PRODUCT STEWARDSHIP AND THE CHANGE IN THE VALUE OF WASTE IN A CIRCULAR ECONOMY: A BUSINESS CASE STUDY

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ABSTRACT

By discussing the partnership between Plastic Energy, Sabic, and Unilever, this research analyzes how product stewardship increases the value of waste and circularity of the plastic industry. An abductive approach is followed, by using interviews as a method of qualitative data collection to link theory to practice. This research shows theoretical relevance by: firstly, arguing that the waste hierarchy is outdated and chemical recycling must be added to the scheme; secondly, it shows that, although pre-cycling is a valid addition to a circular economy, product stewardship is an even more determinant factor in allowing for circularity and its addition to circular economy theory is necessary. As for practical relevance, the results illustrate to industry professionals that there is a solution to the plastic pollution problem, and that engaging with product stewardship and sustainability increases value for the business and its stakeholders.

INTRODUCTION

In 1997, Charles Moore, with his 25-ton research ship, discovered what would become known as the Great Pacific Garbage Patch. Moore encountered large amounts of floating plastic, which surpassed surface zooplankton by a ratio of six to one (Doucette, 2009). He described it as if it were "never-ending plastic confetti" floating on water (Doucette, 2009). The Pacific Ocean is not the only area impacted by the increasing global plastic production since the 1950s. Plastics have now managed to infiltrate all oceans of the planet, including those believed to be as pristine, posing tremendous threats to marine bio life (Free, Jensen, Mason, Eriksen, Williamson, & Boldgiv, 2014). Besides threatening marine ecosystems, plastics can be hazardous to the environment when they are incinerated by waste management companies that do not have the technology to efficiently sort them. In addition, poor disposal practices from consumers also play a role in the challenge to recycle plastic (Turner, 2018).

For the last years, companies have been scrutinized for producing plastics. The current assumption is that businesses operating in linear economic models cannot be sustainable and beneficial to the environment (Ellen MacArthur Foundation, 2016). Scholars have discussed the plastic industry's inability to develop circular production processes (Arena, Mastellone, & Perugini, 2003; Demetrious & Crossin, 2019; Geyer, Jambeck, & Law, 2007; Hegberg, Hallenbeck, & Brenniman, 1993; Hopewell, Dvorak, & Kosior, 2009; Andrady, 2015; Nielsen, Hasselbach, Holmberg, & Stripple, 2019). Questions have been raised, extensively debating how plastic products can be restored and regenerated. In particular, how mechanical recycling often leads to down-cycling and a lower valued recycled plastic product (Dodbiba & Fujita, 2004). By addressing reuse and recycling, along with the necessity to reduce waste and optimize the use of resources, the concept of a circular economy has been linked with the debate on plastic.

In January 2020, Unilever was nominated for the Product Technology Innovation of the Year award for their recyclable plastics technology. Unilever has started to use a Certified Circular Polypropylene for consumer food packaging provided by the petrochemical manufacturing company Sabic. This innovative technology involves various companies. Firstly, Plastic Energy, a recycling company that buys polypropylene (PP) and polyethylene (PE) that would otherwise be

incinerated by waste collection companies, and turns these plastics into what they call Tacoil. Secondly, Sabic, who buys this oil and produces new plastic (polymers). Thirdly, multinational companies, such as Unilever, who buy the plastic from Sabic to use for their packaging for consumer goods. Unlike linear models, where materials are usually discarded after its use, these companies engage in activities which allow plastic waste to be put back into a circular system for plastic production.

Considering the partnership above, the aim of this paper is to shed light on the internal workings of a circular economic system and the impacts it may have on the environment. Hence, this research answers the following question: *how does product stewardship increase the value of waste and circularity of the plastic industry?* In order to answer this question, this paper considers the partnership between Plastic Energy, Sabic and Unilever as a business case study.

For this research, it is important to outline the distinction between Product Stewardship and Extended Producer Responsibility (EPR). The concept of product stewardship is often interlinked with EPR, but contains significant distinctions (Jensen & Remmen, 2017). While product stewardship may involve voluntary action and adoption, EPR "is a mandatory type of product stewardship" with certain legal requirements (Monroe, 2014: 224). Although both concepts consist of placing responsibility on producers, EPR provides economic incentives to consider environmental impact of their products (Monroe, 2014: 224). For these reasons, this research solely focuses on the product stewardship concept, in order to understand why this role has been adopted by the companies discussed hereafter.

Although there is consensus about the circular economy and its aim to reduce waste, recycle materials and provide product re-design thinking, the concept is fairly recent and is still under development (Gallaud & Laperche, 2016). Hence, this research addresses gaps in the current academic debate on the circular economy, arguing that it lacks the integration of product stewardship. Although the circular economy addresses closed-loop systems, the six Rs (reduce, reuse, recycle, redesign, remanufacture, recover), this research shows that product stewardship is essential for firms to put the six Rs into practice. In addition, results show that the waste hierarchy scheme is outdated, and chemical recycling needs to be incorporated into the approaches that deal

with waste. Another gap addressed in this research concerns pre-cycling. Although pre-cycling is an important component of the circular economy, this research illustrates that whilst designing products that do not turn into waste, firms that recover waste and use it as input of production processes is an even more determinant factor allowing for a circular economy.

Focusing on the companies Plastic Energy, Sabic, and Unilever, this research discusses the characteristics of the partnership that would allow for a more circular plastic economy and an increase in the value of waste. In order to answer the research question posed previously, this research will firstly provide a literature review discussing the background on plastics, waste management challenges, plastic products in a linear economy, followed by an introduction to the concept of a circular economy, value creation from waste and product stewardship. This will be followed by a methods section outlining the research approach and methods for data collection. Then, a section on the results obtained will be presented, followed by a conclusion. Finally, potential implications for industry practices will be discussed, along with considerations for future research.

THEORY

Plastics: A Background

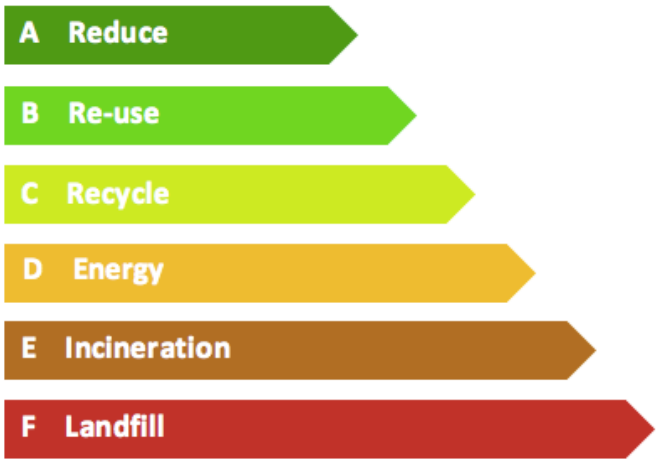
Products made from plastics have integrated worldwide markets in such a way that it has become almost impossible to imagine a world without it (Rosato, Rosato, & Schott, 2010). Inevitably, plastics have become a part of individuals' lifestyles, ranging from domestic to sophisticated products. The versatility of plastics allowed the industry to meet consumer demands, delivering cost-effective products which provided "exceptional benefits for people and industries worldwide" (Rosato et al., 2010: 3). The plastic life cycle has been said to have the following stages: production, consumption, waste management including collection, sorting and processing, incineration, landfill, and, lastly, re-usage (Nielsen, Hasselbach, Holmberg, & Stripple, 2019; Arena, Mastellone, & Perugini, 2003; Demetrious & Crossin, 2019; Hegberg, Hallenbeck, & Brenniman, 1993). The production of plastics is very much connected to petro-chemistry and fossil fuels, where the outstanding majority of the feedstock for plastic production comes from fossil

fuels (Nielsen et al., 2019; Hopewell, Dvorak, & Kosior, 2009; Andrady, 2015). A further explanation on the chemical composition of plastics can be found in Appendix A.

Challenges for Waste Management

Lansink's waste hierarchy allows for a better conceptualization of the waste management phase of the plastic life cycle. As shown below, reduction of waste occurs in the following manners: starting with the ideal solution to reduce, followed by re-use, recycling and energy recovery. Then, moving to the lower end of the hierarchy, with the less desirable solutions incineration and landfill (van Leeuwen, de Vries, Koop, & Roest, 2018: 787). This order of desired actions stems from the environmental impact of each approach to managing waste (van Ewijk & Stegemann, 2016).

Figure 1: Waste Hierarchy



Adapted from Recycling.com

The waste hierarchy concept is said to have originated in the United States by 3M, a private company (Pires & Martinho; van Ewijk & Stegemann, 2016). In Europe, the concept was developed by former Dutch politician Ad Lansink, in a proposal for Dutch Parliament in 1979 (Pires & Martinho; van Ewijk & Stegemann, 2016). Over the years, Lansink's proposal become known as Lansink's Ladder (van Ewijk & Stegemann, 2016). Using the waste hierarchy, the European Union assesses performance of waste operations in relation to collection, recovery and

recycling rates (Pires & Martinho, 2019). However, limitations to quantifying recycling rates have been pointed out due to the failure to distinguish between closed-loop and open-loop recycling (Pires & Martinho, 2019). Open-loop is problematic because it consists of down-cycling, where the material's lifetime is reduced (Pires & Martinho, 2019). Indifference between up-cycling and down-cycling in results measurement can be misleading, as up-cycling is more beneficial to a more circular economy (Pires & Martinho, 2019).

Prominence has been given to the improvement of the waste management of plastics, particularly for the sorting and processing to allow for recycling (Hopewell et al., 2009; Nielsen et al. 2019; Rivers, Shenstone-Harris, & Young, 2017; Oyake-Ombis, van Vliet, & Mol, 2015). The lack of technology for plastic assortment can lead to negative environmental externalities. Mechanical recycling, for example, can often result in down-cycling, a process in which the outcome is a low-value end product (Dodbiba & Fujita, 2004). This particular technology places the plastic under thermo-mechanical degradation where its polymeric structure and properties are altered (Soroudi & Jakubowicz, 2013: 2851). Subsequently, lower long-term quality and stability of these mechanically recycled plastics compromise future recovery attempts at end of life (Soroudi & Jakubowicz, 2013: 2851). Another option to dealing with unsorted plastic waste is incineration. Although this can provide electric efficiency, the process carries environmental burdens (Arena et al., 2003). When incineration is not possible, plastic goes to landfill sites, where, besides leaking into the environment, it is only degraded within a time frame of one hundred years (Arena, Mastellone, & Perugini, 2003).

In addition to limited technology, another challenge for plastic waste management can result from inappropriate consumer disposal. Consumer behavior has been studied in relation to the disposal of products such as plastic bags, plastic bottles, disposable cups, and food packaging (Nielsen et al., 2019). Behavior responses can vary depending on an individual's socio-economic background, their habits as consumers, and their environmental awareness (Nielsen et al. 2019; Jakovcevic et al., 2014; Poortinga, Sautkina, Thomas, & Wolstenholme, 2016). Differences in behavior can be; using alternative products to plastic, avoiding single-use plastic, appropriately or inappropriately discarding plastic products (Dauvergne, 2018; Mendenhall, 2018; Nielsen et al., 2019; Steensgaard, Syberg, Rist, Hartmann, Boldrin, & Hansen, 2017). Inappropriate disposal of plastic

can have detrimental impacts on the reuse and recycling of the material. Mixing plastic with organic waste, for example, can negatively influence the sorting procedures for mechanical recycling (Soroudi & Jakubowicz, 2013).

Plastics in a Linear Economy

The plastic pollution generated by the lack of technology in waste management companies, as well as from inappropriate disposals from consumers, means that the plastic product created by multinational companies are destroyed at the end of its life cycle (Didenko, Klochkov, & Skripnuk, 2018; Turner, 2018; Sariatli, 2017; Andrews, 2015). This destruction, in turn, leads to the depletion of natural resources that are required for production (Didenko et al., 2018). This system, where products are not re-used after their end cycles, is called the Linear Economic Model, or Linear Socio-Economic System (Didenko, Klochkov, & Skripnuk, 2018; Turner, 2018; Sariatli, 2017; Andrews, 2015). Under this economic system, individuals have tremendous negative impact on the environment. Human-induced depletion of natural resources significantly alters the balance and internal connections of earth's biosphere systems. These negative externalities often have irreversible consequences for the environment (Didenko et al., 2018).

Plastics are confined to a linear economic system if; the material is unsorted at waste management facilities or sent to landfills, incineration plants and even when used for energy recovery (Turner, 2018). Even if the energy recovered from the process of incineration is beneficial to the environment to a certain extent, it still represents linearity as this energy is single-use, and the plastic waste is not recycled for re-usage for the production of new goods (Turner, 2018). According to the Ellen MacArthur Foundation (2016), "95% of plastic packaging material value, or USD 80-120 billion annually, is lost to the economy after a short first use" (Ellen MacArthur Foundation, 2016: 12). Out of all plastic that is produced, only 14 percent is collected for recycling (Ellen MacArthur Foundation, 2016). Moreover, the plastics that are recycled are usually downgraded to "lower-value applications that are not again recyclable after use" (Ellen MacArthur Foundation, 2016: 12). As mentioned above, down-cycling occurs due to the alteration of structure and properties plastics undergo within mechanical recycling (Soroudi & Jakubowicz, 2013).

