



Article

Single-Use Plastic Bans: Exploring Stakeholder Perspectives on Best Practices for Reducing Plastic Pollution

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Abstract: In this study, we conducted and documented workshops and interviews in Norway and Slovenia to identify stakeholder and future generation opinions and mitigation strategies for solving one of the most prominent environmental issues: plastic pollution. As part of the EU H2020 project *GoJelly*, stakeholders were brought together to explore their perceptions on considering jellyfish mucus as a new resource to contribute to reducing plastic pollution from entering the marine environment. The study was conducted in the spring of 2019, in a context directly after the European Union (EU) announced its Directive to ban the most commonly used single-use plastic (SUP) items. The study applied the snowball method as a methodological choice to identify relevant stakeholders. Systems thinking was utilized as a participatory modelling approach, which allowed for the creation of conceptual mind maps from the various workshops and interviews, to understand consumers' consciousness, and to map out ideas on plastic pollution reduction. Plastic pollution takes place on a global scale and stakeholders discussed their individual perceptions of national and international solutions that could be put in place to solve it, including the opportunities around utilizing jellyfish mucus to filter and capture micro- and nanoplastic. We found that industry stakeholders in both case areas were generally more accepting of policy and increased innovation moving forward, but placed weight on the scientific community to conduct more research on the pollution issue and propose solutions. Future generation stakeholders (youth aged 14–18), however, put emphasis on consumer behavior and buying patterns of single-use products fueling the plastic crisis.

Keywords: single-use plastic; stakeholder integration; plastic pollution; systems thinking

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1. Introduction

Since the start of the Covid-19 pandemic, plastic production and consumption has been intensified, especially from the use of disposable personal protective equipment [1] (e.g., face masks) and the return to plastic shopping bags to avoid cross-contamination [2]. This enhanced the complexities regarding plastic waste management [3], which was pushed back in the societal challenges priorities agenda during the pandemic. Furthermore, the global lockdown has driven a huge increase in e-commerce and shipping of products, resulting in massive consumption of materials for containment and packaging [4], and increased levels of COVID-related litter have already set society back in the fight against plastic waste [4,5]. The rise of plastic pollution and need for a comprehensive governance strategy to manage this global challenge did not start with the pandemic, however. Plastics have been instrumental in the growth and development of the minority world for over 70 years and has more recently expanded onto the majority world. We choose to use the term “Majority World” rather than low-income, global south or developing nations. We do this because it can serve as a reminder that the Western world are just a minority in the global scale [6]. All terms have their benefits and challenges. This lightweight material is cheap, durable, and found in numerous consumer and industrial products in nearly all corners

of society. From the late 20th century onwards, the extremely low cost of plastic products drove an increasing market and culture of throwaway and single use, as also seen with the pandemic needs.

As a result of the rise in plastic pollution and subsequently carbon emissions, consumers have become more environmentally aware of the harmful impacts plastic pollution causes to human health and vital ecosystems, including our oceans. Public awareness for plastic is ranked high among consumers, likely due to constant media coverage [7]. This awareness can also be witnessed in the rise of citizen participation in worldwide ‘beach cleanup’ days. One cleanup organization, The International Coastal Cleanup (ICC), stated that since their founding, ICC has had 16 million volunteers remove over 315 million pounds of plastic from beaches worldwide, with more volunteers aiding in the late 2010s [8]. Although it is a way to get citizens involved at the ground, cleanup is not the only solution as plastic consumption is a still growing problem—literally [9]. Over the past 10 years we have produced more plastic than in the whole of the previous century [10]. PlasticsEurope (2016) calculated that global plastic production reached over 381 million metric tons (mt) in 2015 alone, an amount not expected to decrease anytime soon [9]. The number of Single-Use Plastic (SUP) products has doubled compared to the start of the 21st century, with the largest proportion (40%) dominated by packaging [11]. With production and consumption expected to continue to rise in the decades to come, it has been proposed that plastic litter will outweigh all the fish (a generally fixed biomass) in the world’s oceans by 2050 [12–14]. If no significant production and management changes are implemented, it is estimated that 12,000 Mt of plastic waste will continue to make their way to incineration (12%) or landfills and the natural environment (79%) by 2050, up from 7,000 Mt today [9]. Furthermore, given that fossil fuel-based feedstock accounts for 99% of total plastic production, which corresponds to 8–9% of the global oil and gas consumption (as feedstock and energy) [15,16], plastic is also a significant contributor to climate change through the greenhouse gasses emitted both during production and waste processing (burning and long-term degradation in landfills). The emissions of production and waste processing were recently estimated to be equivalent to the release of 1.7 billion tons of CO₂ in 2015 (nearly 4% of the yearly global emissions in 2015) [17]. This number is expected to rise to 6.5 billion tons of CO₂ released into the atmosphere by 2050—roughly 15% of the 2050 carbon budget [18]. SUP alone makes up much of the pollution, ergo production emissions. In fact, within the EU, 80 to 85% of litter found in and around beaches is plastic, with SUP items representing 50% of marine plastic litter, while fishing and aquaculture gear represent 27% [19]. SUP enters the marine environment through land-based activities via runoffs, and recent studies have demonstrated its harmful effects on marine organisms [20] and human health [21–23].

