as per the regulation to ensure that material they've used as packaging gets picked up," he says.

"So, it's a conflict area where they keep blaming each other. It's an area which needs lot of clarity, and probably, India can learn from some other countries where this has been done successfully."

3.1. Notable findings

While the survey's high-income countries take the top nine positions in the governance category, the standout result is Vietnam, at 10th. It is by far the best-performing lowermiddle-income country, and it outperforms every upper-middle-income nation.

While the survey's high-income countries take the top nine positions in the governance category, the standout result is Vietnam, at 10th.

Vietnam's 5th-place ranking for plastics waste management and its maximum score for promoting safe and informed plastics usage help to overcome a middling score for its efforts to promote responsible plastics production and consumption.

The nine high-income countries not only take the first nine positions for the governance category, but also for sub-category 4, which measures operational enablers like the business environment, corruption and the effectiveness of government. Sub-category 4 is a key area of underperformance for Vietnam and Russia, which come 21st and 23rd respectively.

Encouragingly, 15 countries—including Vietnam—score maximum points for promoting safe and informed plastics usage. Also of note is Australia's under-performance for plastics waste management, where its lack of a comprehensive waste management framework or presence of mandatory labelling sees it manage a lowly 14th place for governance sub-category 3.

Shane Cucow, plastics spokesperson for the Australian Marine Conservation Society, says waste management policies in the country fall to individual states, with responsibility for collecting and recycling waste belonging to councils. He says the absence of a clear overall strategy for a comprehensive waste management framework is a problem.

"It's been very piecemeal," he says of the country's approach. "Many of the state governments are working on policies at the moment, but many are yet to be released."

A lack of labelling also contributes to Australia's relatively low score, though Mr Cucow praised the 2018 Australasian Recycling Label Program ("a step up from the old numbered system, which is opaque in terms of what it means"), which specifies which parts of a product can be recycled, and where.⁹⁷ However, the programme is voluntary "and adoption is very low—so we want to see that mandatory so that it's consistent across all products in Australia".

3.2. Regional focus - Africa

For Dr Olusola Olaitan Ayeleru, a researcher at the University of Johannesburg in South Africa, the low rankings of the four African nations in the index are of little surprise. The continent, he says, "is still very far behind ... especially with respect to plastic waste management".

The governance category

Germany ranks 1st overall, one of three European countries in the top five. The first nine positions were taken by the high-income nations, with Vietnam, a lower-middle-income country, a standout being ranked in 10th place—ahead of every upper-middle-income entrant.

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1	9	Arger	ntina				40.2			
2	20	Jorda	n				27.3			
2	21	Mexic	0				22.6			
2	22	India					22.2			
2	23	Egypt	:				12.8			
2	24	Kenya	а				11.5			
2	25	Niger	ia				11.1			

Source: Economist Impact PMI data

Ghana, for example, is the only one of the four to score points for plastics waste management, a sub-category that assesses, for instance, whether countries penalise violations of waste management laws. (Enforcing anti-dumping laws, for example, is an important way to counter plastics pollution.⁹⁸)

One consequence of poor governance, Dr Ayeleru says, is that the recycling rate in the 48 countries of sub-Saharan Africa, where a combined population of 1 billion people generates 17 million tons of plastic annually, "is still very minimal"—although South Africa has taken some steps in the right direction.⁹⁹

The continent's strongest performer is Ghana, ranked 15th

The continent's strongest performer is Ghana, ranked 15th, which is the only nation of the four with a "high" score for governance. Uniquely among the four African countries, Ghana regulates single-use plastics and microplastics, requires the private sector to report its plastics footprint, and promotes green public procurement.

This proactivity propels Ghana to 3rd—behind Germany and Japan—when assessed on the first of the four sub-categories that constitute the governance category.

Dr Ayeleru says poor political leadership and a lack of funding for waste management are

key to the continent's weak showing. On the other hand, he adds, many countries have far more pressing problems—some are tackling insurgencies or food insecurity, while many have employment and health challenges.

Moreover, Dr Ayeleru says Nigeria, his home country, could do far better by appointing qualified people rather than loyalists to positions of influence in ministries, by subsidising waste management solutions where people are unable to pay for them, and by supporting and funding research around plastic waste. Additionally, he says, it could implement an incentive model that rewards people who have a high rate of plastic recycling or who use less plastic, and it could ensure that community development workers educate people.

"There's still a long way to go," he says. "There is still the issue of the illegal dumping of waste. And we have plastic littering our environment and going into the marine habitat, which we know is having a very negative impact on marine organisms and public health. We need to do more, especially in terms of awareness campaigns and education."

3.3. Focus on Indicator 1.1.2. Regulation of microplastics

Dozens of nations have acted on single-use plastics over the past two decades. As of mid-2018, according to the UNEP, 127 countries had passed laws to regulate the use of plastic bags, most commonly banning retailers from freely distributing them.¹⁰⁰ In addition, more than two-dozen countries had regulated against specific single-use plastic products like plates, cutlery and bottles.¹⁰¹ In the PMI, every country bar Russia has some mechanism to tackle single-use plastics (although Russia did announce in 2019 that it was preparing to ban some such plastics).¹⁰²

An area of increased focus more recently has been microplastics—non-biodegradable particles that come either from the breakdown of larger plastics or the microbeads found in personal care products and cleaning supplies.

An area of increased focus more recently has been microplastics

Microplastics not only contain toxic chemical additives from the manufacturing process, but they also adsorb pollutants like PCBs, DDT and other petroleum hydrocarbons in the surrounding seawater, "and concentrate these contaminants on their plastic surface up to six orders of magnitude greater than the ambient seawater".¹⁰³ These are then eaten by aquatic organisms, contaminating food chains and habitats. One study, published in 2015, estimated that, in the US alone, 8 trillion microbeads entered its aquatic environments daily.¹⁰⁴

Today, 11 countries in the index—including the US, China, France and Germany—have mechanisms in place to regulate the production and use of at least one type of microplastic. The issues relating to microplastics are becoming better understood, with new research showing decade-on-decade rises in the concentration of microplastics on the surface of the North Pacific Ocean, says the University of Tokyo's Professor Yutaka Michida, an oceanographer who studies marine microplastics.

Should that trend continue, he says, it "would cause very big problems for the marine ecosystem".

"The microplastics field is a very challenging area—there are so many unknown factors, so many unknown things in terms of the oceanography, on the behaviour of the particles and what is the impact to the marine ecosystem," he says.

Improvements are needed in monitoring and analysis systems so that researchers can quickly determine what microplastics are in water samples, Professor Michida says.

"It's not easy to detect whether particles are plastic or not—and there are many small particles in seawater," he says. "Currently we use microscopes and infrared instruments to detect which are plastic, but it takes a lot of time."

Another key step would be fitting instruments to ships to take water samples from intake systems. That would provide more data on the density of marine plastics at surface level.

Professor Michida highlights several improvements on the microplastics side in recent years, including greater awareness, an increased focus from governments and the involvement of more scientists.

To that, he adds the 2017 decision by GESAMP, a coalition of scientists focused on protecting the marine environment, to develop guidelines for monitoring macroplastics and microplastics in the oceans, and to assess the occurrence and effects of nanoplastics (which, he warns, could be even more problematic in terms of their effects on human and animal health).¹⁰⁵

"This was just a start," he says of the guidelines, "but in terms of international cooperation it was epoch-making."

The high seas: Littered and lawless

Although resolving marine plastics pollution begins predominantly on land, one crucial challenge is national jurisdiction—or, more precisely, a lack of it. Beyond 200 nautical miles, no country has legal authority to regulate pollution from plastic, and nor does any single body, says Dr Aleke Stöfen-O'Brien, associate research officer at the World Maritime University in Sweden.

And because this vast area belongs to humankind, and because it is so far away, she says, it is not comprehensively protected by one single authority—because each assumes someone else will act in their respective mandate.

"And this is one of the problems we have with areas beyond national jurisdiction—they seem so far away, and the plastic cannot be seen from the shore," she says. "But in the end, that's the wrong calculation, because it will impact us through the food chain, for example, or from potential navigational hazards because there are huge amounts of fishing gear floating around."

Dr Stöfen-O'Brien says that, with recognition of the importance of protecting biodiversity in these areas, discussions are under way for a new treaty to address biodiversity beyond national jurisdictions, with countries discussing how best to do this.

That discussion, she says, necessarily touches on plastic too, "because whatever we throw in here will end up in these ocean gyres, which are mainly in areas beyond national jurisdiction—a sink".

Having such an agreement in place should resolve another issue: the lack of monitoring of pollution in these regions. Currently, much of the extent of the problem is derived from what is observed near coasts. An agreement would help to ensure that funding was made available for assessment and monitoring, which could further inform policy decisions.

4. Systemic capacity

Each country's overall score is highly positively correlated (0.93) to its score for systemic capacity, with nine of the top ten countries overall also in the top ten in terms of capacity for plastics management. (The exception is Chile, which was edged into 11th place here by Thailand.)