Circular Economy Theory

In contrast to the linear economy, the Circular Economy (CE) implies that the damage caused through natural resource extraction is restored, and ensures a lesser generation of waste during product creation and end-of-life (Murray, Skene, & Haynes, 2017). The concept is not new, and has gained increasing consideration since the 1970s (Geißdörfer, Savaget, Bocken, & Hultink, 2017). Many scholars accredit Stahel (1982) and Pearce and Turner (1989) to the introduction of the Circular Economy, which discussed the influence of natural resources on the economy (Andersen, 2007; Geißdörfer et al., 2017; Ghisellini, Cialani, & Ulgiati, 2016; Su, Heshmati, Geng, & Yu, 2013). The authors also described how inputs for production became outputs in the form of waste, characteristic of open-ended economic systems (Geißdörfer et al., 2017; 763). From then, the CE concept has developed further. Stewart and Niero (2018) refer to CE as a system which aims to maximize value of a product by elongating its life-cycle. Geißdörfer et al. (2017) describe CE as a "regenerative system" where energy, emissions and waste are reduced through different product design approaches, reuse, remanufacturing and recycling (Geißdörfer et al., 2017; 762). This includes the six Rs (reduce, reuse, recycle, redesign, remanufacture, recover) (Murray et al., 2017), and also pre-cycling, the action taken by manufactures of re-designing products by correcting characteristics that allow them to become waste (Greyson, 2007).

References to CE theory often accompany the concept of the cycle. More specifically, to biogeochemical cycles as well as the recycling of products (Murray et al., 2017). Focusing on the recycling of products, as is the aim of this research, it is seen that this becomes a significant part of sustainability (Murray et al., 2017). In literature, while the CE concept has been associated with environmental sustainability, scholars also equate it to achieving economic prosperity (Kirchherr, Reike, & Hekkert, 2017; Stewart & Niero, 2018). Among practitioners, CE has shown to be a tool for sustainable development (Kirchherr, Reike, & Hekkert, 2017; Stewart & Niero, 2018). Attempts have been made to demonstrate how circular business models can lead to value creation for various stakeholders (Stewart & Niero, 2018). The link between CE and sustainability has also been conceptualized by; firstly, looking at CE as a condition to reach sustainability, secondly, understanding CE as an approach to advance sustainability, and lastly, as a trade-off relationship, where CE can have positive and negative sustainability outcomes (Geißdörfer et al., 2017).

Furthermore, the cradle-to-cradle approach has also been related to CE and sustainability. In particular, how this approach emphasizes reutilization of materials (Braungart & McDonough,

2002; Ghosh, 2019; Mao, Li, Pei, & Xu, 2016; McDonough, Braungart, Anastas, & Zimmerman, 2003; Murray et al., 2017; Sauvé, Bernard, & Sloan, 2016). Within the cradle-to-cradle approach, recovering waste is paramount. This may consist of using waste from recycling procedures, including its reintegration and regeneration (Ghosh, 2019), as well as using renewable energy (McDonough et al., 2003). Both cases imply a closed-loop system, where resources can be re-utilized in the production process (Ghosh, 2019; McDonough et al., 2003). A closed-loop system offers the possibility of decreasing the necessity of landfill sites and incineration of plastic waste (Ghosh, 2019). Placing waste back into recirculation within industries, allows it to become a valuable resource (Sauvé, Bernard, & Sloan, 2016). Redesigning life cycles of products, with this approach to using waste as a resource, generates a recovery of material and economic value (Ghosh, 2019).

Creating Value from Waste

Firms' abilities to create value have been, to a large extent, equated to the development of disruptive innovations (Bocken, Short, Rana, & Evans, 2014; Hart & Milstein, 2003; Neumeyer & Santos, 2017; Porter & Kramer, 2011). Green innovations have the capabilities to decrease the human footprint and negative externalities on the planet's ecosystems (Hart & Milstein, 2003). In turn, firms create shareholder value by "reconceiving products and markets" (Porter & Kramer, 2011; 7). Porter & Kramer (2011) state that firms create economic value for them by creating value within communities and societies. In addition, firms possess greater resources than governments and non-governmental organizations that allow them to be more effective in creating benefits for society; for example, products that have a positive impact on the environment (Porter & Kramer, 2011). Better resource utilization has also been possible through the development of new technologies.

New technologies have been able to transform the concept of waste, turning it into valuable resource streams for production (Bocken et al., 2014). Bocken et al. (2014) discusses a particular business model that creates value from waste. In this model, firms, along with its partners, close material loops by using waste streams as resources. The value capture for society is a reduced usage of virgin input materials, which also lead to reduced waste in landfills and reduced footprint on the planet (Bocken et al., 2014). An assumption of this model is that companies are able to

reduce economic costs by reusing materials (Bocken et al., 2014). In addition, this model also places responsibilities on producers. The work of Neumeyer & Santos (2017) further elaborate this idea, stating that producers can introduce under-utilized materials as production feedstock. Hence, producers engage in production processes that are more attentive to the demands and necessities of societies and the environment.

Product Stewardship

In addition to the business model that creates value from waste, Bocken et al. (2014) discuss the stewardship business model. However, it is important to define product stewardship before discussing this business model. Product Stewardship can be considered "the act of minimizing health, safety, environmental and social impacts, and maximizing economic benefits of a product and its packaging throughout all lifecycle stages" (Monroe, 2014; 224). Scholars have highlighted the responsibility of producers as stewards, where they assess impacts on health and the environment arising from production and the entire life-cycle of products (Lewis, 2005; Monroe, 2014; Perey, Benn, Agarwal, & Edwards, 2016; Veleva, 2009). Therefore, by definition, the product stewardship business model ensures the health and well-being of a firm's stakeholders (Bocken et al., 2014). In addition, the authors argue that this business model, when combined with the creating value from waste model, can generate greater benefits.

One of the value captures of the stewardship business model, in addition to producer responsibility, is its focus on educating society on "reuse across generations" (Bocken et al., 2014: 51). Therefore, it can be said that the model aims to exert positive impacts for society and the environment, while simultaneously protecting bio-diverisity and natural resources (Bocken et al., 2014; Jensen & Remmen, 2017). Another important aspect of product stewardship is its voluntary nature (Lewis, 2005; Monroe, 2014; Veleva, 2009). Product stewardship roles can be adopted between businesses as voluntary agreements, under no regulation (Jensen & Remmen, 2017). In sum, with the objective of encouraging producers to use recycled materials (Veleva, 2009), product stewardship targets all industry actors to share responsibility in production (Lewis, 2005).

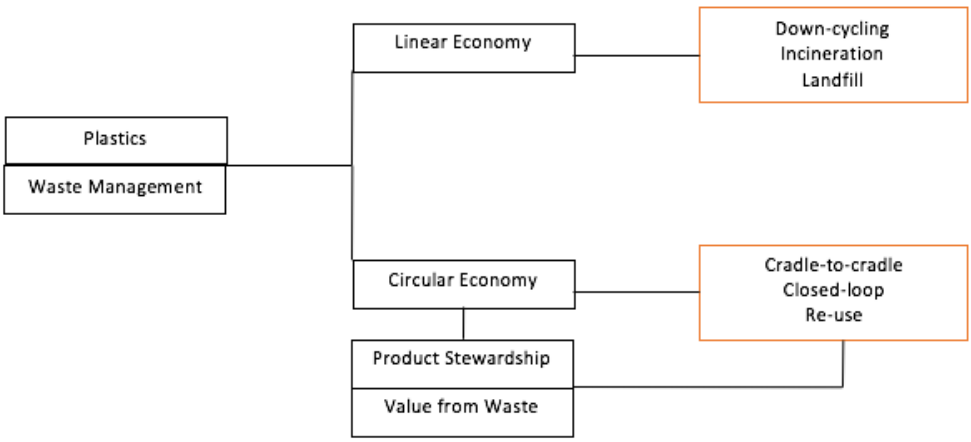
While some view stewardship from the standpoint that participants in production and overall industries assume responsibility from their impacts on the environment (Lewis, 2005), others view

stewardship as a direct engagement with stakeholders to address impacts and ensure their well-being (Bocken et al., 2014; Neumeyer & Santos, 2017). This direct engagement can be ensured through consumer education about environmental impacts of products (Lewis, 2005). While producer responsibility internalizes environmental impacts of products, direct stakeholder engagement increases awareness about environmental and health impacts beyond consumption and disposal (Stitzhal, 2011: 37). Nonetheless, whether there is an indirect engagement through product re-design, or direct stakeholder engagement through education, product stewardship encourages producers to re-design products in a way that benefits all stakeholders.

Conceptual Framework

The diagram below illustrates the connections from the theoretical review presented above. The starting point, plastics and waste management, may lead to either a linear economy, or a circular model. For the linear economy path, the end result is including, but not excluded to; down-cycling, incineration and landfill. The circular economy path leads to concepts such as the cradle-to-cradle approach, re-use and the closed-loop system. Other terms that relate to the circular economy are product stewardship and value creation from waste. The literature presented above also indicates that these two terms have a connection to re-use, closed-loop and the cradle-to-cradle approach.

Figure 2: Theoretical Framework Diagram



METHODOLOGY

In order to answer the research question posed previously, the partnership between Plastic Energy, Sabic and Unilever was considered as a business case study in this research. An in-depth interview study was conducted on these companies. This form of interviewing is a "one-to-one method of data collection" through semi-structured interviews (Hennink, Hutter, & Bailey, 2011: 116). In-depth interviewing is an approach taken when attempting to understand how individuals make decisions, their motivations for these behaviors, and to better comprehend the context of these individuals (Hennink et al., 2011). Furthermore, this research, in line with the work of Daft & Lewin (1993) and Tracey, Phillips, & Travis (2011), studies organizations by not presuming to test hypotheses empirically. Thence, an abduction approach is taken (Tavory & Timmermans, 2014), by using interviews as a method of qualitative data collection, to link theory to practice. This approach views meaning as an ongoing construction, where researchers "move back and forth between a set of observations and a theoretical generalization" (Tavory & Timmermans, 2014; 4).

In relation to induction and deduction, abduction has a different "logical form" (Tavory & Timmermans, 2014; 37). Abduction is distinct because it begins with "consequences and then constructs reasons" (Tavory & Timmermans, 2014; 37). It can be said that abduction seeks for theory, and not facts – such as induction (Tavory & Timmermans, 2014; 38). In addition, unlike deduction, abduction does not assume propositions to be true (Tavory & Timmermans, 2014; 37). Due to its distinct logic, abduction is an approach useful for observations with unknown and hidden causes (Tavory & Timmermans, 2014; 37). In this research, abduction is used to explain observations that are not easy to explain. This is because sustainability has often been referred to as a wicked problem, a difficult issue to appropriately comprehend and tackle (Batie, 2008; Lazarus, 2008; Meckenstock, Barbosa-Póvoa, & Carvalho, 2016).

Data Collection

The interviews were conducted remotely via video or audio calls with all respondents, for all companies. The interview questions follow a logical order (Hennink et al., 2011), from a general theoretical perspective to specific concepts. Moreover, the first two questions provide insight on whether the respondent is involved with sustainability within the company, and if they are

knowledgeable about chemical recycling and the company's product portfolio. This was done in order to determine whether the respondents had sufficient knowledge to contribute to data gathering, and to increase the validity of the interview. Understanding whether the right respondent was interviewed was also important to determine whether saturation was reached.

Interview preparation requires initial permission by the interviewees for the research to be carried out, as well as setting other requirements and procedures (Hennink et al., 2011). Hence, for each interview, a Consent Form was sent to the respective interviewees prior to the interview (Appendix C), and also discussed prior to the interview. The document refers to the interviewees' consent, the objective of the research, the option for anonymity, as well as the purpose of recording and transcribing the interviews. An interview guide was also prepared for the interviews (Appendix B). The guide allows the interviewees to receive an introduction to the research, as well as to be reminded of their right to anonymity and overall consent.

Data Analysis

Prior to analysis, all interviews were transcribed. Each interview was coded, first in Microsoft Word and then in Excel, following the work of Ruona (2005). Interviews were analyzed looking for codes in order to label and categorize these in a code tree. The pre-conceived codes were derived from the theory section, looking for specific codes that highlight the concepts of interest for this research; such as circular economy, creation of value, waste reduction, and product stewardship. As a coding method, this research utilizes the "open coding" technique (Khandkar, 2009). This approach is said to be a valid option as it permits the researcher to generally view the research theoretical aspect, and as a consequence, to be more selective when searching for the concepts of interest in the interviews (Glaser, 2016). After all interviews were coded, a matching technique was applied (Dubois & Gadde, 2002). This consisted of going back and forth from the theory to the data collected (Dubois & Gadde, 2002). Essentially, this technique seeks to highlight the codes that are consistent with the theory discussed in the research. The analysis starts with the theoretical framework, then compares theories to the coded findings, and, lastly, links these findings to theory; the abduction approach.

Research Quality and Ethics

A final consideration on research quality and ethics is important. Following the COREQ checklist by Tong, Sainsbury, and Craig (2007), this research follows the appropriate criteria for data collection and reporting. Because audio recording and transcription reflects the respondents' views to a larger extent (Tong, Sainsbury, & Craig, 2007: 356), instead of using researcher notes, transcriptions of interviews have been carried out. Moreover, participants had the opportunity to review transcriptions to assess whether their responses were appropriately recorded. Therefore, contextual interpretation from the researcher was eliminated from the data collection process. In addition, as the length of interviews may influence the amount of data obtained (Tong, Sainsbury, & Craig, 2007: 356), all interviews have been restricted to thirty minutes. Lastly, in order to add transparency to the research, data reporting consists of analyzing all participants' answers, and therefore including all participants' perspectives on the subject.

As mentioned previously, the first two questions served the purpose of assessing whether the respondents were knowledgeable about the subject at hand. Hence, respondents were chosen according to their expertise about sustainability and chemical recycling. This also allowed for a determination of whether data saturation had been reached. According to Saunders et al. (2018), deciding whether saturation has occurred is based on the information the researcher has been obtaining in interviews. Informational redundancy, for example, views data saturation dependent on new information acquired in interviews, or the lack thereof (Saunders et al., 2018). Based on these definitions, and because the same concepts have appeared throughout all interviews without the emergence of new concepts, data saturation has been reached with nine respondents for this research.