Plastics are multifaceted and exhibit a variety of beneficial properties and qualities in terms of applicability in consumer products. Despite its many positive functions, the durability and synthetic nature of the material becomes a double-edged sword when examining environmental pollution. Moreover, microplastics have become a point of interest in the pollution debate. The term ‘microplastics’ was originally coined by Thompson et al. [24] to describe and categorize small fragments of plastic (<5 mm) that were found to be released and accumulating in the marine environment. Microplastics have subsequently been found in natural waters, soils, sediments, ice, snow, air, and a huge range of organisms, from the equator to the poles, and they have emerged as a serious concern and a potential threat towards living organisms and human health [24–27]. These microplastics stem from everyday plastic consumer products, including SUP items, through their direct use or through mismanagement of waste.

As a step towards curbing plastic pollution, European national governments did pass Directive (EU) 2019/904, better known as the SUP Directive in early 2019, which fully took effect on 3 July 2021. The Directive aims at halting the consumption of the 10 most commonly used SUP items, as well as lost and/or abandoned fishing gear, which currently only has a 1.5% successful recycling rate. The overarching goal of the Directive is as such

to prevent plastic pollution and force producers to design products without plastic. In light of this, we wanted to learn more about stakeholders' perspectives on the harmful nature of marine plastics in their own nation, as well as their ideal mitigation strategies, both considering the SUP directive and beyond. We also sought stakeholder considerations of a new method being developed to tackle micro- and nanoplastic pollution, using the marine resource of jellyfish (<https://gojelly.eu/> accessed on 1 August 2021). As the seas warm, the threat of jellyfish overpopulation has risen [28]. Jellyfish are a menace in the fishing industry, as they become caught in nets and steer fish away [29]. On the other hand, the mucus from jellyfish has been proven to capture micro- and nanoplastics—ultimately hindering it from reaching the ocean when attached to waste-water treatment plants [30]. To gain citizen perspectives we therefore facilitated a series of citizen, policy, academia, and industry stakeholder workshops and in-depth interviews across Slovenia and Norway where the goal was to identify and map citizen and stakeholder perceptions on reducing plastics contribution to pollution in our oceans and consider using jellyfish as a tool towards reaching this goal.

In the first section, the current plastic mitigation strategies in the EU and their relation to stakeholder perspectives are investigated. This is followed by a section examining the case of jellyfish as a resource in plastic pollution mitigation, followed by a methodology section, where the setup of the participatory stakeholder workshops, interviews, and selection process of the participants is explained. The results of the workshops and interviews are then presented and examined, followed by the overall findings of the study and discussion.

2. The Circular Economy and Extended Producer Responsibility

Typically, the blame for plastic pollution in the environment has been put on the consumers as the end users of plastic products [7]. However, few effective choices for plastic free alternatives have been available to consumers [31]. The lack of choices, and subsequently fed-up consumers, has led public perception to be hypothesized as one of the main drivers for the EU's own SUP ban [32]. This is corroborated by the emergence of more coherent environmental policies introduced by the EU around the issue of plastics in the 21st century. One of the most prevalent examples is the creation of the 2015 Circular Economy Action Plan (CEAP), where the SUP ban was considered a main feature [19]. To understand the CEAP and SUP ban within the context of assessing the responsibility of plastic pollution, it is essential to recognize the concept of the Extended Producer Responsibility (EPR) scheme. We chose to highlight this concept as it is a vital part within the framework of environmental policy, and more significantly the broader debate on the SUP ban. The EPR scheme is a principal policy tool employed by policymakers within the SUP Directive to shift the focus from consumers to producers in terms of responsibility for production and environmental clean-up [33,34], whether at sea or on land. The EPR scheme would incentivize producers to design products that are easily recyclable and reusable, ultimately leading to less plastic needing to be mitigated and improperly disposed of [32,35]. In Norway, a recent report by Deloitte and the World Wildlife Fund (WWF) analyzed the potential for a global plastic EPR scheme. For EPR to function, it found that widescale plastic use must be reported, incentives for recycling need to be implemented (i.e., deposit return schemes), and producers need a legally binding obligation for plastic clean-up [36]. As such, it is critical that EPR is integrated into an international agreement on plastics governance for it to have far-reaching effects and the stakeholders in this study have hypothesized on how this might look like within their national areas.

3. Who Is Willing to Do What?

The development and content of the EU's SUP Directive was influenced by a diverse range of actors and stakeholder groups. Through workshops, open consultations, interviews, Eurobarometer surveys, and conferences the EC was able to gain a wide variety of input on the best implementation methods for the SUP ban [19]. This variety reflects the growing 'green movement', which includes external stakeholders such as NGO advocates

like Greenpeace and WWF, individual changemakers and citizen stakeholders such as Greta Thunberg, and even municipality stakeholders involved in projects like smart cities. There is a strong motivation for engaging with stakeholders in general, and with different generations of stakeholders specifically in the context of plastic pollution, which has a naturally strong human dimension. The power stakeholder groups hold can be instrumental in setting the agenda for policymaking and ensuring that different voices are heard. Stakeholders then become invested in the final decision, ensuring a sense of legitimacy and encouraging long-term compliance with legislations that result from feedback from these consultations at the local level [37,38].