The two outliers are Egypt, which outperformed with a 15th-place ranking and a score of 54.1, and Malaysia, which underperforms relative to its overall score, coming in 18th place with a below-average score of 50.2 points. Egypt, which scores zero in just three of the 14 indicators that comprise this category, performs strongly when it comes to frequency of waste collection, where it ranks 3rd in our index (behind Japan and China) with 80% of respondents to the consumer survey saying primary waste collection services visit their residence daily or several times a week. Egypt also does relatively well in terms of infrastructure that enables recycling.

Malaysia is dragged down with scores of zero points in five of the 14 sub-categories, three of which relate to the oversight of

Outlining the systemic capacity category

The purpose of this category is to assess the structural and systemic capacity of a country—its physical infrastructure, systems and processes—that are dedicated to keeping plastic within the value chain and promoting the optimal use of plastics.

The four sub-categories and respective indicators that comprise this category are:

- **1. Oversight of management processes:** evaluating the source of responsibility for plastics waste management; responsibility for overall waste management in urban and rural areas; mechanisms to ensure accountability; promoting coordination and communication across the plastics value chain; fairness of the judicial process; and enforceability of contracts.
- 2. Efficient collection and sorting channels: access to waste disposal bins before collection and frequency of waste collection.
- **3. Infrastructure to enable recycling: t**he existence of a secondary market for recycled plastics; the quality of the road network; and the quality of the rail network.
- **4. Investment in capacity-building** to ensure sustainability of systems: incentives for sustainable product design; initiatives for sustainable product design; and the training of staff involved in plastics waste management.

waste management processes. Malaysia's former environment minister Yeo Bee Yin says this is in large part because there's no single source of responsibility for plastics waste management. Instead, Malaysia's local authorities are responsible for waste management, which includes quantifying and measuring waste, with the environment ministry's role limited to dealing with plastics only once they become pollution—and even then, only if those plastics flow into areas for which the ministry is responsible (rivers and protected areas, for example, are the responsibility of other ministries).

"I do hope one day we will be able to get environmental waste management inside the environment ministry, as it will be much easier for us to control," says Ms Yeo.

4.1. Notable findings

For the most part, high-income countries outperform others—although China and Thailand stand out in 8th and 10th positions respectively.

For sub-category 1, which assesses six indicators that contribute to oversight of waste management processes, richer countries typically outperform poorer ones—although Mexico's 7th place makes it the best-performing upper-middleincome country, followed by the Russia in 12th place. Mexico is helped by efforts to promote coordination and communication across the plastics value chain. However, its performance for the category is undermined by its last place in sub-category 4 (investment in capacitybuilding) and 22nd place for sub-category 2 (efficient collection and sorting channels).

Sub-category 1 shows the importance of strong oversight of management processes in tackling plastics pollution, with the five key polluters named in a 2015 report appearing in the bottom half of the table—China (13th), Thailand (16th), India (19th), Vietnam (20th) and Indonesia (22nd).

For the most part, high-income countries outperform others

China is the standout on sub-category 2 (efficient collection and sorting channels), ranking 2nd behind France. Other Asia-Pacific countries also score highly for this sub-indicator, with India, Vietnam, Malaysia, Indonesia, Japan and Thailand in the top ten. In many countries—particularly in Asia—wastepickers are central to sub-category 2, an issue examined more closely in the next section.

China again outperforms on sub-category 3 (infrastructure to enable recycling), coming joint 4th place with Japan, and just behind France, Sweden and Finland. China's road and rail networks help it, as does the existence

The systemic capacity category

Once again, high-income countries dominate the top positions, with the UK, Japan and Germany leading. China, in 8th place, was the best-placed upper-middle-income nation, with Thailand 10th. Ghana, at 14th, leads the lower-middle-income countries, with Egypt and Vietnam close behind.

10	20 30	40	50	60	70	80	90	100
untries a	re scored from 0-100,	where 100	= best					
nk	Country			s	core / 1	00		Visualisatio
1	The UK				85.4			
2	Japan				85.2			
3	Germany				85.0			
4	The US				84.4			
5	France				80.6			
6	Finland				78.5			
7	Sweden				78.1			
8	China				75.7			
9	Australia				73.3			
10	Thailand				64.1			
11	Chile		60.6					
12	Brazil							
13	India				56.7			
14	Ghana				54.2			
15	Egypt				54.1			
16	Vietnam				52.9			
17	Russia				51.5			
18	Malaysia				50.2			
19	Argentina				49.9			
20	Mexico				49.4			
21	South Africa				43.2			
22	Indonesia				39.7			
23	Kenya				34.0			
24	Jordan				27.4			
25	Nigeria				24.5			

Source: Economist Impact PMI data

of a secondary market for recycled plastics. Argentina also performs well, taking 10th place. As with sub-category 1, the key polluters (bar China) are in the bottom half of this indicator: India and Thailand were ranked joint 16th, followed by Indonesia (19th) and Vietnam (21st).

Sub-category 4 looks at investment in capacity-building to ensure sustainability of systems, with incentives and initiatives for sustainable product design comprising about two-thirds of the weighting for the final score. (Training staff for plastics waste management is the third component.) Once again, China outperforms in 4th, with Brazil and Thailand ranked 6th and 7th, while India and Ghana close out the top ten.

Finally, while three high-income countries took the top positions for sub-category 4 (the UK, the US and Germany), their peers France, Chile, Finland and Sweden were ranked 12th to 15th.

4.2. Country focus – Australia

For decades, wealthy countries like Australia simply exported a large proportion of their plastic waste. Like many, Australia was caught out when China, followed by other countries, blocked most waste imports, says Shane Cucow of the Australian Marine Conservation Society.

"So, we didn't have the infrastructure and facilities to deal with it when those countries

stopped taking that waste," he says. "When China rejected Australia's plastic waste and refused to take any more, it was a huge catalyst for action."

Successful action, though, will take time. Australia has limited infrastructure for recycling, which is one reason most plastic packaging, for example, doesn't get recycled.

Australia is targeting all packaging to be reusable, recyclable or compostable by 2025, with 70% of plastic packaging either recycled or composted by then, and problematic and unnecessary single-use plastic packaging phased out.¹⁰⁶

For decades, wealthy countries like Australia simply exported a large proportion of their plastics waste.

On the recycling front, there is some way to go. According to the Australian Packaging Covenant Organization, just 182,000 tons of the 1 million tons of plastic packaging placed on the market in 2018-19 was recovered.¹⁰⁷ Some 818,000 tons went to landfill, even though 663,000 tons of plastics packaging is classed as being of "good recyclability".

And it's not just that Australia's recycling infrastructure is "woefully behind" where it needs to be, Mr Cucow says—although funding has been announced to boost that. It's also that there isn't sufficient demand for recycled plastics, and that virgin plastics are far cheaper. Those, of course, are challenges globally.

4.3. Focus on Indicator 2.2.2. Frequency of waste collection

In many countries, it is the vast, informal workforce of waste-pickers who are at the heart of this sub-indicator, and without their efforts pollution rates would be higher. By one estimate, the 11 million waste pickers globally were responsible for about 60% of the world's plastic recycling.¹⁰⁸

Indeed, Japan (1st) and France (9th) are the only high-income countries in the top ten for frequency of waste collection, which is based on a survey question that asked respondents how many times a week primary waste collection services visited their locality or residence—and where the highest scores were achieved if people answered that this was either daily or several times a week.

China, Egypt, Russia, Thailand, Vietnam, Argentina, Indonesia and India are the other nations in the top ten, with China, India and Indonesia among those that have large communities of waste-pickers.

Their situation is one that the Ellen MacArthur Foundation has highlighted, placing their welfare at the heart of its New Plastics Economy Vision—its blueprint for a circular economy for plastics.¹⁰⁹ Signatories include businesses with more than US\$2trn in revenue, including FMCG companies like The Coca-Cola Company and Unilever, and seven of the top ten global plastic packaging producers.¹¹⁰

Among the six characteristics of its vision are that it is "essential to respect the health, safety, and rights of all people involved in all parts of the plastics system, and particularly to improve worker conditions" in this sector.

The issue of buying plastics sourced from waste-pickers can be complex and will require more work on the ground in terms of transparency and measurement in the recycling supply chain. That is in part because brands need to tread carefully, as they cannot be seen to be buying from recyclers if there are issues like child labour, for example, in the supply chain.

And while better working conditions are important, so too is the need to increase the market value of what they pick.

Dr Winnie Lau of The Pew Charitable Trusts says the organisation's research revealed a range of problems that waste-pickers face, including lack of formal recognition of their job by governments. That has practical consequences, including little government support, poor pay and unsanitary working conditions, she says. "It is important for waste-pickers to have better and safer working conditions, as well as fair pay," Dr Lau says. "For example, during the pandemic, waste-workers needed protection so they wouldn't get sick from handling all the PPE waste."

And while better working conditions are important, so too is the need to increase the market value of what they pick.

Dr Pandey says he's noticed that beverage bottles in India have been getting lighter.

