Produced by the PlastiCity Consortium July 2022

Actors and their attitudes

Report analysing the behaviour of actors in the value chains of plastic waste recycling in Europe

Interreg
2 Seas Mers Zeeën
PlastiCity
European Regional Development Fund

Partners

This project has received funding from the Interreg 2 Seas programme 2014-2020 co-funded by the European Regional Development Fund under subsidy contract No 2S05021.
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Summary

This report analyses the factors influencing the behaviour of actors in the value chains of recycling of plastic waste in Europe. It presents context specific analyses for Ghent in Belgium, Douai in France, The Hague in the Netherlands, and Southend-on-sea in the United Kingdom.

DELIVERABLE D.1.1.2
REPORT ON ACTORS AND THEIR ATTITUDES.

PlastiCity Consortium
D.1.1.2 lead partner: University of Portsmouth Higher Education

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Executive Summary

This report on actors and their attitudes presents a study on behavioural and institutional factors that influence plastic recycling in four cities: Ghent (Belgium), Douai (France), The Hague (Netherlands) and Southend-on-Sea (United Kingdom).

The foundation for the study was a behavioural survey conducted in the initial stages of the project, which tested our theoretical framework to understand commercial plastic behaviour and identified areas where exploratory qualitative analysis was needed. To address such needs, the current study was conducted with the use of interviews with organisational actors across the plastics supply chain in four regions.
The main findings are:

Overall, the supply chain actors have a positive attitude towards plastic ecycling.

Organisations range from novice to competent and expert proficiency in recycling. Novices, competent organizations and expert organizations experience are affected for distinctive pressures and barriers.

Respondents perceive that the main parties that set norms on recycling are municipal councils, consumers, industry peers, and the local community.
Respondents offer many insights into the availability of organisational resources and knowledge of recycling. Top market pressures to recycle come from customers and competitors, whilst top regulatory pressure comes from the local regulatory level.

Interviewed supply chain actors highlight that the barriers to recycling can be attributed to challenges with funding; buyers and suppliers; facilities, technology, and infrastructure; management; and legislation. Respondents suggest that major enablers for recycling could be government incentives; regulation and enforcement; advising and funding; and networking.

Finally, the report offers recommendations to improve recycling grouped under categories of technology and innovation; supply chain management; capacity building and awareness; business case and economic instruments; facilities and infrastructure; and regulation.

Acknowledgements

We would like to acknowledge the Interreg 2 Seas programme that funded the PlastiCity project, which is co-funded by the European Regional Development Fund and the Province of East Flanders.

We would like to thank all organisations and managers in four countries (Belgium, France, the Netherlands, and the United Kingdom) who took part in this study.

1. Introduction

Understanding behaviour of organisations and different actors within the supply chain of plastic recycling is complex. Reducing the use of virgin plastics and improving plastic recycling in Europe is a multi-layered challenge that requires changes in behaviour of individual households, organisations, and companies. This report aims to explore factors that influence different supply chain actors to undertake and improve recycling of plastic waste and thus, support a transition towards the circular economy.

Although there are many political, economic, and social similarities between the national contexts of Belgium, France, the Netherlands, and the United Kingdom, we observe differences in how organisations perform recycling and what pressures and challenges they experience.

This report focuses on studying the recycling behaviours in four cities: Ghent in Belgium, Douai in France, The Hague in the Netherlands, and Southend-on-Sea in the United Kingdom. A team of researchers from these regions conducted interviews with different actors in the plastic waste supply chains to understand factors that influence their recycling behaviours. Relying on the Theory of Perceived Behavioural Controls (Ajzen, 1985; Khan et al., 2020), the researchers asked the same set of questions in four regions on personal and corporate attitudes towards recycling; sources of social pressures for recycling; resources and knowledge of recycling; barriers and enablers; and suggestions to improve recycling in these regions.

Eight groups of organisational actors (not households or individuals) typically represented in the plastic waste supply chain were approached for the study in each region. They included: 1) logistics companies, 2) non-governmental organisations (NGOs), 3) plastic manufacturers, 4) policy makers, 5) product makers and designers, 6) recycling companies, 7) waste management companies, and 8) waste owners.

Following the collection of 87 interviews across four regions, the interview data were coded using NVivo 12 and analysed thematically following the concepts derived from the existing literature on plastic waste recycling (see Khan et al., 2020).

The report presents the background literature that supported the study; study methodology; and the findings on behavioural and institutional factors of recycling for each region. Finally, the report offers a comparison between the regions and a summary of recommendations to improve plastic recycling.

2. Literature review and background information

The Theory of Planned Behaviour (TPB) (Ajzen, 1985) is one of the most influential theories used to understand human behaviour. This theory is highly useful to examine organisational plans and performance on plastic recycling because it investigates the links between human intentions and behaviours with other societal factors (Botetzagias et al., 2015; Chen and Tung, 2010; Davis et al., 2006; Khan et al., 2019; Knussen et al., 2004; Knussen and Yule, 2008; Nigbur et al., 2010; Ramayah et al., 2012; Taylor and Todd, 1995; Tonglet et al., 2004).

Decisions relating to the circular economy are very complex. They can be guided by perceptions, attitudes, and personal values of decision-makers or managers of public and private organisations which in sum directly influence organisational strategies and actions towards waste recycling (Daddi et al., 2019; Gusmerotti et al., 2019). To investigate the recycling behaviours in the plastics supply chain in four countries (Belgium, France, the Netherlands, and the United Kingdom) we examine several related concepts and factors that influence the plastic recycling behaviour of various actors along the supply chain following the Theory of Planned Behaviour (Ajzen, 1985; Khan et al., 2020) (see Glossary for more details).

TPB, as developed by Ajzen (1985), asserts that individuals' attitudes and social norms as well as individuals' perceived controls (such as resources and knowledge) guide their behaviour and serve as predictors of behavioural intentions. Behavioural intentions and perceived behavioural controls are considered to be significant determinants of actual behaviours (Ajzen, 1985). Khan et al (2020) applies TPB for the study of factors influencing the recycling behaviour of companies producing plastic waste. The paper presented results of surveys with waste-owners conducted in the initial stage of Plasticity. Khan et al (2020) provided the theoretical foundations for this report and identified the aspects where deeper analysis using qualitative research was needed to understand actors and their attitudes

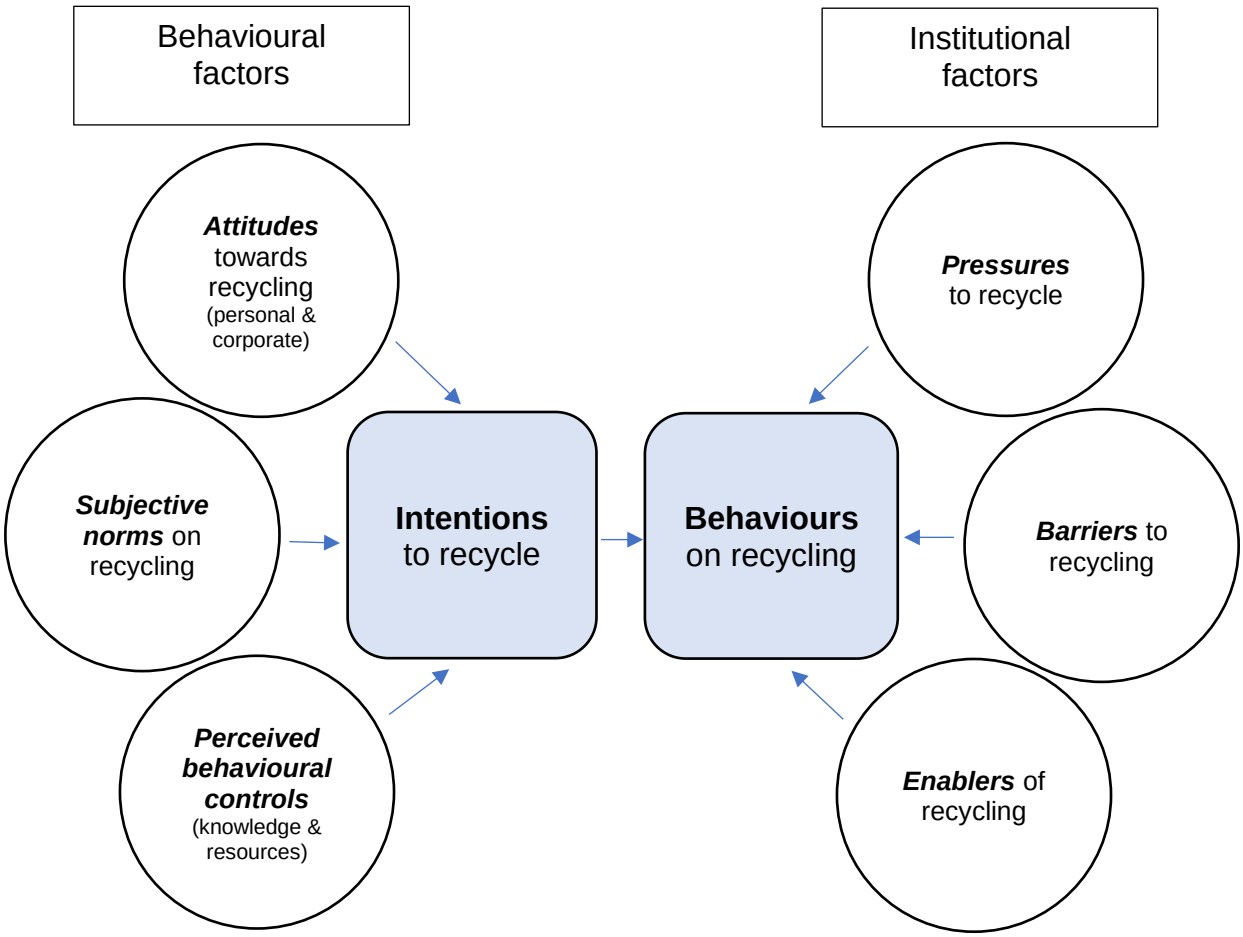
Based on Khan et al's extension of TPB to commercial plastic waste behaviour, we can identify a number of factors that contribute to plastic recycling (see Figure 1). Firstly, we distinguish between recycling behaviours and intentions as they are related, but distinct concepts:

- ***Behaviours*** (reported plastic recycling behaviour of organisations); and
- ***Intentions*** (actionable plans to improve recycling in an organisation).

In this study, we consider behavioural ***intentions to recycle*** to be "a perceived likelihood or subjective probability of decision makers that they will implement plastic recycling in their organizations" (Khan et al., 2020) The ***actual recycling behaviours*** are interpreted as "the extent to which organisations have implemented best practices of plastic recycling" (Khan et al., 2020). These recycling practices can include activities of reducing, reusing, and recycling of plastic waste, and they contribute to the circular economy. We assume that the larger the number of organisations that perform recycling practices in supply chains, the greater is the advance towards circular economy.

We need to examine the factor that influence recycling behaviours and intentions in order to understand how we can transition to the circular economy.

Framework for analysis of factors influencing plastic recycling behaviour



Source: Adapted from Khan et al., 2020 and Ajzen, 1985.

Although not all intentions lead to behaviours, there is a strong correlation between the two. Thus, research often focuses on factors that form the intention to behave. These are the behaviour factors: attitudes, subjective norms, and perceived behavioural controls.

Behavioural factors:

- ***Attitudes*** (personal and organisational attitudes towards recycling);
- ***Subjective norms*** (external stakeholder pressure on organisations to engage in recycling); and
- ***Perceived behavioural controls*** (such as resources and knowledge at the disposal of an organisation).

Personal and organisational ***attitudes*** matter, because a study by Khan et al. (2020) demonstrates that “environmentally conscious” decision-makers, or those who have a positive attitude towards recycling, do successfully implement circular economy practices. Therefore, it is important to study whether managers and decision-makers have a positive attitude towards plastic recycling. We assume that if managers have a positive attitude towards recycling, they are more likely to drive best recycling

practices in their organisations. Further, we assume that having a proactive corporate policy on recycling will positively influence recycling behaviour.

Societal expectations or norms also influence behavioural intentions. They can be injunctive (perceptions of what others consider to be correct behaviour) and descriptive (perceptions of what others are actually doing) (Fishbein and Ajzen, 2011). In our study, we look at ***subjective norms*** that are societal norms on recycling, noting that societal norms can vary from country to country (Khan et al., 2020).

Perceived behavioural control or perception of how easy or difficult it is to perform a behaviour is an important predictor of behavioural intention (Ajzen, 1991). In our study, we look at the knowledge of recycling and organisational resources to conduct plastic recycling (technological, human resources, and financial, etc) as perceived behavioural controls or powers to recycle within an organisation.

Studies examining such behavioural factors (attitudes, subjective norms, and perceived behavioural controls) are well established in the academic literature and can be applied not only to individual behaviour but to organisational behaviour as well (Cordano and Frieze, 2000; Klein et al., 1994; Papagiannakis and Lioukas, 2012; Singh et al., 2018).

Further, we examine three additional factors, which we can call “institutional factors” – barriers, enablers, and pressures for recycling - that can influence actual behaviours rather than examine the relationship with intentions to behave (Yuriev et al., 2020).

Institutional factors influencing behaviour:

- ***Barriers*** (obstacles to recycling as identified by managers);
- ***Enablers*** (external factors that can improve recycling behaviour in organisations); and
- ***Pressures*** (internal and external drivers and motivators to improve recycling).

We refer to ***barriers*** as “factors that hinder an organisation to implement the best practice of plastic recycling” (Khan et al., 2020). If organisations encounter significant hindrances, they are unlikely to improve recycling practices.

On the other hand, we consider that ***enablers*** are “factors that may facilitate an organisation to implement best practices of plastic recycling” (Khan et al., 2020). Enablers are actions or potential solutions and, if introduced, may motivate organisations towards plastic recycling.

Finally, ***pressures to recycle*** could be regulatory of market pressures, these are interpreted as “the perceived push on organisations, to implement best practices of plastic recycling, from regulatory bodies, competitors, and customers” (Khan et al., 2020). These pressures are often cited to improve environmental performance in organisations and could relate to recycling behaviours as well (Daddi et al., 2016; Jain et al., 2020; Phan and Baird, 2015; Singh et al., 2018).

3. Methodology

3.1. Data collection

The project collected the views on plastic recycling from 8 groups of actors in a typical plastic waste supply chain: 1) logistics companies, 2) non-governmental organisations (NGOs), 3) plastic manufacturers, 4) policy makers, 5) product makers and designers, 6) recycling companies, 7) waste management companies, and 8) waste owners or end users (see Appendix I for the description of each actor type). We approached 8 groups in each region and conducted one-to-one interviews with employees or managers. Interviewees from different groups were asked similar but tailored questions on attributes of behavioural intentions and factors influencing behaviour.

The project went through an ethical approval at the University of Portsmouth[1]. Consent to participate in the study was sought from each participant, each participant was asked to sign an ethical consent form.

Interviews were digitally recorded on audio with permission from the interviewees. They were transcribed verbatim in either Dutch, English, or French. The interviews were later transcribed and translated into English with a help of Sonix.ai software and analysed using NVivo 12, a qualitative analysis software. Overall, 87 interviews were conducted in four regions during 2021-2022.

3.2. Data analysis

Interviews were coded deductively or top-down using categories from the existing literature on perceived behavioural controls and plastic recycling. *A priori* codes (or top-down codes identified from the existing literature) were borrowed from the framework on recycling behaviour developed by Khan et al. (2020). The framework applies key attributes from the Theory of Planned Behaviour (Ajken, 1985, 1991) and additional institutional factors that influence plastic recycling.

In addition, emerging codes (or bottom-up codes arising from the interview data itself) were developed during interview coding. Following an open coding, textual data was coded axially. The codes were analysed by region and that contributed to the development of regional case studies on factors influencing recycling behaviour. Each regional case study was constructed around several common themes: 1) personal and corporate attitudes towards recycling; 2) sources of subjective norms; 3) resources and knowledge of recycling; 4) pressures; 5) barriers; 6) enablers; and 7) suggestions to improve plastic recycling.

Further, we investigated aspects relevant to supply chain relations, and similarities and differences across four regions on behavioural and institutional factors that

[1] Research Ethics at the University of Portsmouth, https://www.port.ac.uk/research/research-culture/research-ethics

influence recycling. Finally, we present recommendations that arise from respondents' suggestions to improve recycling.

Barriers were analysed following the pre-defined components from Khan et al., (2020) (see glossary of terms and section of Literature Review).

Some behavioural factors were analysed using a qualitative assessment of their significance. When respondents repeat the same term or concept several times, it indicates a significance of the topic to the respondent. A degree of significance was defined on a scale from 1 to 3 (where 1 - agree, 2 – strongly agree and 3 absolutely agree).

Qualitative assessment is based on the number of mentions by respondents of various terms or concepts (e.g., 1 or 2 mentions means "agree", 2 or 3 mentions by more than one member of an actor group means "strongly agree", 3 or 4 mentions by most or all members of an actor group means "absolutely agree"). The scores demonstrate the degree of significance of various components of barriers as expressed by supply chain actors.

> ○ – agree (mentioned once or twice), ○○ — strongly agree (mentioned few times by different actors), ○○○ – absolutely agree (mentioned several times by most or all actors).

Other behavioural factors were analysed using an interpretative analysis. Topics raised by respondents were grouped into larger themes. These themes either come from the existing literature (top-down analysis) or constructed inductively and emerge from the interview data (bottom-up analysis). For instance, enablers and suggestions were analysed using this interpretative technique and respondents' ideas were summarised into original themes. In text, the quotes are presented as evidence of these findings.