Behavioral studies are widely used to help understand the motivations for plastic policy creation and mitigation strategies [39]. A 2019 Eurobarometer survey found that 94% of Europeans were anxious about the impacts of plastics on their health [40]. Amongst the more than 27,000 Europeans interviewed, solid support was identified for policy measures aimed at reducing plastic waste and littering. By 2021, the Eurobarometer results stated that nine out of ten Europeans (88%) were concerned about the environmental impact of microplastics, while a similar portion (89%) were worried about the impact of plastic products on the environment [41]. The same EC-led assessment on public opinion on the impact of SUP found that recent documentaries such as *A Plastic Ocean* and *Blue Planet* had brought the dimension of harm caused by SUP to a global level and wider audience. Through nation-led case studies, the EC learned that implementing restrictive measures, such as the plastic bag ban, yielded immediate results, and public acceptance would likely follow. An Irish case study found that when a 0.10-euro tax was added to plastic bags consumers began to bring their own bags, leading the EC to understand the direct impacts policies can have on consumer behavior [42]. A similar study demonstrated the same effects in 2015 when England implemented a small fee on plastic bags at supermarkets; within a month all ages, genders, and income groups significantly reduced their plastic bag use [43]. These studies demonstrated a clear reduction (up to 90%) in plastic bag use, which has been found to correlate with a corresponding decline in the number of plastic bags found on beaches [44].

Knowing this importance, the EC conducted a series of public consultations over the course of 3 months in 2018, a year before the SUP Directive was passed. The resulting data represented >1800 contributions and overwhelmingly demonstrated a wide public desire, awareness, and preparedness for actions against SUP. Over 98.5% of the respondents said it was necessary to ban SUPs, while 95% considered the move to be urgent [45]. This knowledge, coupled with the push for more open science platforms, ensuring EU-funded projects include citizen participation, and by creating avenues for citizen environmental activism (e.g. the European Climate Pact), the EU is clearly signaling that citizen's opinions matter to the decision-making processes of European governing bodies. Public participation through consultations, surveys, and hackathons is becoming ever-more embedded in environmental policy development as decision-makers recognize the need to understand who is affected by the decisions and actions they take [46].

4. A Gelatinous Solution?

Some argue that increased jellyfish blooms may be linked to synergistic effects of global climate change such as, for example, ocean warming, regional natural ecosystem fluctuations, and direct anthropogenic changes such as eutrophication, marine constructions, and overfishing [47–50]. The blooms severely impact food web structure and dynamics in affected locations [51], and previous studies with stakeholders demonstrate how they also affect local communities along the coast that depend on the sea as a resource [52–55]. Freeman, Booth [56], and others have recently brought forward a solution to solve both the crisis of jellyfish blooms, as well as plastic leaking into the marine environment. This solution involves a new innovative technology to capture and use jellyfish mucus as a filter to attach to wastewater treatment plants to capture micro- and nanoplastics. Researchers consider this to potentially be a cost-effective option that requires very little capital, en-

ergy, or other operating costs, while also holding a low carbon footprint. The process would involve the developing of upstream jobs for commercial fishers and more, as the fishers would catch the jellyfish, send it for processing and then ultimately deliver it to the wastewater treatment plants. This would be a benefit to fisheries as it would remove the extra jellyfish from areas where it is becoming a challenge for the industry. The mucus filter has been demonstrated effectively as an innovative, natural technology for removing plastics [57], especially nanoplastics, and as such is an option that could be of interest and worth discussing more closely with stakeholders.

5. Theoretical Framework and Methods

The aim of the research conducted in this study was to identify stakeholder and future generation opinions and mitigation strategies for solving the crisis of plastic pollution. Therefore, the involvement of any stakeholders (research community, industry, governance, and citizens) is important within this context to understand consumer behavior, disseminate information, and advocate for innovative solutions to combat plastic pollution [58]. In terms of the problematic challenges of plastic pollution, citizens can be involved in monitoring and data provision campaigns, thus increasing sampling power and saving researchers' time and money [59]. For the purposes of this study, and within the context of stakeholder integration in research, we will use the theoretical framework of agenda setting theory [60]. This is important because citizens play a role for both researchers and policymakers alike in raising awareness and providing feedback on a given issue area, thus translating the will of the people into policy, while simultaneously guiding and mapping citizens' ideologies around the topic of negative impacts of plastic pollution. For a given topic such as plastic pollution to rise to the top of the political agenda, however, it needs to capture the attention of both citizen stakeholders and policymakers alike [61]. The ideology boils down to the specific issues concerning the public and what is prominently portrayed in the news and media.

A framework for conceptualizing the agenda setting theory on citizens' opinions, and how they can in turn affect policy, was created by Liu, Lindquist [61] and employed by Tiller, Arenas [62]. This framework focused on "attention-grabbing factors" within the agenda setting theory. It emphasized problem indicators, focusing events, and feedback. Utilizing theories within the social sciences allows for a phenomenon (plastic pollution, in this case) to be better understood by researchers in explaining, organizing, and analyzing their study [63]. The problem indicators for stakeholders, in this case, typically stemmed from personal experience, for example walking along a beach and witnessing SUP litter first-hand. As Tiller, Arenas [62] explain, these problem indicators are not alone able to reach the attention of policymakers, but need strengthening through a series of 'focusing or triggering' events that push the issue forward. An example within the context of SUP pollution is the 2015 video of a researcher pulling a straw out of a sea turtle's nostril, which triggered an emotional and action-based response from citizens who stopped using plastic straws [64]. The last factor for this framework to be completed involves feedback, which typically derives from NGOs in the form of pressure from scholarly articles and press releases.