"In terms of how you incentivise the collection of plastic bags over plastic bottles, it's an economics issue," Dr Lau says. "Unless wastepickers are paid for the time it takes to pick a plastic bag, which has lower value, over a plastic bottle, it's going to be tough."

TERI's Dr Suneel Pandey highlights a related issue: how measures taken at the design stage can have unintended effects for waste-pickers who are paid by weight by those further up the recycling chain.

Dr Pandey says he's noticed that beverage bottles in India have been getting lighter. "So, in one way, that is waste reduction—but in another way what you're doing is making them less attractive to recyclers because they need to collect more bottles to arrive at the same weight," he explains.

"In the longer run, that would be detrimental for recycling because they will be less and less interested in collecting something which is much lighter. So that probably needs to be looked at – how much lighter you can make your packaging without compromising its recyclability," he says.

Rural versus urban areas

When it comes to infrastructure, countries like India that have a large rural population and where populations are dispersed across thousands of islands, like Indonesia (which is part of our index) and the Philippines (which is not), face a range of capacity challenges.

Dr Suneel Pandey from The Energy and Resources Institute points out that the penetration of plastic into rural areas in India has risen fast in recent years. While that means many products are now available to rural households, it also means dealing with plastic packaging is becoming a problem.

Even though the Clean India Mission has a rural component, with villages advised how to deal with waste management, there is seldom access to recycling centres.

"So, even if this plastic is collected, many times, people just burn them," he says.

While this happens to some extent in cities, when it does so it is mostly in winter and done by people in informal settings to stay warm.

"But it's rampant in rural areas year-round," Dr Pandey says, "and while it's very convenient to burn these plastics so that nothing remains, it does lead to air pollution problems."

The Philippines faces a related challenge, says Anna Oposa, executive director of Save Philippine Seas, a non-government organisation that seeks to narrow the gap between scientists and the public to drive behaviour change and collective action from citizens.

A key challenge in this country of more than 7,000 islands is a lack of infrastructure to collect and manage waste. The government's two-decade-old policy for waste management mandates that all local governments have sanitary landfills, close their dumpsites and have materials recovery facilities.

"But as of mid-2020, the materials-recovery facilities service only 34% of local government units, while sanitary landfills cover only 24% of local government units," says Ms Oposa. "That means a lot of our trash ends up in dumpsites or who knows where else?"

Ms Oposa, who also consults for the Asian Development Bank and the UN Development Programme on plastics and waste management, says that in the past seven years the government did close many illegal dumpsites as it seeks to counter its image as one of the world's biggest polluters. "In terms of infrastructure, the Philippines is the second-largest archipelago in the world, which means it's hard to get things to different places, especially the far-flung islands, and it's also hard to collect waste from far-flung islands, so there are logistical challenges—and plastic is the easiest, lightest, cheapest material to get goods across islands," she says.

Both Ms Oposa and Dr Pandey agree that plastic sachets—for example, single-serve pillowshaped containers of cleaning liquids targeted at economically marginalised populations are a major problem.

"For a lot of people, it's a socioeconomic issue," says Ms Oposa. "Items like sachets are difficult to recycle or don't have value for recovery and recycling, so that's the kind of waste that always ends up in the environment, both in our streets but also our seas."

Dr Pandey says part of the difficulty is that sachets are lightweight, which makes it hard to collect them once they've been discarded. And although some companies are experimenting with using vending machines that deliver the product into the buyer's container, sachets aren't going away any time soon.

"These types of packaging are still popular because, being plastic, they provide a longer shelf-life—around six months," Dr Pandey says. "So, in a country like India, where goods have to be transported long distances, they have a clear advantage. There is no easy solution."

Incineration: Controversial and prevalent

One solution for dealing with plastics waste is incineration, in which waste is burned to generate energy.

However, there are many reasons why incineration is controversial, including that the infrastructure is costly to build and operate; the process generates residual ash and dangerous pollutants (like dioxins and particulate matter) that must be captured to avoid damaging human health and the environment; the plastics are lost, which undermines the concept of a circular economy; and incinerators generate CO₂.

Despite these drawbacks, incineration is widely used. As of 2016 Europe had about 500 incinerators, while China had more than 200 in operation.¹¹¹ Incineration is also widely used in Japan, the US and Singapore, with the waste-to-energy industry targeting Asian markets for future growth.¹¹²

China is pushing ahead with large-scale incineration, and "is planning 60-150 big waste-toenergy plants as part of its five-year plan," says Doug Woodring, who founded and leads Ocean Recovery Alliance, which works to improve ocean health.

"These are big, and will take the place, somewhat, from the coal-power plants, which China said it would phase out to some extent," he says, adding that one issue with its waste-to-energy plants "is the high volume of wet food waste or organics, which require a lot more [energy] to burn—which means they will want paper and plastic feedstock."

"The hope is that China will use state-of-the-art scrubbing technology to combat any associated air pollution," he says. "This is likely to be better than burning coal, as there is no mining needed, and some of the waste that cannot be recycled is at least not going to landfill."

Some worry that the human and environmental health aspects are being significantly underplayed by the incinerator industry. The Centre for International Environmental Law, a legal research and advocacy body, says that even newer facilities fitted with air pollution control technologies like fabric filters, electrostatic precipitators and scrubbers, "do not prevent hazardous emissions, such as ultra-fine particles that are unregulated and particularly harmful to health, from escaping into the air".¹¹³

5. Stakeholder engagement

Stakeholder engagement is the category least positively correlated (0.81) to a country's overall score, in part because this category carries the lowest weighting (around 27% versus about 36% each for the others). Just seven of the top ten countries overall appear in this category's top ten, with the results highlighting three outliers of note: Malaysia, Finland and the US.

Germany and Japan come in at 1st and 3rd, respectively, in this category,

meaning that both finish no lower than 3rd in any of the categories. Less impressive are the US and Finland, 11th and 15th respectively, with the US's poor score in part reflecting its decision not to ratify relevant international agreements.

Malaysia's 2nd place is the standout, with fellow South-east Asian countries Indonesia and Vietnam also outperforming in joint 8th and 10th respectively.

Outlining the stakeholder engagement category

The purpose of this category is to assess the actions taken by the private sector and consumers in the management of plastics, while also looking at the steps that governments take to enable those actions.

- **1. National commitment through co-operation and adherence to international standards:** comprising two indicators that assess countries' participation in partnerships and initiatives, and their commitment to international standards.
- 2. National government-led approach to minimising plastic mismanagement: whether there is awareness-raising of existing initiatives that address plastics management—particularly about the environmental benefits of recycled plastics; whether there are information drives via media; whether the issue is part of the education curriculum; and whether the country has a comprehensive plastics waste management database.
- 3. Private-sector commitments on reducing plastic waste and promoting responsible plastics use: the five indicators include how business perceives government action; business CSR initiatives; business sustainability initiatives; business commitment; and business practices.
- **4. Responsible consumer actions and perceptions:** the five sub-indicators are consumer perceptions of government actions; use of plastic products; segregation of waste by consumers; purchasing habits; and the frequency of consumer-specific initiatives to minimise plastic waste.

The stakeholder engagement category

Germany and Japan were the best performing of the high-income countries, while the US (11th) and Finland (15th) were the weakest. The best relative performance was from Malaysia (2nd), with Indonesia (joint 8th) also doing well, and Vietnam (10th) proving the strongest of the lower-middle-income nations.

10	20	30 40) 50	60	70	80	90	100
untries	are scored fro	om 0-100, whei	e 100 = best	:				
nk	Count	r y			Score / 1	100		Visualisatio
1	Germa	any			77.9			
2	Malay	sia			75.7			
3	Japan				70.6			
4	Austra	alia			69.6			
5	Chile				69.3			
6	The U	K			67.3			
7	Swede	en			65.2			
=8	France	5			62.2			
=8	Indon	esia			62.2			
10	Vietna	im			58.8			
11	The U	S						
12	South	Africa						
13	Thaila	nd						
14	Ghana	3			50.5			
15	Finlan	d			50.3			
16	China				49.1			
17	India				46.9			
18	Mexic	0			46.0			
19	Kenya				45.1			
20	Brazil				43.7			
21	Russia				38.4			
22	Egypt				37.0			
23	Argen	tina			34.3			
24	Nigeri	а			30.9			
25	Jordar	n			29.7			

Source: Economist Impact PMI data

The results for this category are in large part (54% by weighting) based on the results of an Economist Intelligence Unit survey of consumers and businesses in the 25 constituent nations. In that process, we questioned 1,800 consumers and nearly 770 business executives to elicit their thoughts on a range of related subjects—including how they feel their government is performing on plastics waste management and how much effort they are making as individuals or businesses. (Every executive questioned was familiar with their organisation's approach to sustainability issues.)

The government side constitutes the remainder of this category and saw us assess each country's efforts to co-operate and adhere to international standards, and weighing their work on raising awareness of the issue of plastics waste management.

5.1. Notable findings

Malaysia is the outperformer, ranked 2nd with a score of 75.7, just behind Germany. Malaysia ranks 1st for responsible consumer actions and perceptions of plastic waste management—a key component of the stakeholder engagement category—and 2nd overall in that category, just behind Germany.