RESULTS

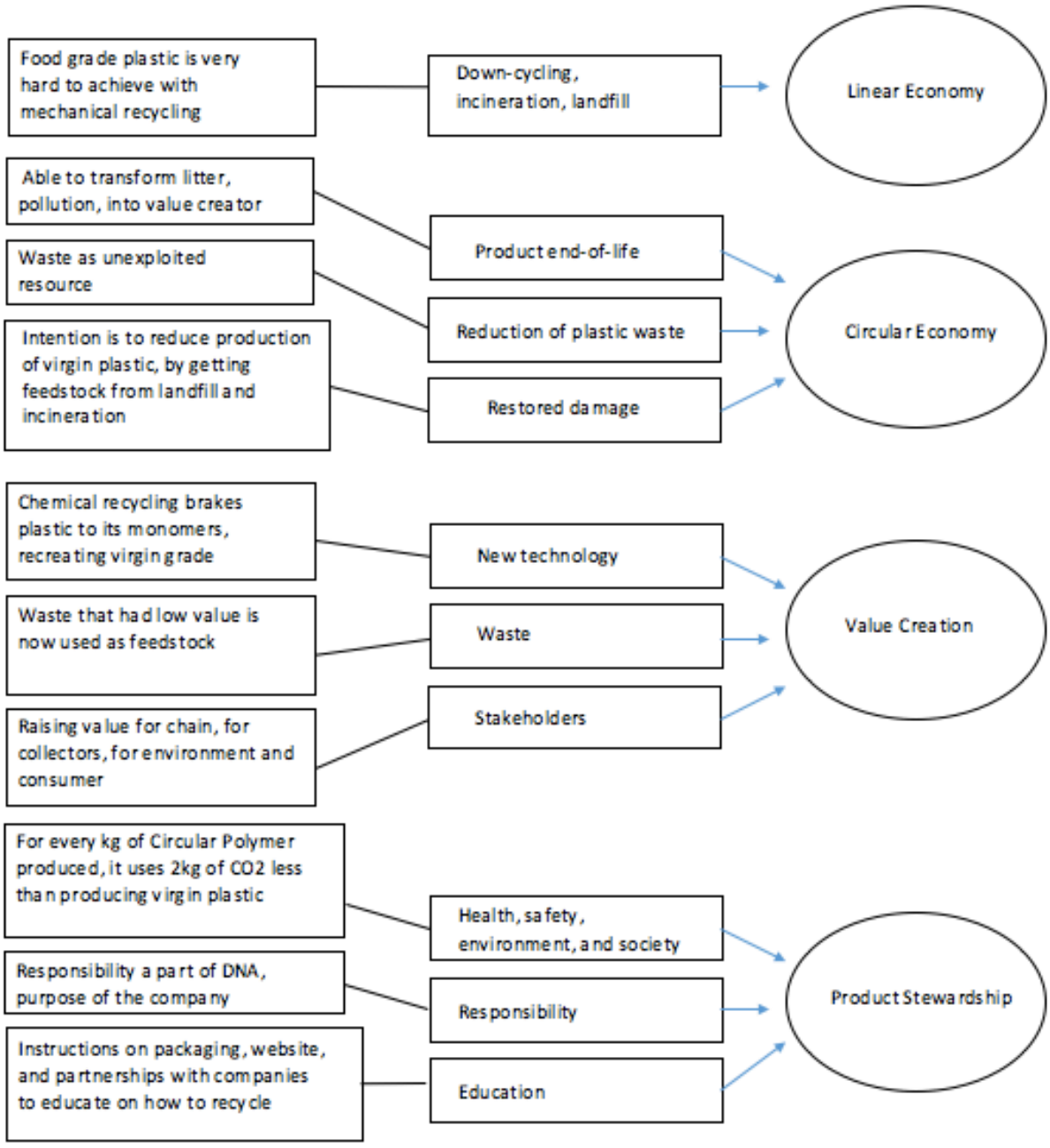
Case Description

As mentioned previously, the case considered in this research is the partnership between Plastic Energy, Sabic and Unilever. Plastic Energy, according to their website, is a global company with the mission of addressing plastic pollution through chemical recycling. According to Sabic's website, they are a chemical manufacturing company, with products such as polyethylene and polypropylene made from pyrolysis oil. As a multinational consumption goods company,

Unilever, as mentioned on their website, brings brands and products to consumers with the aim of making sustainable living commonplace.

As shown in the interviews conducted (Appendixes E, F, G), and summarized in the individual code trees for each company (Appendix D), the three companies are involved in a partnership where plastic waste is used as input for production. Firstly, Plastic Energy melts mixed plastic waste at high temperatures, breaking this down into hydrocarbons. From there, the company creates what is called Tacoil. This is the process of chemical recycling, also known as pyrolysis; breaking down plastic waste back to its monomers, its original form. Then, the Tacoil, also referred to as pyro oil, goes to Sabic into a cracker and transformed into polypropylene, for example. Finally, the new plastic, polypropylene, is then bought by Unilever to be used in a variety of applications, such as ice cream packaging. The summarized overall results are shown in the code tree below.

Figure 3: General Code Tree (Results)



Waste Management Challenges and the Linear Economy

The results obtained in this research relate to much of the theoretical framework discussed previously. In regards to waste management challenges, all respondents addressed the limitations of mechanical recycling. In accordance with Dodbiba and Fujita (2004), interviewees for all companies emphasized that a large majority of plastic waste is down-cycled and end up in a lower

quality. In addition, Unilever's respondents discussed the difficulty of obtaining the necessary grade (quality) of recycled plastic through mechanical recycling. As pointed out by Soroudi and Jakubowicz (2013), mechanical recycling alters the plastic's structure and properties. Consequently, shown in interviews two and three with Unilever, obtaining food grade recycled plastic is challenging with this technology (Appendix G). Because the end result is a lower quality material, it compromises food safety, as stated by Unilever's and Sabic's respondents. In addition, in particular for ice cream applications, this mechanically recycled material may break in frozen environments (Appendix G).

As shown in the literature review, another challenge to plastic waste management is inappropriate consumer disposal. The respondents, particularly from Unilever, confirmed that consumer behavior is a challenge and that there needs to be educational programs in place to assist consumers to dispose appropriately. However, due to the nature of this research and its focus on a new technology, most references to waste management challenges relates to mechanical recycling. In addition to down-cycling, Plastic Energy's second interviewee stated that, with this type of recycling, only two percent of plastic waste has a "closed-loop solution", where the remainder is either down-cycled, incinerated or sent to landfills (Appendix E). This response indicates, as previously seen in the work of Turner (2018), that these plastics are confined to a linear economy when down-cycled, incinerated or sent to landfills. Because mechanically recycled plastic cannot be used in food applications, as stated by all respondents, and because landfill is the direct link to environmental leakage, as mentioned by Unilever's respondents, the linearity discussed in the theoretical framework is seen here.

Circular Economy

As the partnership between the three companies revolve around chemical recycling, participants were asked if this new technology can reduce plastic waste. Reflecting the work of Murray, Skene and Haynes (2017), where a circular economy ensures a lesser generation of waste, Plastic Energy's first respondent mentioned that the company is innovating by recycling a mix of low value plastic waste, which would otherwise be incinerated or sent to landfill, and generating an outcome with a quality almost identical to virgin plastic material (Appendix E). The second respondent added to this, by emphasizing that the main characteristic that allows for circularity is

that the Tacoil, or pyro oil, meets the demands of petrochemical companies for plastic production (Appendix E). Therefore, the innovation, according to the respondents, allows for a replacement of fossil oil by recycled oil from end of life plastics.

In respect to waste reduction, the first two respondents for Sabic stated that in order to make one ton of Circular Polymer, the company needs 1,5 ton of mixed plastic waste. Moreover, when compared to incineration, chemical recycling can save two kilograms of carbon dioxide emissions for every kilogram of polyethylene or polypropylene produced. The comparison to the quality of virgin plastic material was also made by Sabic's respondents. Because waste is taken back to its original form, monomers, the plastic that is built from Tacoil has the same quality as virgin plastic (Appendix F). The third respondent stated that because plastic waste is recycled to its purest form, there is no down-cycling in place. Instead, the material is being upgraded because it is given another life in a new application (Appendix F).

The plastic life cycle was also discussed by Unilever's interviewees. The first respondent asserted that by turning waste into a resource, keeping it out of the environment, the material gets a second life (Appendix G). Furthermore, it was also stated that the material stays within the loop through an elongated life. The second respondent added by arguing that "from a waste point of view, it is finding an alternative treatment for plastic waste", and avoiding plastic to leak into the environment (Appendix G). The respondent concluded by stating that it is also an economic incentive to the value chain, because the material is considered "…a resource and not as waste". These results reflect the works of Ghosh (2019) and McDonough et al. (2003), where resources are reutilized for production and the materials stay within a closed-loop system. Subsequently, as indicated by the authors above and the respondents, this system allows for plastic waste to be redirected from landfills and incineration processes.

These responses also reflected the cradle to cradle approach mentioned in the theoretical framework, where the reutilization of materials is emphasized (Braungart & McDonough, 2002; Ghosh, 2019; Mao, Li, Pei, & Xu, 2016; McDonough, Braungart, Anastas, & Zimmerman, 2003; Murray et al., 2017; Sauvé, Bernard, & Sloan, 2016). Many concepts from the theoretical framework were identified in the results, but there were no mentions of pre-cycling or regenerative

systems. Lastly, although the demand for Tacoil has the potential to reduce plastic waste, it was also said that Plastic Energy currently has a small capacity. Nonetheless, the company processes thirty ton of plastic waste in their plants (Appendix E). Moreover, the technology shows to emit less emissions compared to incineration and even virgin plastic production. However, the process, currently at a small scale, requires a substantial amount of energy for heating the plastic and cooling the oil.

Creating Value from Waste

The results further indicate that plastic is seen as a resource by these companies, and according to the work of Ghosh (2019), using waste as a resource can increase its value. Therefore, participants were asked whether chemical recycling had the potential to increase the value of waste and value for the companies' respective stakeholders. The results from the interviews indicate that plastic waste has started to gain value through chemical recycling. All respondents shared the perception that the value of waste increases as it becomes the new feedstock for plastic production. According to Unilever's first respondent, incineration has very low value, sometimes a negative one, and creating a demand for Circular Polymers increases the value of waste because the recycled oil is the feedstock for production (Appendix G). The third respondent adds to this, stating that with increasing the demand for waste as an input for production, there is higher interest in collecting plastic waste – which increases its non-economical value, its importance (Appendix G).

In the theoretical section, it was discussed that green innovations have the ability to decrease negative externalities on the planet's ecosystems (Hart & Milstein, 2003), and the ability to generate value (Bocken et al., 2014; Hart & Milstein, 2003; Neumeyer & Santos, 2017; Porter & Kramer, 2011). In addition to changing the value of waste, all respondents mentioned the creation of value for stakeholders. For Plastic Energy, its was mentioned that the technology creates value for their stakeholders as it allows for a more positive image of companies and the opportunity to reach their sustainability commitments. In the case of Sabic, as mentioned in the interviews, it creates value for their stakeholders as these companies can now use recycled food grade plastic for specific applications. As both Plastic Energy and Sabic are business to business companies, their stakeholders and views on this matter are similar. However, Sabic also stated that value is

created for society, by addressing plastic pollution, and for waste collection companies from a financial perspective, as they profit from selling plastic waste.

Lastly, Unilever's respondents mentioned that there is value creation for multiple stakeholders. Because Unilever is a business to consumer company, there are different stakeholders mentioned in the responses. Firstly, for collectors, who are able to sell their plastic waste. Secondly, the environment, which benefits from less waste in landfills and incineration processes. And lastly, as discussed by the third interviewee, for consumers. Having recycled plastics that are food grade in food applications guarantees safety for consumers (Appendix G). Three parameters are used to determine the safety of the consumer within plastic food applications. Firstly, the taste of the food which should remain the same quality. Secondly, because it is illegal to use post-consumer recycled plastic in food applications due to safety concerns, addressing this issue is beneficial. And lastly, the quality of the packaging that allows it to be resistant in frozen environments.

Product Stewardship

Participants were asked the reasons for engaging in the partnership and with chemical recycling. In accordance with the definition of product stewardship, its focus on producer responsibility, and stakeholder well-being and engagement through education (Lewis, 2005; Monroe, 2014; Perey, Benn, Agarwal, & Edwards, 2016; Veleva, 2009), the results show that Plastic Energy, Sabic and Unilever adopt a product stewardship role in the industry. Respondents for Plastic Energy emphasized a feeling of responsibility to address the issue of plastic pollution. However, the demand for a solution from customers was another determinant factor. As for Sabic, the third respondent stated that a feeling of responsibility plays a role in why the company implements chemical recycling. It was said that higher management believes they should do something about plastic pollution, and that, as an industry, they are responsible for sharing their knowledge "for a greater good" (Appendix F). Moreover, the first respondent made a direct reference to product stewardship. The respondent mentioned there is a story of product stewardship in place at the company, where an importance is placed on consumer safety in plastic applications. Therefore, there is engagement with chemical recycling in order to assure that there is no contamination in food applications, and where consumer safety is secured (Appendix F).