For the purposes of this study, we used a participatory modelling approach called "Systems Thinking". Systems thinking and systems analysis is an effective method for exploring real world problems as identified by the stakeholders that inhabit the given system [65]. This process takes the form of group conceptualization or group modelling [65] which has the aim to develop a stakeholder-driven representation of their 'system'. This is a conceptualization process that allows social scientists to investigate a given system (plastic pollution and mitigation strategies) by eliciting information from stakeholders [66]. This study uses Freeman's definition of a stakeholder " . . . any group or individual who can affect or is affected by the achievement of the organization's objectives" [66]. We used both in-depth interviews and workshops to assess stakeholder perceptions of plastic pollution in their case areas and their own mitigation methods for solving the crisis.

These workshops took place in both Slovenia and Norway in 2019. These cases were chosen because of their role as case areas in an ongoing research project focusing on plastic pollution mitigation and multilevel governance issues. Interviews were employed as a substitute for full-fledged workshops in some cases as a methodological choice when availability was a challenge for key stakeholders. We developed conceptual system models based on stakeholders' perceptions using the freeware Vensim for developing the model, followed by analyzing the narratives from the recorded sessions to validate the model. The Vensim model was conceptualized and presented to stakeholders with seven different pre-determined drivers for each case area. The drivers were decided upon by the researchers of the *GoJelly* project during a meeting in May of 2018. The drivers were selected based on researchers' expertise and the availability for drivers to influence each other. The researchers agreed upon the following drivers to drive the workshop discussion in Norway which involved future generations, with a focus on the plastic pollution mitigation:

1. Governance
2. Pollution
3. Lifestyle
4. Geography
5. Ocean
6. Economy
7. Waste Sorting

As the stakeholders were different within the Slovenia workshop and were more industry focused, the topic of jellyfish mucus' ability to mitigate plastic pollution was discussed and the researchers agreed upon the following drivers:

1. Seasonality
2. Pollution
3. Fishing
4. River Runoffs
5. Invasive species
6. Consumption patterns
7. Policy

The aim of the workshops and interviews was to analyze and understand the current systems in place for reducing and mitigating plastic waste from a stakeholder perspective while also exploring further ideas from citizens and stakeholders to improve plastic waste management even beyond the SUP Directive, such as the innovative solution of jellyfish mucus. This process involved providing input to the science-policy interface that is grounded in a bottom-up approach, involving citizen and stakeholder opinions. This is in line with current scholarship on the efficacy of stakeholder inclusion in terms of achieving co-production of knowledge by expanding networks to other expert sources to ensure compliance with and legitimacy of future regulations and contribute to a grounded transfer of knowledge from stakeholders to science to policymakers [67–70].

The conceptual models from the Systems thinking analysis are graphical visualizations of a basic construct of the system feedback structure, which relies on both qualitative and subjective interpretations of the system [71]. The conceptual model consists of concepts or state variables with the causalities existing between these variables, which highlighted how the stakeholders perceive their system. The purpose of a conceptual model such as the one developed here in this study is to use it either as a research tool for further exploration and quantitative modelling, or as a management tool for consensus building amongst stakeholders and for exploring possible actions of a given group [72,73]. These conceptual models are also referred to as 'concept networks' or 'concepts maps' [74]. We selected the groups of stakeholders for the workshops using the snowball method [75]. This approach was chosen because the quality of results sampled from these groups would outweigh the relatively small number of stakeholders the method usually produces. This is often the case in qualitative research studies, where large samples can at times be ineffective and

do not provide the detailed and contextual information required by the researcher. Our aim was to achieve a holistic narrative, where key participants have been given ample opportunities to share their perceptions [76]. In addition to the workshops, in-depth interviews with relevant stakeholders were also conducted in Norway. During the in-depth interviews, researchers spoke with stakeholders following a semi-structured interview guide, meaning that there were several questions of interest to the study. We considered, for the purposes of this study, that a more qualitative and conversational approach was better suited to supplement the study. The interview guide covers seven different topics related to microplastics, with several open-ended questions linked to each topic on marine plastic pollution.

To develop a scientific basis surrounding the workshops and interviews, the narrative was also transcribed after the workshops. Narratives are popularly described as “discourses with a clear sequential order that connect events in a meaningful way for a definite audience and thus offer insights about the world and/or people’s experiences of it” [77]. After having obtained narratives, in this case through the recordings from the workshop or in-depth interviews, there are two methods of employment. The first is to formulate one’s own narrative of the researcher’s interpretations from what was discussed during the workshops, rewritten from its original form. The second option is to analyze them as special kinds of texts, in and of themselves, using conversation analysis [78]. For the purposes of this study, we used a mix/combination of the two, interpreting the narratives within the context of the workshop setting, or alternatively, treating the text literally as it related to the output of the systems thinking analysis from the workshop. Table 1 summarizes the number of respondents participating in the workshops and in the individual interviews. The field marked in green represents the stakeholder sectors where workshops were held.