Why did Malaysia do so well? The country's former environment minister, Yeo Bee Yin, ascribes that to the fallout from the dumping of international plastic waste that made global headlines in 2018, weeks after she took office. "I think the media played a very important role in this," she says of Malaysia ranking 1st in that sub-category, adding that media coverage of plastic waste then extended to issues like single-use plastics. (On Ms Yeo's watch, Malaysia implemented its roadmap to phase out single-use plastics by 2030.)

Malaysia is the outperformer, ranked 2nd with a score of 75.7, just behind Germany.

As a result, Malaysia ranks 1st in the subcategory of responsible consumer actions and perceptions, which is comprised of aspects like their use of plastic products, purchasing habits and how well they segregate plastic waste. Indeed, Malaysia is the only country to enjoy a "very high" score for this sub-category.

The second surprise is Finland, for which its lowly 15th place for the stakeholder engagement category is due to poor scores for the government-led approach to raising awareness about minimising plastics mismanagement (in part because the subject isn't covered in schools) and, even more so, for private sector commitments to reduce plastic use and promote its responsible use (examined in more detail below).

Vesa Kärhä, CEO of the Finnish Plastics Industries Federation, says the country's Plastics Management Roadmap and its longrunning deposit scheme ("very effective in neutralising waste") are positives. On the other hand, he acknowledges, there is very little education in school about plastics, despite demand.

"We as an industry have distributed our own material, trying to make it very neutral and not promoting any specific industries, but our resources are limited," he says. "And I can see that the demand is enormous. When we have some small booklets, they are immediately ordered by schools. We are always out of stock."

Finally, the US's 11th place—behind Indonesia and Vietnam—is largely due to two factors. First, the country has failed to sign international agreements committing it to adhere to international standards (the only country in the index to score zero on this measure). Second, it received a below-average score for responsible consumer actions and perceptions, including some of the lowest numbers for purchasing habits and frequency of consumer-specific initiatives to minimise plastic waste.

For sub-category 1, which assesses the national commitment to co-operation and adherence to international standards, 14 countries share the top ranking, including three of the Asian nations named in 2015 as among the biggest plastics polluters (China, Indonesia and Vietnam), along with Ghana and South Africa.

While co-operating and agreeing to adhere to international standards are commendable, implementing policies and practices at home is crucial. That is the crux of sub-category 2, and here Germany and Japan lead, followed by Malaysia (3rd), Australia, Chile and the US (all in joint 4th).

Nigeria and Jordan, on the other hand, are the only two countries to record zero for each of the four indicators in sub-category 2, of which the two most significant are perceptions of the government's efforts to highlight the importance of plastics management specifically whether it communicates the environmental benefits of recycled plastics and education in schools on the subject.

Dr Emmanuel Olusegun Akindele from Nigeria's Obafemi Awolowo University says that, barring one parliamentary debate in 2019 about banning plastic bags, nothing has happened on the subject since.

"That tells you the level of importance attached to environmental issues in Nigeria," says Dr Akindele, who, outside of his academic work, also campaigns to prohibit plastic bags from being handed out for free.

Low public awareness of plastics pollution means many people in Nigeria dump plastic waste indiscriminately, he says, including into waterways, and wait for the rains to take it away. Such poor waste management practices—"the ultimate source of all these plastics" —combine with weak or absent legislation and a failure to implement what laws do exist.

Information drives via media are another factor the index assesses. Dr Akindele says the media in Nigeria rarely covers plastics pollution—he has been approached just once to write about his research—in part because there are other pressing topics in the country, including security challenges, but also because the media is ignoring the issue.

"If the media make enough noise, then maybe the government will wake up," he says. "The media is not talking enough about this in Nigeria, and that's the only thing that can change the dynamics."

Dr Akindele suggests one action the government could take with regard to university graduates, who must complete one year of work for the federal government after graduation. Those who qualify in relevant science-based subjects, he says, could be sent to schools and communities across the country to teach about environmental issues, including plastics pollution.

5.2. Country focus: Malaysia

Malaysia's performance in the stakeholder engagement category is a prime example of how positive results can flow from a bad situation—in its case, other (often wealthier) countries dumping waste.

The country's former environment minister, Yeo Bee Yin, says one consequence of the 2018 plastics waste scandal is that Malaysians are now more aware of plastics issues and keen to act. It also led to the closure of many illegal plastics-processing factories. And third, it propelled the passage of actions like the national roadmap towards zero single-use plastics by 2030. The scandal had other effects too, Ms Yeo says: many watched a BBC show on plastics pollution in the oceans and saw celebrities volunteer to get involved in plastics-related issues, raising awareness. And in political terms, issues like plastics and climate change are not partisan. "Everyone in parliament thinks we should do it," she says, but notes that there is a gap between talk and action. "We should be more urgent. And we can be a lot faster than we are."

Malaysia's performance in the stakeholder engagement category is a prime example of how positive results can flow from a bad situation

One improvement, says Ms Yeo, is that standard operating procedures within her former ministry define actions to be taken; previously, that relied on officials knowing what to do. As a result, "you don't need an institutional memory because it's documented".

One anomaly that the index highlights is that just 53% of Malaysian consumers segregate their waste. Ms Yeo explains why: the law requires that people segregate their waste, and mandates that the state authorities collect it.

"The problem is that, although a lot of people segregate their waste... when the truck comes to collect their garbage, everything gets thrown in together, and makes people ask why they're separating," she says. As a result, some people take their segregated waste to recycling centres, while others don't bother.

Ms Yeo says Malaysia's approaches towards waste management and measurement are insufficient, with conflicting or unclear responsibilities in part to blame. As an interim solution, Ms Yeo says better communication and co-ordination between ministers and responsible parties would help. Long term, she says, responsibility should be placed under a single ministry.

Ms Yeo has noticed several improvements in recent years, not least that multinationals are proactively trying to find ways to limit plastics use. On the other hand, she says, plasticsprocessing factories want permission to import more plastic waste.

"When I was the environment minister, I didn't agree with importing plastics until we have the right machinery, regulations and capacity in our government to deal with and enforce the regulations," she says. "We don't at the moment, so we wouldn't be able to cope [if more imports are approved]."

Ms Yeo says that led to another consequence of the 2018 scandal: Malaysia stopped issuing permits for new plastics-processing factories to be built, while those that had permits were told to gradually cut imports of waste and collect more plastic waste locally. And are they doing so? With parliament having been suspended for most of 2021, says Ms Yeo, it's impossible to know.

5.3. Focus on sub-category 3. Private sector commitments

The results for sub-category 3, which looks at private sector commitments to reduce and promote responsible plastic use, are mixed: Vietnam, Thailand, China and India took the top four spots, ahead of the UK and Chile, with Sweden, Kenya, Brazil and Australia rounding out the top ten.

The underperformer is Finland, which is ranked 24th for private sector commitments —with just four out of the ten executives surveyed having a positive view of the government's actions, and only five saying their organisation commits to and practises efforts on plastics use.

Vesa Kärhä, CEO of the Finnish Plastics Industries Federation, says the country's poor performance surprises him—but only to a point. He notes that while agreements are in place to, for example, recycle construction plastics, those are often voluntary, "so I could imagine ... people don't feel those are sufficient".

The results for sub-category 3 came from the survey conducted by Economist Impact in late 2020 and early 2021. About 60% of the 768 respondents were of director or senior manager level; two-thirds were based in Asia-Pacific or Europe; and 57% of businesses posted annual revenue of US\$10m-250m, with the remainder recording over US\$250m. Among the key findings:

- 85% said their business encourages employees to segregate plastic waste from general waste.
- 75% said the sustainable use of plastics is important or very important to their organisation's overall environmental sustainability plan.
- 68% said the responsible production/use of plastics or plastics waste management is part of their organisation's overall CSR programme.

Additionally, of the 95% of firms that buy plastic—whether in the form of products, inputs, or for packaging or shippingmost are focused on ways to reduce their plastics use (see chart).

What is also encouraging is that between half and two-thirds of those organisations collect data on their plastic footprint, including what is: recycled; purchased and used; and waste generated.

This means, though, that a sizeable number of organisations aren't making efforts where they otherwise might—two-thirds, for example, aren't focused on sustainable product design. And many could track their plastics use and leakage across the corporate value chain, including by using innovations like the Plastic Leak Project guidelines (see box).

Improving plastics usage within businesses

Executives were asked: has your organisation taken any of the following measures to optimise plastics use across your supply chain? (They could mark all options that apply.)



Source: Economist Intelligence Unit survey

Plastic Leak Project guidelines

The Plastic Leak Project (PLP) guidelines, which were published in early 2020, help firms measure and map plastics leakage across the corporate value chain.¹¹⁴

The PLP guidelines provide companies at all stages of the plastics value chain with a robust, standardised way to calculate and report their use of plastics—including, of course, leakage. Knowing how much plastic is leaking, and where, means they can create strategies to counter that and cut pollution.