List of interviews in four countries on plastic recycling

Country	Belgium	France	Netherlands	United Kingdom	Total
City	Ghent	Douai	The Hague	Southend-on-Sea	Across 4 countries
Actor type	27	22	20	18	87
Logistics Companies	0	3	1	0	4
NGOs	3	3	2	5	13
Plastic Manufacturers	1	3	0	0*	3
Policy Makers	3	3	4	3	13
Product Makers and Designers	5	4	5	4	19
Recycling companies	2	2	2	1	7
Waste Management Companies	2	3	2	2	9
Waste Owners and End Users	11	1	4	3	19

* No plastic manufacturers are present in the region

3.3. Word frequency analysis

One way to analyse the textual data is to determine word frequencies; they demonstrate the range and variety of words used for each topic. Word clouds can be generated from word frequencies. Here are some word clouds (400 most used words per region), the size of words in the diagrams indicates the significance or number of mentions of certain concepts by regional respondents.

Word frequency analysis was used to calculate the use of words in responses to specific questions. For instance, to understand the different pressures for recycling experienced by supply chain actors. We also indicate when we use an extended word search, i.e., extensions for words such as talk and talking, or the use of synonyms and related words.

Word cloud from interviews in Ghent, Belgium

Word cloud from interviews in Douai, France

Word cloud from interviews in The Hague, Netherlands

Word cloud from interviews in Southend-on-Sea, United Kingdom

3.4 Limitations

Although a similar number of interviews were conducted in each region, there are disparities between the number of actors interviewed in each country. This was due to the unavailability of actors to participate in the study or the absence of certain supply chain members in the regions. For instance, there are no plastic manufacturers in the United Kingdom, they were interviewed in other countries.

Plastic recycling is a specialist sector with a limited number of actors in each country. Thus, it was not possible to conduct a large-scale survey. Instead, we chose to conduct a qualitative study with use of interviews. Further research can examine the behavioural factors of waste owners through a quantitative survey of recycling practices across Europe and beyond.

There are some interviewee biases. Interviews were conducted by different interviewees and there was a disparity in interviewing techniques. It affected the range of answers offered to the same questions in the interview schedule. The interview schedule contained open questions, and the answers differ between organisations and regions. Finally, interviews were translated from French and Dutch into English and analysed in English which could have led to a distortion of meaning after translation.

4. Results of behavioural study by region

4.1. Ghent, Belgium

Attitudes towards recycling

Strong personal attitudes towards recycling. Many respondents from Belgium understand and appreciate the circular economy and the input of plastic recycling to the development of circular economy:

> "Well, plastic recycling, yes, is part of a circular model…Plastic recycling actually ensures that raw materials are reused, so that a kind of loop is made… New plastics that are made from fossil fuels, they are petroleum-based. That is, of course, and you do that to a depletion of fossil fuels on the one hand, but on the other hand you also have an impact on the environment if you continuously have to dump or burn that waste… Plastic recycling is extremely important for these two issues, because you are actually trying to keep the raw materials in the chain as long as possible." (Belgian Non-governmental organisation 1).

> "I believe very strongly in recycling. I know there have been documentaries … about shipping to other countries where the waste is processed. I am convinced that this is still happening, but perhaps to a lesser extent than in the past, because laws are now approved at the European level. That that's not allowed anymore." (Belgian Non-governmental organisation 3).

> "Of course, that is a very important one. When I applied for this position, being intrinsically motivated to be involved with the environment was certainly one of the conditions. So, I'm convinced of that too, at home I try to set a good example and think about my own impact on the climate." (Belgian Waste owner 6).

Origins of personal attitudes towards recycling. Respondents bring up several topics when discussing their personal attitudes towards recycling and they are linked to: education, media, green political activity, local community, environmental impact, environmental pollution, effect on water resources, awareness of climate change effects, depletion of non-renewable resources, need to reduce the reliance of fossil fuels, availability of land for landfill, reduction of consumption, focus on local consumption, concern for the impact on developing countries, sustainable development, circular economy, national and European policy, consumer awareness.

Convergence of personal and corporate attitudes. Respondents reveal that often their personal attitudes coincide with corporate attitudes towards plastic recycling. Individuals and their organisations have a positive attitude towards recycling.

> "I think we should put all our efforts into that. My personal opinion is about the same as the opinion of our [organisation]. For me it is important that we no

> longer see waste as waste. But as a source of materials and thus actually try to avoid as much as possible that we have to use new raw materials." (Belgian Non-governmental organisation 2).

There are examples when personal views of manager-owners drive corporate policy and personal pro-environmental attitudes fuel a change in corporate recycling practices. For instance, in a family firm, a top manager-owner is driving environmental innovation by reconfiguring products towards ecological options.

> "I just think it's very important. I'm a very big nature lover, so I was also very interested in those biopolymers… And yes, I am now further orienting myself on that. So, I want to finally make a new product based on that new raw material… I have now heard from our supplier that a fossil-free version will be available in 2022. And then I'm participating in the first pilots, so there I can increase the percentage on fossil free PVC over time." (Belgian product maker 1).

Scales of concern for plastic recycling. Supply chain actors differentiate between levels of concerns for plastic recycling: a) local considerations such as local environment and landfill; b) regional considerations such as circular economy; and c) global considerations such as the impact on climate change, reduction of fossil fuel use, and impact of plastic waste management in developing countries.

Shades of plastics. Often those working in plastic waste management have a more nuanced view of plastic as a material, valuing its properties for manufacturing, transportation, and services. On the other hand, they also recognise the detrimental effects of single-use plastics in the system.

> "In recent years, plastic has been given a very bad reputation, which is actually very unfortunate because it is a super valuable material, one of the most reusable and workable and reliable materials that we have available with flexible production techniques. So, I understand that a lot of people are like plastic is bad. And that is very bad for the environment and very bad for water quality. But actually, if it is used correctly and the right application is chosen. Is that a fantastic material." (Belgian Product designer 5).

> "Plastics have very good qualities, but you have to know how to use them well. That they don't fall into the outside that circular flow." (Belgian Product designer 2).

> "There are different types of plastics. There are different types of applications for plastics and they all deserve to be recycled. Today, the focus is mainly on packaging. Because there is legislation about collecting and processing these. But there are still a lot of other possibilities to recycle. In addition, there is currently a focus on a number of materials within the plastics sector that are mainly recycled, again because these are the materials that were collected. You can only recycle what's collected. Which will come back together somehow." (Belgian Non-governmental organisation 2).

Environmental leadership. There are cases when managers not only lead pro-environmental behaviour within organisations, but beyond through community engagement and lobbying at national and industry levels.

> "I am also active … at regional level…I'm also in the national section. So, I know very well what lobbying is, for example…And that certain things, when it comes to ecology, will have to be pushed through. And those firms then have to adapt and pass that on to their customers." (Belgian Waste owner 3).

Corporate attitudes. There are differences levels of engagement with recycling in organisations. Based on the responses, we identify three levels of organisational proficiency in recycling: novice, competent, and expert.

Proficiency in recycling	Details	Quotes
Novice	• Started recycling recently. • This could relate to the size and age of an organisation. • Organisation is shaping its policy on recycling. • The scope of recycling is limited; organisation has resource constraints or internal barriers. • These organisations will benefit from training and support.	"That's a first problem and a second one; we have already started with the diaper recycling; it all has to go in an extra bin…But what is especially a problem: It is so difficult to get all of our staff and all of our students in the right line of what can and cannot be done." (Belgian waste owner 8).
Competent	• Organisation has experience in recycling for several years. • Recycling is part of a corporate policy. • The circular economy is acknowledged as part of corporate policy. • Expertise in recycling is proven in practice. • Organisation can benefit from further training, guidance, and support.	"This is very important, of course. All our companies, both the producers and the plastics processors, also see this as an alternative source of raw materials. It is clear that we have to move more and more in that direction. Keeping those materials in a cycle as long as possible and avoiding the waste phase. And that's important." (Belgian Non-governmental organisation 2). "Yes, a hot topic. Of course, that recycling story. We are now trying to make more and more customers aware of this. We offer that too. So, we already produce with recycled material. Material that has already been incorporated into plastic. Can be in

		several applications." (Belgian Producer 3).
Expert	• Recycling is central to the organisational mission and strategy. • Organisation pursues the circular economy principles, including the use and generation of renewable energy. • Organisation has resources, knowledge, and skills. • Organisation is developing new technologies for recycling and material development. • Organisation can contribute to development of training on recycling.	"We are one of the pioneering tech companies around what they call chemical recycling of plastics, working in particular with pyrolysis." (Belgian Recycling company 2). "I'm exploring new raw materials, so in that envelope I'm looking very critically. What do I put in the casing?... I am also orienting on other raw materials, and I will now participate in a pilot with our PVC supplier in fossil free PVC, they are now working on the certification of it." (Belgian Producer 1).

Origins of corporate attitudes. Respondents report that corporate policies on environmental behaviour and recycling in their organisations relate to the following origins: environmental regulation, environmental certification and auditing, pressure from environmental organisations, industry best practices, principles of circular economy, industrial guidance, industry networking such as North Sea Hub, regional and national political and business context, waste management, product life cycle, climate-neural purchasing, sustainable purchasing, promoting renewable energy and reduction of energy use, corporate evolution, engineering and design, manufacturing, materials management, reduction of environmental impact, local production, win-win economic and environmental solutions, carbon calculations, responsible supply chain management, stakeholder commitment, client pressure, and future generation.

Corporate good will and motivation are important for waste recycling rather than profit making. Respondents suggest that waste recycling is a value-driven activity within organisations rather than a market-driven activity. It does not necessarily improve the business model or bring a significant revenue stream.

> "Waste is not the sexiest topic or anything either. It's not something that needs to be discussed to make your business run better or anything. That still often comes from goodwill. That's not going to change the numbers at the end of the year. There's a little less focus on that. But you feel that there is a will to do something about it." (Belgian Non-governmental organisation 3).

> "We want to be able to process our waste more cheaply or we actually want to position ourselves as someone who has very little waste. How important is that in your annual report, to report on your waste. It really depends from company to company." (Belgian Non-governmental organisation 3).

> “The only thing I do notice is that it is very difficult to develop a profitable business model around these circular projects: It is very difficult to develop a profitable business model around them.” (Belgian Policy maker 1).

Gap between values and behaviour. Some respondents point to a superficial nature of commitment to environmental values, that environmental behaviour of individuals and companies is riddled with contradictions to stated beliefs.

> “I am convinced that the majority is really not concerned with sustainability. Maybe superficially, but not in depth. The clichés are well known. We are going to argue for the environment and an hour to the airport to travel for a weekend in Barcelona. Pfff, yes, that does bother me. And you have that with individuals, but you have that with companies too.” (Belgian Waste owner 3).

> “Yes, what I notice is that companies. They are very often open to that kind of topic. That's not the problem. They do see the possibilities and such more. But yes, waste and energy and so on, that's not their core business. So, they really just don't have time for that. Or they don't want to make time for it.” (Belgian Policy maker 2).

Holistic approach to environmental behaviour. Importantly, respondents remind that plastic recycling cannot be seen outside of a holistic pro-environmental behaviour, applied to all elements of consumption and production, and using environmental criteria widely in purchasing behaviour not only with regards to plastic packaging.

> “Sustainability is not just about content or packaging…Privately, I always buy those vegan shampoos that are a tad more expensive, and they are always in a slightly harder to find place. I've actually been buying a certain type of shower gel for about three or four years now and one time I go to a Delhaize store to buy for the hotel…” (Belgian Waste owner 3).

Sources of subjective norms

Subjective norms are external stakeholder pressure on organisations to engage in recycling. These norms come from a variety of social groups. The sources of norms are based on the existing literature (see Khan et al., 2020) with slight additions.

Sources of norms	Responses from different actors					
	NGOs	Policy makers	Product makers & designers	Recycler	Waste management company	Waste owners
International community	○		○○○		○○	○○○
European community	○○		○○○	○○○	○○	○○○
National government	○○○	○○	○○	○○	○○○	○○○
Municipal council		○	○		○○○	○○○
Local community	○	○○	○○○	○○○	○	○○
Businesses	○○○	○○	○○○	○○	○○○	○○○
Consumers	○○○		○○○		○	○○
Owners						○
Non-governmental organisations	○○			○		○○
Employees			○	○		
General public	○○	○	○○	○		○○
Public media	○○			○		
Financial organisations				○○		○
Universities	○				○	

○ – agree, ○○ — strongly agree, ○○○ – absolutely agree

Resources and knowledge of recycling

Perceived behavioural controls are resources and knowledge at the disposal of an organisation that influence the behaviour. Organisations have different capabilities for recycling. Below is the range of resources and knowledge at the disposal of supply chain actors, when they talk about plastic recycling and recycling in general. Types of resources (financial, human, and technical) were borrowed from Khan et al. (2020) with some additions, whilst types of knowledge were identified from primary data analysis rather than from the existing literature.

Resources for recycling

Elements - Resources	Details of Perceived Behavioural Controls
Financial resources	Financial resources to invest in recycling facilities and systems. The extent of recycling and advocacy activities is often limited by the available resources at organisations.
Human resources	Organisations report on their teams that work on recycling specifically, often human resources are stretched.
Facilities, technology & equipment	Organisations report that recycling is limited by their facilities and the extent of waste streams they generate, as well as by technologies available to recycle complex plastic products (such as soft and hard plastics).
Energy resources	Energy prices are going up, especially for oil that is one of the controls of the recycling activity. Organisations are concerned about energy consumption.
Logistics	Logistics systems behind recycling is linked to the size of the market and the amount of waste flows also determines the rate of recycling.

Knowledge of recycling

Elements - Resources	Details of Perceived Behavioural Controls
Knowledge of national and European legislation on recycling	The recycling practices in organisations in Belgium are influenced by European legislation with increasing requirements of mandatory recycled plastic content in products such as PET bottles.
Knowledge of recycling technology	Organisations dedicate resources to improving their knowledge of recycling technologies, by extending the dedicated teams and investing resourcing into acquiring new technologies.
Mechanical and Chemical recycling	Respondents discuss the boundaries of mechanical recycling and advancement of chemical recycling and whether it is adequately supported by the legislation.
LCA	Organisations use life cycle assessment techniques in manufacturing products to determine the material use and guide them on waste recycling decisions.
Inventory	Organisation maintain an inventory of the materials used in their production and assess how much hazardous and non-hazardous materials are used and released.
Research and development	Some organisations are involved in conducting R&D on plastic recycling as well as in collaboration with other companies and universities.
Business-University collaborations	Organisations report on collaboration with universities on training, knowledge exchange, and research and development.

Eco-design	Eco-design can reduce the use of plastics and promote recycling that is enabled by data gap collection, new technologies and more eco-design. Eco-design should also be backed up by data collection and analysis using circular economy models and testing.
Industrial associations and federations	Industry bodies are sources of knowledge for members and can assist individual organisations to access knowledge on recycling and understand the legislation requirement as well as technological development.
Training on recycling	Training on recycling legislation, technology and practices on waste collection, waste treatment and waste recycling is offered for instance by non-governmental organisations.
Events	To raise awareness events on waste management are organised, such as Belgium Plastics Day, which is an event on circular plastics.
Business partners and peers	Business partners and peers are also a source of knowledge and knowledge development on waste recycling. Companies collaborate on waste recycling with other businesses.

Pressures

When talking about pressures or drivers for recycling respondents mention the following key concepts and stakeholders and as sources of pressure. Top 20 pressures using Word frequency analysis.

No.	Types of barriers	Number of mentions
1	Companies	190
2	Material	143
3	Product	119
4	People	90
5	Legislative	81
6	Customers	66
7	Containers	64
8	Process	63
9	Packaging	61
10	Goods	60
11	Governments	57
12	Sustainability	54
13	Time	53
14	Price	46
15	Market	45
16	Sectors	40
17	Business	36
18	Industry	35
19	Project	34
20	City	31

Note: Includes extended word search

Barriers

Respondents highlight the main barriers or challenges to implementing plastic recycling in their organisations or sectors. These are internal and external challenges that managers perceive to be obstacles to the reduction of virgin plastic use and implementation of plastic waste recycling. The types of barriers come from the existing literature (Khan et al., 2020) with some additions.

The table below demonstrates whether different groups of supply chain actors consider certain aspects to be barriers to plastic recycling. Certain aspects are mentioned more frequently than others, but there is a difference in perceptions between actor groups.

Types of barriers	Responses from different actors					
	NGOs	Policy makers	Product makers& designers	Recycler	Waste management company	Waste owners
Funds	○○	○	○○○	○○	○○	○○
Time		○	○		○	○
Skills & Knowledge	○	○	○○○	○	○○	○○○
Space					○	○○○
Access	○○	○				○
Transport		○		○○	○○	○
Management & Leadership	○○	○○	○	○	○○	○○
Buyers & suppliers	○○	○	○○○	○○	○	○○
Facilities, technology & infrastructure	○○	○	○	○○○	○	○○○
Legislation	○○○	○	○	○○	○○	
New types of barriers identified from interviews						
Communication and collaboration		○○	○	○○	○	
Volume of waste streams generated	○			○○	○○○	○○

○ – agree, ○○ — strongly agree, ○○○ – absolutely agree

Two new types of barriers were identified from the interview analysis: communication/collaboration in the supply chain and limited volumes of waste streams generated by individual organisations. The first type of barrier relates to a lack of collaboration or communication between organisations to improve recycling. The second type is a physical constrain.

Respondents are concerned about the volume and flow of materials collected as well as the frequency and organisation of collection and logistics of the plastic recycling system. Low volumes of different types of plastic waste collected and generated by individual organisations hinder actors from effectively managing waste for recycling activities. It is a challenge for waste management companies to collect and process plastics that come from small waste streams.

Enablers

Enablers are potential actions or solutions that may encourage recycling in organisations. Enablers for recycling are grouped into pre-determined categories that come from the existing literature (Khan et al., 2020). Respondents offer insights for each category of enablers: regulation and enforcement; government incentives; advising and funding; training; networking; guidelines; and fees.