Table 1. Overview over the number of participants from each sector on plastic pollution perceptions. Green marks the workshops, whereas the others are in-depth interviews.

Stakeholders	Norway	Slovenia
Politicians	3	
NGOs	4	
Wastewater Treatments Plants	1	20
Education		
Municipality		
Future Generations	115	

The different sectors were chosen during a stakeholder mapping process where the case area representatives discussed together the categories of stakeholders that would be best suited to participate in this process to gain a comprehensive understanding of the situation in each of these case areas. Stakeholders were mapped based on their sector, potential interest, and influence. This mapping exercise was necessary to provide contacts and names of individuals that would provide feedback to help shape the views on plastic mitigation strategies [79].

6. Results

Through our workshops and in-depth interviews in Norway and Slovenia, researchers were able to pinpoint citizen perceptions on both plastic pollution and avenues for mitigation, specifically when it comes to SUP. The results demonstrate similar findings to what the EU has found from their own surveys [40,41,45]—that citizens are invested in finding solutions for plastic waste and reversing environmental degradation. Rather than surveys at the EU level, our study was able to go more in-depth into understanding stakeholder perceptions on what the policymaking sector can and should accomplish when mitigating plastic pollution. From the data collected throughout the workshops, concep-

tual maps of stakeholder’s perception on plastic pollution were developed and narratives were transcribed.

6.1. Workshop and In-Depth Interviews in Norway—Stakeholder Perceptions of the Challenge

Using the systems of thinking methodology and utilizing drivers to understand that the issue is bigger than simply solving one problem, the future generation workshop held with students at a secondary school in Norway used seven main drivers to outline the plastic problem and mitigation methods, as seen on the top line of Figure 1. In a narrative analysis such as the workshop, the number of participants is typically found to be best with a maximum number of 20 participants. This is to allow each participant to share their experience, while providing a holistic narrative for the research. In this future generation workshop, however, a sample of 15–20 students was expected and the actual amount surpassed 100 students. This was an unexpected challenge, which was solved by splitting students into smaller groups and having the individual groups report on the main drivers of plastic pollution. As the Vensim diagram above illustrates, the students examined several mitigation measures of plastic, in the context of single-use and microplastics, that could be implemented on a national or international level, such as improving waste collection and sorting. In this workshop session, the participants suggested that a reduction in packaging of products could be an effective measure to reduce unnecessary plastic such as plastic for single use with available alternatives. The overarching problem indicated during this session was consumer consumption patterns in terms of buying too much unnecessary products, further leading to increased disposal. Additionally, youth in the workshop, without being fully aware of the EPR scheme, suggested that corporations need to be held accountable for the plastic they produce. This accountability was suggested by the future generations to come in the form of economic penalty such as fines for people and corporations that improperly dispose plastic. The economic measures suggested by the youth particularly pertain to discouraging consumers and corporations against plastic littering and overconsuming plastic (in the form of single-use products with available alternatives). In future workshops of a similar matter, the EPR scheme could be discussed further with the youth to gain their insight on the producers’ pay policies regarding the SUP Directive.