The responses for Unilever further demonstrated a connection with the theory and definition for product stewardship. When asked about the well-being of stakeholders, the first respondent for Unilever stated that this is in the forefront of the business (Appendix G). This also holds true for sustainability, according to the interviewee, which added that Unilever has signed multiple plastic pacts globally and made partnership with various waste collectors. All interviewees confirmed that these Circular Polymers bought from Sabic are substantially more expensive when compared to virgin plastic. When asked the reasons for pursuing this direction, regardless of the price, the first respondent emphasized that brands need take responsibility and have a purpose to be around in the future. Moreover, the third respondent added that the well-being of Unilever's stakeholders, customers, consumers, employees, governments and NGOs, is a part of its Sustainable Living Plan.

In regards to educating stakeholders, Plastic Energy, due to their size, does not have any programs that incentivize plastic collection or recycling. However, the company builds partnerships with Unilever to support programs in place. According to the interviewees, there are commercial discussions to improve and develop recycling. Due to their role in the value chain, the company usually provides information on what should be recycled and how to move forward in a certain direction. Sabic, similarly to Plastic Energy, works with Unilever and waste management companies to collect mixed plastic waste from kitchens, according to the second respondent. The third respondent added to this, stating that Sabic is learning how to communicate with consumers and brand owners, which typically is not usual activity for them. As for Unilever, within Food Solutions, Unilever has a campaign called Please Recycle. These display guidelines for consumers on how to recycle. Moreover, with the re-pledging of their packaging sustainability strategy, Unilever has been in contact with waste management companies to recycle and collect more plastic. Information on recycling is also displayed on the website. The third respondent identified this educational component as important and an obligation of companies to try to clarify the process for consumers.

DISCUSSION

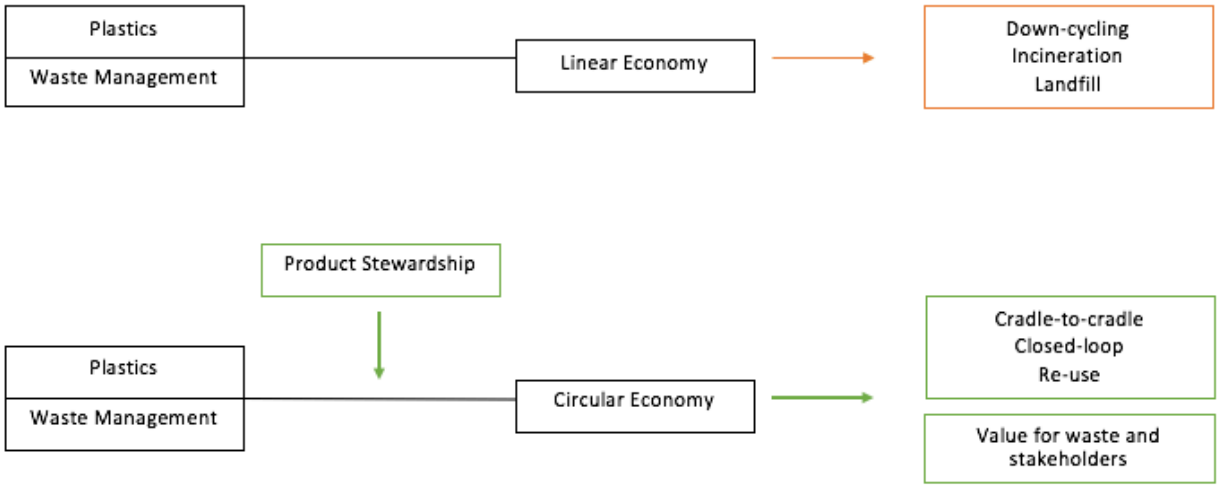
This section aims to answer the research question posed previously: *how does product stewardship increase the value of waste and circularity of the plastic industry?* The results showed that, through a business partnership, Plastic Energy, Sabic and Unilever adopt a product stewardship role in the

plastic industry. It was seen that the reason the companies engage in this partnership is the feeling of responsibility to address the plastic pollution problem and to ensure the well-being of stakeholders. As shown in the theory section, this reflects the definition of product stewardship. In addition to the feeling of responsibility, the companies engage with product stewardship in the following ways. By using chemical recycling and waste as input for production, they address the life cycle issue of mixed plastic waste. It was shown that for 1 ton of Circular Polymer produced by Sabic, 1,5 ton of waste was required. This reduction of waste can be considered product stewardship as it minimizes environmental and social impacts from production.

In addition, there is also concern for the health and safety of consumers. As shown previously, mechanically recycled plastics cannot be used in food applications due to safety concerns. Through the partnership, chemical recycling was found as a solution ensuring consumer safety and as a substitute for fossil fuel feedstock. This aspect of the partnership relates to another component of product stewardship; the protection of natural resources. By using plastic waste as a resource, converting it into recycled oil, the demand for fossil fuel and depletion of this natural resource can be avoided. Lastly, Plastic Energy, Sabic and Unilever directly engage with stakeholders to educate them on reusing and collecting plastics. As this direct engagement focuses on education of stakeholders to address environmental impacts, it is considered a key component of product stewardship.

The results illustrated how product stewardship favor a circular economic system and positive impacts on the environment. The diagram below demonstrates product stewardship in action. Upon the recognition that waste management challenges, such as down-cycling, incineration and landfill, led to a linear economy and negative externalities, product stewardship was adopted by Plastic Energy, Sabic and Unilever. This new role within the industry is an important contribution to a circular economy, where resource reutilization, the cradle-to-cradle approach, closed-loop systems are possible, and where the value of waste and for stakeholders have changed.

Figure 4: Product Stewardship In Action



This research also supports previous academic works. The interviews showed that there are challenges to waste management, including inappropriate consumer disposal and limitations of chemical recycling, as discussed by Dodbiba and Fujita (2004), Soroudi and Jakubowicz (2013), Arena, Mastellone, and Perugini (2003), Dauvergne (2018), Mendenhall (2018) and Nielsen et al., (2019), for example. It was also shown that, according to the waste hierarchy, incineration and landfill are the worst options to manage plastic waste. In accordance with the work of Turner (2018) and Didenko et al. (2018), the interviews reassured that plastics within a linear economy have detrimental impacts on the environment.

Moreover, the Circular Economy theory involves various concepts, such as re-use, recycling, resource reutilization, closed-loop systems and the cradle-to-cradle approach. This research illustrated that these concepts are often interlinked. The cradle-to-cradle approach implies that resource reutilization and a closed-loop system are in place. This, however, is only made possible by recycling and waste recovery. It was also shown, in reference to the work of Ghosh (2019), Kirchherr et al. (2017) and Stewart and Niero (2018), that recovering and reutilizing materials can generate economic value. The ideas discussed by the authors within circular economy theory are similar to what other authors have mentioned in relation to business models and innovations. In reference to the works of Bocken et al. (2014), Hart and Milstein (2003) and Neumeyer and Santos

(2017), the disruptive innovation put forth by Plastic Energy, Sabic and Unilever have led to the creation of value.

The results of this research have also showed theoretical relevance by addressing important gaps. Although the concept of a circular economy is still under development, this research demonstrates that product stewardship is an important driver for circularity and value creation. By illustrating how the adoption of product stewardship can favor circularity, the addition of the concept within circular economy theory is necessary. Many of the concepts within product stewardship and circular economy theory are similar. For example, both stress the reduction of negative impacts arising from production on the environment. However, product stewardship adds to circular economy theory with its focus on the health and well-being of companies' stakeholder, which can occur through direct engagement. This research has shown that product stewardship, and direct engagement in stakeholders' well-being, is an important factor in achieving circular solutions for production.

Another gap addressed relates to the waste hierarchy. As the partnership between Plastic Energy, Sabic and Unilever, along with the innovative technology, is quite recent, the waste hierarchy does not take into account chemical recycling. Because the new technology allows for closed-loop solutions, up-cycling and reduction of waste, the results show that chemical recycling should be placed on the hierarchy scheme. Moreover, as mentioned by Pires and Martinho (2019), the waste hierarchy does not make a distinction between up-cycling and down-cycling within the third option - to recycle. As up-cycling is more beneficial to the circular economy, chemical recycling should be placed as the third option in the waste hierarchy, above recycling.

The last academic gap addressed relates to the concept "pre-cycling". Although pre-cycling, as the theory shows, could be a valuable addition to the circular economic model, the three companies interviewed do not engage in pre-cycling in their partnership. Quite differently, the actors engage in a process that reduces waste and provides high-quality recycled plastic materials. Pre-cycling, on the other hand, may even present other issues in the future. Respondent three for Sabic emphasized that pre-cycling solutions, such as "bamboo toothbrushes", contain mixed materials in order to avoid virgin plastic. However, it is even more challenging to recycle mixed materials

than chemically recycling mixed plastic. Finally, chemical recycling addresses an important aspect of the circular economy which pre-cycling does not; reduction of waste.

This research also presents significant relevance for practice. The example of the business partnership discussed demonstrates to others in the plastic industry that addressing sustainability issues can add value to the business and stakeholders. Furthermore, it shows to the plastic industry, NGOs and individuals that there is a solution to the plastic pollution problem. It shows that multinational corporations can provide solutions and that plastic, as a material, is not the problem. Engaging in product stewardship in this way, by pushing forward chemical recycling, can reduce plastic waste and elevate the quality of recycling. This research indicates that there is a clear path to be taken; one that is successful but requires substantial investment in order to reduce initial production costs and energy.

LIMITATIONS

There may be limitations to this research. It may be said that, although chemical recycling can reduce plastic waste, it still requires substantial energy for production, which can be an offset for the environment. While this is the current scenario, as mentioned by the respondents, the cost and energy used in production will decrease as this technology is scaled-up. For this to happen, action is required by various actors in the plastic industry in order to increase demand for the product. Secondly, it could also be said that the respondents had a biased view towards their own company. This issue was addressed by maintaining participant anonymity and confidentiality. In addition, most questions had a more technical nature; such as asking whether the technology reduced waste, increased value for waste and their stakeholders, instead of questions about the image of the company. In conclusion, there are future research possibilities deriving from this research. All companies showed to demonstrate a feeling of responsibility towards different stakeholders according to their position within the value chain. Future research can be carried out analyzing whether the position of the value chain, and having different stakeholders, may impact the adoption of the role as product steward. It may be the case that companies at the end of the supply chain face more scrutiny from citizens and NGOs, and therefore, may feel more responsible for negative externalities on the environment.

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APPENDIXES

Appendix A

Plastics: Polypropylene

"The chemical composition of plastics is basically organic polymers" (Rosato et al., 2010: 22). There are more than 35,000 types of plastics from various different families. For example,

polyethylene, polypropylene, polyvinyl chloride, and nylons are only a few families of plastics (Rosato et al., 2010). For this research, it is important to focus on polypropylene (PP). This is because, in the partnership between Sabic and Unilever, Unilever buys PP polymers from Sabic for foods and personal care product applications (Sabic, 2019). PP is one of the most common consumption plastics used in the global market (Nobbmann, 2017). In addition, it has great resistance to chemicals, a moderate cost, is stiff and has higher strength. PP's thermal and electrical properties, makes the material "attractive for many indoor and outdoor applications" (Rosato et al., 2010: 130). Due to its stiffness and strength, PP is commonly used for products such as kettles, chairs, and garbage bins, whereas different densities of polypropylene can also be used for food packaging applications (Mills, 2005).

Plastics: Monomers, Polymers, and Polymerization

Monomers and polymers are molecules. Molecules are a group of atoms. These groups of atoms have relatively strong bonds, where as molecules have weaker bonds with other molecules (Chanda, 2018). There are small and large molecules. Water (H20), methanol (CH3OH), and carbon dioxide (CO2) are examples of small molecules. Polymers, on the other hand, are large molecules, also known as macro-molecules (Chanda, 2018; Rosato et al., 2010). Polymers are composed of thousands to millions of atoms. Hence, polymers are made of thousands of small molecules. These small molecules are called monomers (Chanda, 2018; Rosato et al., 2010). Chanda (2018) proposes an analogy for these two terms, where polymers could be seen as a building, and monomers as the building blocks of the building.

Moreover, monomers are simple organic molecules which consist of a double bond. When these double bonds are added to another monomer molecule, repeatedly, leads to a polymer molecule. This reaction of monomers is called polymerization; it is the creation of polymers (Chanda, 2018; Rosato et al., 2010). Rosato et al., (2010) gives an example of polymerization, by using the plastic polyvinyl chloride (PVC). The monomer for PVC is vinyl chloride, and when this monomer is under pressure and heat it goes through the process of polymerization, subsequently leading to the creation of a larger molecule, a polymer (Rosato et al., 2010). Simply put, this process leads to the creation of plastic. Polypropylene is made the same way. When placed under heat, the monomer propylene undergoes chemical reactions that initiates a process of self-addition: various propylene

molecules bond together. This results "in the production of a high-molecular-weight material almost identical in chemical composition to propylene, known as polypropylene, the polymer of propylene" (Chanda, 2018: 1). This process of polymerization is what the company Sabic carries out with the pyro oil bought from Plastic Energy (Sabic, 2019). The end result of this polymerization, polypropylene, is then sold to Unilever to be used in packaging applications (Sabic, 2019).

Appendix B

Interview Guide

Research question:

How does product stewardship increase the value of waste and circularity of the plastic industry?

Introduction:

Thank you very much for participating in this research. This is a great opportunity for me to better understand your business, and how you adopt decisions that reinforce a circular economy. The purpose of this research is to shed light into how different businesses can increase the value of waste and circularity of the plastic industry. As your private information is valued, anonymity is maintained throughout this research. Therefore, your answers will be kept anonymous.

My name is Guilherme, and I am a master student of Sustainable Entrepreneurship at the University of Groningen. As mentioned previously in our email, this interview will be recorded for quality and transcription purposes. The transcriptions will be submitted to you for final approval before it is used in our research. I have also prepared a Consent Form explaining these agreements for us to review before commencing.