Types of enablers	Details
Regulation and enforcement	• *Clarifying the legislation on approach to mechanical and chemical plastic recycling*. "And the so the whole legislative framework to label this also as fully circular and recycling is part of the obstacles. If the government says we absolutely want the producers of plastic to take responsibility for recycling at least x percent of their plastic. That is of course relevant to know Is Chemical Recycling accepted as recycling? (Belgian Recycler 2). • *Demanding recycled plastic contents in products and tenders*. "The only way to do that; is to start imposing recycling content targets. That's not the only option, that's a possibility. You could incorporate criteria via public tendering (award criteria). That recycle should be used, so that people who subscribe to these things are encouraged to come up with initiatives in which recycled or circular material is used. Adapting specifications to allow for these new business models and product-service combinations. These are things that governments can help with." (Belgian Non-governmental organisation 2). • *Updating the legislation on use of recycled plastic in products and industries.* " They are working on it now, but there is still a lot of work to be done. There's still a lot to be done. There is also legislation, for example, that simply stands in the way of circularity. Old legislation product norm BVB which literally states that you cannot use recycle to make products." (Belgian Non-governmental organisation 1). "We also see that there are standards and specifications that prohibit the use of recycle. There are a few like that in the construction industry. Where it is stipulated: this product may not contain any recycle. And that's historic, because

	20, 30 years ago the quality of it was not as good. Because of the fact that as a construction company you also have warranty obligations, you don't take risks and you don't want to do that. And so, it is forbidden. There are customers of our plastic processors who often forbid the use of recyclate." There are still many obstacles." (Belgian Non-governmental organisation 2).
Government Incentives	• *Subsidies to promote circularity of plastics are welcome*. "Yes, subsidies are of course always useful when we make the investments." (Belgian Product designer 2). • *Taxation on plastic packaging*. "That packaging, that's only a very small part of the price because plastics are very cheap. That zero-point 80-euro cents is really not going to have much of an impact on the total price tag of the product, so that's just going to be passed on to the consumer. And that is not going to motivate the producer, because the tax is not high enough to do that, to use other packaging that is recyclable. So, it's not a steering measure. It is a budgetary measure and that is a missed opportunity." (Belgian Non-governmental organisation 1).
Advising and Funding	• *Researching waste streams*. "So, there is absolutely no connection between the volume that is put on the market and produced, and the volume that comes onto the market as waste. So, first of all, we're already sitting there with a data gap. What is the volume of plastic waste coming onto the market? We don't have a complete picture of that. Packaging, yes, but not the rest. So, then we have to go and sort that out somehow. How? Not so clear at the moment. Where are we going to measure that?" Second, yes, not all streams are collected very effectively. There are still a lot of streams that are lost." (Belgian Non-governmental organisation 1). • *Funding and co-financing for development of new technology.* "But we do proclaim that these new technologies are needed and that there is also government funding to finance them. Because yes, that funding. I say it our members live in a rather uncertain climate. You have to that market which is very volatile…It's just a question of the price. And yes, so that means that they don't always have enough security of their own to make investments. So, the government has to be there a little bit. We will play a role in this, either by co-financing a project or perhaps in other ways, but we do advocate the introduction of these new technologies." (Belgian Non-governmental organisation 1). • *Government financial investment in recycling projects and tax reduction.* "I do think that we should be careful with these financial incentives. The government really does do well in that area. Again, I'm critical of the government but in a number of areas it does really well. Increased investment,

	deduction for ecological or sustainable investment, for example." (Belgian Waste owner 3).
Training	• *Improving recycling through improving waste sorting*. "We can save your money plastic processing…we want you to sort plastic in this way, because it ensures that we have fewer work and processing costs at the beginning of our own chain. So that would mean that you could get a premium for it. Every company that we approached in this way at the time was very positive about it at the beginning." (Belgian Recycler 1).
Networking	• *Supply chain integration*. "So, basically the whole chain. In order to achieve a success story, the entire chain must work together, and that is happening. At the moment, this chain is not yet sufficiently integrated. Producers of virgin materials are not always aware of the problems facing the recycling sector and vice versa. So, we do try to bring those members together and set up joint events, so we are both convinced that that has to happen." (Belgian Non-governmental organisation 1). • *Cooperation between actors. "*The cooperation and the will must be there to take the cycle into account. Unfortunately, this does not happen spontaneously. And we see that unfortunately it only happens when targets are actually imposed, legally speaking. But cooperation in the chain is important." (Belgian Non-governmental organisation 2). • *Tripartite relationship between NGOs, companies, and consumers to improve recycling. "*We are trying to enter into a triangular relationship with companies; between us, the company and the consumer. Each to bring a story that makes products that are actually better, such as less plastic, better plastic, different packaging." (Belgian Non-governmental organisation 3).
Guidelines	• *OVAM policies and procedures on waste recycling for organisations*. "OVAM (Public Waste Agency of Flanders) is an internally independent agency with powers of jurisdiction and is part of the Environment, Nature and Energy policy domain of the Flemish government. This governmental agency was established by the decree of July 2nd in 1981. It was also described as the first Waste Management Act in Flanders. The primary purpose of this legislation was the improvement of solid waste disposal practices." (OVAM, 2022, https://eurelco.org/ovam-belgium/).
Fees	• *Encourage recycling by saving on recycling fees*. "What is a fact is that most of the plastic that is currently processed or that is recycled here at the moment from companies and from the industry has to be paid for. There is a great gate fee in the industry, and this is actually a recycling industry at large that lives for about 80 percent on gate fee. That it says: you make a company pay for the processing of plastic." (Belgian Recycler 1).

Suggestions to improve plastic recycling

Respondents from Belgium make several suggestions to improve plastic recycling.

Types of suggestions	Detailed suggestions
	1. Technology and innovation
Design solutions to reduce, reuse and recycling of plastics	• *Reduce the use of plastic in products and substituting with other materials*. "Although that plastic can be used for several years. In that way, I think that if people want to use plastic in a more ecological way, it is first up to the people who put that into production who choose to look at that: "Is that really the best solution? Or can we use a different material for what is needed?" (Belgian Product designer 5). • *Design/Redesign to facilitate recovery and reuse of plastics.* "You have a right to repair movement. I don't know if you like to replace things yourself or if you're a tinkerer? It's really very difficult to fix any item, especially electronics, but really any other items. I do like to do that, I find that interesting to see what breaks down first and whether it can be repaired or not…Small-scale production, especially with digital product techniques, is interesting. There are a lot of techniques by which you can produce locally, on a small scale, with virgin or recycled material to make such things, things that break down or things that you only need a little of." (Belgian Product designer 5). • *Encourage eco-design of products.* "More eco-design. We simply need rules for eco-design. Every product should be subjected to a circular test before it is actually put on the market." (Belgian Non-governmental organisation 1).
Research and assessment of potential solutions	• *Conduct impact assessment of potential solutions with use of evidence*. "And that by banning certain things and focusing on other materials, alternative materials, it doesn't necessarily mean that you're going to have environmental gains if you look at the big picture. Via life cycle analyses, for example." (Belgian Non-governmental organisation 2).
Develop technology	• *Develop and diffuse new recycling technologies.* "Not everything can be recycled mechanically. But there are also a lot of new innovations underway and new recycling technologies being developed to give even more possibilities. The legislation does not take into account the new recycling technologies. So, there's still some work to be done." (Belgian Non-governmental organisation 2). • *Develop new recycling technologies for complex products.* "There also needs to be more deployment of technologies. There must be new technologies to sort out better? The functionality of products is constantly increasing, but so is their complexity. So, they're actually getting harder and

	harder to recycle." (Belgian Non-governmental organisation 1).
	2. Supply chain management
Improve logistics of plastic recycling	• *Management of volumes and flows of waste would be improved with development of appropriate logistics systems.* "So yes, the volumes are often too scattered. So, you have to try to develop a logistics system in which the volumes are sufficiently large. And on the other hand, I think you have a flow that also poses a lot of challenges because one type of plastic is not the other." (Belgian Policy maker 1).
Audit waste management	• *Audit waste management in supply chain, especially internationally.* "From the moment we give that waste to a professional organisation, I assume it will be professionally processed. We don't do audits or anything like that. We're not at that stage in the organisation to do that either. I think very few companies audit their waste management. I suppose there are agencies for that who do, of course. We do need to make sure that it gets there. Again, in Belgium, I am assuming that this is done properly. When we are in Africa, that is something we have to look at with a bigger magnifying glass." (Belgian Non-governmental organisation 3).
Introduce quality label on plastic recycling	• *Introduce quality label on plastic recycling.* "Then it is reliably dated to become sustainable. For me, having a known quality label is important. Preferably not invent another one because there are already enough, I think of everything and anything. I also find it more reliable via the umbrella organisations. And I think the government can play a role in that." (Belgian Waste owner 8).
	3. Capacity building and awareness
Train organisations on waste recycling	• *To improve recycling in organisations, managers need to invest in employee training and international communication.* "And employees aren't always into it, either. Depending on what kind of profile that it is, it also doesn't matter that much what their company does. A company is more than a CEO and the directors. I think if you want a company to change in terms of waste, you have to involve everyone. And you have to communicate that throughout your company." (Belgian Non-governmental organisation 3).
	4. Business case and economic instruments
Develop win-win solutions for take up	• *Promote win-win solutions to improve recycling. "*This is a better product because ... and then the explanation of: that is made with recycled materials, they use less CO2, they use less raw materials." (Belgian Non-governmental organisation 3).
	5. Facilities and infrastructure
	None.
	6. Regulation
	None.

4.2. Douai, France

Attitudes towards recycling

Personal attitudes. When discussing personal attitudes towards recycling, managers across the plastics supply chain in France mention environmental values such as reduction of carbon footprint, use of alternative energy, and development of alternative materials. Respondents mention their household and consumer behaviours, including the reduction of plastic packaging and purchasing products with recycled plastics. Respondents strive to reduce plastic use at home by reducing the use of bottled water in favour of filtering tap water or carbonating water at home, undertaking waste separation, and plastic waste recycling plastic at home. Respondents relate plastic recycling to wider sustainable consumption including food and transport such as the use of electric cars, sustainable tourism, and sustainable living including rainwater collection at home, composting biowaste, and growing food at home. Finally, some respondents express concern about the effects of microplastics on human health and have doubts about the environmental benefits of bioplastics.

Plastic waste is a significant problem. Respondents are aware of the challenges that plastic waste presents in contemporary society. As an example, a respondent states:

> “I think that plastic is the most problematic waste today. It is a waste that is difficult to recycle and valorise because of the different particles, which is part of every formula, of every plastic object. And for me, it is important to try to find a possible formula to revalue it as much as possible or even to stop trying to create it and to find other materials that can replace it.” (French Non-governmental organisation 1).

Challenges in reducing plastic waste. Respondents highlight challenges in pursuing the reduction of plastic waste at an individual level.

> “So, it's not easy every day to be able to have the necessary rigor to deal with all that it requires in terms of gesture and the level of attention.” (French Policy maker 1).

Origins of personal attitudes. When discussing personal attitudes to plastic waste, managers state the reasons for plastic recycling such as environmental protection, conservation of raw materials, and concern for environmental impacts of plastic waste, and planetary boundaries as reasons for changing their individual behaviour. They demonstrate awareness of sustainable development, product life cycles, waste hierarchy with reduce, reuse, and recycle principles, the need to search for substitutes for plastic products and packaging, and individual responsibility for recycling. Some mention green energy and the need to reduce nuclear and coal-generated energy sources. Respondents reflect on their training, education, and upbringing, including formal education such as university studies, and work experiences when discussing their personal attitudes towards recycling. Others

discuss international experiences, and exposure to different cultures as sources of environmental awareness. Some are concerned about the state of environmental awareness of the younger generations. Respondents also comment on differences in environmental awareness and behaviours between different generations and the rise of awareness of the environmental consequences of consumption. One respondent pointed out:

> "We are moving from a society or hyper, from continuous growth to an awareness of the fact that it is not continuous and that we will have to, at some point, be able to find a solution to recycle and then create a circular economy." (French Policy maker 1).

Corporate attitudes. Corporate attitudes towards recycling the organisations could be divided into three levels: novice, competent, and expert.

Proficiency in recycling	Details	Quotes
Novice	• Organisation does not have a formal policy on recycling. • Organisation is shaping its policy on recycling. • The scope of recycling is limited. • These organisations will benefit from training and support.	"We don't have a written charter as such, but we are all very aware of this. Generally speaking, it's done with common sense... we have at the moment are recycled plastic pens... we have eco cup that we reuse regularly, so it's like that…For years, our communication manager has been promoting local and waste-free products. If possible, that's great." (French Non-governmental organisation 1).
Competent	• Recycling is part of a corporate policy. • Organisation has experience in recycling. • Organisation trains employees on recycling. • Organisations are proactive with recycling and expanding the sphere of influence in the supply chain. • Organisations can benefit from support and funding.	"There is a great deal of awareness about environmental issues at [the company], but not only about plastics or waste management. We have an ambitious environmental policy. It is [the company] that is pushing us to the ambition of producing a set of eco-designed products in 2026, for example, among other actions. But what I wanted to say is that [the company] is also taking steps to raise awareness among all its employees on the subject, so that they are well aware of Why do we want to go? Why do we have this ambition? As a result, there is a good conscience afterwards about the recycling itself." (French Product maker 2)

Expert	• Recycling is central to the organisational mission and strategy. • Organisation pursues the circular economy principles, including use and generation of renewable energy. • Organisation has resources, knowledge, and skills. • Organisation is developing new technologies for recycling. • Organisation can contribute to development of training on recycling.	"As a recycling company, our main role is to find in the flow of waste that we recover to recycle, to find, to recover the maximum of secondary raw materials that we send afterwards in recycling channel so that the sorting is refined, so that the material is cleaned and prepared and that it allows that it is reinjected in the industrial fabric as we are an independent company and that we have neither a landfill, nor an incinerator. It is in our interest to maximize the recovery of the waste." (French Waste management company 3).

Origins of corporate attitudes. Respondents mention parties or stakeholders that influence their corporate approaches to recycling: 1) peer pressure and collaboration with colleagues; 2) collaboration with outside stakeholders that reinforce environmental values in organisations, such as a partnership in green projects (with regional and city councils such as PlastiCity and others); 3) professional community experiences (such as membership of Chamber of Commerce and industry associations); 4) shareholder demands; 5) policy makers, public policies and legislation; 6) neighbouring countries; 7) influential industry organisations that promote recycling.

For managers, their previous work and professional experience on plastic materials and recycling shape their knowledge and approach to recycling in organisations. Respondents suggest that corporate approaches to recycling in their organisations are linked to circularity, circular economy, responsible consumption, systems view, carbon management (such as carbon assessment, carbon footprint), eco-design, extended producer responsibility, and environmental legislation on waste management such as the Waste of Eclectic and Electronic Equipment. They mention concerns for climate change and the transition to green energy as part of the conversation about corporate efforts on recycling.

Corporate managers are aware of sustainable development dimensions applicable to organisations: economic, social, and ecological. They discuss economic transformation, the ecological transition of organisations towards bio-economy, eco-production, and a new economic model. They mention both regional and industrial transitions to sustainable territory and sustainable industry as part of corporate attitudes to recycling.

Sources of subjective norms

Subjective norms are external stakeholder pressure on organisations to engage in recycling. These norms come from a variety of social groups. The list of sources of norms is based on the existing literature (see Khan et al., 2020) with additions.

Sources of norms	Responses from different actors							
	Logistics co.	NGOs	Plastic manuf.	Policy makers	Product makers	Recycler	Waste man. co.	Waste owners
International community		○○	○	○○	○	○	○	
European community	○	○		○○	○○			
National government	○○	○○		○○	○○		○	
Municipal council	○○○	○	○○○	○○○	○○○	○○○	○	
Local community	○○			○○	○		○	○○
Businesses	○○	○○○	○○○	○○	○○○	○	○○	○
Consumers	○○○	○	○○		○○	○	○○	
Employees			○					
General public	○○	○○○	○○○	○	○○	○	○○○	
Public media							○	
Financial organisa-tions								
Universities		○						

○ – agree, ○○ — strongly agree, ○○○ – absolutely agree

Resources and knowledge of recycling

Perceived behavioural controls are resources and knowledge at the disposal of an organisation that influence their behaviour. Organisations have different capabilities for recycling. Below is the range of resources and knowledge at the disposal of respondents, when they talk about plastic recycling and recycling in general.

Types of resources (financial, human, and technical) come from Khan et al. (2020) with some additions. Types of knowledge are originally identified from interviews rather than from the existing literature.

Resources for recycling

Elements - Resources	Details of Perceived Behavioural Controls
Financial resources	Financial resources are important to maintain recycling practices. For-profit organisations rely on their business with customers to fund recycling activities. Some organisations apply for grants and external investment for recycling projects, as well as seek investment from European Union. NGOs rely on donations and grants and public funds. Some organisations seek government subsidies, such as producers, e.g. “We are not only on subsidies, so we have a whole pole service which consists finally in leaning on classic machines available to this day …This is quite strong, because finally, we could not afford to buy so many machines when starting a start-up.” (French Product designer 1). Others want to stay independent from public subsidies, i.e. “We don't want to receive subsidies because we don't want politicians to use our image to please France” (French Non-governmental organisation 1). However, there are companies who do not have subsidies at the moment, but would like to consider public funding to develop further recycling projects in the future, e.g. “In my opinion, we will be limited at some point, we will need to call upon projects subsidized by Europe, by France or by regions. I know there are lots of possibilities. We are not necessarily experts in fundraising.” (French Plastic manufacturer 3).
Human resources	Some organisations have dedicated staff to deal with plastic recycling, others do not have full-time staff on green jobs, e.g. “And as a small business, we don't have full-time employees who are in charge of green jobs.” (French Waste owner 1). This depends on the size and nature of the organisation or business and the degree of their involvement in recycling, whether it’s one of a core or supplementary operation. In other organisations, all staff does the recycling activities, e.g. “We don't, we don't, we don't have a person dedicated to plastic recycling. Everyone is involved. When we are on, when we are at the place where we do the sorting, each one, each one will go to get the plastic and will transport it in the cell where it must be put.” (French Waste management company 3). Often organisations take trainees as well and employ them on recycling projects and offer training to their staff.
Facilities, technology & equipment	When discussing facilities, technology, and equipment, dedicated to recycling. Depending on what type of activities the organisations are in, they have dedicated resources. In terms of transportation respondents mention green mobility options (electric vehicles), and in terms of energy supply, they discuss green energy supply and energy-saving technologies. In terms of facilities, some organisations mention being housed in eco-parks.