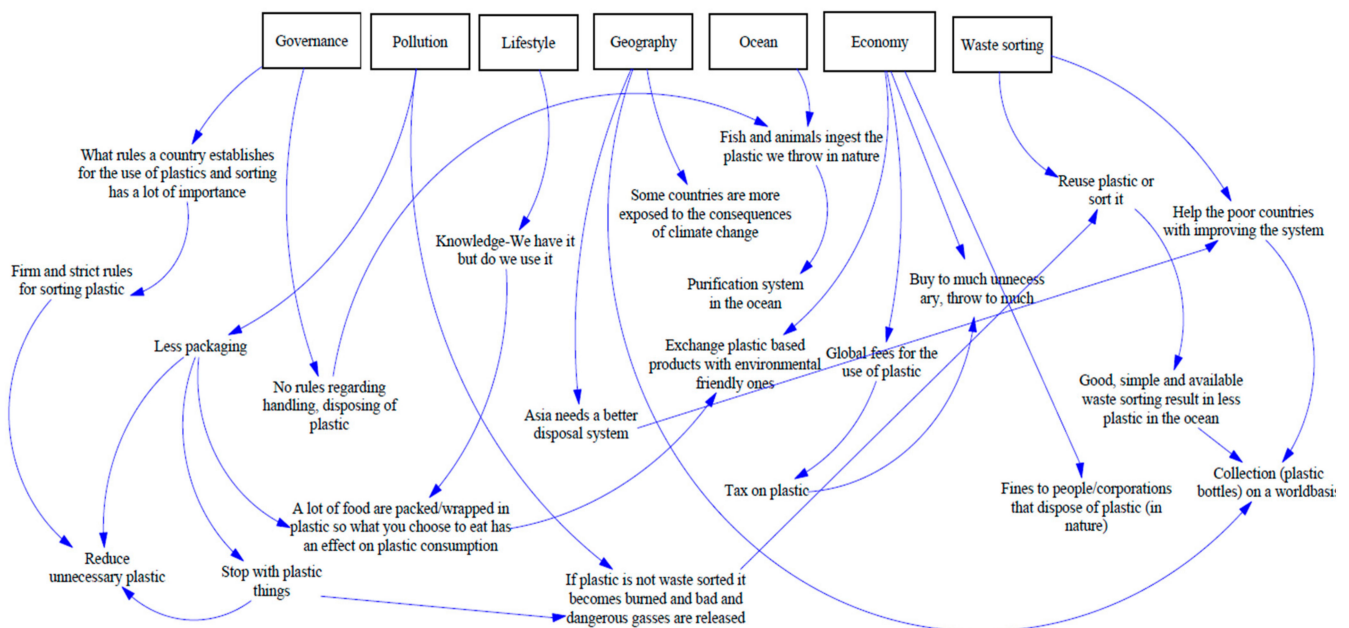


Figure 1. Vensim diagram of Norwegian youth workshop.

An interesting point made by the participants was the availability and need for global waste sorting systems, that additionally were not too complicated to use. This idea also has the backing from the research community [80,81]. Establishing a plastic bottle collection system worldwide was also deemed to be important for reducing plastic litter in the ocean [82]. Paying the bill for helping majority nations establish their own collection systems was also recognized as a viable solution by the youth. The majority nations were perceived and written about as the primary source of ocean plastic littering worldwide. This is, however, a consequence of the increased shipments of plastic waste from the minority to the majority world since 1993, while fully understanding their lack of recycling infrastructure and creating a crisis on a global scale [83]. The students therefore emphasized that future global plastic agreements need to ensure funds are available and establish efficient and adequate waste disposal systems in these majority nations. This is where plastic waste is largely shipped and if nations shipping the plastic there provide aid in building waste sorting infrastructures and introduce reuse or recycling alternatives, the release of plastics and ultimately microplastics into our oceans can be largely hindered.

In the case of the in-depth interviews, several interviewees pointed to microplastic stemming from car tires and artificial grass fields as their perceived major emitter of microplastics pollution. Numerous interviewees believed that by tracing pathways of plastic pollution (from production to disposal) and fostering conscientious consumers, this could help mitigate and understand the wider areas of the plastic crisis. Stakeholders from Norwegian non-profit sectors then highlighted the importance of tracing and identifying the sources of microplastic.

“It’s an extensive job to gain a good assessment and to find out where the disposal/release occurs and how, and which technological solutions are necessary to solve this.”

(Norwegian NGO 2)

“Focus on pathways. I mean that the attention should be on pathways and where the microplastic ends up. How you can avoid it, how you can be preventative to avoid the dispersion of microplastic everywhere.”

(Norwegian WWTP)

Norwegian stakeholders also pointed to regulatory measures and initiatives, like the circular economy and SUP Directive, to be the champion out of the plastic problem. One proposed solution pertained to the inclusion of plastic materials into the circular economy in Norway, where NGOs believed that increased attention should be given to standards throughout the industry including end-of-life handling of plastic products.

“We are talking about putting plastic into the circular economy, but that is difficult unless we reduce our consumption. The first thing we must do is reduce our general consumption on unnecessary plastic. The plastic that we still need could then be produced in a more sustainable manner, without the dependency on fossil raw materials.”

(Norwegian NGO 2)

One stakeholder in particular emphasized the benefits of having infrastructure that enables the reuse or recycling of plastic that is already in circulation. Nonetheless, a high consumption is still regarded by another Norwegian stakeholder as problematic for including plastic in the circular economy. The introduction of regulatory or legislative measures with the intent of reducing microplastics would, according to some of the stakeholders, be both beneficial and possible. This applies especially towards a ban at the EU level of SUPs. The Norwegian stakeholders from NGOs believed the SUP Directive and eco-design initiatives are positive first steps towards reducing plastic waste. Similar studies have traced how consumers are willing to pay more when it comes to products that are microplastic free [84]. This was said within the context of EU directives and initiatives that are currently being developed and implemented with the intention of either improving plastic products (eco-design initiatives) or having an all-out ban such as the SUP Directive. These measures

are part of the EU circular economy strategy to reduce plastic littering and dispersion of microplastic.

“We have seen that it is possible to ban microplastics added in cosmetics on the EU level. The unnecessary redundant microplastic cannot be removed only by placing a ban. For example, food packaging needs alternatives that we know are just as good or better.”

(Norwegian NGO 1)

Despite such initiatives, some stakeholders stated that trying to change regulations and legislations at the international level could be complex and time consuming. They believed it would be difficult to garner any international legally binding and comprehensive legislation, and therefore not worth the effort. Notwithstanding, momentum for a globally binding agreement covering all forms of plastic pollution is increasingly believed to be up for negotiations to start at the United National Environmental Assembly (UNEA) in Nairobi, Kenya February 2022 [85]. As the problem worsens, without swiftly enacting effective solutions, more waste will continue to be added the ever-growing environmental disaster of plastic pollution.