Start of interview.

Appendix C

Consent Form

Your Consent and Understanding to Participate in a Case Study Interview

Dear Interviewee(s):

You are invited to take part in an interview for a Thesis research project, delivered within the master program (MSc) Sustainable Entrepreneurship at Campus Fryslân, University of Groningen.

The purpose of this interview is to identify how product stewardship can increase value and circularity of the plastic industry.

This interview, as well as its inclusion in the project, may remain entirely anonymous. If you wish for your name to not be disclosed, you may inform me at any time. If you feel there is sensitive information given in the interview, you may request for the research to not be published on any public platform. In any case, the research will not be used for non-academic purposes.

By consenting to this interview, you acknowledge and agree to the following:

1. I understand that I voluntarily agree to participate in this research study.
2. I understand that even if I agree to participate now, I can withdraw at any time or refuse to answer any question without consequences of any kind.
3. For the purpose of conducting the research, the interview will be recorded, transcribed and analyzed. Recording and transcription will not be used for any other purpose besides conducting the research.
4. The recordings will be used for transcription purposes only, and deleted immediately thereafter.
5. You may withdraw this consent before 20th April 2020, when the research data analysis will commence.

Date:
Interviewer name:
Interviewer email:

Interviewer signature:

Date:

Interviewee name (optional):

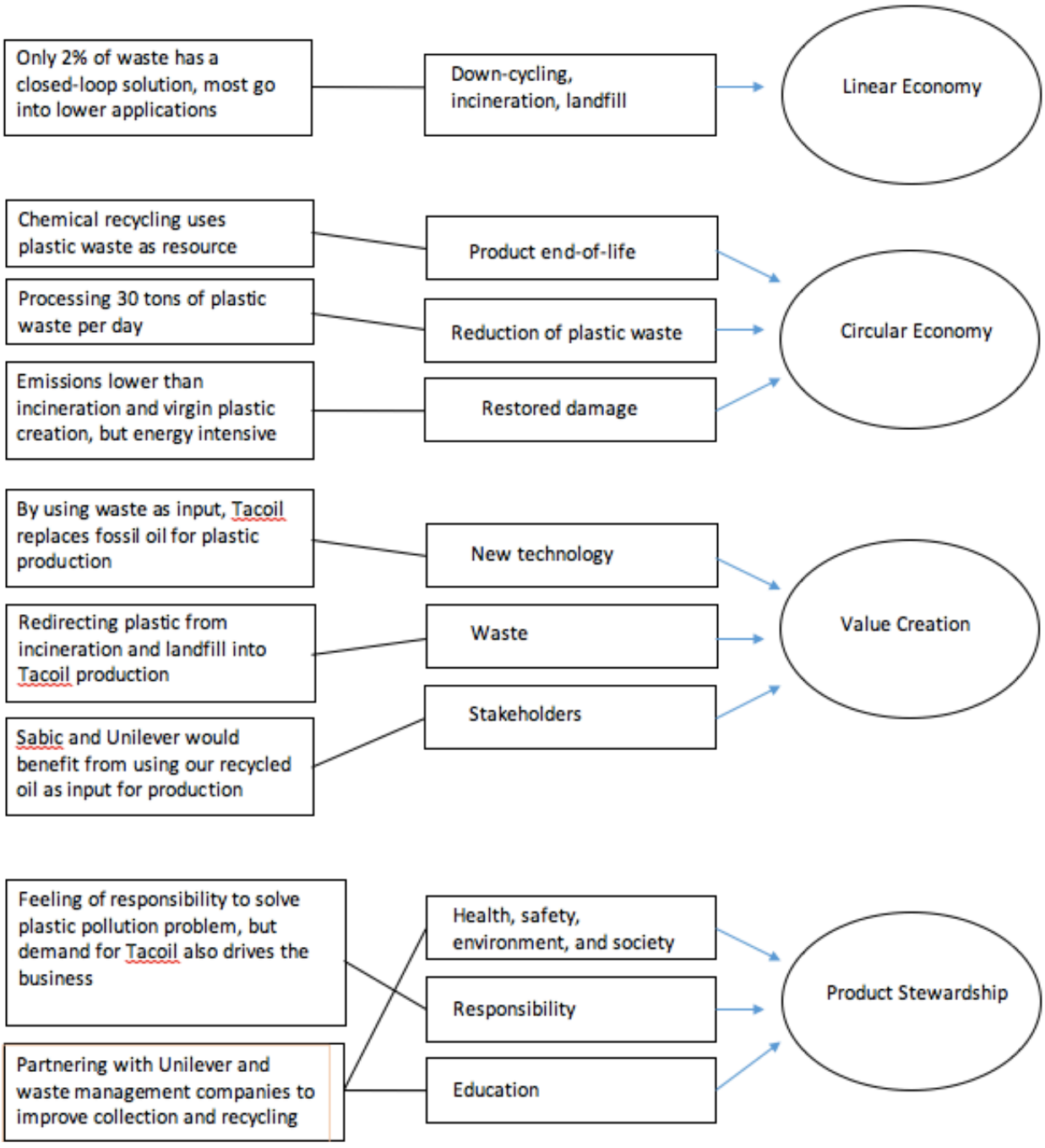
Interviewee email (optional):

Interviewee signature:

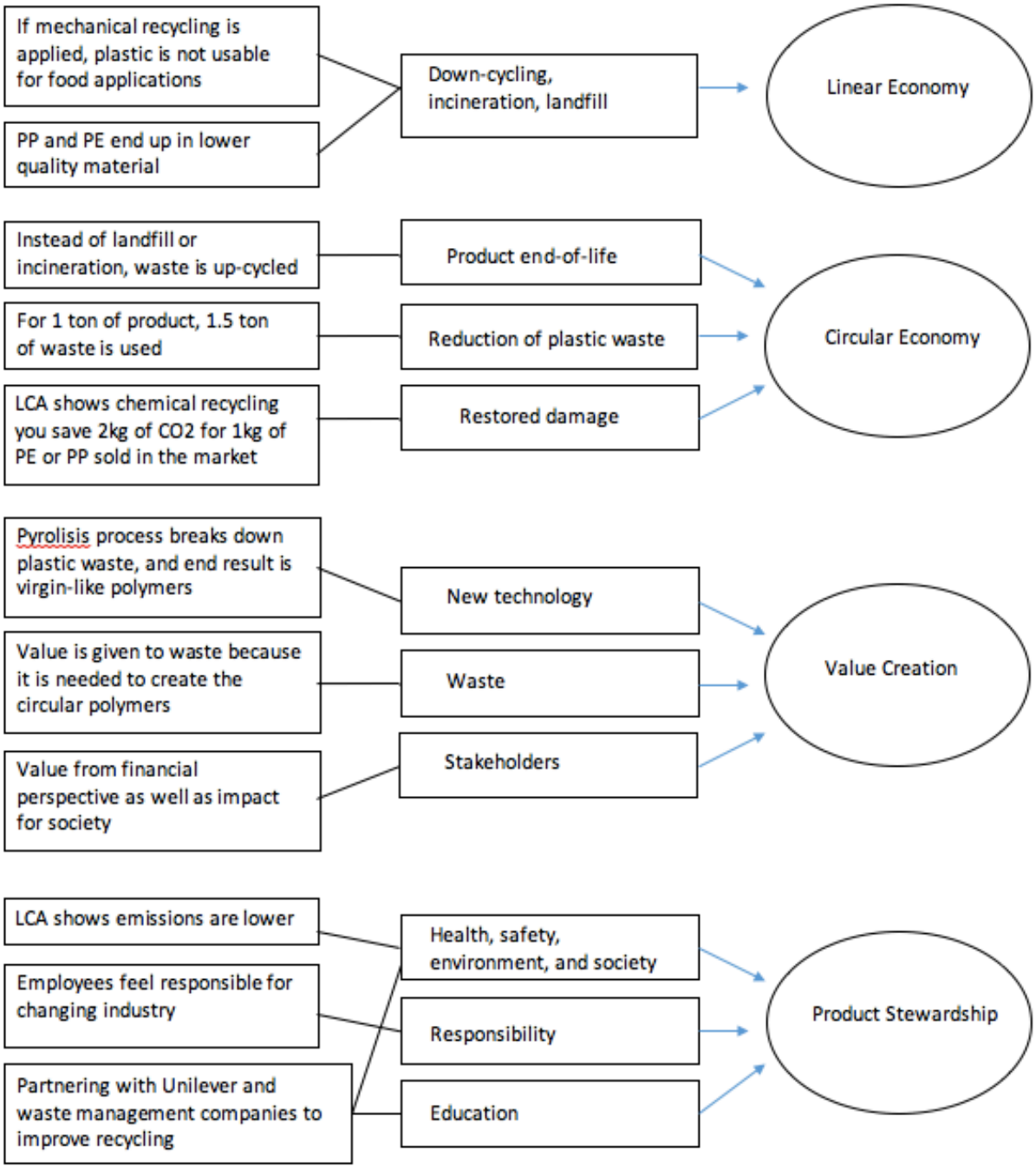
Appendix D

Code Trees: summary of the interviews

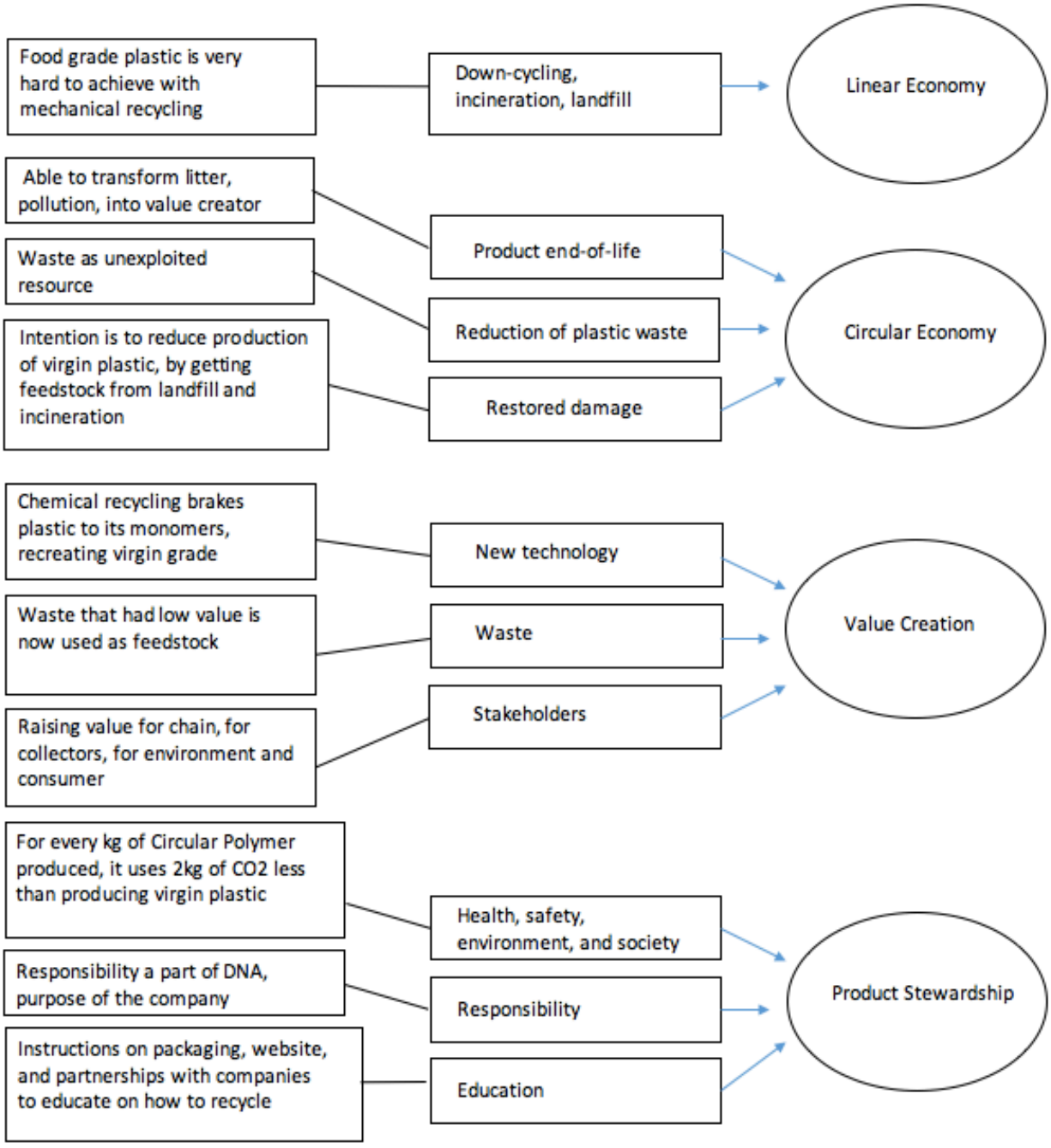
1. Plastic Energy Code Tree



2. Sabic Code Tree



3. Unilever Code Tree



Appendix E

Interviews Plastic Energy

For all interviews, respondents were either sent the consent form or discussed the consent form prior to the interview. Due to the COVID-19 pandemic, respondents were unable to sign consent forms. Therefore, consent was given either through email or LinkedIn.

Interview #1 with Plastic Energy
Date: 27/04/2020
Time: 10:00 – 10:30
Interviewer: Guilherme Monteiro Silveira
g.monteiro.silveira@student.rug.nl / gui_msilveira@hotmail.com
Interviewee: Remained anonymous.