Knowledge of recycling

Elements – Knowledge	Details of Perceived Behavioural Controls
Knowledge on recycling technology	Organisations possess knowledge of recycling technologies and processes (including production of plastics, means of recycling plastics and circularity of plastics).
Mechanical and chemical recycling	Organisations have knowledge of mechanical recycling and developing knowledge on chemical recycling, starting to assess the risks and benefits associated with chemical recycling, e.g. "We will say a technological risk because the technologies are not used today and that is where the risk lies. Absolutely, and that's why we're putting it in place. A pilot is being built and will be used to verify the technology." (French Plastics manufacturer 1).
Types of plastics	Some organisations have expert knowledge on plastic material and types of plastic waste, e.g. "Now there are 25 different categories of plastics such as trays, film, plastic bags, polystyrene…I believe that the initiatives that are put in place by the State to collect the 25 or 26 types of plastics." (French Waste management company 1) and "I know more or less what plastics are and the major issues, the types of plastics, the use of plastics, I can tell the difference between a composite and a packaging plastic, it's clear and simple." (French Policy maker 2).
R&D and developing new technology	Many organisations are involved in research around plastics for internal and external benefits. Non-governmental organisations promote research in the industry. Companies also develop technological innovations on recycling, notably: "We are in 2022 and we have invented a new synthesis of styrene by de-polymerization." (French Plastics manufacturer, 1). Producers also invest in product innovation, eco-design, and the development of new products with reduced plastic use or use of recycled plastic. In addition, they invest in equipment and process innovation. Finally, policy makers want to promote solutions on alternatives to plastics.
Traceability	Some organisations have a good or detailed knowledge of product traceability and traceability of materials in the supply chain within France and from other countries. These are clearly experts in the field, but this knowledge is not common across difference actors interviewed.
Environmental compliance	Organisations are aware of the regulation, and it influences their practices as well as future policies and plans on recycling.
Tools and techniques: LCA, carbon footprint	Organisations use a variety of tools that inform their environmental decision-making, such as LCA and carbon footprint.
Environmental standards	Companies improve their knowledge as part of adopting environmental standards such as ISO 14000. "Yes, so we have already passed ISO 14001." (French Logistics company 2).

Training and education for employees	Companies train their staff on environmental matters. “For the moment, we don't have an awareness campaign, but at least we have regular information notes here on the use of electricity, etc.” (French Logistics company 2).
Knowledge contribution of new staff	Organisations admit that their organisational knowledge and practice expand with new colleagues: “We have evolved all together in this direction and with people in any case, especially the youngest people who arrived in the team being ultra-sensitive to this, even almost formidable in their practice.” (French Logistics company 1).
Sources of knowledge	Respondents mention several sources of knowledge: such as the government, region, municipal authorities, recyclers, competitors, industry peers national and in Europe, industry organisations, and international industry organisations. Organisations foster internal experts on specific subjects about recycling as well and also internal colleagues are sources of knowledge.
Gaps in knowledge	Organisations mention knowledge deficiencies, e.g., “there are still gaps and lack of knowledge, it is on the design part for recycling… by working on the subject, I realize that there are also a lot of questions which remain suspended, for example on the materials to be used, which plastics seem more interesting to recycle. We can have that data there. However, what is the surface treatments? What are the additives that will interfere with recycling? This is still information that is not yet well enough known and well enough structured to be disseminated.” (French product maker 2).
Importance of public awareness campaigns	Respondents point out to the importance of increasing public awareness of plastic recycling, e.g. “It's a lot about people's behaviour. Evolve their awareness of impact. And ecological that can have. Not sorting, not reusing Throwing into nature.” (French Plastics manufacturer 2). Respondents also suggest that the government should take a lead nationally and internationally on this front.

Pressures

When discussing pressures or drivers for recycling, respondents in the plastics supply chain mention in France the following key concepts and stakeholders as sources of pressure. Top 20 pressures using Word frequency analysis.

No.	Types of barriers	Number of mentions
1	Products	54
2	Materials	43
3	Customers and clients	42
4	Regulation and law	37
5	Companies	26
6	Industry	25
7	Design	20
8	Price	18
9	Economic	17
10	Market	17
11	Projects	17
12	Business	17
13	People	15
14	Public	14
15	France	13
16	Citizens	10
17	Economy	10
18	Producers	9
19	Manufacturers	9
20	Regional	8

Note: Includes extended word search.

Barriers

Respondents highlighted barriers or challenges to implementing plastic waste recycling in their organisations or sectors. These are internal and external challenges that organisations perceive to be obstacles to the reduction of virgin plastic use and implementation of plastic waste recycling. The types of barriers are defined by the existing literature (Khan et al., 2020).

The table below demonstrates whether different groups of actors agree on barriers to plastic recycling. These are determined qualitatively. But there is a difference in perceptions between actor groups and certain aspects are mentioned more frequently than others.

Types of barriers	Responses from different actors							
	Logistics co.	NGOs	Plastic manuf.	Policy makers	Product makers	Recycler	Waste manag. co.	Waste owners
Funds	○○	○○○	○		○○○		○○	○
Time	○	○		○	○○	○	○	
Skills & Knowledge		○○						
Space		○				○○		
Access								
Transport	○○	○○		○	○		○	○
Management & Leadership	○○	○○○	○○	○○○	○○○	○○○	○	○
Buyers & suppliers	○○	○	○		○○○			○○
Facilities, technology & infrastructure	○	○○	○○	○○	○○○		○○	○
Legislation	○	○		○○			○○	○○
	New types of barriers identified from interviews							
Consumer behaviour		○○			○			○
Energy prices	○○	○○			○			
Supply chain coordination		○	○					

○ – agree, ○○ — strongly agree, ○○○ – absolutely agree

Enablers

Enablers are potential actions or solutions that may encourage recycling in organisations. Enablers for recycling are grouped into pre-determined categories that come from the existing literature (Khan et al., 2020). Respondents offer insights for each category of enablers: regulation and enforcement; government incentives; advising and funding; training; networking; guidelines; and fees.

Types of enablers	Details
Regulation and enforcement	**Regulation on plastics**. Respondents believe that stricter regulation of plastic waste does improve recycling rates. “I think there are points where we can cite examples. For example, on circularity, I think that the government is pushing in this direction because given the regulation on polystyrene, the government has said: Basically, all polystyrene in the food industry can continue to be used only if they can be or come from a recycling channel. So, it's clear that this is a way to push everyone in the right direction.” (French Plastic manufacturer 1).

Government Incentives	**Subsidies**. Respondents view the role of the government to offer subsidies for the development of recycling projects, and research and development. In addition, subsidies are useful to update towards green transport. Policy makers develop new subsidies for green and circular economy initiatives in companies, e.g. "Within this framework, we have had several projects that fall under the circular economy, including deposit projects for the reuse of donated containers rather than buying plastic containers. We will subsidize and support these actors so that they can establish themselves in good conditions." (French Policy maker 1). "Another driving force is the subsidies that can be obtained to invest in an efficient sorting tool. In France, there is a stimulus plan that has been voted." (French Waste management company 3). **VAT relief**. Recycling company reported on the benefits of state financial incentive that encourages recycling in France, such as reduced VAT rate, e.g. "From the moment that we are a financial incentive, it creates a considerable call for air. From the moment we have a reduced VAT rate, it also sends a signal to all market players. So, there is the part, but there is a real will. It makes it easier." (French Recycling company 2). **Public awareness campaigns on recycling.** Respondents suggest that it is the role of the French state to promote public environmental awareness. "Not enough awareness today about this. And I think that it is a major role of the French State to alert on this subject and not only the French, the whole world." (French Non-governmental organisation 1).
Advising and Funding	**Grants from EU**. Organisations do seek funding from the EU for their projects and apply for grants. "So, recently we had a European aid. We are in the process of validating it for an automation for order picking, this is an example." (French Logistics company 1). **EU funded projects**. Companies do mention PlastiCity project as a source of support for recycling waste. "PlastiCity is also our method to get interesting grants. So, they are also powerful engines because in the end, for a company, the activity generated must be profitable." (French Waste management company 2).

	Ademe* funding. In France, Ademe offers funding for organisations to work on sustainable development projects. “We get help from the Ademe. It is the Ademe that oversees all these aids.” (French Waste management company 1). “There is the Ademe, which is in charge of studying the files and looking at the subsidies that it can eventually give if the project is viable and if the project is interesting.” (French Waste management company 2). “For Ademe funding, they are directed towards companies. So, we are working with Ademe to support our companies' investments so that they can implement their sustainable development projects.” (French Policy maker 3).
Training	Organisations recognise that they would benefit from external training on plastic recycling, e.g. “I can't do general sorting internally, but on the other hand, I don't have the training to do plastic sorting, which is quite specific according to the different plastics, so I need an external trainer, or I need to go on a training course and then I can be the trainer on this subject.” (French Non-governmental organisation 1).
Networking	Respondents mention partnership on recycling as beneficial for their practices as well as networking within industry associations, e.g. “Yes, indeed, we were looking for a partnership for the plastic.” (French Non-governmental organisation 1). “Oh yes! Afterwards, we are in all the work groups of the interprofession. One at the Atla level. The milk processors' association does. So, it's true that we have quite a lot, I had also used a publication yesterday on the dependence of the agri-food industries on gas. So that's true that it's a subject, but then again. On the other hand, like all the great ones of this world, they try to.” (French Logistics company 3).
Guidelines	Policy makers recognise that SMEs need support for plastic recycling. “So, I'm not talking about the very large companies that have engineering, that are going to know, but rather the very small and medium-sized companies when it's a metropolis like ours. They are 95 percent very small companies, so they need engineering support to help them understand where the issues are, when they use materials, when they use plastic, is it possible to use something else? What it is. And all this requires

	studies and means, dedicated means that they do not necessarily have." (French Policy maker 1).
Fees	No comments.

* Ademe – French ecological transition agency.

Suggestions to improve plastic recycling

Respondents make the following suggestions to improve the recycling of plastics in France.

Types of suggestions	Detailed suggestions
	1. Technology and innovation
Foster innovation	• *Promote R&D in plastic recycling.* "It's not just about the grant and the collaboration. It must also be an intrinsic will, to the factories and industrialists who say to themselves today, I am going to lose some time in R&D." (French Product maker 1). • *Foster innovation in plastic industry.* "It is the plastics industry that must adapt and the suppliers of handling supports to logistics that must show innovation." (French Logistics company 1). • *Promote technological innovation.* "So, to improve today the possibilities of the sorting machines, in fact which today have their limits, and which are a little bit limited in term of polymers in the short term. After that, there's the whole part too." (French Product maker 3). • *Improve recyclability of plastics.* "So, the ideas to put in place are just to try to find ways to transform this plastic with a really useful use or even to try to find solutions to replace it and that it becomes a material that is completely recyclable, not like plastic where you can't do anything with it." (French Non-governmental organisation 1). • *Improve durability of plastics and new types of materials.* "So, I think it's really a number one topic which is how to consume less plastic in all our packaging and how to maybe start on biodegradable or reusable plastics, or I don't know what we can invent." (French Plastic manufacturer 3).
Promote eco-design	• *Promote eco-design for improved end-of-life of products.* **"**Eco-design is something we don't talk about very much and I think there is a great deal to be done about it. Because when you have a multi-component package, no matter how hard you try to improve the machines, you won't succeed. There comes a time when you have to go beyond that. It is necessary to de-complexify the product to try to think about its end of life. And eco-design, we see, we are just starting in this area." (French Product maker 3).

	"It's eco design. From the beginning, we must think about recycling at the end of the product's life." (French Waste management company 3).
Promote research on biomaterials	• *Promote research on alternatives to plastics and building new business models.* "We know that from the moment we manufacture products from bio sourced materials, it will cost more. So, there is a real question about how to succeed in positioning these new products and therefore build a new business model. Today, this has not been studied. It is necessary to know that currently, our final customers, that is to say roughly, the inhabitant of his house where there are very few people who are sensitized with the bio sourced materials, therefore roughly, it is not them who put the pressure on us." (French Plastic manufacturer 3).
	2. Supply chain management
Improve end-of-life of products	• *Improve research on plastic products for the end-of-life planning.* **"**The problem today is that they have data on products that have arrived massively from the chains or on products that have been produced. It may be now a decade and we have no data and since the processes and we use new processes and new processes, etc. But we do not have the necessary hindsight to know how our products will be treated at the end of their life. So, we are obliged to make specific studies if we really want to be interested in the recyclability of each of our products and to have more global data, that would be more interesting." (French Product maker 2). • *Promote reuse of products and reduce plastic production.* "But it's in terms of awareness, to continue to say that the best waste is that which is not produced. Quite simply. But yeah, and that even before recycling, it's yeah, it's reuse. Because recycling has a carbon footprint, it's not neutral." (French Waste management company 2).
Improve plastic collection	• *Improve international plastic collection.* **"**If we want to be able to recycle plastics, we need to set up a collection system in all the countries where we operate so that we can recover these plastics, either from [our company] to manufacture plastics or from other plastics manufacturers." (French Plastic manufacturer 3).
Promote collaboration	• *Promote collaboration in the industry on developing recycling solutions.* "And then external can be consortium work, as I was saying a little bit earlier, but working more collaboratively with even competing companies, etc. on recycling issues, this will allow the whole recycling sector to move forward rather than working on each solution in its own corner." (French Product maker 2). • *Promote cross-sector collaboration.* "And plastics are approached from a cross-sectional perspective. Plastic is everywhere, in fact. So, because the circular economy

	strategy, we have determined priority channels textile, food, construction materials and in a slightly lesser scope, but rather on the reuse and recycling part, health equipment and digital. Plastic will be found everywhere, so how do we get to work on cross-cutting projects?...The meeting between consumers and producers, which will also facilitate the least packaging. We're going to limit packaging in this way, so, but it's not. It's not the measure on plastic per se, it's more global. It is a much more systemic approach." (French Policy maker 1). • *Promote exchange of information via industry collaborations.* **"**I think that consortium work, bringing together all the players around the table, is essential. We, for example, work a lot precisely to avoid having too many intermediaries. We work a lot with the eco organisations in France which are in charge of the collection and the link between the market issuer and the recyclers on the products. So, we try to work with them to have data precisely, information on our products to be able, afterwards, to give the good, good advice and the good advice of eco-design." (French Product maker 2).
Promote supply chain coordination	• *Promote coordination of the supply chain actors on plastic recycling***.** "But now it's here, everyone is starting in their own field and sector. So maybe in a way, not necessarily in the best coordinations, we'll say, but everyone starts to work in the sector that there is the little click that is missing maybe, that there is a coordination system, but I think that is something that can come very quickly. And I am convinced that the citizens will also follow very quickly and that the industrialists, in any case, are already in this process." (French Plastic manufacturer 1).
	3. Capacity building and awareness
Promote public awareness	• *Promote public awareness about risks and benefits of recycling and recycling units.* "The citizens were afraid that we would make a waste dump on our site. This was not the case. That's why we had an exchange with the citizens of the area in which we are to explain it. It was not a waste dump, but a polystyrene recycling unit. And that, which led us to have exchanges with the story that led these people to have a totally different point of view than what they thought on the subject." (French Plastic manufacturer 1).
	4. Business case and economic instruments
	None.
	5. Facilities and infrastructure
	None.
	6. Regulation
	None.

4.3. The Hague, Netherlands

Attitudes towards recycling

Personal attitudes. Respondents broadly agree that plastic recycling is important. They reflect on their personal values to reduce plastic use at home as householders and consumers, but also as professionals. Respondents do apply their values at home, at work and as consumers.

> “Privately, I do try to use that less plastic. At the same time, this is extremely difficult… Yeah, and I'm incredibly bothered by the amount of plastic and also the fact that it's so many different kinds that are then also glued together before you know it, which actually makes that recycling very difficult. In my opinion, it really should be able to do a lot better.” (Netherlands Policy maker 1).

> “But we're still in the trend of more products being packaged in plastic, so that very first thing there needs to be a lot more focus on, to start packing plastic less and to start using more reusable packaging” (Netherlands Logistics company 2).

Waste hierarchy. At an individual level, respondents express the importance of applying waste hierarchy at home and at work – reducing plastic waste, reusing plastic and recycling plastic. Respondents support the separation of waste at home, and overall plastic recycling, upcycling, and use of reusable packaging.

> ***Reduce***:
> “Is that my view there is that there really should be significantly less plastic used. It is a nice product, but for the short-term applications we are using it, it is actually a worthless product.” (Netherlands Logistics company 1).

> “I always try to reduce my waste packaging in the first place, where I can.” Netherlands Waste management company 2).

> ***Reuse***:
> “I think reuse in general is very important” (Netherlands Non-governmental organisation 2).

> “It's really all about reducing CO2, that's really the goal we're striving for. And making sure that materials are reused as a result is a very important contribution to that.” (Non-governmental organisation 1).

> ***Recycle***:
> “I think plastic should be able to be recycled…At home, I neatly separate my waste streams with the goal of putting it back into the chain.” (Netherlands Policy maker 3).

> “They have to be sustainable, they have to recycle” (Netherlands Policy maker 4).

Upcycle:
"My personal view that super good is that there is more focus on recycling and upcycling." (Netherlands Logistics company 2).