6.2. Slovenia Workshop—Finding a Solution

The workshop in Slovenia focused on the perception of jellyfish blooms and various benefits that could be provided from their biomass besides the use of jellyfish mucus as microplastic filter. The stakeholders brought in mitigation strategies of marine plastic pollution from the municipality, education sector, and wastewater treatment plants as shown in Figure 2. Stakeholders discussed how jellyfish mucus could potentially be a source to develop a filter to stop micro- and nanoplastic pollution within wastewater treatment plants [56]. On the topic of SUP, microplastics, and overall plastic pollution involving citizens in Slovenia, the stakeholders expressed concerns relating to the possible hazardous and toxic effects that microplastics could potentially have on humans. Nanoplastics constituted a concern for one stakeholder due to the inability of our internal organs to excrete these particles, which could create a serious health concern [86]. Nevertheless, more research on the potential hazardous effects of microplastic were needed, according to stakeholders. A topic of discussion was the removal of microplastic additives in various products such as cosmetics. As stated by participants in the workshop it was not necessary to enforce legislation upon manufacturers, as stakeholders themselves perceived it as a major competitive advantage for those manufacturers and suppliers who choose to avoid plastic in their products. This leads to the belief that consumers are willing to pay more for products that exclude plastic additives [84]. The Slovenian workshop stakeholders also stated that consumers were still to be held responsible in reading warning labels and to be educated about plastic pollution to aid the problem.

Furthermore, the stakeholders stated that finding a solution to microplastic pollution depends on the identification and adequate assessments of the plastic's primary sources. As the stakeholder participants were not part of the scientific community, one can assume that a major issue is found in dissemination of research results as many studies have assessed microplastics as primary sources of pollution [87–89]. This workshop emphasized that the efforts to solve the microplastic problem will be futile if SUP sources maintain the current level of pollution. In this same vein, during the Slovenian workshop session, topics concerning consumer knowledge and communication efforts from scientific experts were also discussed. Ambiguous and conflicting information related to certain products could create confusion amongst consumers and one stakeholder stressed the responsibility of scientist/researchers in disseminating information pertaining to microplastic. Nevertheless, the other half of the responsibility was placed on the consumers themselves, as the importance of reading product labels was emphasized.

The extensive proliferation of microplastics was emphasized by stakeholders in the Slovenian workshop as well as the Norwegian one. One participant said they read six months before the workshop that in the hand harvested sea salt, *Fleur the sal*, microplastics were found even in the extraction mines, leading to their belief that plastics truly are

everywhere and find a way to negatively affect various industries throughout the world. This consequently emphasizes the comprehensive aspects of the microplastic release into the environment at a scale not fully intelligible to this day. Meanwhile, other participants were most concerned about the sheer amount of pollution we already witness leading to potential harmful effects on human health. For example, the impact of eating sea salt with microplastics in it. Statements made during the workshop pointed to the need for more coherent research on the quantities of microplastic in humans and how it full effects human health as it is one source of pollution that we have a hard time seeing, yet it already exists. As examined in the Slovenian workshop, nanoplastics were declared to be more problematic and detrimental than microplastics, as the organs are witnesses to be unable to excrete plastic particles on the nanoscale [90]. In addition to calculating the amount of plastic in organisms and the human body, tracing and quantifying of primary sources and pathways of microplastic origins and dispersions became an important topic for several stakeholders. Regardless, the vast amount of SUP that is improperly disposed of breaks down into micro- or nanoplastics, therefore the overarching issue of our plastics consumption and improper disposal of plastics into the environment must be immediately addressed.