Interview:

1. Could you provide a quick overview of how your daily tasks relate to sustainability?

My job is really related to sustainability and working on, basically, policies at the European level but also at national level to enable chemical recycling and general recycling to improve. So in that sense, it is directly related to sustainability, about increasing collection, making sure all recycling technologies are accounted for, making sure then that there is the right approach to enable recycled content from different types of recycling to be accounted for. So it is very much, you know, in line with the whole, I would say, platform and the whole agenda of the EU related to sustainability, recycling, and plastic strategy - circular economy package, and you know, it is very much related to - directly to that in terms of policies. Alongside, I'm also very much working on, basically working with the whole value chain to enable the full circularity to be validated. So very much working on partnerships with various companies within basic part of the value chain basically, and so in that sense it's trying to show that the system is circular and, obviously, sustainable.

2. Could you tell me a bit about chemical recycling and the innovation that Plastic Energy uses to recycle end of life plastics?

So far the type of chemical recycling that we do there is rich with possibilities. First, using what is called pyrolysis. So basically the melting of plastic at high temperatures, so there is no burning

or what not – it is a very much melting process. That then goes back into hydrocarbons, and from there basically we create what is called Tacoil, which is basically recycled oils that can be placed into petrochemical crackers. So the idea is that we are basically replacing fossil oil by recycled oil from end of life plastics. Our company is innovative in that, the idea is that we are taking a broader range of plastics that we are recycling together, so as a mix instead of by separating by types of plastics streams. And then at the end we create an outcome that is basically the basis to make again virgin quality plastic but from recycled origins. What we brought I would say, I would call it a grade of recycled oil. So there is obviously a lot of experience and a lot of operational experience of the pyrolysis that is essential to understand how to treat different types of plastics. So we've had two plants in south of Spain for the past three years, and obviously, you know, improving our understanding of as much the input, the plastic waste, and also the output. So now we can take different streams of plastic waste at the start but also adapt the output so that the Tacoil, the recycled oil, meets the desires of petrochemical companies. For us, the main innovation in terms of circularity is that we manage to reach the specification of petrochemical companies for the making of plastics.

3. Are there significant emissions of GHGs generated during the chemical recycling process?

We are currently doing an LCA on our side. Sabic has already done one, I believe I don't think it's public yet. An indication that I can tell you from our first results and from seeing Sabic's results is that it is very much lower, well below, incineration. We have just found that it seems it is also lower than creating virgin plastic.

4. What impacts can chemical recycling have on the plastic industry?

I believe it has, generally speaking, a positive impact. Instead of, you know, using conceptually a very linear economy, meaning the full extraction and production of plastic from fossil oil, it brings back the loop. Basically, plastic that is normally incinerated, again a linear pathway, so it brings circularity to very valuable resources and, in addition of bringing circularity, I would call it upcycling. Given that most current recycling goes into lower applications, so you know a packaging turns into a pipe or something like that. So, it is very often what is happening with mechanical recycling, and here it is very much upcycling because they can put back the oil into food grade applications. It is literally the first time it has happened beyond PET, otherwise it is

actually not legal to put recycled content into food grade packaging. So this is quite revolutionary, I would say. It brings back recycled content into food grade packaging but from plastic that is normally incinerated.

5. Do you believe using plastic waste as an input for production can increase its value?

I think if the plastic waste is valued then it is not discarded, because it has a value. So I think yes, it has a greater value if we can give it value. And clearly, this is starting to become the case. It also has, I would say, greater value in the sense that, you know, normally there is, to treat these types of plastics, at least in Europe, it is either landfilling or incineration, or with energy which is really expensive, at least in most countries in Western Europe it is quite expensive. So the idea is that we are overcoming that and, in addition, we are doing a product that is circular and of very high quality. In that sense, it is quite rare given that so far we are the only ones to try it. So in that sense there is so far a greater value put in the circular polymers compared to regular virgin plastic. Because it is new and also because it fulfills many of the commitments that Unilever and other brands have made. They all want to recycle one hundred percent of their plastics by 2025 or 2030, and they all want to have at least fifty percent of recycled content in the plastic. And given that all of them are doing food grade packaging, they need to find a solution to basically create this recycled content, and so far the only or one of the only solutions is chemical recycling.

6. Does this type of input-for-production reduce plastic waste?

If you look at the commitments of Unilever plus Danone, Mars, and all the big companies, if you look at their demand together, their demand for recycled content, then it would obviously remove a big part of the plastic waste. However, at the level of our collaboration currently, given that we have plants in the South of Spain that are quite small, it is obviously small amounts because it is a starting up technology. So in that sense, currently on our side we are processing about thirty tons of plastic waste per day in our two plants in Spain, so it is obviously still small amounts being recycled. But it is a start, and a proof of concept for further projects. And that is why now we have projects in the Netherlands with Sabic that is currently developing, and should be ready the start of 2021. And, you know, then we also have other projects that we have just announced. So if one plant works then it would lead to more projects. The point is that everyone is trying to develop and upscale chemical recycling to reach those demands.

7. How does the product ensure long-term health and well-being of stakeholders (including society and environment)?

It depends how you define well-being. In terms of, I would say, sustainability of companies, I think if, you know, Sabic replace a large portion of fossil oil by our recycled oil, this would be a very positive image for them given that it would be less based on extraction, which is very negative on the environment. Similarly, for brands like Unilever where, you know, they would manage to reach and fulfill some of the commitments, you know, commitments based on sustainable goals I would say in the long-term it would, hopefully with more projects, decrease the amount of plastic waste and develop infrastructure in countries. But overall I would say in terms of benefits and the wellbeing of these companies, I would say that it is actually very positive for them. Also the whole image of their company. I would say for other stakeholders, similarly for governments, it's positive because it would help them medium-term to reach recycling targets, which would be affected by the fact that currently some of the exports is accounted in recycling, which will change. So, you know, they'll need to find more ways to recycle more. And in terms of the public, and NGOs and other types of stakeholders, I think that plastic recycled versus being exported is something positive. Everyone believes that, you know, if you put it in the trash it is recycled but obviously it is not the case currently. So – more and more of that waste being recycled is very positive for people. In terms of emissions, it is true that a technology and development would improve the energy impact. But we already see that this is positive, but it certainly should improve.

8. Is there a feeling of responsibility of Plastic Energy towards the well-being of its stakeholders?

I would say the whole reason why we exist is because there is – you know, we are a small company so on that basis if there is no demand for that, for us we have no business. So in that sense, we are very much working along the goals of those companies, specifically brand owners that are very much pressuring their clients, the petrochemicals are then pressuring us. So basically the whole value chain that is demanding and in that sense, yes it is very much the reason why exist in the first place.

9. Why do you think Plastic Energy has been committed to this innovation?

When we saw the clear focus on plastic waste, of being non-circular, and also the growing demand of brands, it's clearly from that point that led us to fully regard our strategy towards that. We had, obviously, lots of piloting based on that in the very early days. We discussed with petrochemical companies and tried in collaboration with them to improve our product, to reach their specification. So, you know, from the start we worked on improving the product but we were not sure whether we could reach the kind of specification for crackers, to enter into a cracker. But when we saw we were improving, when we saw also that the policy direction was clearly gearing towards a circular economy action, really promoting it, so, you know, at that point we saw we could be supported and fully went for it.

10. Does Plastic Energy have any awareness programs with waste collection companies to improve consumer disposal?

Yes, we are in a partnership with Unilever that have very much, you know, have capabilities and work alongside and have very much an interest in working with them because the more collection for them, the more recycling, the better. There is a lot of relationships to be built and to be improved for them. So in that sense they have full programs on that. So for us we are very much working with them because we are working with them to try to see if they have the type of plastic we can recycle and if they have the quantity we need. So for us, instead of directly having a program to improve collection and sorting, for us it's directly commercial discussions on the type of plastics we can recycle and if these companies have something – and maybe then we can collaborate with another one to basically have a project to further develop recycling. So for us, given that we are a small company it is hard to develop programs, we don't have the capacities for that. But we are working with, supporting some of the programs that, you know, Unilever and other companies are putting forward. Usually more in terms of providing information, on what we recycle and providing them an idea of when we'll develop in that country and the technology available. So we are contributing to it but we are not leading or setting up those platforms that are important but very time consuming for a small company. So we try to be as useful as possible, and help where possible, but we are not leading them. Usually when we talk to waste management companies it is very much to try to recycle and try to, you know, get access and to secure plastics over the long- to build a project and to recycle further.

Interview #2 with Plastic Energy

Date: 27/04/2020

Time: 13:30 – 14:00

Interviewer: Guilherme Monteiro Silveira

g.monteiro.silveira@student.rug.nl / gui_msilveira@hotmail.com

Interviewee: Remained anonymous.

Interview:

1. Could you provide a quick overview of how your daily tasks relate to sustainability?

I work as a strategy manager. What it means is that I work within policy, finance and business development. My role is looking at the long-term business planning. So, when I say long-term, it means more than two years, and even between five to ten years. So this is kind of the thing that we are looking ahead just understanding the market, understanding the policy with sustainability, and the competitors. So, recently we have developed an updated business model for the long-term, and so how it relates to sustainability is obviously understanding how our product fits into the future world, how we fit into the net-zero world, how do we reduce plastic pollution and so on.

2. Could you tell me a bit about chemical recycling and the innovation that Plastic Energy uses to recycle end of life plastics?

Within chemical recycling, there is marked many types of technologies that are slightly similar that takes plastic and turns it into some sort of fuel. So for us, we are at the pyrolysis, where we use anaerobic processes, where we heat the plastic within a very high temperature in the absence of oxygen. And a lot of pyrolysis technologies have existed, but we don't see many in the market right now partially because, you know, the market wasn't ready, there were not many policies supporting plastic recycling, and now I think the opportunity is much clearer with our technology being more mature and there is just the right market conditions for us to hopefully succeed in this field. And within Plastic Energy specifically, our process produces a virgin quality like where you can make any plastic out of it.

3. Are there significant emissions of GHGs generated during the chemical recycling process?

That is actually one of the big questions we are thinking of in terms of business planning and in terms of fitting into the long-term net-zero world, because right now with our current technology there is quite a lot of energy in terms of heating the plastic, cooling the oil – the whole process is very energy intensive. So we do know that and we are keeping this in mind, and we do have plans of making this a bit more efficient. When all you can do is make energy more, the technology more efficient to reduce energy consumption, and a few more things that we are planning to do in the future.

4. What impacts can chemical recycling have on the plastic industry?

When we talk about recycling, for sure it would help with the waste. So the way waste, currently the way it works now is that it is going mostly into incineration in Europe or to landfills – but it is very controlled the legislation in Europe. In Asia, for example, this was leaked into the ocean because the waste management is not as efficient in these developing countries – so it is not exclusively in Asia. I also know of these problems in the Caribbean, in Latin America. So - first, the goal is to prevent waste from leaking into the natural environment. And a slightly more ambitious goal is to offer a closed-loop processing of waste. So, today, in today's world, you must have seen the China ban on plastic waste that forced European countries to keep their waste and deal with them. So a lot of this waste either goes into incineration where you kind of just burned it really. And then, or, mechanical recycling. Within mechanical recycling, only two percent of this waste has a closed-loop solution where it goes back into plastic. Everything else is a little bit of a down-cycling. So going down to, let's say you recycle a PET bottle, maybe it will go back to a PET bottle but maybe it will go into making a rope, making tires. So it is down-cycling more than closed-loop. When we are talking about closed-loop, literally going from the bottle into the bottle.

5. Do you believe using plastic waste as an input for production can increase its value?

For the time being, yes. So what is going on is that the market, the people, are pushing companies, pushing supermarkets and brands to use more recycled plastic. But when you look at the recycled plastic industry, there is not much of a solution offered on a large scale. When we offer something like this then the value of our product increases significantly. But, for me, I think in the long-term

we shouldn't have the value of plastic increase like that. Because in the long-term, when we learn to live in a circular economy world, that should be the norm.

6. Does this type of input-for-production reduce plastic waste?

Right now we are quite small, so right now no. But, the idea is to grow the company, right, the idea is to grow this technology out. And when we reach a scale that is significant enough, then I would say yes, because it will prove valuable as a product, so Tacoil will prove valuable to produce virgin plastic. So, if you are thinking of throwing away a box of strawberries with a plastic film, from the strawberry you buy from the shop, then you will think of not putting it into trash or just throw it away but you will actually try to recycle it. So I think that is how, when we reach a large scale that will be a way for us to reduce the plastic waste.

7. How does the product ensure long-term health and well-being of stakeholders (including society and environment)?

In any project, the project with Sabic that we our press release weekly with emails, so all of these projects actually involve quite a long collaboration before we put out any press release, any agreement. When I say long, it's years. So we work with, obviously, the city where we want to have this project, we work with environmental conductors to understand how the land works, what we are doing there. So I think all of these collaborations is ensured to satisfy all the stakeholders. We get a permit to have a chemical plant, which is quite a challenging and long process where everybody has to be happy – that we are satisfying these conditions. And, so yes, so I think it is through collaboration, long-term collaboration.

8. Is there a feeling of responsibility of Plastic Energy towards the well-being of its stakeholders?

Yes, of course, I think so. In our business plan, we really stress the fact that we are conducting in a way, that we are maintaining the stakeholders' expectations and well-being. So either it is our partners who are our off-takers, who are buying our Tacoil, or partners such as the city council, or mechanical recyclers, or EPR providers that give us the feedstock – that we are always making sure that we are on the same page. Because to do business in the long-term I think this is very very needed.

9. Why do you think Plastic Energy has been committed to this innovation?

I think it comes from our CEO, he is very passionate about this project. And I think, well we all see how plastic pollution is horrible, so I think that is the mission that connects all of us in the company to some degree, whether you are an engineer or a business developer, you do feel responsible for this problem you want to solve. It is a big problem. In Europe, it may not be as such a big problem, because we have our waste management sorted, we do have people that come to pick our waste, we do have places where it goes, you don't walk into the street and see it. But our heart is in places for where this infrastructure is not present and is not ready. So that's why we want to breakthrough and provide these kinds of solutions.