Among those involved are the UN Environment Programme, WWF, the World Business Council for Sustainable Development, Massachusetts Institute of Technology and the International Union for Conservation of Nature. Major corporates like Dow Chemical, Adidas, Decathlon, McDonald's Corporation and associations like PlasticsEurope are also part of the PLP.

WWF-US's Alix Grabowski, manager of plastics and packaging, says the project provides "a robust way forward" with its "important advancements towards a credible accounting system for plastic leakage at product level".¹¹⁵

"It's essential that all stakeholders commit to improving data collection and transparency regarding plastic value chains, waste management, and pollution," Ms Grabowski says. "We see these guidelines as one piece of the puzzle as we work towards our broader No Plastic in Nature vision."

Positive towards change

Executives were asked: to what extent do you agree or disagree with the following statements? (Selecting one answer for each statement.)



Source: Economist Intelligence Unit survey

Other findings highlight further actions they can take—like joining a non-profit alliance that aims to reduce plastic waste, for example. We found that 42% of firms are not members of such groupings, while 33% are members and have made changes at a business level. Most of the rest are members but have yet to make changes.

Clearly, there is much more firms can do, and there is an understanding that action is needed (see chart): 84% of respondents say they are in favour of EPR and agree that businesses that produce or use plastic should be partly responsible for funding its collection and recycling, while 74% recognise that consumers will pay extra for more sustainable products.

29%

33%

32%

32%

19%

100%

1%

5.4. Focus on sub-category 3.4. Consumer actions and perceptions

The final sub-category looks at responsible consumer actions and perceptions. Malaysia, as mentioned, ranks 1st, and is the only nation awarded a "very high" score. France and Thailand are 2nd and 3rd respectively, followed by Finland and Germany (equal 4th), with the UK, Sweden, Mexico, Russia and India rounding out the top ten.

The bottom of the ranking saw some surprises too, with two key producers and polluters the US and China—in 22nd place and last place respectively. Also of note is Japan's 24th place. The country scores poorly in terms of the frequency of consumer-specific initiatives to minimise plastic waste and just 15% of consumers express a positive perception of their government's actions, which is the lowest of any nation.

A surprising number of countries do not require consumers to segregate their waste. Argentina, Egypt, Ghana, Indonesia, Mexico and Vietnam record zero on that measure, while Brazil, Chile, China, Jordan and Kenya score less than 10%.

The results for Indicator 4 come from the consumer-facing part of our survey with 33% of the 1,800 respondents in Asia-Pacific, 25% in Europe, 4% in the US and 38% in the rest of the world (Africa, the Middle East, South America). Half were born before 1981, with near-equal numbers of male and female respondents.

Sixty percent either have a university or technical degree, or are studying towards one, while a further 13% have a higher qualification. The level of knowledge of plastics is relatively low, with just 44% saying they are somewhat or very knowledgeable on plastics-related issues.

When it comes to personal actions, the survey shows that about two-fifths of consumers always segregate their waste, two-fifths sometimes segregate it, and a fifth never do. Most of those who sometimes or never segregate (about 1,100 respondents) say it is too time-consuming and/or the waste collectors mix it up anyway. However, more than a quarter say they aren't aware of the benefits of segregating waste, indicating that awareness-raising could have a significant impact on this one area alone.

The survey also asked consumers to pick one barrier that prevents them reducing their plastic use or increasing recycling. The highest proportion (43%) say nonplastic alternatives are too costly, while another 36% cite convenience. The remainder say it is too difficult to understand which materials are recyclable, which again shows that more could be achieved by awarenessraising efforts. Finally, the survey asked consumers a range of questions on plastic waste, including about bans on single-use plastics, how frequently they recycle, how much responsibility they and other players bear, and their willingness to get involved in local or national initiatives like beach clean-ups (see chart).

Encouragingly, most consumers believe that their actions can have a major impact on the issue (81%), while 72% frequently recycle plastic products, and three-quarters are prepared to take part in local initiatives.

The survey also found that two-thirds of respondents want a ban on single-use plastics,

1%

1%

1%

3%

3%

1%

2%

100%

Plastic waste: Where consumers stand

Consumers were asked, to what extent do you agree or disagree with the following statements? Select one in each row.



Source: Economist Intelligence Unit survey

waste management
and more than half are prepared to pay more for products that are more sustainable. And a sizeable minority do not believe government, industry and waste management authorities are doing enough.

Lastly, the survey asked consumers what actions would work for them.

Seventy percent say sustainable packaging or product design would be effective or very effective in reducing plastic use the highest score for any of the recommendations (see chart). This, then, is something more firms should consider, given that just a third say they engage in sustainable product design.

What works?

Consumers were asked: please rank on a scale of 1-5 the following recommendations to reduce plastic use based on your perceived level of effectiveness, with 1 being not effective and 5 being very effective. Select one in each row.



Source: Economist Intelligence Unit survey

Conclusion

When it comes to plastics, the world cannot continue along the same path that it has trodden for 70 years. The transboundary nature of plastics pollution, its harmful (and yet largely unknown) effects on the environment, on human health and on the food chain, and its pervasive and growing reach mean that change is needed, and urgently.

Among the key steps that are needed:

- The world must undertake concerted action by key stakeholders—governments, plastics producers, brands and other businesses, and consumers—to use less plastic, and to operate with a circular economy in mind.
- A global framework is needed that will underpin plastics waste management across the plastics lifecycle. The February 2022 UNEA meeting is an important step, and one that should constitute the start of a legally binding treaty.
- It is not just key polluters that must do more to better manage plastics waste; wealthier nations should step up too, sharing knowledge and helping to fund solutions.
- Wealthier nations must deal with their trash domestically rather than exporting it to countries with weak labour and environmental regulations—as they have done for decades. While the Basel Convention amendments go some way to helping, they are not ironclad.
- At the same time, richer nations should not impose solutions, but should instead

listen to those who know local conditions and challenges. Several interviewees said one effect of the pandemic was that people who would not normally be heard at hotel-based conferences—community workers in villages in India or local experts from islands in the Caribbean—were able to give input relevant to their situation via conference calls.

- Industry must do more at every stage of the plastics lifecycle. And that starts at the design stage by stripping out toxic chemicals, ensuring that products are designed with recycling in mind, and minimising how much plastic is needed in the first place.
- Where industry is not moving fast enough, governments must not be afraid to legislate. That could include implementing, for example, EPR schemes and/or plastic credits to fund better waste collection, changing the perception of plastics from valueless to valuable, and improving the lot of waste-pickers. It could also see smaller nations join hands via regional forums to stand up to corporates seeking to stymie change.
- Brands that do act should trumpet their efforts—because consumers regularly say they have had enough of plastic waste. One brand that is vocal about its approach is Germany's Frosch: it uses plant-based surfactants in its cleaning products, which means they are wholly biodegradable, and recyclable materials and 100% recycled plastic in its packaging.¹¹⁶ Frosch's market share increased 14% in the two years to 2018, with sales up 21%, because, as the

brand says, it put "a lot of effort into making ourselves heard" to consumers.¹¹⁷

- The financial services industry—banks, asset managers, insurers—need to apply the environmental, social and governance metrics to plastics that they use in areas like decarbonisation, for example. Plastics production has a large carbon footprint, externality costs estimated to be in the hundreds of billions of dollars annually, and, in a low-carbon future, runs the risk of petrochemical companies being stuck with stranded assets.
- Although consumers have the least power in this equation, they can still act—and that starts before walking into their local store. They can, for example:
- Demand that brands do more, which includes refusing single-use plastic items like straws, cutlery and coffee-cup tops.
- Where local waste collection and recycling facilities are inadequate, they can pressure their representatives to improve them.
- Seek to influence a more plastic-aware approach at work.
- Join local clean-up efforts and environmental movements.
- Ultimately, they can vote with their money buying better alternatives where those exist.

Finally, it is worth examining examples of successful community engagement to show that actions are not necessarily limited by nations' wealth, and that much can be achieved by effort. There are numerous examples of programmes, including womenled or youth-led initiatives, that improve plastic waste management.

Such programmes exist and have been successful in the past three years in 16 of the PMI countries, including in Argentina, China, Ghana, Indonesia, Kenya, Malaysia, South Africa, Thailand, the US and Vietnam. In a further seven there is evidence only of such programmes' existence (Brazil, Finland, France, India, Jordan, Mexico and Russia), while just two countries lack such evidence entirely: Egypt and Nigeria.

And although this covers only NGO-linked programmes, there are plenty of examples to show that initiatives done in partnership with local or national government can also be successful. In Indonesia, for example, Project STOP has worked since 2017 with a coastal fishing community and the authorities in Muncar, East Java, to create a comprehensive waste management system to prevent plastics leaking into the sea.¹¹⁸ It has since expanded to two more cities in Indonesia.

Another Bali-based example is Bye Bye Plastic Bags, an NGO created in 2013 by sisters Melati and Isabel Wijsen when they were just 12 and 10, which has become a hub for action against plastics in dozens of cities around the world, including in 15 of the 25 countries in the PMI.¹¹⁹

Given that resolving the world's plastics waste challenges will require action from every stakeholder, the fact that two children could start a global movement to tackle plastic bags and other single-use plastics in just a few years is a salutary lesson. If nothing else, it shows what is possible when determination is applied to tackle what seems an intractable problem.