From ban on single-use and fused plastic to smart application of plastic. Respondents in the plastics supply chain also point out the need to reduce single-use plastics in individual consumption. Respondents suggest reducing fused products when biodegradable materials are merged with plastics for packaging such as coffee cups and reducing the fusing of metal/aluminium with plastics such as Tetra Pak packaging due to the complexity of recycling such products. On the other hand, some respondents point out to useful properties of plastics as a material and emphasise the importance of dealing with the end-of-life of products and recycling plastics. Respondents come up with suggestions to improve uniformity in plastic production to improve the recyclability of plastics in the system.

"Is that my view there is that there really should be significantly less plastic used. It is a nice product, but for the short-term applications we are using it, it is actually a worthless product. It is handled too badly, and especially from the supplier side... a Dutch company and it uses coffee grounds to make cups, which is 70% virgin plastic and then coffee grounds with it. They then call that bioplastic. That needs to be stomped on really, really, really hard to get that out of the market. It is now a wild Westland with all the lobby groups in it trying to market their own petroleum substitute or petroleum products. And we have to start putting strict rules on that; what is still allowed to enter the market?" (Netherlands Logistics company 1).

"I always say that plastic is a genius material. It is talked about very negatively and people have quite a negative view of it. But if you look purely at the material itself it is really genius. We can adapt it to the properties we want. On the one hand, that's very nice, because it allows us to apply it in all sorts of different ways. But therein lies the problem, because there are so many different types of plastics, each with their own properties. That makes it very difficult at the end of the line, when it's actually used, to then be able to recycle it again properly in a high quality to be able to use it again. I think the importance of recycling is very great. Adjustments must be made throughout the chain. Only with recycling we are not going to make it." (Netherlands Producer 4).

Origins of personal attitudes. When discussing the origins of their personal views on plastic waste and plastic recycling, respondents mention household consumption, a holistic approach to sustainable household consumption including reduction of food waste and use of electric cars, and the reduction of ecological footprint. In fact, respondents are reflective that they are not able to achieve a lower ecological footprint, they see the size of the household matters as well as how they consume as households. Work experience with waste is an important origin of personal views on plastic waste, which contributes to the development of household habits to reduce waste. Respondents are aware of the negative environmental consequences of plastic waste, such as resource depletion, CO2 emissions, pollution, water pollution,

and land degradation through poorly degradable plastic. Sometimes, they mention environmental NGOs and public media and documentaries as sources for increased awareness of plastic pollution and the need for plastic recycling. However, they also criticise the general awareness of plastic waste treatment in households and industry in general.

> “But I don't live frugally, I have quite a large footprint, I realize that too… I mean I eat very little animal food for example, I drive fully electric. So yes, I try to do something about it that way in my personal life as well, but I'm not very strict with myself about that.” (Netherlands Non-governmental organisation 1).

> “Yeah, well, obviously it's super important that it's going to get better. Because everyone knows the problem, of course, the plastics soup. Problem of plastic fibres ending up everywhere in nature, which are also poorly degradable. Apart from that, oil is often used for it. Which we also don't have a lot of at our disposal. So, well, super important, so that we start doing more with that.” (Netherlands Policy maker 1).

Who is responsible? Respondents offer personal views on how the solutions should be developed for the reduction and improved recycling of plastic waste. Respondents recognise that plastic waste needs to be dealt with a systems approach, and the reduction of plastic waste is not only dependent on consumers but suppliers and producers as well. Some point towards the role of government, public policy, and legislation; improvement of public awareness; others suggest industry standards such as uniformity in plastic product development; and application of circular economy principles, and development of sustainable supply chain thinking in the industry.

> “And we have to start putting strict rules on that; what is still allowed to enter the market? The whole problem would be less present if there were a law for packaging materials that said, you can only use one kind of plastic.” (Netherlands Logistics company 1).

> “That doesn't make it any clearer to the layman. Then we are not even a layman, because we know somewhat about what happens with the plastic and in the waste industry. That also plays into translating to the customer when they have the questions.” (Waste management company 1).

> “And actually, you shouldn't leave it to the consumer either, but should make much more agreements with the producers.” (Netherlands Policy maker 1).

> “Complexity on the front end is even greater complexity on the back end. And I'm quite an advocate of uniformity myself, so we try to use as many equivalent plastics as possible where possible to also ultimately give the recyclability a better chance with that.” (Netherlands Recycling company 1).

> “Let's be mindful of flows. Let's bring materials back into the chain to be as circular as possible.” (Recycling company 1).

Convergence of personal beliefs and corporate attitudes. Respondents suggest that their personal beliefs do contribute to their professional practices. Some choose to work for environmentally conscious organisations because they support environmental values. Some apply personal environmental values as motivation to design sustainable products in the workplace.

> "I try to be conscious about residual streams myself. In our designs only work with that. I also try to find the commercial value in that again through design thinking and design doing, you could say. We are a foundation because we have the objective to literally make the world beautiful…But the motivation is very, is also personal." (Netherlands Plastic designer/manufacturer 1).

> "I think reuse in general is very important that is also what our associations are largely concerned with. This also applies to plastics and all other waste streams. We are all working towards the circular economy with a waste oven society. And that's what we're trying to do. Of course, this is also important to me personally, otherwise I wouldn't be working here." (Netherlands Non-governmental organisation 2).

Corporate attitudes. There are differences in how much recycling had been part of corporate attitudes. Organisations can be broadly categorised as novice, competent, and expert in their proficiency in recycling.

Proficiency in recycling	Details	Quotes
Novice	• Organisation started recycling recently. • This could relate to the size and age of an organisation. • Organisation is shaping its policy of recycling. • The scope of recycling is limited. • These organisations will benefit from training and support.	"I am only a small business. I'm enrolled in a business centre, and they didn't separate plastic there. There I indicated that they should separate and that they should contract with the with your garbage collector. That they also collect plastic separately…That's what I'm doing in my own circle of influence to make sure that those plastic streams are handled cleanly." (Netherlands Logistics company 2).
Competent	• Organisation has an experience in recycling for several years. • Recycling is part of a corporate policy. • Expertise in recycling is proven in practice. • Organisation can benefit from further training, guidance, and support	"[Our organisation] always brings with it some waste and we try to arrange everything as sustainably as possible. And we organize this together with a lot of volunteers and interns and artists who are involved as self-employed workers." (Netherlands Waste owner 4).

Expert	• Recycling is central to the organisational mission and strategy. • Organisation pursues the circular economy principles, including the use and generation of renewable energy. • Organisation has resources, knowledge, and skills in recycling. • Organisation is developing new technologies for recycling. • Organisation can contribute to the development of training on recycling.	"[Our company] actually runs completely on circularity. We are also now in the process of making the machinery electric. And actually, the entire company has to do with circularity. It even goes so far that we also have our own windmills, our own solar panels." (Netherlands Recycling company 1). "We're involved in a lot of working groups… that are engaged in developing and designing new techniques and technologies…That also just comes from the trade magazines, the trade shows, the network that we are in…And we believe that in this way or with these ways, we are nevertheless maximally involved in how this market is moving." (Netherlands Recycling company 2).

Origins of corporate attitudes. When discussing corporate attitudes, respondents suggest that the origins of corporate approaches to recycling is linked to: national legislation, policies and practices of municipalities, external influences from other companies and NGOs, behaviour of competitors, suppliers and peers, networks, trade shows, recycling projects such as PlastiCity, product and industry certification initiatives such as Fair Trade, awareness of environmental impacts, resource depletion, climate change, support of renewable energy use, social concerns, community approval or licence to operate, circular economy and sustainability principles, top management, employee initiative, employee experience in other organisations and industries, employee knowledge, consumer demand and attitudes, market of plastics and price for virgin plastics.

Sources of subjective norms

Subjective norms are the external stakeholder pressures on organisations to engage in recycling. Respondents from actor groups report that they experience pressures to recycle from different stakeholders to a varying degree.

Sources of norms	Responses from different actors						
	Logistics co.	NGOs	Policy makers	Product makers	Recyclers	Waste man. co.	Waste owners
International community							○○
European community			○		○	○○	○○
National government		○	○○	○○○	○○○	○○○	○○
Municipal council	○○○	○○	○○○	○○○	○○	○○	○○○
Local community					○		○
Businesses	○○○		○○○	○○○	○○○	○○○	○○○
Consumers	○○○	○○	○	○○○	○○	○○○	○
Employees	○○		○	○	○	○	
General public			○○	○○	○	○	○
Public media			○		○	○	
Financial organisations							
Universities				○			

○ – agree, ○○ — strongly agree, ○○○ – absolutely agree

Resources and knowledge of recycling

According to the Theory of Planned Behaviour, the intention to act is influenced by the actor's perception of their ability to act, that covers resources and knowledge at their disposal. We asked respondents to comment about the resources they have for recycling and about their knowledge of recycling.

Respondents indicate a varying degree of availability of resources and knowledge of recycling in their organisations. The main elements of the perceived behavioural controls (resources and knowledge) in surveyed organisations are highlighted in the table below.

Types of resources (financial, human, and technical) come from Khan et al. (2020) with some additions. Types of knowledge are identified from the interviews rather than from the existing literature.

Resources for recycling

Elements - Resources	Details of Perceived Behavioural Controls
Financial resources	Organisations report that the extent of their waste management activities are constrained by the availability of financial resources. Some organisations receive subsidies and grant support (such as from the PlastiCity Project) that aids their waste management practices. Those organisations that do not receive subsidies seek to manage their processes with internal resources on cost-benefit basis. The type of organisation (e.g., family business) determines the investment sought from the outside for corporate activities. For projects to replace car fleet for electric vehicles, the investment is limited in organisations. Organisations mention that government could support such initiatives on green energy transition.
Human resources	Sometimes organisations hire temporary staff to deal with recycling. Smaller organisations report that they do not have dedicated full-time staff to deal with recycling alone. Some organisations have staff with recycling duties as part of their job specification. Organisations sometimes report shortages of staff to deal with waste management. Often organisations train staff in house to conduct activities as experienced personnel is not available. Staff is hired as part of apprenticeship programmes to work on projects, organisations also hire trainees for waste management. Collaborative projects with other parties contribute to organisations when the resources or knowledge of recycling are limited. Some organisations experience problems with hiring low-skilled personnel for waste management duties and instead look for automation of these tasks.
Facilities, technology & equipment	Includes processing sites, processing centres, and the equipment. Updating the equipment is desirable, but costly for many organisations. Organisations seek to organise efficient supply chains to be circular within a network of partners. Some organisations hire facilities from the outside. Others built their own machinery.

Knowledge of recycling

Elements – Knowledge	Details of Perceived Behavioural Controls
Knowledge of recycling technology	Knowledge of recycling technologies varies in organisations, depending on where they are in the supply chain and how do they relate to waste recycling as a business. Some organisations have an expert knowledge as it is core to their business model such as the waste processing companies, some producers and logistics companies and non-governmental organisations and municipalities.
Mechanical and chemical recycling	Organisations mention differences between mechanical and chemical recycling. Some organisations only focus on one type, others pursue two types of recycling.
Adopting new technologies	Those organisations that deal with a lot of plastic materials and plastic waste are on the look-out to develop and adopt new technologies around plastic recycling. Some develop technologies in house; others acquire technologies from other organisations.
Transparency	The transparency in the supply chain is not clear. Users of plastics are not always aware where the plastics comes from and how it is disposed of at the end. Managers in organisations rely on labelling to inform themselves on certain aspects of plastics for the recycling purposes. However, the destinations and points of origins are not fully traceable. Organisations are not always seeking for more transparency as some are trusting their supply chain partners, for instance, when waste owners are passing waste to their waste management contractors. Nonetheless, supply chain actors find that knowing more about waste disposal may stimulate further plastic recycling: Interviewer: “Would you find that interesting if you knew what happens to your waste?” Respondent: “Yeah, that's kind of nice. Maybe send an email with results or that you see the products that are made from it, things like that. That might be stimulating too.” (Netherlands Waste owner 4).
Reliance on knowledge of suppliers and contractors	Some waste owners do not know about plastic recycling much as they are engaged in sorting and passing on plastic waste for disposal to contractors. Thus, they rely on the knowledge of contractors to deal with plastic recycling: “No, not really. We had a kind of flyer in the beginning. That then gets lost again and we could look it up if we wanted. But it didn't come to that. We trusted them to do something good with it.” (Netherlands Waste owner 4).
Environmental compliance	Knowledge of legislation as well as environmental policy is important for guiding the recycling in organisations.

Tools and techniques: LCA, SIA, CAD	Organisations apply a variety of tools to analyse environmental impact such as life-cycle assessment (LCA) as well as social impacts through social impact assessment (SIA). Some organisations integrate environmental information in computer assisted designs (CAD).
Sources of knowledge and knowledge dissemination	Companies organise internal training. Universities, industry networks, exhibitions and trade shows are seen as sources of knowledge, as well as waste processing organisations, non-governmental organisations, municipalities, government, and industry associations. Organisation mention various sources of knowledge: social media, websites, newsletters, industry networks, events, webinars, and collaborative projects.
Gaps in knowledge and in the supply chain	Organisations notice a gap in knowledge between processors of waste and entrepreneurs that needs to be addressed: “There is quite a gap between the processors and the entrepreneurs. A business owner may think he is doing a very good job of separating but there is still a lot that is rejected by processors… Plastic processors need to engage in much more conversation with large entrepreneurs to make separation much easier and better.” (Netherlands Logistics company 2). Many point to poor knowledge of their individual and organisational customers on recycling: “We communicate this honestly, also with percentages. 20 percent is recycled. But in fact, it's just a story that people really don't want to hear. We are on the side of waste management. People reason, "I'm rid of it and I don't want to know anything more about it. The processor says to me that I did a good job, so then I'm done.” (Netherlands Logistics company 1).
Importance of public awareness campaigns	Organisations report on contributing to public awareness campaigns to reduce plastic waste and to increase plastic recycling. “And so, several organisations have all kinds of actions throughout the year to make citizens aware of cleaning up plastics. You don't throw it in the sewer, you don't throw it in the water. That's a very positive thing though.” (Netherlands Policy maker 4). “A great deal of the knowledge is in our companies, and we try to ensure that the right information is given to citizens in these kinds of campaigns.” (Netherlands Non-governmental organisation 1).
Knowledge exchange	Some organisations are happy to get involved in knowledge exchange with entrepreneurs to improve the knowledge of recycling in the supply chain:

	“My end game what I want to do in that is that knowledge exchange between the different cities and entrepreneurs. And you see that now at our locations Amsterdam, Utrecht, and Rotterdam. The Hague to a lesser extent.” (Netherlands Logistics company 1).
Innovation through supply chain collaborations	Many organisations collaborate with other members and knowledge centres in the supply chain, including universities to develop innovations in recycling. “I set up a lot of innovation projects where chains come together. New research also comes out of this.” (Netherlands Non-governmental organisation 1).

Pressures

When discussing pressures or drivers for recycling, respondents across the plastics supply chain in the Netherlands mention the following key concepts and stakeholders and as sources of pressure. Top 20 pressures using Word frequency analysis.

No.	Types of barriers	Number of mentions
1	Companies	52
2	Products	48
3	Governments	46
4	Policy	45
5	Municipality	44
6	Circular	32
7	Materials	29
8	Netherlands	28
9	Industry	27
10	People	27
11	Producers	25
12	National	23
13	Province	23
14	Boards	23
15	Citizens	21
16	Process	18
17	Business	17
18	Customers	17
19	Market	17
20	Packaging	17

Note: Includes extended word search.

Barriers

Respondents mention various barriers to plastic recycling in the Netherlands. These are internal and external challenges that managers perceive to be obstacles to the reduction of virgin plastic use and implementation of plastic waste recycling. The types of barriers come from the existing literature on plastic recycling (Khan et al., 2020), as well as from the interview analysis.

Types of barriers	Responses from different actors						
	Logistics co.	NGOs	Policy makers	Product makers & designers	Recycler	Waste man. co.	Waste owners
Funds	○	○	○○	○○○	○○○	○	○
Time	○			○			
Skills & Knowledge		○	○	○○			○
Space				○			○
Access							
Transport	○					○	
Management & Leadership							
Buyers & suppliers	○○○	○	○○	○○○	○	○	○
Facilities, technology & infrastructure		○	○○○	○	○○		
Legislation	○○	○		○○○		○	○
New types of barriers identified from interviews							
Transparency in supply chain		○○				○	
Consumer behaviour		○					
Supply chain collaboration		○	○	○			
Quality and quantity of recyclate				○○	○		

○ – agree, ○○ — strongly agree, ○○○ – absolutely agree

Enablers

Enablers are potential actions or solutions that may encourage recycling in organisations. Enablers for recycling are grouped into pre-determined categories that come from the existing literature (Khan et al., 2020). Respondents from the Netherlands highlight various external enablers that can help organisations improve plastic recycling and implement the circular economy solutions.