10. Does Plastic Energy have any awareness programs with waste collection companies to improve consumer disposal?

On our own, no. I don't think we are in a position where we can do that. But we do have partnership with brand owners which are the brands which, you know, push for this type of recycling. They tell you – you can recycle this more. And through social media, but we also collaborate with a lot of government policy making processes to make sure that, you know, when we build this plant there then you need to have people know, you need to make sure that people know that they now can send plastic films and recycle this. And so, in our company, what we can ensure is that we can always make sure that x percent of our input, which is the feedstock, must come from consumer waste otherwise there is no point. There are other types of waste, from the industry, but for us it is very important that a large majority of our feedstock comes from consumer waste.

Appendix F

Interviews Sabic

For all interviews, respondents were either sent the consent form or discussed the consent form prior to the interview. Due to the COVID-19 pandemic, respondents were unable to sign consent forms. Therefore, consent was given either through email or LinkedIn.

Interview #1 with Sabic
Date: 16/03/2020
Time: 16:00 – 16:30
Interviewer: Guilherme Monteiro Silveira
g.monteiro.silveira@student.rug.nl / gui_msilveira@hotmail.com

Interviewees: Two respondents which remained anonymous

Interview:

1. Could you provide a quick overview of how daily tasks could relate to Sabic's vision and mission for sustainability?

Respondent 1: Sabic is a leading chemical company. We are involved in the production of many different types of materials, polymers of course are a strategic part of our business. [Respondent 2] and myself are predominantly looking into polyethylene and polypropylene, which are two crucial building blocks for the packaging industry. The packaging industry is, of course, a strategic segment for us. The driving force within packaging these days is, of course, sustainability. That is based on the need to transform the value chain more and more towards circular concepts. Recycling is becoming more and more a well established approach in packaging. So there is a need for recycling and there is a need to go to more sustainable feed stocks, non-oil based, for example, bio feed stocks. Sabic has recognized the challenge to make that transition together with partners in the value chain. [Respondent 2] and myself are deeply involved in rolling out the complete solutions on the circular concepts. We do that with our, what we call, TRUCIRCLE solutions. These solutions are based on four pillars. Pillar number one is that we try to help the value chain in designing packaging in such a way that they can be recycled more easily. In terms of the recycling concept itself there are two routes for this. Mechanical recycling is already well established but should be rolled out broader, and there should be acceleration and upscaling. In mechanical recycling, you melt the plastic waste back and you make new granules out of that. Sabic goes one step further, that is with the chemical recycling: the third pillar. And with chemical recycling we transform or transfer mixed plastic waste back into an oil. The oil then is used as new feedstock. And the fourth pillar is the renewables. That is the bio feedstock where we increase that part.

2. Is the oil produced from the mixed plastic waste made by Sabic?

Respondent 2: We are starting a collaboration, in this case, with Plastic Energy. Plastic Energy is one of the farthest in the industry who can, with their technology, pyrolysis technology, guarantee

a certain quality and supply security which I don't think a lot of other players in the market can guarantee. We are partnering up now with Plastic Energy, but it doesn't mean that this is the only technology available in the market to produce pyrolysis oil. We are not making the pyrolysis oil ourselves, so we are buying that pyrolysis oil and putting it in the cracker.

3. What is the quality of this product, in comparison to virgin plastic produced from natural resources, is it the same?

Respondent 2: Yes, exactly. Indeed, in the end, bringing it back to the chemicals and dosing it into the cracker. There again you will have the normal propylene and ethylene for producing the polymers. The quality of the end product is exactly the same.

4. What are the amount of emissions (impact on environment) for this production process?

Respondent 2: I am not able to explain exactly what happens there, I am not involved in that area. I cannot touch upon that in a lot of detail. But, if you look at mechanical recycling, from an LCA point of view, it is the preferred route. In chemical recycling you have an additional step, which also costs energy. Chemical recycling comes in when mechanical recycling is not an option. We have our LCA studies, and they show that if you compare chemical recycling routes to, for example, incineration, you still save 2 kilograms of CO2 for 1 kilogram of polyethylene or polypropylene which we sell based on chemical recycling. You have an LCA saving, however, if you compare to mechanical recycling, mechanical recycling always has the preference.

5. Do you see implications for other companies in the industry that still produce virgin plastic from natural resources? Can Sabic's customers follow a more circular approach to plastic production?

Respondent 2: The implications for them could be that in the end they don't need to change their critical packaging types, where they have high demands of regularity requirements. They, in principal, can benefit from this solution without having an impact on the end product, on the packaging itself. While, for example, if you apply mechanical recycling that in the end you cannot use it in applications where food contact is required, but also I think the quality of the product as such is, after recycling steps, not on the level where it is with virgin material. So I think our end customers can really benefit from this solution in such a way that they don't need to change their packaging but still can benefit, first of all, of having an LCA of CO2 saving, and also contributing to the fact that we enable a circular economy and really re-using mixed plastic waste.

6. Does Sabic use other firm's waste as resources?

Respondent 2: The waste we use for chemical recycling is the post-consumer recycling. It is municipal waste, so it is not industrial waste.

7. Can using plastic waste as an input for production increase its value?

Respondent 1: We have to look at short term and long term. On the short term, it is important that not only Sabic invests in rolling out this technology but also our partners. So, we are talking of

partners supplying mixed plastic waste, and of course, we are looking at the demand side, for example, Unilever. All parties will need to invest in the beginning. This is a new technology, this needs to be up-scaled, and in the beginning that will require significant investment of all parties involved. We hope there will be a joint social responsibility to take actions for society. On the long term, very difficult to predict, but to now a very simple answer, there is enough mixed plastic waste all over the world available to start seeing that as the new feedstock for the future. We do not believe it will totally replace the conventional oil based feedstock. There will always be a part that is oil based, but we have to do the maximum; that is, start leveraging the mixed plastic waste which is now being incinerated or which is landing up in landfills. But on the long term, we believe that this will result in a new economical model where all parties involved, if they do the investment now, will create value. Not acting is the other opposite. Not acting will also mean not being a part in playing this game.

8. Do you think this type of product can reduce waste?

Respondent 1: Yes, because for 1 ton of product which we bring in the market as certified circular polymers, we need 1.5 ton of mixed plastic waste. So you could say that we start contributing here with cleaning up this plastic waste.

9. How does the product ensure long-term health and well-being of stakeholders (including society and environment)?

Respondent 1: There are two elements. One element is the life-cycle analysis, typically selected by CO2 emission data. Another element of product stewardship relates to consumer safety. Let me start on the first part, the CO2 emissions. We make a very detailed life-cycle analysis; we have those data available, and we explain also those data to all our partners. We have the data in place that overall CO2 emissions with this new concept are less compared to the current routes which are followed with mixed plastic waste. We feel very confident on that part. And on the consumer safety part, with mechanical recycling, there is always risk of contamination or that the purity is not secured. With our concept, we guarantee that the purity and quality is equal to virgin methods. We have a very solid product stewardship story there in place. This is also required because we cannot take any risks, any negative perception in society or any contamination case or so, will not only destroy the brand value of a brand owner but also will influence Sabic's reputation. But we have done there our homework, and we have all the data available.

10. Why has Sabic committed to this role of responsibility towards their stakeholders? Do you see other companies following the innovation the Sabic has put forth?

Respondent 1: It goes back to the roots of Sabic, where recycling has always has been in the genes of the company. It all started in the 70s, where Sabic was one of the first to transfer gases which were related to the oil refineries; those bi-products were flared in the past and those gases went into the environment. Sabic was one of the pioneers who started using those waste gases as new feedstock for producing chemicals, and we always have been in the driving seat when circularity became a strategic topic. And, of course, Sabic has the global power, innovation power, to push through these big investments that are required. Sabic has now become a part of the Aramco

company, the biggest company in the world, involved in oil. This gives us confidence that also here we can take the next steps, and the rest will follow and join us.

11. Regarding the partnership with Unilever, for products such as Magnum and Knorr, what type of materials do you provide the company with?

Respondent 2: It is a combination. With this concept, we can sell almost all our polyethylene and polypropylene which is produced in Europe. In principle, the solution is applicable to all the polyethylene and polypropylenes.

12. Are these circular polymers more expensive than virgin plastic made from natural resources?

Respondent 2: The feedstock is much more expensive, and that is in principle the upcharge which we need to apply to make this happen. And next to that, we started to invest in bigger units, which hopefully in the long term future will bring down the investments and costs to purchase the product. I think it is still quite a challenge to up-scale as quickly as possible without expecting that we also easily can drop these additional costs because in the end what we see is that we really need a value chain collaboration. We are pioneering, so a lot has to happen; waste streams, collection, cleaning, the pyrolysis, all these things have to be established in order to sell the solution. Although, we fully believe in it, of course there are some costs involved, and everyone has to contribute to that in order to make it a success

13. Does Sabic have any awareness programs with waste collection companies to improve consumer disposal?

Respondent 2: We have a program with Unilever, it is about joint collaboration in the chain. Here, the waste collector is involved, Sodexo is also involved because they have waste streams that they typically throw away, and now together with Renewi who is arranging different bins to keep the plastics separately. We have a joint collaboration in the chain to have a closed-loop in the end. This is just one of the examples, there are several initiatives where we engage in these days.

Interview #2 with Sabic
Date: 20/05/2020
Time: 11:10 – 11:40
Interviewer: Guilherme Monteiro Silveira
g.monteiro.silveira@student.rug.nl / gui_msilveira@hotmail.com

Interviewee: Remained anonymous

Interview:

1. Could you provide a quick overview of how your daily tasks relate to sustainability?

Everything I do relates to sustainability. I am part of the Circular Economy team within Sabic and I am responsible for the closed-loop projects, or at least the execution of the closed-loop projects

under the TRUCIRCLE umbrella - the brand name within Sabic that focuses on all circular sustainable activities, because we also have a corporate sustainability team at Sabic. Under the TRUCIRCLE umbrella, I work on the closed-loop models, mainly to try to take waste from, let's say a brand owner, find a way to recycle it and bring that material back to the brand owner so that they can re-sell it. It is really focused on the element of circularity, which is the circle element material. So that is what I focus on. I work with both chemical and mechanical recycling, and I work with brand owners but also a lot of different people within Sabic. I think we try to work together trying to make plastics circular. Everything we do around that is embedded in sustainability, both in the sense of environmental focus as well as business focus, showing circularity can also be a sustainable business model.

2. Could you tell me a little more about the technology behind chemical recycling and certified circular polymers (TRUCIRCLE)?

In basis, the chemical recycling is a method to bring material back to its original form. So imagine mixed plastic waste made of polymers; because plastic is just a polymer chain, and in a pyrolysis process, which what the chemical recycling is based on, the polymers are broken down into monomers again and they go back to their molecule basis. And then, from there on the monomers are again rebuilt as polymers. And that is why we can claim that the material is almost as equal to virgin material, because you are really breaking down the material. So the plastic that you started with is not the exact same plastic that you end with because the chemicals have moved around, but in basis it is the same material.

a. So, for example a plastic bottle, you could break down the material in a way that you could make, technically, anything out of it again?

Exactly, and the main distinction is you need to realize is between mechanical and chemical recycling. In mechanical recycling, to stick with your bottle example, I'll put a bottle in a machine that will clean it and shred it, then it becomes a resin or a granule. Then that granule is either, for example, with extrusion methods you heat it up again and you press it through a pipe or shape or anything, and you press it in the mold that you want, and then you have a new material. But the plastic bottle that you start with has got a different form but is still in basis that plastic bottle because nothing about the chemical component has changed – you will find the exact same

molecules and the same plastic bottle as you found in your end product. And that is also why mechanical recycling to an extent is down-cycling, because, well a plastic bottle is a bad example because PET can be recycled into new PET bottles, but a lot of times, specially PP and PE, so the polyolefin, they end up in a lower quality material. But what you want to do with chemical recycling is you really bring it back to its original form, you cannot trace anymore what the original material was that went into the process. Meaning that, at the end, you can literally make anything out of it again – so you don't down-cycle, you just recycle it in its purest form, because you're bringing it back to applications that can be useful. However, why we use the term up-cycling a lot is because the material that we put into the chemical recycling tends to be very low quality waste. It would normally go to landfill or incineration, and by doing chemical recycling, we are upgrading the material because we are giving it a new application, let's say food packaging or medical equipment. That is kind of the main distinction between the two recycling processes, and that is why also SABIC has introduced chemical recycling as a really good plan as part of the TRUCIRCLE portfolio that you can say – okay, we have that dirty waste but look, we can still get great value out of it, which in the end enhances or makes the dream of a circular economy more real.

3. Does this type of technology have the potential to reduce plastic waste, and also increase its value?

Yes, I think so, because this entire scheme, entire model we are setting up, plastic waste starts to get a value. In a lot of countries, waste doesn't have a value, not at all. You actually get paid to get rid of the waste. So by doing these kind of methods, we are giving waste a value again. And once you start giving products a value, people start to show interest in them. And then I think by that, we don't need to waste anymore – as in, put it in a landfill, because we need those products to make new plastic. So that's inherently what you would get with the circular economy, that every end product will be needed because it's the start of something new again. So also in countries like Indonesia, for example, where waste is definitely an issue. And also with the river plastic, and then leading later to ocean plastic. I do think that we are giving that plastic, that now is valueless to the people, a value because we need it for the recycling process to create the circular polymers. It becomes a value so people want to start collecting it, and hand-cycling plastic waste will go down. It will be more limited than it is now. This will take quite some time, but I think that every change

you make in the industry – I mean, paper and glass went through very similar challenges before it became this more organized system where we collect them separately because they do have a value. I think something similar will happen to the plastic industry. However, the difference with plastic is you can recycle plastic endlessly – infinitely recycle plastic. And you cannot do the same with, for example, paper. Paper can only be recycled up to seven times before it loses its value and the power, because its fibers become so short that you cannot make new paper out of it anymore.