Appendix 1: Index Methodology

Plastics Management Index 2021

A. Overview

The Plastics Management Index (PMI) assesses the capacity of a country to minimise plastics mismanagement while promoting the optimal production and use of plastic as a resource. It measures, compares and contrasts targeted efforts made by 25 countries across the world on this topic.

The index focuses on the plastics lifecycle through the lens of existing policies, regulations, infrastructure and systems, business practices, as well as consumer actions and perspectives. This first iteration of the index endeavours to drive conversation and bring attention to the growing concerns around the use of plastic across the globe.

B. The PMI framework

The framework for the PMI was designed based on a comprehensive literature review of academic studies and reports focused on plastics as well as in-depth consultations with experts through an Expert Panel.

The framework of the PMI comprises three categories: the system of governance, existing systemic capacity and engagement of key stakeholders involved in the plastics management process.

The framework consists of both qualitative and quantitative indicators. A portion of the quantitative indicators were selected from the consumer and executive surveys conducted between January and March 2021.

C. Index categories

Governance assesses the overall enabling governing environment for optimal production, consumption and end-use of plastics including mechanisms like policies, regulations, legal frameworks and voluntary initiatives across the plastics value chain. The category also studies the state of enforcement of these mechanisms (eg, through funding).

Systemic capacity examines the structural and systemic capacity of a country—physical infrastructure, systems and processes dedicated to keeping plastics within the value chain and promoting the optimal use of plastics. The category also includes a forwardlooking aspect to examine investment in future systemic capacity, for example, through training.

Stakeholder engagement considers the actions taken by different stakeholder groups, specifically the consumers and businesses in the management of plastics, while also looking at the actions taken by the government. The difference in the focus of government actions in this category and governance is that this category examines actions undertaken by the government to inform stakeholders on their

policies and plans to manage plastics as well as their broader actions to enable efforts from other stakeholders in this space.

D. Indicators

The PMI comprises 12 indicators and 44 individual sub-indicators.

Quantitative indicators: 20 of the 44 subindicators draw from quantitative data. For example, two indicators assess the corruption level and business environment in the country respectively.

Qualitative indicators: 24 of the 44 subindicators are qualitative assessments, based on a methodology decided upon by Economist Impact. For example, one indicator assesses the mechanisms in place for management of single-use plastics in the country.

E. Expert Panel

In December 2020, a group of experts on plastics were invited to join a two-day panel to discuss and review a preliminary framework for the PMI. The team presented the draft framework to the experts, seeking feedback on the overall structure and to ensure key areas and topics of interest were covered. The comments and discussions from the panel were invaluable in framing the final categories and indicators for the index. We are grateful to the following experts who kindly agreed to participate:

- Aleke Stöfen-O-Brien, WMU-Sasakawa Global Ocean Institute, World Maritime University
- **Jeff Wooster,** global sustainability director, Dow Packaging and Specialty Plastics
- Joi Danielson, partner and Asia programme director, SYSTEMIQ
- Martyn Tickner, project sourcing and development, Alliance to End Plastic Waste
- Satoquo Seino, associate professor, Ecological Engineering Laboratory, Graduate School of Engineering, Kyushu University
- **Suneel Pandey,** director, Environment and Waste Management Division, The Energy and Resources Institute (TERI)
- **Susan Ruffo,** senior advisor, The Circulate Initiative
- Winnie Lau, senior manager, preventing ocean plastics, The Pew Charitable Trusts
- Yutaka Michida, professor, Atmosphere and Ocean Research Institute, The University of Tokyo
- Morihito Imai, manager, sustainability department, Seven Eleven Japan

F. Surveys: Consumer and Executive

Economist Impact conducted two surveys one focusing on consumers and the other on business executives—between January and March 2021 across the 25 selected countries. The goal of the surveys was to gather primary insights and perspectives on the use of plastics and approaches to plastics management in each country, to supplement the desk-based research. Both survey questionnaires included five preliminary demographic questions to understand the background of respondents, such as age and gender. The remaining ten questions were designed to understand habits, perceptions and individual views of consumers and business executives. The table below provides a snapshot of the selection criteria used for respondents in each survey.

G. Indicator normalisation

In order to be able to compare data points across countries, as well as to construct aggregate scores for each country, the gathered data are made comparable. To do so, the quantitative indicators were normalised on a scale of 0-100 using a min-max normalisation, where each score represents the standard deviation/s from the mean, with the best performing country scoring 100 points and the worst weakest performing country scoring 0.

Consumer survey

- Length: 15 questions
 (10 content + 5 demographic)
- Sample size: 1,800
- Age: 50% from Generation Z (1997-) & Millennials (1981-1996) and 50% from Generation X (1965-80) and Baby Boomers (1946-64)
- Gender: Minimum 40% male/female
- Education: A range
- Employment: A range

Executive survey

- Length: 15 questions
 (10 content + 5 demographic)
- Sample size: 768
- Seniority: Senior managers and above
- Function: Range
- Sector: Range (include responses from automotive, construction, electronics, fast moving consumer goods, food & beverages, healthcare, manufacturing, packaging, textiles, travel & tourism)
- Organisation size: Greater than US\$10m in annual revenue
- Screener: Familiarity with company approach to sustainability

Qualitative indicators were normalised as well. In some instances, those scores were on a scale of 0–2 with 0 being the lowest or most negative score, and 2 being the highest or most positive score—these were normalised in a similar manner to quantitative indicators.

H. Index construction

The index generates an aggregate score/ ranking across all the underlying indicators. The index is first aggregated by category creating a score for each category (for example, stakeholder engagement) —and finally, overall, based on the composite of the underlying category scores. To create the underlying category scores, each underlying indicator and sub-indicator was aggregated according to an assigned weighting.

I. Index weights

Assigning weights helps capture the specific importance of each category, indicator, and sub indicator. We consulted with our Expert Panel members who scored the importance of each category, indicator and sub-indicator on a scale of 1-5. The final aggregate scores and ranking is based on these weights, termed as Economist Impact default weights. The model, however, provides an option for the reader to create specific weighting as well as view scores with equal weights.

Economist Impact default weights for each category in the 2021 index are as follows:

Governance	36.4%
Systemic capacity	36.4%
Stakeholder engagement	27.3%

Table A1: Country list and selection process

Argentina	Egypt	India	Malaysia	Sweden
Australia	Finland	Indonesia	Mexico	Thailand
Brazil	France	Japan	Nigeria	UK
Chile	Germany	Jordan	Russian Federation	US
China	Ghana	Kenya	South Africa	Vietnam

The table below includes the list of 25 countries selected for this Index.

Economist Impact examined a series of metrics to assess feasibility of countries to include in the index. Standard metrics considered include the proportion of GDP, population, income levels, as well as a regional mix to maintain a balance of coverage.

A literature review was also conducted to identify countries that have been called out for generating high volumes of plastic waste or as the largest exporters of plastic waste and countries with high volumes of mismanaged plastic waste. A large number of countries from Asia were included given that the highest volume of mismanaged plastic waste is concentrated in the region (East-Asia and Pacific followed by South Asia) including countries that are some of the largest importers of plastic waste.

Given the high volume of plastic-ocean-input from rivers, Economist Impact also looked at countries that contain the most polluted rivers/water bodies. It has been estimated that more than a quarter of all that waste could be pouring in from just ten rivers, eight of them in Asia. This was a crucial factor considered while selecting countries from the region. By contrast, we also selected countries that have been recognised for their efforts in recycling/ good plastic management.

Lastly, we also looked at the feasibility of conducting surveys in these countries, given that availability/ease of obtaining information could also pose a challenge for reliable data collection.