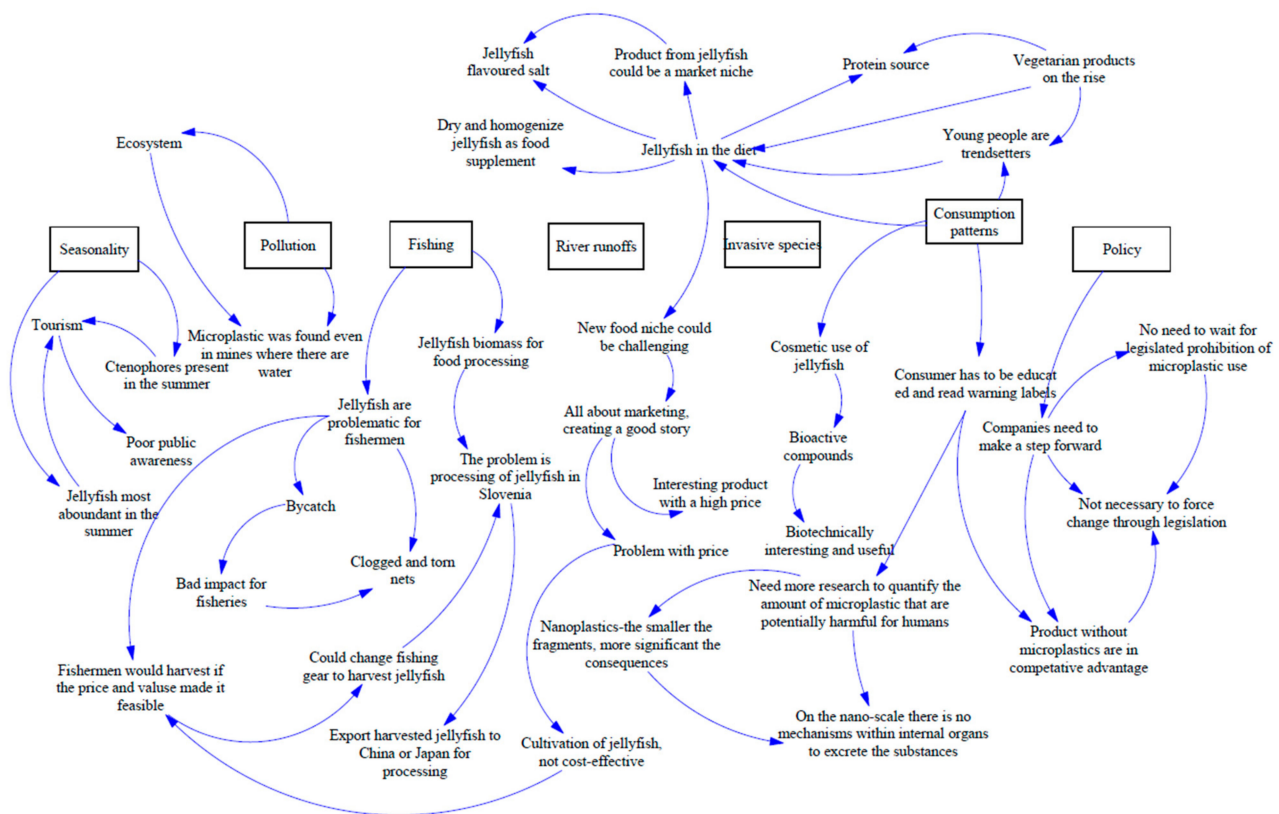


Figure 2. Vensim diagram of Slovenian mixed workshop.

7. Discussion and Conclusions

The systems thinking participatory modelling approach, which allowed for the creation of Mind Maps, provided important information on the best perceived mitigation methods of plastic pollution from stakeholders in Norway and Slovenia. While the results should not be viewed in-and-of-itself, they still provide a valid account of stakeholder perceptions on plastic pollution and future approaches to solve the pollution crisis, such as the ability of jellyfish mucus to capture micro- and nanoplastic leaching from wastewater treatment plants. Stakeholders from Slovenia and Norway were targeted using the snowball method for an assessment of their perceptions on marine plastic pollution amid a growing ocean of pollution. The stakeholders were comprised of future generations (youth), scientists, policymakers, education workers, industry, and NGOs. The focus was

on determining stakeholder strategies for solutions to diminish plastic pollution in our oceans as part of a project which utilizes jellyfish mucus to filter out microplastic. As global ideals can only be realized if local realities are considered, it is argued that to introduce policy integration on plastic, the conversation must be based on stakeholder perceptions. In each of the case area workshops, stakeholders participated in collaborative exercises to analyse challenges and mitigation strategies to combat plastic pollution. Given the critical role of the public in steering policymakers' 'willingness to place issues on the agenda', we found that a majority of the stakeholders across the two countries believed that more funding needs to be put towards disseminating scientific results to the public. A particular focus area was bridging the links between science, policy, and citizen opinions on managing plastic pollution and the pursuant mitigation within the science–policy nexus.

The industry stakeholders in the Slovenia workshop reiterated the claim that plastic pollution is highly visible, and as such seen in salt mines of Slovenia. On the other hand, the future generation workshop in Norway emphasized consumer behavior to be at the top of the pollution problem, leaving a clear path for policymakers to envision a future with informed and engaged consumers by making the problem more relevant to the general public. The conducted interviews allowed for a greater understanding of the plastic pollution crisis on a more personal level, with citizens who might propose novel plastic management solutions and/or represent advocates for their implementation in practice. In terms of conception and dispersion of plastic materials in the ocean, all interviewed stakeholders had input on next step actions, such as making studies on pollution pathways more widely available to policymakers, followed by the introduction of regulatory initiatives such as the circular economy and SUP Directive implemented on a global scale. On the other hand, Slovenian stakeholders wanted to gain more knowledge on sources, fate, and impact of plastic pollution, while the Norwegian future generations were more focused on applying legislative measures and determining responsibilities.

A wide range of measures to the plastic problem are now under development or discussion and would benefit from being examined in another round of workshops with the stakeholders from this study. The EU continues to gain insight into citizen and stakeholder input on how the plastic pollution is affecting communities locally. On the macro level, organizations such as UNEA are expected to soon start negotiations for a global plastic treaty to end plastic pollution. The scientific community has joined the appeal and are calling for global action now [91–93]. What we found during our in-depth interviews and workshops was that overall, it was relatively well known that plastics were a challenge that needs to be solved. This fits with the information gathered from the Eurobarometer surveys developed by the EU to test citizen's knowledge, awareness, and willingness to act in terms of mitigating plastic pollution as demonstrated by large quantities of Europeans surveyed, who were in favor of more plastic legislation. However, our study was able to bring first-hand input on citizen mitigation strategies that could be included in future plastic legislation. Future studies should discuss new schemes within the workshops such as the EPR scheme, circular economy, and recycling infrastructures in the individual's country case area. Finally, a new study could now be conducted after the SUP Directive has gone into effect, to re-examine citizen stakeholder perspectives on the issue and inform future global policy on how the ban affects them individually. This research must also be available to everyday citizen consumers in the form of popular science or open access journals. Open and widely disseminated science and awareness campaigns on the impact of plastic pollution will be essential for an international solution to tackle plastic pollution globally.

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