Types of enablers	Details
Regulation and enforcement	• *Municipalities enforcing waste management. "*When it comes to the collection of household waste, they obviously have a big role. Municipalities are responsible for organizing it, so they are the ones who determine how waste collection takes place and how it is communicated." (Netherlands Non-governmental organisation 2). • *Discussion on banning single use plastics. "*But we don't have any clear tools for that, other than a voluntary agreement or something. (Netherlands Policy maker 1). • *Introducing stricter regulation on plastic recycling. "*Okay, national and European laws and regulations. Absolutely as top one. If that includes CO2 pricing, if that includes an obligation with regard to the use of recyclate and even stricter legislation for single-use plastics, then we will be very much helped." (Netherlands Policy maker 2). • *Monitoring of performance helps identify areas for improvement. "*We do monitor that, the circular economy, and its impact. The vernacular also drives new models. To be able to see where we could do something extra, so that's where the government is. We are also invited to explain things in conversation discussions." (Netherlands Policy maker 3).
Government Incentives	• *Encouraging public awareness campaigns for recycling involving citizens*. " • *Subsidies*. "The Dutch government has issued a very large subsidy for municipalities and all of those municipalities are now going to make all of these circular craft centres." (Netherlands Logistics company 1). • *Government funding for recycling technology and behaviour projects*. "Look that national growth fund is a really big one, if it goes through, because that's really about big projects, from low to high RTL levels of both mechanical recycling and chemical recycling, as well as consumer behaviour influence." (Netherlands Non-governmental organisation 1). • *Offering grants to companies involved in technological innovation.* "We are trying to improve the techniques for chemical recycling, and that means also providing grants to companies that want to try new techniques." (Netherlands Policy maker 2). • *Awards for innovative companies to promote technological development.* "*A* new company won a prize to see if they could use a different technique to make residual waste, real household residual waste" (Netherlands Policy maker 2). • *Introducing plastic recycling in other waste streams such as textiles and in different sectors such as agriculture. "*We're also looking at, we recently talked to an initiative around the collection of leftover textiles. Textiles also contain plastics

	and, of course, in part you have to see that they are reused and in part you want to chemically recycle what can no longer even be a cleaning cloth, so we have also been working on that. That's one, chemical recycling." (Netherlands Policy maker 2). • *Funding research on how to reduce single-use plastics. "*We are going to see what can we do to reduce the number of plastics and the amount of single-use plastics? And so that's a research story. We are still working on that." (Netherlands Policy maker 2). • *Funding research on reusable packaging.* "And a third project I just want to mention is that we're working with a kind of coalition of parties that are around that are looking at how can we encourage reusable cups, packaging?" (Netherlands Policy maker 2). • *Funding pilot projects use plastic substitutes.* "We give funding to pilots around recycling and also money to pilots around using other materials." (Netherlands Policy maker 2).
Advising and Funding	• *Encouraging entrepreneurs on managing plastics*. "And by setting up a standard separation method, they can facilitate entrepreneurs to separate. That's where the municipality could still help. So, there is quite a lot of willingness." (Netherlands Logistics company 2). • *Funding processing facilities*. "It would help a lot, if there is development with local processing capabilities." (Netherlands Logistics company 2). • *Developing research projects*. "The research program. If it is approved, it will be a program in which again all kinds of projects will be implemented. That will go from consumer influencing to nudging. To make sure they deliver their waste properly." (Netherlands Non-governmental organisation 1).
Training	• *Encourage knowledge exchange between waste processors and businesses*. "Knowledge exchange between the different cities and entrepreneurs." (Netherlands Logistics company 1).
Networking	• *Networking in the supply chain*. "I believe that together we can do a lot in the world, that's why it's called Ours. With all the different talents, from everyone's own carrying capacity, we can achieve a lot. That collaboration is necessary to move forward and to be able to work more structurally, to achieve a larger scale than what anyone can do individually." (Netherlands Plastic designer 4). • *Network projects around specific topics can encourage plastic recycling.* we also have these networks that start thinking together about how we are going to do this, how we are going to make it the next steps? What is needed? (Netherlands Policy maker 2).

	• *Local municipal networking*. “Yes, then surely just the municipality. The municipality and through certain neighbourhood associations. I know that there are a lot of initiatives already being done from the neighbourhood management for sustainability. But I think the municipality should stimulate that much more.” (Netherlands Waste owner 4).
Guidelines	• *Clear guidelines to the existing national policy on waste for businesses and households*. “We do speak to the national government about that. That we think they should have stronger guidance on that. Because this also ultimately erodes support for separate home collection. Which does not help the credibility of the of the whole policy.” (Netherlands Non-governmental organisation 2). • *Clear guidance from government on policy to businesses*. “The government, I think, should provide much more guidance and policy in that regard.” (Netherlands Waste management company 2). • *However, policy makers are not always developing detailed guides for the industry and want to encourage industry innovation and business model development on plastic recycling.* “We don't have people to guide companies to recycle better. So, we really leave it to the market because we don't think that's up to us… What you do often see is that industry does look for: Let the central government explain what they intend to do with it. Then we can take over the baton again to develop it further… We set policy once again and it is up to the market to come up with earning models behind it.” (Netherlands Policy maker 3). • *Labelling encourages recycling*. “Yeah sure, those eco labels and that recyclability and stuff, that kind of thing.” (Netherlands Policy maker 1).
Fees	• *Prices for virgin plastics vs recycled plastics would encourage the market to recycle.* “A few years back, plastic waste was significantly cheaper than virgin plastic. In Eastern European countries you could get good quality, unique plastics. In the Netherlands and Belgium, everything is first thrown together and then you start separating it, with all the pollution and mixed flows. Now the virgin plastics have become cheaper than the recycled plastics. Those are market mechanisms you have to deal with.” (Netherlands Plastic designer 2).

Suggestions to improve plastic recycling

Finally, respondents make a variety of suggestions to promote plastic recycling in the Dutch plastics supply chain.

Types of suggestions	Details
	1. Technology and innovation
Improve the quality of recycled plastics	• *Improving the quality recycled plastics. "*Better monostreams of plastics at the source. So, get better quality recycled plastics. We can include these in our product design." (Netherlands Plastic designer 2).
Improve recycling technology	• *Research recycling technologies and their environmental effects.* "There are developments there now that chemical recycling techniques are emerging, where it's broken down to the primary raw materials, to oil. Which you can refine again, and they can make new plastics out of. This is a technique that is very much on the rise and of that I wonder what is the environmental impact of that recycling process? Does that outweigh the current recycling processes? Or does that outweigh the burning of plastic?" (Netherlands Producer 4).
Co-create solutions	• *To develop solutions to plastic waste a co-creation of knowledge and solutions is needed.* "At least participatory. Not top down, but very much that there is interaction and co-creation." (Netherlands Policy maker 2).
Research plastic use during Covid-19 pandemic	• *Before, during and after the COVID-19 pandemic, the use of plastics has changed and that affects the use of single-use plastics. The matter requires further investigation in getting out of the pandemic. "*Single use plastic is, of course, mainly in the hospitality industry. But yes, with Corona, there is no grand café, there is no company restaurant. So right before or between lockdowns, I did see that they adjusted well to the rules in the canteen. So, they are definitely working on that. And that also has real attention internally." (Netherlands Policy maker 2).
Research microplastics and health	• *Research on the effect and measurement of microplastics is encouraged.* "The big problem for us, of course, are microplastics…Who said again there is no single unified method for sampling and analysing microplastics…The Netherlands collaborates a great deal in connection with health research. A lot of effort is being put into that, a lot of research is taking place…So we're trying to help a lot of studies especially, grant funding for good, reliable sampling and analytical methods…Is very complex and very difficult." (Netherlands Policy maker 4).
	2. Supply chain management

Improve the plastics logistics	• *Improve the plastic logistics.* "The improvement of logistics. Because of our finely meshed approach, we are able to collect very pure, beautiful waste streams that can be used to make very nice products again." (Netherlands Logistics company 1).
Improve collaboration	• *Improve collaboration* "With the municipality of The Hague, we have run a really worthless project where we really made a lot of losses. Which would also be covered by the municipality itself but then they withdrew it. I would not dare to work with the municipality again." (Netherlands Logistics company 1).
Improve transparency of plastic supply chain	• *Improve the transparency of the plastic supply chain*. "I think that transparency that I mentioned earlier is a very important one. But I also think we need laws and regulations to do that. The whole legal framework within which we work now that is actually particularly the waste materials regime." (Netherlands Non-governmental organisation 2). "Yes, it needs to be much more transparent. Especially if you start thinking in terms of a circular economy. That only works if the different steps in the chain are transparent and also report to each other. There is still a world to be won there." (Netherlands Non-governmental organisation 2).
Encourage recycling within Europe	• *Require the use of recylcate in products from within Europe rather than from abroad. "*What we did state is that the recyclate must be from the European Union and not from China or somewhere. Because otherwise we're just pumping resources around the world. We have stated very strongly of if we recycle, it has to be from within Europe. If we reuse, the recyclate has to be from within Europe." (Netherlands Policy maker 3).
	3. Capacity building and awareness
Improve the attitude towards use of recycled plastics	• *Producers can improve their attitude to using parts with recycled plastics. "*It should be and more positive angle. Existing producers often refuse to put recycled material in the machines. Because the machines break down or there are high quality requirements. That should be more accepted." (Netherlands Plastic designer 2).
Raise awareness with businesses and citizens on plastic recycling	• *Municipalities can raise awareness with businesses*. "As far as I am concerned, the municipality could do much more about raising awareness of sustainable business practices." (Netherlands Waste owner 4). • *Encourage public awareness campaigns including poor neighbourhoods and tourists.* "There is a kind of rich part in the centre that might be excitable for it. But a very large part are pure poverty neighbourhoods. And they barely reach those residents with other projects… I think you could do it for the tourism sector as well. The Hague is also well-known for events and conventions. That's one possible approach to

	take, though. The residents themselves, that's really tough…Involving residents in such things is so spicy. "It ends up in the general waste anyway" or "I pay taxes to have it cleaned up anyway" such reactions you get from some people." (Netherlands Logistics company 1). • *Improve awareness of different types of plastics and what is recyclable to encourage better consumer choices. "*But the customer also needs to know what makes something not recyclable. For example, you can tell the customers orange juice from Tetra Pak is bad and that they better switch to a better alternative." (Netherlands Logistics company 1).
Disseminate knowledge on plastic recycling	• *Businesses would benefit from accessing knowledge of plastic recycling to improve their production. "*I think there are opportunities. You do have to be knowledgeable or have the data to know what type of plastic it is… they also had a team and material experts. In retrospect, that was a piece of knowledge I did not possess. And that you need it anyway to make high-quality products again with recycled plastic. Just in selecting recyclate you need that knowledge. The range is enormous. There is so much recyclate available on the market, but to know all of its properties, you need to have an expertise, which I did not have." (Netherlands Producer 4).
Support recycling projects for longer time	• *There are different projects that have short-term funding not allowing the business models to develop. These recycling projects could run for longer to allow take up and aid with employment.* "There are some pretty good initiatives. But then after a few months it stops again. You should just let this kind of thing run maybe two years before it actually takes off at different companies and not such a short period of time. Here's how we think. It would just take a lot of running. Of course, that's an investment for a while to get something like that going… Many people could be employed in that, there are many people with distance to the labour market. I think those could play a very big role in recycling." (Netherlands Waste owner 4).
	4. Business case and economic instruments
Tax plastic waste	• *Tax businesses for plastic waste.* "When I see the effect of deposits on the small PET bottles in the Netherlands, I think that a certain tax on plastic business waste, a financial incentive, could help." (Netherlands Producer 4).
Revise subsidies	• *Suggestion to revise subsidies for waste solutions to improve efficiency of waste management. "*If governments would review what is now subsidized in terms of collection and sorting. There are a lot of extra cars driving around for separate collection… I think, help a lot if that subsidy was not given out only on the basis of separate collection or sorting. But that maybe you could move to a pre-separator for every transition come in the Netherlands. Because you can set it exactly to a piece of supply and demand from the

	market on certain streams that can be used as semi-finished products." (Netherlands Waste management company 2).
	5. Facilities and infrastructure
Improve facilities for recycling	• *Improve bins and recycling facilities for households.* "In terms of infrastructure and collection, I wonder if you need to go to even more bins and distinguish between different types of plastic, because it is already very difficult for the citizen to know what to do." (Netherlands Producer 4).
	6. Regulation
Set standards for waste separation in businesses	• *Set standards for businesses to separate waste.* "We believe that the separation rules that apply to household waste should, in principle, apply in full to commercial waste. So that the behaviour you are expected to exhibit at home is the same as what you do at work. Now, separating household waste is more or less mandatory and for businesses it all be exceptions. Within which you don't have to." (Netherlands Non-governmental organisation 2).
Introduce ban on single-use plastics	• *Ban on plastics, for instance single-use in catering*. "If you look at the big strikes, you would have to start banning. This is not feasible at this time." (Netherlands Logistics company 1).
Introduce stricter regulation	• *Introduce clear limitations on use of plastics and types of plastics.* "Either all the way to the front by policy prescribing that only certain plastics and certain plastics may be used. Or design regulations that no more products are made where different materials are used together." (Netherlands Producer 4). • *Introduce requirement on minimum recyclable content.* "The laws and regulations in countries, so at a time when incineration rates are going up everywhere, that means there are more opportunities for us. So, the more recycling obligations, the better for us… I find, it's better to let everyone use 30 percent, so that everyone can also develop and think about what the best methodology is to work with recycled materials." (Netherlands Recycling company 1). "I would be very much in favour, for example, of having a rule that whoever can use recycled material has to use 30 percent." (Netherlands Recycling company 2). • *Introduce product-based policy on plastics. "*And I think that we cannot escape the fact that we have to develop the waste policy into a product policy. This should not be so much about what we discard, but about what we produce and consume. Therein lies a one a key, especially when it comes to plastics. We have done research on this, and we see that over one third of the plastics that our members collect separately are not suitable for recycling at all. Then you can collect it all beautifully and with a lot of effort and effort separately, but after that you can still drive it to an

	incinerator, because it's just not recyclable. And that can only change him by making sure at the beginning of the chain that everything that comes onto the market is suitable for recycling in the first place. This is a minimum requirement. But better yet, it is also suitable for reuse and repair…We need to move toward a products policy rather than a policy that focuses only on waste." (Netherlands Non-governmental organisation 2).

4.4. Southend on Sea, United Kingdom

Attitudes towards recycling

Personal attitudes. When talking about personal attitudes towards plastic recycling, respondents in the UK plastics supply chain reflect on their roles as consumers and householders. They reflect on the history of plastic waste in well-known consumer products (presenting the examples of no plastic wrapping in food products to plastic wrapped of individual vegetables, and a transition from glass bottles to plastic Coca-Cola bottles) and their personal history of recycling in households:

> “I've been recycling things like bottles at home for probably the past 35 years. You know, my kids are very young. We used to collect all the bottles we had, and we'd store them in the garage until I had a whole car full. And then we filled the car up and then drive it to a bottle bank somewhere to dispose of it. So that's something I've done for many, many years.” (UK Product maker 2).

Waste hierarchy. Respondents describe strategies within the waste hierarchy (reduce, reuse, recycle), pointing to recycling as the least preferred options against the preferred reduction of waste production and material reuse.

> “Actually, before you think about recycling stuff, you should think about reuse. So actually, reuse is more important than recycling and yet happens less often. Yes. And then when it comes to kind of my own personal views, I feel that plastic recycling has become a kind of totemic issue. But um, but not necessarily a fair one.” (UK Non-governmental organisation 2).

> “And also, you know, looking at the waste hierarchy in terms of making sure that we're kind of minimizing our waste and, you know, not producing additional waste and causing potential harm.” (UK Policy maker 2).

Plastic ban to plastic fantastic. Personal attitudes of managers towards plastic recycling vary from radical reduction of plastic use and penalising the use of non-recyclable plastic and to full support of effective use of plastic with recycling as a solution:

> “I think is absolutely appalling. I'm angered on a daily basis by the amount of plastics I see being used, and I'm especially angered…But I'm especially angered by the amount of plastics that I use that are not recyclable and why anyone is being allowed to use non-recyclable plastics without being severely fined.” (UK Waste owner 2).

> “I'm definitely an advocate for the use of plastics where needed. I don't I don't agree with a lot of some of the some of the so-called single use plastics out there and on things like toys on the front of magazines to attract. I totally disagree with that, but plastic is a fantastic resource. And if recycled properly, you know, is a very, very effective, cost-effective way of packaging, food and also useful in many, many other applications.” (UK Waste management company 1).

Voices against plastics often come from waste owners but they are questioned by waste management companies:

> “Some of the lobby groups are very vociferous. Some of them are a little bit misguided. If I'm honest, I think some of the anti-plastics commentary is, is, is wrong. And moving into paper might not be the best environmental solution because you're going to something that is harder to recycle and potentially less appropriate for some of the uses that the plastic is performing.” (UK Waste management company 2).

Origins of personal attitudes. Respondents state that the origins of their personal recycling attitudes relate to: climate change concerns, reduction of carbon, reduction of fossil fuel use, veganism, sustainable shopping, biodiversity conservation, marine conservation, public media, TV, famous brands, conservation of local environment such as coast, concern for future generations, diversion of waste from landfill, sustainable building practices, use of environmental sustainable materials, environmental awareness, waste reduction, education, green party, family practice, gardening, monetary incentives for recycling, bottle collection, ethical consumerism, and sustainability principles.

Convergence of personal beliefs and corporate attitudes. Respondents report a link between personal attitudes towards recycling and organisational practices. Respondents indicate that personal beliefs contribute to recycling at home and in the organisations.

> “I think, quite aware all of us, personally in our lives recycle.” (UK Non-governmental organisation 3).

> “We aren't like a strict, dogmatic organisation. All of us are local residents, which in in large agree to those three aspects.” (UK Non-governmental organisation 4).

Disparity in attitudes. Sometimes, respondents observe a disparity between their personal attitudes and corporate attitudes. For instance, when organisational strategy on recycling is lacking.

> “I personally feel that we could do more, and I can discuss that further on.” (UK Non-governmental organisation 3).

Decreasing recycling. Alarmingly, respondents admit that plastic recycling has been reduced in organisations.

> “I think at the moment is the trend that recycling rates are declining. Our recycling rate has been declining here.” (UK Policy maker 1).

Corporate attitudes. Respondents reflect on the advancement of recycling in their organisations. The proficiency of organisations on recycling can be broadly divided into three categories: novice, competent, and expert.