Table A2: The Index Framework

Category no.	Category	Indicator	Sub-indicator	Definition/question	Unit	Scoring guidance	Source	Туре
1	1 Governance	1.1 Promoting responsible plastic production and consumption	1.1.1 Regulation of single-use plastics	Does the country have a mechanism (financial/ non-financial) to regulate the production and use of single-use plastics? The mechanism could include: - Policy/law/regulation/mandate - National target - Ban (complete or partial) - Voluntary initiative/partnership - Consumer tax - Any other means	0-2 score	 2 - There is evidence of a mechanism 1 - There is evidence of a mechanism but there is evidence of gaps in enforcement/insufficient sources of financing 0 - There is no evidence of a mechanism 	Economist Impact custom	Qualitative
1	1 Governance	1.1 Promoting responsible plastic production and consumption	1.1.2 Regulation of microplastics	Does the country have a mechanism (financial/non- financial) to regulate the production and use of at least one type of microplastic? The mechanism could include: - Policy/law/regulation/mandate - National target - Ban (complete or partial) - Voluntary initiative/partnership - Any other means	0-2 score	 2 - There is evidence of a mechanism 1 - There is evidence of a mechanism but there is evidence of gaps in enforcement/insufficient sources of financing 0 - There is no evidence of a mechanism 	Economist Impact custom	Qualitative
1	1 Governance	1.1 Promoting responsible plastic production and consumption	1.1.3 Incentivising use of sustainable plastic inputs	Does the country have a mechanism (financial/non- financial) to incentivise sustainable production behaviour? The mechanism could include: - Financial incentives such as a subsidy, tax credit, tax (a disincentive) - Policy/law/regulation/mandate - National target - Ban (complete or partial) - Voluntary initiative/partnership - Any other means	0-2 score	2 - There is evidence of a mechanism 1 - There is evidence of a mechanism but there is evidence of gaps in enforcement/insufficient sources of financing 0 - There is no evidence of a mechanism	Economist Impact custom	Qualitative
1	1 Governance	1.1 Promoting responsible plastic production and consumption	1.1.4 Penalising irresponsible business action	Does the country have any schemes (either mandatory or voluntary) on the 'polluter-pays- principle' to encourage plastic producers to take responsibility for post-consumer processing of their products? Some examples include: - Any form of Extended Producer Responsibility (EPR) for plastic products - Any form of a Deposit Refund Scheme (DRS) or a Container Deposit Legislation (CDL) for plastic products - Any other scheme/initiative, either mandated by law or a voluntary industry/consumer partnership	0-2 score	 2 - There is evidence of more than one scheme 1 - There is evidence of one scheme 0 - There is no evidence of a scheme 	Economist Impact custom	Qualitative
1	1 Governance	1.1 Promoting responsible plastic production and consumption	1.1.5 Promoting Green Public Procurement	Does the government have public procurement policies that support more sustainable behaviour among plastic producers? This could be measured through: - Mandatory percentage of recycled content - Complete ban on procurement of single-use plastics - Promoting products that can be reused and repurposed	0-2 score	2 - There is evidence of a policy or policies at the national, state and local level 1 - There is evidence of a policy or policies at either the national, state or local level 0 - There is no evidence of a policy or policies at the national, state or local level	Economist Impact custom	Qualitative

Category no.	Category	Indicator	Sub-indicator	Definition/question	Unit	Scoring guidance	Source	Туре
1	1 Governance	1.1 Promoting responsible plastic production and consumption	1.1.6 Reporting of plastic footprint by private sector	Does the government make it mandatory for the private sector to report its plastic footprint?	0-1 score	 There is evidence of mandatory reporting There is no evidence of mandatory reporting 	Economist Impact custom	Qualitative
1	1 Governance	1.2 Promoting safe and informed plastic usage	1.2.1 Safe product use	Does the country have laws to regulate the safe use of plastics in sectors with direct impact on human health? This could include (but is not limited to): - Children's toys - Food grade plastics - Infant products (such as baby bottles, baby utensils, pacifiers etc.)	0-2 score	2 - There is evidence that laws exist and compliance is high 1 - There is evidence that laws exist but compliance is low 0 - There is no evidence that laws exist	Economist Impact custom	Qualitative
1	1 Governance	1.2 Promoting safe and informed plastic usage	1.2.2 Safe product design	Does the country regulate the use of chemical additives to plastic products in sectors with direct impact on human health? This could include (but is not limited to): - Children's toys - Food grade plastics - Infant products (such as baby bottles, baby utensils, pacifiers etc.)	0-2 score	2 - There is evidence that laws exist and compliance is high 1 - There is evidence that laws exist but compliance is low 0 - There is no evidence that laws exist	Economist Impact custom	Qualitative
1	1 Governance	1.3 Plastic waste management	1.3.1 Presence of comprehensive waste management framework	Does the country have a solid waste management framework/law in place that mandates the segregation and streamlined collection of plastic waste?	0-2 score	2 - There is evidence of a framework 1 - There is evidence of a framework but there is evidence of gaps in enforcement/insufficient sources of financing 0 - There is no evidence of a framework	Economist Impact custom	Qualitative
1	1 Governance	1.3 Plastic waste management	1.3.2 Presence of mandatory labelling	Does the country mandate the labelling of plastic products for their recyclability?	0-1 score	1 - There is evidence of a mandate 0 - There is no evidence of a mandate	Economist Impact custom	Qualitative
	1 Governance	1.3 Plastic waste management	1.3.3 Penalising violations of waste management laws	Does the country impose penalties on improper disposal of plastic waste by either consumers or industry?	0-2 score	2 - There is evidence of penalties imposed and enforcement is strict or compliance is high 1 - There is evidence of penalties imposed, but enforcement is lax or compliance is low 0 - There is no evidence of penalties imposed	Economist Impact custom	Qualitative
1	1 Governance	1.4 Operational enablers	1.4.1 Business environment	Economist Impacts business environment rankings quantify the attractiveness of the business environment. The overall score is derived as an unweighted average of ten component category scores.	1-10 score		Economist Impact Busines Environment Ranking	Quantitative s

Category no.	Category	Indicator	Sub-indicator	Definition/question	Unit	Scoring guidance	Source	Туре
1	1 Governance	1.4 Operational enablers	1.4.2 Corruption	What is the country's operational business risk score for official corruption?	0-4 score		Economist Impact Risk Briefing	Quantitative
1	1 Governance	1.4 Operational enablers	1.4.3 Government effectiveness risk	What is the risk to political stability in the country?	0-100 score	e	Economist Impact Risk Briefing	Quantitative
1	1 Governance	2.1 Oversight of management processes	2.1.1 Source of responsibility for plastic waste management	Has the country identified a source or sources of responsibility to drive plastic waste management?	0-1 score	 1 - There is evidence of a source or sources of responsibility to drive plastic waste management 0 - There is no evidence/ there are overlaps or inefficiencies in implementation/lack of defined roles 	Economist Impact custom	Qualitative
2	2 Systemic capacity	2.1 Oversight of management processes	2.1.2 Responsibility for overall waste management in rural and urban areas	Is responsibility for waste management by local bodies legally the same in urban and rural areas?	0-1 score	 There is evidence that responsibilities are the same in urban and rural areas/there are clearly defined differences in responsibilities between urban and rural areas o - There is no evidence that the responsibilities are the same/the division of responsibilities is unclear (i.e. they are different/ divided/not well-defined in urban and rural areas) 	Economist Impact custom	Qualitative
2	2 Systemic capacity	2.1 Oversight of management processes	2.1.3 Mechanism to ensure accountability	Is there a mechanism to hold governing bodies accountable to their roles in waste management?	0-1 score	1 - There is evidence of a mechanism 0 - There is no evidence of a mechanism	Economist Impact custom	Qualitative
2	2 Systemic capacity	2.1 Oversight of management processes	2.1.4 Promoting coordination and communication across the plastics value chain	Is there a mechanism to facilitate coordination and communication across the plastics value chain, including through promotion of chemical information systems?	0-2 score	2 - There is evidence of a mechanism 1 - There is evidence of an intention to implement a mechanism 0 - There is no evidence of a mechanism	Economist Impact custom	Qualitative
2	2 Systemic capacity	2.1 Oversight of management processes	2.1.5 Fairness of judicial process	What is the extent to which the legal process/the courts can be interfered with or distorted to serve particular interests?	0-4 score		Economist Impact Risk Briefing	Quantitative
2	2 Systemic capacity	2.1 Oversight of management processes	2.1.6 Enforceability of contracts	What is the risk that contract rights will not be enforced?	0-4 score		Economist Impact Risk Briefing	Quantitative

Category no.	Category	Indicator	Sub-indicator	Definition/question	Unit	Scoring guidance	Source	Туре
2	2 Systemic capacity	2.2 Efficient collection and sorting channels	2.2.1 Access to waste disposal bins before collection	In your locality/place of residence, do you have access to separate bins for waste disposal?	%	% of respondents who answered "strongly agree" and "agree" with the statement "Waste management authorities in my locality have provided access to separate bins, at a reasonable distance, for waste disposal"	Economist Impact Consumer survey	Quantitative
2	2 Systemic capacity	2.2 Efficient collection and sorting channels	2.2.2 Frequency of waste collection	How often do primary waste collection services visit your locality/place of residence?	%	% of respondents who answered "On a daily basis" and "A few times a week"	Economist Impact Consumer Survey	Quantitative
2	2 Systemic capacity	2.3 Infrastructure to enable recycling	2.3.1 Existence of a secondary market for recycled plastics	Does the country have an established market for post-consumer collected plastic waste, either formal or informal?	0-1 score	 There is evidence of a market (either formal or informal) There is no evidence of a market (either formal or informal) 	Economist Impact custom	Qualitative
2	2 Systemic capacity	2.3 Infrastructure to enable recycling	2.3.2 Road network	What is the risk that the road network will prove inadequate to business needs? Evaluate the risk based on three criteria: - degree of obsolescence, - maintenance and - sufficient supply to meet demand	0-4 score		Economist Impact Risk Briefing	Quantitative
2	2 Systemic capacity	2.3 Infrastructure to enable recycling	2.3.3 Rail network	What is the risk that the rail network will prove inadequate to business needs? Evaluate the risk based on three criteria: - degree of obsolescence, - maintenance and - sufficient supply to meet demand	0-4 score		Economist Impact Risk Briefing	Quantitative
2	2 Systemic capacity	2.4 Investment in capacity- building to ensure sustainability of systems	2.4.1 Sustainable product design - incentives	Does the government provide incentives (financial/ non-financial) for companies/research organisations to invest in the development of plastic alternatives or to design sustainable plastic products and packaging better suited for easy recycling?	0-1 score	1 - There is evidence of at least one incentive from the government 0 - There is no evidence of incentives from the government	Economist Impact custom	Qualitative
2	2 Systemic capacity	2.4 Investment in capacity- building to ensure sustainability of systems	2.4.2 Sustainable product design - initiatives	On average, what proportion of businesses in the country are optimising use of plastic in their value chain via sustainable product design and/or use of substitutes for plastic packaging?	%	% of respondents who answered "Use of substitutes for plastic packaging" and/or "Sustainable product design"	Economist Impact Executive Survey	Quantitative