Proficiency in recycling	Details	Quotes
Novice	• Organisation started recycling recently. • Organisation is shaping its policy on recycling. • The scope of recycling is limited. • Sometimes confused on what can and cannot be recycled. • Organisation can benefit from training and guidance.	"So, we're just kind of at the start of a sustainability and recycling journey, really, that we've been trying to." (UK Non-governmental organisation 1).
Competent	• Organisation has experience of recycling for several years. • Recycling is part of a corporate policy. • Expertise in recycling is proven in practice. • Organisation can still benefit from further training and guidance.	"So, environmentalism is written into our charter, and it's very much at the heart of what we do." (UK Non-governmental organisation 3).
Expert	• Organisation has experience of recycling for a long time. • Recycling is central to the organisational mission and strategy. • Organisation has resources, knowledge and skills in recycling and advising others and collaborates with supply chain members. • Organisation can contribute to delivering training and developing guides.	"Of course, it's absolutely central… we represent the full plastic supply chain, or the value chain is otherwise known as. So, obviously it's firm and central to all our activities." (UK Non-governmental organisation 5).

Origins of corporate attitudes. Respondents in the UK plastics supply chain relate the origins of corporate attitudes on recycling to the following factors: environmental awareness, influence of Trustees, net-zero carbon strategies, climate change strategies and commitments, carbon footprint, stakeholder influence, transparency, peers, neighbours, local businesses, competitors, regulation, neighbourhood, local landscape such as coastline, networking, environmental friendly production, traceability of products, ISO 14000 standards, local community, senior management, pressure from environmental organisations, environmental management practices, influence of customers, strategic expansion plans, and contractors' practices.

Sources of subjective norms

Subjective norms are external stakeholder pressure on organisations to engage in recycling. They come from a variety of social groups.

Sources of norms	Responses from different actors					
	NGOs	Policy makers	Product makers	Recycler	Waste management company	Waste owners
International community		○	○○		○	
European community						
National government		○○				
Municipal council	○○○	○○○	○○○			○
Local community	○○	○○	○○○	○○	○	○
Businesses	○○	○○	○○○	○○○	○	○
Consumers		○	○○	○		
Employees		○				
General public	○○	○			○	
Public media	○	○○			○	
Financial organisations				○		
Universities						

○ – agree, ○○ — strongly agree, ○○○ – absolutely agree

Resources and knowledge of recycling

According to the Theory of Planned Behaviour, the intention to act is influenced by the actor's perception of their ability to act, that covers resources and knowledge at their disposal. So, to illicit if the organisations have sufficient and appropriate resources and knowledge for recycling, open questions were asked during the interviews.

Respondents indicated a varying degree of availability of resources and knowledge in their organisations. The main elements of perceived behavioural controls (e.g., resources and knowledge) in organisations surveyed in the UK are highlighted in the table below.

Types of resources (financial, human, and technical) come from Khan et al. (2020). Types of knowledge are originally identified from interviews rather than from the existing literature.

Elements	Details of Perceived Behavioural Controls
	Resources
Financial resources	Organisations report varying availability of financial resources for recycling. Have investment plans to finance recycling activities.
Human resources	Some have a large number of staff working on recycling, others have small teams. SMEs particularly have limited staff dedicated to green roles in organisations.
Facilities, technology & equipment	Some point to the lack of facilities and technologies, others have a high level of resourcing. Specialised waste management companies are well resourced with physical resources for recycling.
	Knowledge
Knowledge on recycling technology	Non-specialist organisations have a varying degree of knowledge on what can be recycled and what not. Especially, SMEs can gain from further training on recycling.
Reliance on knowledge of contractors	Many organisations rely on their contractors to deal with waste management and waste recycling and only perform sorting of waste on premises.
Product design specification	Product makers are guided by the product design and specification set with the clients that set parameters on the use of materials.
Reliance on labelling	Waste owners rely on labelling, information from contractors, suppliers, and local council when it comes to decision about waste management and recycling.
Environmental compliance	Organisations such as manufacturers and product makers comply with the legislation – and regulation guides their waste management strategies.
Tools and techniques: Carbon	Some organisations also use assessments to understand the carbon footprint of their activities and production to guide their policies on climate change including waste recycling. Others

footprint and LCA	use life cycle assessment and similar tools and techniques to guide reusing materials and reducing the energy use.
Sustainable waste management strategies	Waste recycling specialists are highly knowledgeable in a variety of management tools that are relevant to waste recycling such as sustainable waste management, resource recovery, recycling, waste prevention and re-use.
Traceability	Expert organisations have full cradle to grave information about their products and have a traceability system in place as well as auditing.
Expert knowledge on recycling	Some organisations with expert knowledge contribute to training others and consultation for the development of national legislation on waste management policies.
Distributing knowledge on recycling	NGOs and local councils share information on waste management and recycling with businesses, local communities via websites, training, and other media.

Pressures

When talking about pressures or drivers for recycling, managers in the UK mention the following key concepts and stakeholders and as sources of pressure to recycle. Top 20 pressures using Word frequency analysis.

No.	Types of barriers	Number of mentions
1	Products	30
2	Organisation	23
3	Customers and clients	21
4	People	14
5	Design	14
6	Packaging	14
7	Policy	12
8	Material	10
9	Company	10
10	PVC	10
11	Authority	9
12	Industry	9
13	Council	8
14	System	8
15	Consumer	7
16	Market	6
17	Public	6
18	Standard	5
19	Community	4
20	Business	4

Note: Includes extended word search.

Barriers

Respondents identify various barriers to plastic recycling in the UK. These are internal and external challenges that organisations perceive to be obstacles to the reduction of virgin plastic use and implementation of plastic waste recycling. Discussed barriers are grouped into types that are identified in the existing literature (Khan et al., 2020).

Types of barriers	Responses from different actors					
	NGOs	Policy makers	Product makers	Recycler	Waste management company	Waste owners
Funds	○○	○○○		○		○
Time	○		○			○
Skills & Knowledge	○○		○○○		○○	○
Space	○					○
Access	○					○
Transport		○			○	
Management & Leadership	○○○	○○				○○
Buyers & suppliers	○○		○○○	○	○	○○
Facilities, technology & infrastructure	○	○	○	○		○
Legislation	○	○○○	○			

○ – agree, ○○ — strongly agree, ○○○ – absolutely agree

Enablers

Enablers are potential actions or solutions that may encourage organisation to improve plastic recycling. The UK respondents highlight that external support is needed for organisations to improve the logistics of plastic recycling and promote the circular economy solutions. The categories of enablers come from the existing literature on plastic recycling (Khan et al., 2020).

Types of enablers	Details
Regulation and enforcement	• *National policy to reduce plastic*: "I think I think the problem here is that this is this is in need of national policy. Policies which aim to reduce the use of plastics generally and restrict problematic or unnecessary single use plastic… Also, policies increasing the demand for reprocessed plastics so

	that there is a reuse for the recycling element. So, we think that testing taxing plastic products with less than 30 percent recycled content is a good move forward. Policies that drive improvement in recyclability and reusability are an absolute must." (UK Policy maker 3). • *Ban on plastic*: "ban PVC as a plastic used in food packaging." (UK Waste management company 1). • *Enforcement of regulation*: "But of course, a lot of that goes back to enforcement from government through the Environment Agency penalties for those that that fly tipping." (UK Non-governmental organisation 4).
Government Incentives	• *Simplifying recycling for end users*: "So you have to make it easy for people. You have to make it easier. It has to be the easiest option is to do the right thing." (UK Non-governmental organisation 1). • *Green business awards*. "One of the things that we are doing is we're going to be starting a green accreditation scheme for businesses. "(UK Policy maker 3). • *Tax on plastic waste*. Taxing companies which have 30% of non-recyclable plastic waste.
Advising and Funding	• *Funding for promotion of extended producer responsibility*: "extended producer responsibility, increasing the funding in the system… using the funding in the right way to make sure we obviously maximise the opportunities." (UK Non-governmental organisation 4). • *Subsidies for the recycling sector*: "there's going to need there needs to be subsidies to increase the capacity of the recycling sector." (UK Policy maker 3).
Training	• *Learning about new technology and tools*: "For instance, life cycle analysis and sustainability, because you can analyse this and set up a database of materials and their relative sustainability…I think it's allocating some time to learn more about it and getting some training in the tools that can help us." (UK Product maker 1). • *Technical training*: "happy to be part of a coalition technical training and support in plastic sorting, recycling, reprocessing." (UK Non-governmental organisation 4).
Networking	• *Building partnerships on circular economy*: "Networking and partnership building. And to facilitate plastic waste, reverse logistics." (UK Non-governmental organisation 4). • *Promoting industrial symbiosis*: "if you pull together and, you know, look at installation or energy efficiency or, you know, energy efficient light bulbs or solar panels on your buildings, would it be easier if you did it together rather than separate businesses." (UK Non-governmental organisation 4). • *Promoting a triple helix approach – partnerships between industry, authorities, and academia*: "We are partnering with colleges. You've got university, you have a business

	improvement district. We engage with our residents and businesses over the internet." (UK Policy maker 2). • *Developing online platforms*: "we're developing a digital platform and one of the aims of that is to connect waste producers and commercial plastic collectors so that the right waste goes to the right person." (UK Policy maker 3).
Guidelines	• *Availability of information on recycling*: "promotional materials, which can be given out, which can be shared with people at events…share a leaflet. So having easy access to these can help us promote commercial plastic recycling." (UK Non-governmental organisation 4). • *Sharing best practice*: "Probably some learning and sharing how other organisations are approaching it, that would be helpful as well. They started to work and then thinking of sharing information of successes and schemes. I think that would help." (UK Policy maker 2).
Fees	No suggestions.

Suggestions to improve plastic recycling

The UK respondents in the plastics supply chain make the following suggestions to improve recycling of plastics in the UK:

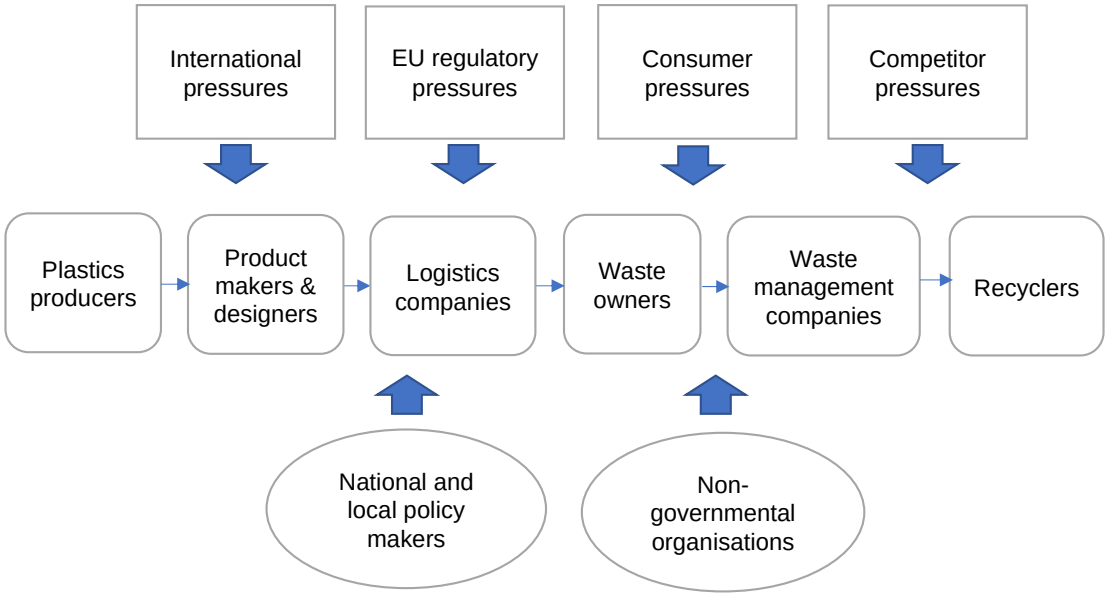
Types of suggestions	Details
	1. Technology and innovation
	None.
	2. Supply chain management
Improve transparency in the supply chain	• *Transparency on waste flows*: "Policies that aim to increase transparency in the waste flows so that we know where the waste is, where it's going." (UK Policy maker 3). • *Eco-labels for consumers:* "We need the government to step in and have policies about eco-labels so that people readily understand what it is." (UK Policy maker 3).
	3. Capacity building and awareness
Raise public awareness on plastic recycling	• *Improve public awareness about plastic recycling*: "And I think also that we need to redouble our efforts in terms of education, not just for the children who are getting it anyway, but for their older generation." (UK Policy Maker 3). • *Targeted campaign in underperforming geographical areas*: "A leaflet delivery with certain specific targeted materials we're looking at in certain geographical areas and comparing that with different approaches that might be used elsewhere, like maybe for social media." (UK Non-governmental organisation 4). • *Research into barriers to green consumer behaviour*: "consumer insight research… talking to consumers and

	understanding what they can recycle where there is a confusion lie." (UK Non-governmental organisation 4). • *Research into fly tipping*: "Fly tipping is an increasing problem in the UK, so it's understanding that a little bit better." (UK Non-governmental organisation 4).
Support recycling in SMEs	• *Delivery training on plastic recycling with SMEs*: "They're confused. And what happens to it? Where can it be recycled? How do I recycle it? So, it's kind of depending on the organisation, we can have different, different training packages we use." (UK Non-governmental organisation 4).
	4. Business case and economic instruments
	None.
	5. Facilities and infrastructure
Improve physical infrastructure	• *Increase the recycling facilities infrastructure*: "More recycling facilities would make it…more financially viable for other people to do... I'm afraid it all does come down to cost." (UK Product maker 2). • *Spatial planning and cooperation between municipalities to share recycling facilities*: "And there, you know, one council will have a facility nearby where another council will have to drive 100 miles to get rid of a particular type of waste, and that has an effect on the environment as well with the traffic." (UK Policy maker 3). • *Research into recycling infrastructure in various sectors*: "We're trying to understand the infrastructure to collect and recycle that for packaging in retailers and also from households. But of course, there's other, as I mentioned, about construction, demolition, agricultural, even, you know, packaging that's used for other online deliveries, for example." (UK Non-governmental organisation 4).
	6. Regulation
	None.

5. Discussion, conclusion, and recommendations

5.1. Supply chain

Supply chain of plastic waste and pressures



The supply chain of plastics is integrated across Europe and in terms of the production of plastics in Europe, whilst the downstream stages are mostly influenced by national operations. Besides the economic actors that are involved in producing, generating, collecting, and recycling plastics in each region, there are organisations that actively involved in influencing the plastics recycling such as national and local policy makers and non-governmental organisations.

Interviewed managers often highlight that transparency and supply chain coordination is one of the main challenges to improve plastic recycling.

5.2. Behavioural factors influencing recycling

Attitudes towards recycling

Positive attitude contributes to recycling

Managers across the plastics supply chain in four regions recognise that corporate attitudes towards recycling within organisations is an important factor that contributes to recycling behaviour. Overall, organisations are supportive of plastics recycling.

> "The majority of people in the organisation and we're talking from senior management trustees are genuinely and naturally, even outside of the

organisation, concerned and passionate about the fact that the environmental situation needs to be addressed." (UK Non-governmental organisation 3).

Lack of leadership hinders recycling

At the same time, respondents acknowledge that leadership in organisations maybe a barrier to effective recycling policies.

> "So, I guess where, you know, an internal barrier might be, whether or not it's on their radar or whether or not they want to bring it forward. And similarly, whether or not the people in power have the drive and passion to bring it forward, I guess." (UK Policy maker 1).

In terms of proficiency in recycling, after discussing corporate attitudes on recycling three categories of organisations have been identified: novice, competent, and expert. Their common characteristics are identified below. Plastic manufacturers and waste management companies are likely to be expert in plastic recycling, as well as some other players in the supply chain. Often larger companies are competent and expert in plastic recycling, whilst smaller organisations or waste owners can be novice in plastic recycling that can benefit from further training and support.

Proficiency in recycling	Details
Novice	• Organisation started recycling recently or on a limited scale. • Organisation is shaping its policy on recycling. • The scope of recycling is limited; organisation has resource constraints or internal barriers. • These organisations will benefit from training and support.
Competent	• Organisation has experience of recycling for several years. • Recycling is part of a corporate policy. • Circular economy is acknowledged as part corporate policy. • Expertise in recycling is proven in practice. • Organisation can benefit from further training, guidance, and support.
Expert	• Recycling is central to the organisational mission and strategy. • Organisation pursues the circular economy principles, including use and generation of renewable energy. • Organisation has resources, knowledge, and skills. • Organisation is developing new technologies for recycling, and material development. • Organisation can contribute to the development of training and guidance on recycling.

Subjective norms on recycling

According to Khan et al. (2020), there are five groups of sources of social norms on recycling: 1) policy makers; 2) organisational insiders; 3) organisational outsiders; 4) peers; and 5) neighbouring organisations.

Respondents from all four regions identified several very significant sources of social norms on recycling (i.e., when most actors across the supply chain see them as such – see sections on sources of social norms for each region).

The table below shows some regional differences. However, across all regions, local policy makers such as municipal councils have the strongest influence on actors in plastics supply chains, as well as businesses, consumers, and local community and the general public.

Sources of social norms	Belgium	France	Netherlands	United Kingdom
Policy makers	EU community, National government, Municipal council	International community, National government, Municipal council	National government, Municipal council	Municipal council
Insiders	--	--	Employees	--
Outsiders	Consumers	Consumers	Consumers	
Peers	Businesses	Businesses	Businesses	Businesses
Neighbours	Local community	General public	General public	Local community

Note: Those sources of social norms are included in the table when most actors within the regional supply chains agree or strongly agree on these sources of social norms on recycling that influence them.

Resources for recycling

When discussing resources for recycling, actors in the four regions make various comments on the availability of resources in organisations: financial, human, and technological. These resources vary from organisation to organisation. Two new types of resources for recycling have been identified by managers in Belgium: energy resources and logistics.

Knowledge of recycling

When discussing knowledge of recycling, supply chain actors in the four regions highlight a variety of knowledge areas that contribute to recycling, including their sources and content. Here is the matrix of major types of knowledge mentioned by the respondents. Actors demonstrate that they possess knowledge on recycling and

generate and disseminate knowledge on plastic recycling. In addition, the knowledge of recycling is influences by suppliers and customers.