Category no.	Category	Indicator	Sub-indicator	Definition/question	Unit	Scoring guidance	Source	Туре
2	2 Systemic capacity	2.4 Investment in capacity- building to ensure sustainability of systems	2.4.3 Training of staff involved in plastic waste management	Does the national/local government invest in training for staff engaged in plastic waste management?	0-2 score	2 - There is evidence of investment and regular training is required on the job 1 - There is evidence of investment but training is ad-hoc 0 - There is no evidence of investment in training	Economist Impact custom	Qualitative
3	3 Stakeholder engagement	3.1 National commitment through cooperation and adherence to international standards	3.1.1 Partnerships and initiatives	Does the country have an ongoing global/regional initiative aimed at: (a) Reducing plastic pollution (b) Encouraging plastic recycling (c) Building and designing sustainable products and processes	0-1 score	1 - There is evidence that the country has an ongoing global/regional initiative o - There is no evidence that the country has an ongoing global/regional initiative	Economist Impact custom	Qualitative
3	3 Stakeholder engagement	3.1 National commitment through cooperation and adherence to international standards	3.1.2 International agreements	Have the plastic waste amendments to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal come into effect in the country?	0-1 score	1 - There is evidence that the amendments have come into effect i.e. the country has accepted the amendments or not sent a notice of non-acceptance o - There is no evidence that the amendments have come into effect i.e. the country has sent a notice of non- acceptance or not signed/ ratified the Convention	Economist Impact custom	Qualitative
3	3 Stakeholder engagement	3.2 National government-led approach to minimising plastic mismanagement	3.2.1 Overarching initiative addressing plastics management	Has the government initiated consumer education and awareness campaigns focusing on the environmental benefits of recycled plastics?	0-1 score	 1 - There is evidence of consumer education and awareness campaigns initiated by the government 0 - There is no evidence of consumer education and awareness campaigns initiated by the government 	Economist Impact custom	Qualitative
3	3 Stakeholder engagement	3.2 National government-led approach to minimising plastic mismanagement	3.2.2 Information drives via media channels	Does the government utilise media platforms to inform the public about ongoing initiatives related to overall plastic management?	0-1 score	1 - There is evidence that the government utilises media platforms, and has utilised them in the last one year o - There is no evidence that the government utilises any media platforms/utilisation is irregular and prior to the last one year	Economist Impact custom	Qualitative

Category no.	Category	Indicator	Sub-indicator	Definition/question	Unit	Scoring guidance	Source	Туре
3	3 Stakeholder engagement	3.2 National government-led approach to minimising plastic mismanagement	3.2.3 Focus of education curriculum on plastics	Does the country's national education policy mandate school curricula to include topics of sustainability with a specific focus on plastics?	0-1 score	 There is evidence of a mandate including sustainability with a specific focus on plastics There is no evidence of a mandate including sustainability with a specific focus on plastics 	Economist Impact custom	Qualitative
3	3 Stakeholder engagement	3.2 National government-led approach to minimising plastic mismanagement	3.2.4 Establishment of a comprehensive database	Is there a national database and/or local-level databases that include statistics on the use and state of mismanaged plastic in the country/locality?	0-1 score	 1 - There is evidence of a national or local-level database/databases 0 - There is no evidence of a national or local-level database/databases 	Economist Impact custom	Qualitative
3	3 Stakeholder engagement	3.3 Private sector perceptions and commitments on reducing and promoting responsible plastic use	3.3.1 Business perception of government actions	Does your organisation perceive the existing government actions and policies to be supportive enough to regulate plastic use and disposal in the country?	%	% of respondents who answered "strongly agree" and "agree" with the statement "The existing government actions and policies are supportive enough to regulate plastic use and disposal"	Economist Impact Executive Survey	Quantitative
3	3 Stakeholder engagement	3.3 Private sector perceptions and commitments on reducing and promoting responsible plastic use	3.3.2 Business initiatives - Corporate Social Responsibility (CSR)	To what extent is the responsible production/use of plastics/plastic waste management specifically a part of your organisation's overall Corporate Social Responsibility (CSR) commitment?	%	% of respondents who answered "4" and "5" on a scale from 1-5 (1 = No extent, 5 = Great extent)	Economist Impact Executive Survey	Quantitative
3	3 Stakeholder engagement	3.3 Private sector perceptions and commitments on reducing and promoting responsible plastic use	3.3.3 Business initiatives - sustainability plan	How important is the sustainable use of plastics in your organisation's overall environmental sustainability plan?	%	% of respondents who answered "4" and "5" on a scale from 1-5 (1 = No extent, 5 = Great extent)	Economist Impact Executive Survey	Quantitative
3	3 Stakeholder engagement	3.3 Private sector perceptions and commitments on reducing and promoting responsible plastic use	3.3.4 Business commitment	Is your organisation a member of a global/regional/ local non-profit alliance/group specifically aimed at reducing plastic use/waste/ increase recycling etc?	%	% of respondents who answered "Yes, and we have made changes to our business as a result" and "Yes, but we are yet to initiate changes at a business level"	Economist Impact Executive Survey	Quantitative
3	3 Stakeholder engagement	3.3 Private sector perceptions and commitments on reducing and promoting responsible plastic use	3.3.5 Business practices	Does your organisation promote responsible use of plastic products at the workplace?	%	% of respondents who answered "Encourage employees to reuse/ repurpose plastic products as part of business operations (e.g. reusing plastic badge holders for multiple conferences)"	Economist Impact Executive Survey	Quantitative

Category no.	Category	Indicator	Sub-indicator	Definition/question	Unit	Scoring guidance	Source	Туре
3	3 Stakeholder engagement	3.4 Responsible consumer actions and perceptions	3.4.1 Consumer perception of government actions	Do you perceive your government's actions to be effective for plastic waste management in the country?	%	% of respondents who answered "strongly agree" and "agree" with the statement "My government's actions are effective for plastic waste management"	Economist Impact Consumer Survey	Quantitative
3	3 Stakeholder engagement	3.4 Responsible consumer actions and perceptions	3.4.2 Use of plastic products	How likely are you to reuse and recycle plastic bags after they have served their primary purpose in your household?	%	% of respondents who answered "Deposit for recycling" and "Reuse them for other domestic purposes" as opposed to disposing in the trash	Economist Impact Consumer Survey	Quantitative
3	3 Stakeholder engagement	3.4 Responsible consumer actions and perceptions	3.4.3 Segregation of plastic waste by consumers	Do you regularly segregate waste from your household before it is formally collected?	%	% of respondents who answered "Always"	Economist Impact Consumer Survey	Quantitative
3	3 Stakeholder engagement	3.4 Responsible consumer actions and perceptions	3.4.4 Purchasing habits	Do you make purchasing decisions based on the amount of plastic packaging used for a particular product?	%	% of respondents who answered "I try to buy items with less plastic packaging where possible" and "I would buy substitute products with lesser packaging (or more sustainable packaging options) if it costs the same or less"	Economist Impact Consumer Survey	Quantitative
3	3 Stakeholder engagement	3.4 Responsible consumer actions and perceptions	3.4.5 Frequency of consumer-specific initiatives to minimise plastic waste	How open are you to participating in initiatives that help to directly remove or address plastic waste in the environment?	%	% of respondents who answered "strongly agree" and "agree" with the statement "I'm open to participating in initiatives at a local or national level to help reduce plastic waste in the environment (e.g. participating in a beach cleaning event)"	Economist Impact Consumer Survey	Quantitative

Footnotes

- 1. Global executive survey: 60 percent of the 768 respondents were of director or senior manager level; two-thirds were based in Asia-Pacific or Europe; with 57 percent of businesses posting annual revenues of US\$10-250 million, and the remainder recording revenues greater than US\$250 million.
- 2. Global consumer survey: 33 percent of the 1,800 respondents were in Asia-Pacific, 38 percent in the rest of the world (Africa, the Middle East, Latin America), 25 percent in Europe, and the remaining 4 percent in the US. Half were born before 1981, with near-equal numbers of male and female respondents. Sixty percent either have a university or technical degree, or are studying towards one, while a further 13 percent have a higher qualification.
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^{113.} Ibid



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