Across the four regions the most important categories of knowledge were: technology; regulation; supply chain relations; tools and instruments; and knowledge exchange.

Knowledge of recycling	Belgium	France	Netherlands	United Kingdom
Technology	• Knowledge of recycling technology • Mechanical and Chemical recycling	• Knowledge of recycling technology • Mechanical and chemical recycling • Types of plastics	• Knowledge of recycling technology • Mechanical and chemical recycling • Adopting new technologies	• Knowledge of recycling technology • Expert knowledge on recycling
R&D	• Research and development	• R&D and developing new technology	• Innovation through supply chain collaboration	
Regulation	• Knowledge of national and European legislation on recycling	• Environmental compliance	• Environmental compliance	• Environmental compliance
Supply chain relations	• Inventory • Business partners and peers	• Traceability	• Transparency • Reliance on knowledge of suppliers and contractors	• Traceability • Reliance on labelling • Reliance on knowledge of contractors • Product design specification
Gaps in knowledge		• Gaps in knowledge	• Gaps in knowledge in the supply chain	
Knowledge exchange	• Business-University collaboration • Industrial associations and federations • Events	• Sources of knowledge	• Knowledge exchange • Sources of knowledge and knowledge dissemination	• Distributing knowledge of recycling
Tools and instruments	• LCA	• LCA and carbon footprint	• LCA, SIA and CAD	• LCA and carbon footprint
Environmental knowledge	• Eco-design	• Environmental standards		• Sustainable waste management strategies
Employee knowledge	• Training on recycling	• Knowledge contribution		

		• from new staff • Training and education for employees		
Public awareness		• Importance of public awareness campaigns	• Importance of public awareness campaigns	

5.3. Institutional factors influencing recycling behaviour

Pressures to recycle

When we talk about pressures to recycle, we refer to regulatory and market pressures. Here, across the four countries, actor groups experience similar pressures to improve plastic recycling, such as international, EU, local regulatory pressures, and market pressure from competitors and customers.

Based on Word frequency analysis, the ranking between the types of pressures according to Khan et al. (2020) in four countries are presented.

Pressures	Belgium	France	Netherlands	United Kingdom
Type of pressures (Khan et al., 2020)	Ranking per country (number of mentions)	Ranking per country (number of mentions)	Ranking per country (number of mentions)	Ranking per country (number of mentions)
International	# 5 (27)	# 3 (16)	# 3/4(17)	# 3 (10)
EU	# 2 (73)	# 4/5(12)	# 5 (15)	# 5/6 (0)
Local	# 3 (46)	# 6 (8)	# 1 (36)	# 2 (12)
Future	# 6 (12)	# 4/5 (12)	# 6 (1)	# 5/6(0)
Competitors	# 4 (42)	# 2 (25)	# 2 (28)	# 4 (9)
Customers	# 1 (77)	# 1 (42)	# 3/4 (17)	# 1 (21)

Note: Includes extended word search and use of synonyms[2].

Amongst the regulatory pressures, respondents in the four countries highlight the EU regulations and national regulations on waste management. Private regulations include standards such as ISO 14001 from the International Organization for Standardization (ISO) on environmental management as well as soft pressure from peers in the shape of industry awards that recognise pro-environmental behaviour such as the Green Dragon awards in the UK as a driver for improving recycling practice in organisations.

[2] Synonyms and related words used for counting word frequencies, when compiling rankings of pressures for recycling: a) International – includes international, globe, world, global; b) EU – includes EU, Europe, European, Euro; c) Local – includes local, municipal, city, council, mayor, d) Future – includes future, tomorrow; e) Competitors – includes competitors, competition, industry; f) Customers – includes customers, clients (but excludes consumers).

Across the regions, respondents from different stages in the supply chain highlighted the importance of market pressures, such as demand from the customers, clients, and consumers.

As for future pressures, the actors mention possibilities for stricter regulation on recycled plastic content in product manufacturing, and regulation to enforce traceability and transparency in the supply chain of plastics. Another potential future pressure may come from financial organisations that include waste management and recycling as part of ESG (Environmental, Social and Governance) screening.

Finally, institutional pressures could be classified into normative, mimetic and coercive pressures.

Type of pressures

Types of institutional pressures	Description
Normative pressures	The normative pressures come from formal and soft regulation. The most potent pressures identified by respondents relate to formal regulation (such as national climate change commitments and waste policies). Soft regulation at international standards (ISO 14001). In addition, normative pressures come from local peers (such as green business awards and local accreditation) motives organisations to improve recycling strategies.
Mimetic pressures	Organisations would be encouraged to improve recycling if they were guided by best practice, these are mimetic pressures. The market development is seen as a driver for developing recycling in organisations. This includes the volume of plastic waste flows.
Coercive pressures	For-profit organisations point to customer pressure as the paramount source of pressure on organisations to amend their recycling practices. Customer specifications and consumer demands guide the product design and use of plastics in products and packaging. In addition, pressure from financial organisations to demonstrate improvement of waste management could be another coercive pressure in the future with ESG screening.

Barriers to recycling

The following barriers identified by Khan et al. (2020) have been mentioned by actors in four regions.

These scores demonstrate how much actors in the regions perceive whether these categories shape significant barriers to recycling, where 0 is not significant, 1 is most significant.

The perception of barriers varies from region to region, but the top 5 most significant barriers are: 1) funds; 2) buyers & suppliers; 3) facilities, technology, and infrastructure; 4) management and leadership; and 5) legislation.

Barriers to recycling	Belgium	France	Netherlands	United Kingdom
Funds	0.67	0.50	0.57	0.39
Time	0.22	0.29	0.09	0.17
Skills & Knowledge	0.61	0.08	0.24	0.44
Space	0.22	0.12	0.09	0.11
Access	0.22	0.00	0.00	0.11
Transport	0.33	0.33	0.09	0.11
Management & Leadership	0.55	0.75	0.00	0.39
Buyers & suppliers	0.61	0.37	0.57	0.50
Facilities, technology & infrastructure	0.61	0.54	0.33	0.28
Legislation	0.50	0.33	0.38	0.28

Note: Average scores per country, where 0 - not significant, 1 - most significant. These scores are calculated from degrees of agreement (see sections on regional barriers to recycling).

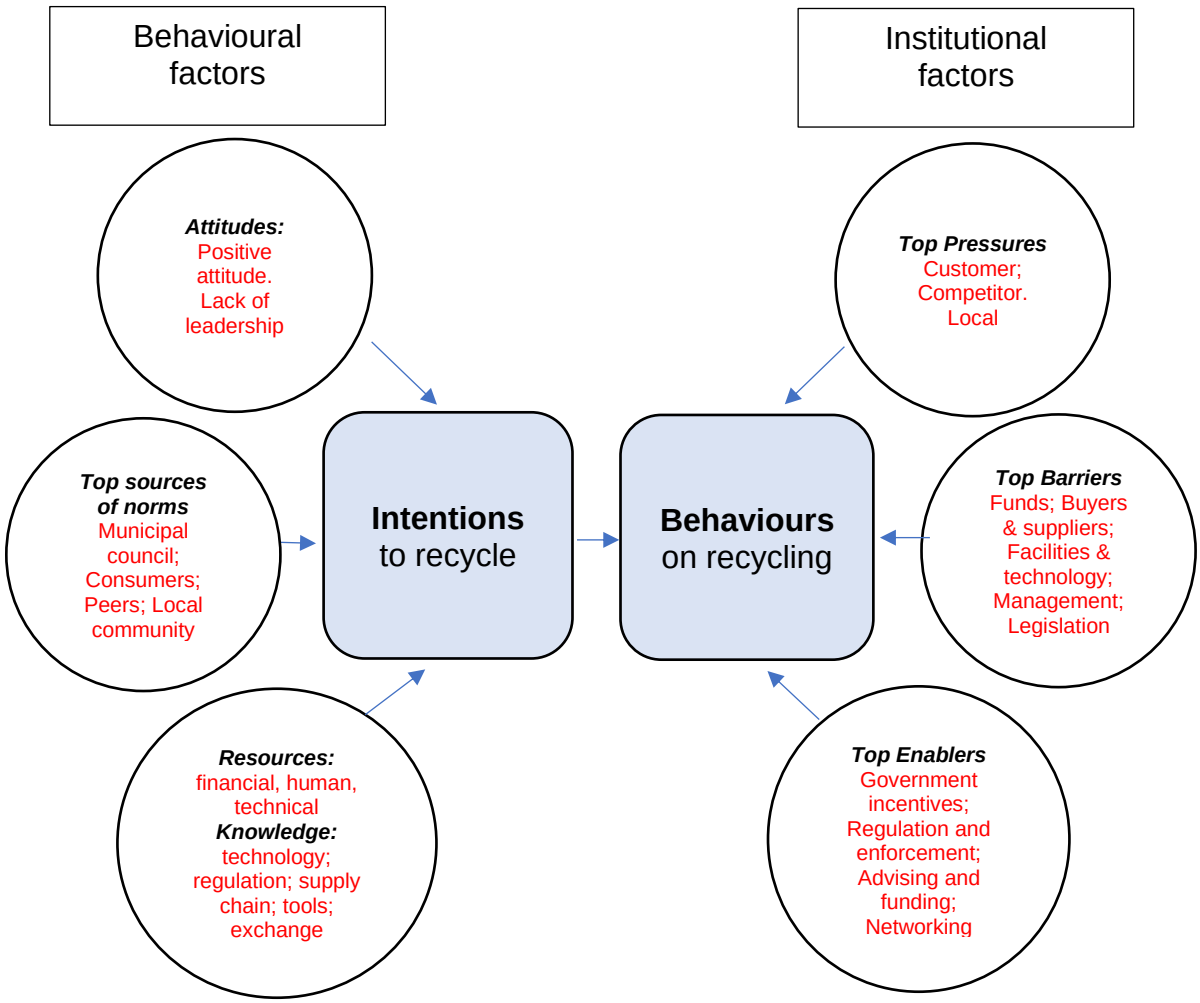
Enablers of recycling

Respondents from the four study regions make various suggestions to improve recycling under categories of enablers, identified by Khan et al., 2020. Below is the number of suggestions made under each category of enablers.

The most sought-after categories of enablers, defined by the number of suggestions and mentions, are – 1) Government incentives; 2) Regulation and enforcement; 3) Advising and funding; and 4) Networking. For details of specific suggestions please see the regional enablers of recycling.

Enablers of recycling	Belgium	France	Netherlands	United Kingdom
Regulation and enforcement	3	1	4	3
Government Incentives	2	3	9	3
Advising and Funding	3	3	3	2
Training	1	1	1	2
Networking	3	1	3	4
Guidelines	1	1	4	2
Fees	1	0	1	0

Factors influencing plastic recycling behaviour in four regions



Source: Author's own - adapted from Khan et al., 2020 and Ajzen, 1985.

The above diagram summarises the major behavioural and institutional factors identified across four regions that influence intentions and behaviour on plastic recycling. These factors can be studied further with quantitative means.

Recommendations

Interviewed actors in the plastics supply chain in Belgium, France, the Netherlands, and the United Kingdom make detailed recommendations on improving plastic recycling. These recommendations can be grouped into 6 categories identified from responses (see Appendix II). Amongst the suggestions voiced by managers, the following recommendations are seen as prominent:

1. Technology and Innovation

- Design solutions to reduce, reuse and recycle plastics
- Foster innovation and improve recycling technology
- Promote research on biomaterials
- Promote eco-design
- Research microplastics and health
- Co-create solutions

2. Supply chain management

- Improve logistics of plastic recycling
- Improve transparency in the supply chain
- Promote supply chain coordination and collaboration
- Improve end of life of products
- Improve plastic collection
- Introduce labels on plastic recycling
- Audit waste management in the supply chain
- Encourage recycling within Europe

3. Capacity building and awareness

- Train organisations on plastic recycling
- Disseminate knowledge on plastic recycling
- Promote awareness on plastic recycling with businesses and citizens
- Improve attitude towards use of recycled plastic
- Supporting recycling in SMEs
- Support recycling projects for a longer time

4. Business case and economic instruments

- Develop win-win solutions
- Tax plastic waste
- Offer subsidies

5. Facilities and infrastructure

- Improve facilities for recycling
- Improve physical infrastructure

6. Regulation

- Set standards for waste separation in businesses
- Introduce ban on single-use plastics
- Introduce stricter regulation on plastic waste.

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Glossary of terms

(Definitions following Khan et al., 2020)

Attitudes – attitudes are defined as “the extent to which plastic recycling is valued by decision makers, whether positive or negative”. We study both personal attitudes of managers in organisations, as well corporate attitudes towards recycling

Barriers - Barriers as factors that hinder an organisation to implement best practices of plastic recycling. In our study, we interpret barriers as “lack of requisite resources and/or appropriate opportunities”. We assume that those organisations that encounter substantial barriers are very unlikely to implement best practices of plastic recycling.

Behavioural intentions - Behavioural intentions as “a perceived likelihood or subjective probability of decision makers that they will implement plastic recycling in their organisations”. We assume that those decision makers that hold positive behavioural intentions are more likely to implement best practices of plastic recycling in their organisations. In other words, it can be stated that those organisations that hold positive intentions are more likely to contribute to a circular economy.

Behaviour - Actual behaviours as “the extent to which organisations have implemented best practices of plastic recycling”. As these best practices include reducing, reusing, and recycling of plastic waste, we can refer to actual behaviours as organisations’ behaviours towards a circular economy for plastics.

Circular economy – “A circular economy for plastics refers to reducing, reusing, and re- cycling of plastic waste.”

Enablers - “necessary actions or potential solutions, if introduced or implemented, may motivate organisations towards plastic recycling”.

Knowledge about recycling – Knowledge about plastic recycling and plastic recycling in general and recycling plastic film and foil in particular, including knowledge on challenges, rules, legal requirements, costs, policy context, technical knowledge, legal knowledge, and market knowledge.

Plastics waste - By 2018 the EU recycled on average only 30% of all plastic waste, and the European Parliament estimated that 95% of the value of plastic packaging material was lost to the economy after a short first-use cycle. The European Commission announced, “a European Strategy for Plastics in a Circular Economy”, and the EU set new recycling targets for plastics at a minimum of 50% by 2025 and 55% by 2030 (European Commission, 2018).

Pressures – as regulatory and market pressures. We interpret pressures as “the perceived push on organisations, to implement best practices of plastic

recycling, from regulatory bodies, competitors, and customers". Some studies point out that such pressures directly improve organisations' environmental performance. Institutional pressures influence organisations' behaviours, practices, and environmental strategies.

Recycling – Activities on plastic recycling including collection, transport, design, implementation of waste logistic solutions for other companies, connecting buyers and sellers of recycled plastic.

Resources for recycling – Resources within organisations available for activities related to plastic recycling such as financial, human, equipment, and facilities. For instance, how many of full-time employees work in green jobs some or all the time in the organisation?

Stakeholder – Actors outside the organisation such as municipality, local authority, neighbouring community, competitors, policy makers.

Subjective norms – these are perceived social pressure to perform or not to perform the behaviour. In our study, we examine subjective norms as societal norms on plastic recycling. These may vary from country to country.

Supply chain – consists of tiers, steps and actors that are responsible for transformation (or processing) of materials for production of products. Each stage of the supply chain has input and outputs of materials (Interreg 2 Seas and PlastiCity Consortium (2021).

Appendices

Appendix I. Description of actor type in plastics supply chain

Actor type	Description
Logistic companies	Companies that engage in logistics professionally.
NGOs	Civil society organisations, citizen initiatives and non-for-profit interest groups.
Plastic Manufacturers	Companies that make plastics out of virgin materials/fossils
Policy Makers	Public institutions involved in public policy-making such as including local authorities, and unions.
Product Makers and Designers	This can be B2B, B2C and B2G. Companies that make products from plastics or uses plastic in its products (e.g., Volvo that uses plastic in car production, and sells cars to customers; or a company that produces plastic trays for small components of a car). Product designers are the designers of new products.
Recycling companies	B2B – company that recycles plastics into a new raw material to be used by other company again for new products.
Waste Management Companies	Companies that engage in waste management professionally.
Waste Owners and End Users	Owners of plastic waste (waste suppliers - anyone or any company that produces plastic waste that might be of a specific composition or amount)

Appendix II. List of recommendations from four regions to improve plastic recycling

Category of recommendations	Belgium	France	Netherlands	United Kingdom
1. Technology and Innovation	- Design solutions to reduce, reuse and recycling of plastics - Research and assessment of potential solutions - Develop technology	- Foster innovation - Promote eco-design - Promote research on biomaterials	- Improve the quality of recycling plastics - Improve recycling technology - Co-create solutions - Research plastic use during Covid-19 pandemic - Research microplastics and health	
2. Supply chain management	- Improve logistics of plastic recycling - Audit waste management in the supply chain - Introduce quality label on plastic recycling	- Improve end-of-life of products - Improve plastic collection - Promote collaboration - Promote supply chain coordination	- Improve plastic logistics - Improve collaboration - Improve transparency of plastic supply chain - Encourage recycling within Europe	- Improve transparency in the supply chain
3. Capacity building and awareness	- Train organisations on waste recycling	- Promote public awareness	- Improve the attitude towards use of recycled plastics - Raise awareness with businesses and citizens on plastic recycling - Disseminate knowledge on plastic recycling - Support recycling projects for longer time	- Raise public awareness on plastic recycling - Support recycling in SMEs
4. Business case and economic instruments	- Develop win-win solutions for take up		- Tax plastic waste - Revise subsidies	
5. Facilities and infrastructure			- Improve facilities for recycling	- Improve physical infrastructure
6. Regulation			- Set standards for waste separation in businesses - Introduce ban on single-use plastics - Introduce stricter regulation	

Note: See individual regional sections of suggestions to improve recycling for further details.