4. How does the product ensure long-term health and well-being of stakeholders (including society and environment)?

Yeah, I would like to think so. I do believe that by setting up this whole portfolio, and making it a topic we can talk about, I think this will benefit everyone in the end. Because we should not forget that plastic has brought the world very good progress as well. Think about the medical field; a lot of material there is made out of plastic, and that has actually helped advance the medical industry. Or think about food packaging; it has helped us to preserve food longer which has brought down food waste in the world. And right now we are, as a society, very quick to judge things because one element of the plastic, which is the end of life point, has been so badly managed up until now. And yes, we are experiencing the consequences of the product we created, and we are realizing that as opposed to paper, plastic takes a very long time to dissolve in nature. I mean, it doesn't happen in a human lifetime. So for us that is incomprehensible. I think by setting up this whole system, where we focus on circularity, we create value for stakeholders from a financial perspective, and also as an impact, as in - hey look, we as brand owners of the companies, we care about these problems. And from a society perspective, we are addressing the issue, while going back to the roots of the problem, we are trying to show that the benefits of plastic should not be eliminated completely because life as we know it is surrounded by plastic materials. And a lot of people don't realize this and they try to find solutions with other materials. I think bamboo is quite popular right now, bamboo toothbrushes for example. But they are not a solution to the problem neither – they are just going to be the next waste problem because these bamboo toothbrushes are a mix of products. There is also plastic in there. And actually the more we mix materials, the harder it is to recycle. The more monolithic materials we have, the easier it will be for all of us. But I really hope these kinds of products – polymers, have a positive on the entire value chain up until

the consumers, and then with an extension to that, to wildlife, nature, the flora and fauna around the world.

5. Do you think these types of polymers can change the plastic industry?

Yeah, I do think so. I think with any material or any product we use in the world, we have to realize that we need to use things in moderation and responsibly. And that goes for anything – I mean, think about how much oil we use for transport, everyone driving around in their own car, and the amount of product we eat and consume, whereas we don't actually need all those things. So I do think this will make an impact, and at some point people are going to realize the flip side of the coin. But I think it is very normal for people, and as society as a whole, to find common enemies in things. It's completely understandable, because we are seeing all these sad pictures of the birds and the turtles. But my reaction is, let's do something about it, instead of saying – ok, let's ban all of it - because then you are looking at only one side of the story. There are always multiple sides and, honestly, I truly believe plastic, as a material, is not the problem. We as humans, as a society, are the problem. Plastics in the oceans is something we have contributed to. And I think it is also time, my personal belief again – this is not SABIC's belief, I think we need to start realizing that a lot of things that are happening around the world we are ourselves responsible for that, and it is, of course, easy to point fingers at something or someone. But we are stakeholders in the process too, so next time someone has a plastic bottle or something - recycle it, so we can do something about it. And, of course, we are trying to extend that as well because we are working in – okay, how can we help take more waste out of the environment, the material doesn't make it into the proper recycling bin. And because this is such a new industry for these big companies, this will take some time before it really has a big impact, I think.

6. Is there a feeling of responsibility of SABIC towards the well-being of its stakeholders?

Yeah, I do think so. I think SABIC is definitely in this topic, and has consciously chosen to go this path because I do believe that there are key figures in the company that believe this is the future. And, as you have a background in this as well, you probably know the stories how CSR often is used for some kind of purpose that is only meant as an outside portrayal of how good companies are. And I would honestly say the CSR activities and circular economy activities within SABIC are not that. People who work in these departments, and in the higher management, they truly

believe that they should do something about it, and that they can. And that's the combination right, they see the problem, and they know they can respond. And I think that is an example of being a responsible global citizen, and also as a company. As an industry we are responsible, and as an industry we have a lot of knowledge and we should show how we should use it and help for a greater good.

7. Why do you think SABIC has been committed to this innovation?

I think the feeling of responsibility definitely plays a role. And then also it followed up with the fact that SABIC did not feel alone, because companies like Unilever were interested in joining in this journey. So I think that the strengthening of organizations has echoed that idea, because as a company you can also come up with an innovation and then its almost like you are screaming in the desert, because no one hears you. But I would say for this innovation there has been a very positive feedback from the market, which then only strengthens the process. If upper management sees people responding to the innovation, then it reinforces itself to be catapulted even further and pushed more. I think Unilever is a great example of how they joined SABIC in this mission, and how they are a very good partner in this process. I really hope that other companies in the industry change as well so together we can change what the entire industry looks like.

8. Does SABIC have any awareness programs with waste collection companies to improve consumer disposal?

I cannot answer the question with a complete yes or no, because there are some activities happening within the company that I am of course not fully aware of. But I will say this; a company like SABIC, traditionally in the value chain, is a company all the way in the beginning. I mean, go into the streets and ask a bunch of random people about SABIC, I will tell you ninety percent of them won't even know what you're talking about. Whereas, if you mention Unilever, everyone will know. So for SABIC this is a completely new role because, with our partnership with Unilever, we have been catapulted into the public eye, but still limited of course. So this is a completely new position for a company like SABIC. So I would say this might happen in the future on a larger scale. SABIC is already doing certain projects on a smaller scale, but for a company like SABIC, or any company in the beginning of the value chain, it is a little bit outside of their normal activities, maybe out of their comfort zone. That's not because we don't want to do that, but that's just purely

because we were never in that position. So we need to slightly figure out how and what it's like to be at the front of the value chain. So yeah, we are learning how to communicate closer to the consumers and how to do that, and how to actually communicate with the individual consumer - and with a brand owner it's already very new for us.

APPENDIX G

Interviews Unilever

For all interviews, respondents were either sent the consent form or discussed the consent form prior to the interview. Due to the COVID-19 pandemic, respondents were unable to sign consent forms. Therefore, consent was given either through email or LinkedIn.

Interview #1 with Unilever
Date: 20/04/2020
Time: 10:00 - 10:30
Interviewer: Guilherme Monteiro Silveira
g.monteiro.silveira@student.rug.nl / gui_msilveira@hotmail.com
Interviewee: Remained anonymous.

Interview:

1. Could you provide a quick overview of how your daily tasks relate to sustainability?

I lead GFS packaging globally. Part of the manifesto, as we call it, from the company is around sustainability. Under our branch-with-purpose type of initiative, all our branches have to have a real reason to, you know, how are they going to contribute to sustainability. Our daily tasks start mainly from a strategic level, and then we work it to an operational level. So – first, kind of setting up with the regions what their portfolio looks like, what the top priorities are, what the biggest impact providers might be, as far as skews and materials. And then, once you have that under review, what we have done is taking a look at where we can go. So, you have got what it is today, you do the impact analysis on how good or bad it is, what is recycled and what is not, and then you come up with transition plans around the different sectors of your portfolio. And then, of course, the last step is to engage with that plan, resources, the priorities, clarifying what people should be working on first second or third, and what we are going to be by 2025. On a very specific daily basis, it is more about looking for new technologies, like Circular Polymers, and how we can apply those to our portfolio. Pyrolysis Oil has been around for about ten years, but really, it took the commitment and partnership formation from Unilever to people like Sabic, as a Polymer provider, to really push it forward and land it. Basically, Unilever committed; we gave them a

specific target, we said we want this many tons of plastic and we are willing to pay for it. That last piece is the most important. The fact is, we put our money where out mouth is; paying fifteen hundred extra euros per ton in the short term, which is a considerable amount. I mean, it is triple the price. And as they build capacity, it allowed their stakeholders to understand that we are really serious about going down this journey with them. And it is not just us, it is Tupperware, there is other people. The point is that their stakeholders said then okay we will invest capital in our own factories to enable this technology at scale.

2. In 2019, Magnum became the first ice-cream brand to use food-grade recycled plastic. Can you tell me a bit about this innovation?

That is right, that was the first Circular Polymer application on our portfolio. They came out with twelve hundred tons. That whole range got to use Circular Polymer. We are following this now with three skews in France. We are using this application around food, and that is the beauty of Circular Polymer; because in many places around the world, you cannot even use post-consumer recycled content in food applications for safety reasons. This technology takes it back all the way to its monomers, its building blocks, and you can recreate it into basically a virgin grade that is indistinguishable from cruel oil based. That is why you are able to use it for food applications. Magnum and Knorr are the first two brands out there, along with Ren. The idea was that Magnum was out in ’19, Knorr in ’20, and Ren in ’20. So it is like a rolling, a progression out into the market.

3. What impacts can Certified Circular Polymers (from chemically recycled plastics), used for products such as Knorr and Magnum, have on the plastic industry?

We, our sales teams, are able to present to the guys at Sabic, and the idea, at least in my mind, is that, you know, with communication around the war on plastic and people vilifying the plastic industry what this does is it allows for us to kind of counter that, saying - look there is applications that don’t harm the environment. There is a way to get litter out of the ocean, there is a way to, you know, keep all the goodness of plastic as far as safety, hygiene, specially today’s day and age. I think this is the future of the industry to be fair. Getting off crude oil, and going to pyro oil at a higher percentage.

4. Do you believe using plastic waste as an input for production can increase its value?

Absolutely it can. I will give you a very specific example. The collection program we started in the Netherlands, with a company called Renewi, takes all the waste inside the kitchen, which was formerly sent as mixed waste to incineration for energy production. Instead, by getting back plastic, metal and drink carton waste, as a mixed waste out of all the kitchens, for example, you able to take something that had very low value, like the flexibles, and you put those directly into pyro oil for Circular Polymers as input. So – what had very low value, as energy producing material, now could be actually made into this Circular Polymer. The more demand that we create for Circular Polymer, the more demand you have for the input, which is pyro oil, and the primary input for pyro oil should come from flexible plastic, which today has very low value. So that is the circle you are trying to create.

5. Do you think this type of input-for-production reduces plastic waste?

It does, it absolutely does. Now, I tend to call it unexploited resource. So it is not waste anymore, it is a resource you need for that input. You can keep it out of the environment, and you are going to keep it from just being burned up, and you are going to eliminate the need for crude oil. So – you go into pyro oil, it stays within the loop and it gets a second life.

6. How does the product ensure long-term health and well-being of stakeholders (including society and environment)?

From society's standpoint, so much of what you see in the ocean, for example. For the environment, if you look at the hills in Malaysia. Well, let me back up a second. All that stuff used to be exported to China, right, and they banned it. But they were basically just dumping it, as MacArthur always states, into eight rivers, which then became the ocean soup that we have today. And if you have these technologies, to make pyro oil, you don't need to dump all that stuff anymore. You can actually make value out of it. You're going to transform it from being litter, your pollution issue, into a value creator by using these technologies – that is the beauty of it. So – that keeps the environment more healthy, keeps systems more protected, and it gets plastic into a value stream. For our stakeholders, it is more of understanding with the life cycle analysis that for every kilogram of Circular Polymer produced, you use two kilograms less of CO2 versus virgin

plastic. That is a really key indicator. So you're actually doing less harm, and keeping all the goodness of plastic, whilst also keeping it out of the environment.

7. Is there a feeling of responsibility of Unilever towards the well-being of its stakeholders?

Well, we are on public record with our external targets. We signed up to multiple different plastics pacts around the world. We made strategic partnerships with waste collectors, like Veolia for example, or polymer producers like Sabic. Externally, we are very clear that sustainability and well-being of our stakeholders is forefront in our minds. Every brand has a responsibility to express how they will do that, as part of their brand DNA.

8. Are these circular polymers more expensive than virgin plastic made from natural resources? If so, why do you think Unilever has been committed to this innovation?

Because, from a responsibility standpoint, brands that don't have a purpose, unless they really explain to the next generation how they are going to take responsibility as a big corporation, for caring for the planet, people are going to stop buying the product. They are going to look at it like Grandma's brand, they are going to say – look, you guys are just an evil big corporation. And that is exactly what Alan Jope and our leadership wants to kind of counter. You have got to care, to take part if you want to be around, otherwise you are not going to be existing. So there is this inherent drive to explain to the next generation what we doing to be corporate citizens and responsible, and this is what sustainability is all about.

9. Does Unilever have any awareness programs with waste collection companies to improve consumer disposal?

We do. For Food Solutions, for example, we are partnering with a company in the Netherlands called Renewi. And Renewi, Unilever and Sodexo all partner together to get this mixed plastic waste out of kitchens, which previously had not been collected. And as part of that, we have a comprehensive communication strategy that we have to get back to after Covid, trying to explain what we are trying to do. Also, on every pack that we have got going on out in the market, across foods and UFS. We are putting on please recycle and waste disposal instructions, along with a web link that explains our sustainability manifesto, our work streams, everything we are trying to do in this space. So lots of education, lots of communication, and it is so critical to be transparent and

honest about what we're doing along with backing it up with life cycle analysis, so you don't get labelled as greenwashers or anything like this. So we are actually also asking our industry partners and colleagues to join us on this mission. So, I'll be talking to Danone, I'll be talking to Nestle, to Henkel, all these other people that are our direct competitors, about how we work together which is total mind shift because sustainability isn't a competitive advantage. Being first is a competitive advantage, but that quickly goes away and what it really becomes and what we need it to become is a price of entry to play in the market. So you have to join this mission otherwise, like I said, you won't be around. That is how I see it, anyway. We can't do it as one division, one company, we can't even do it in one market, we have to do it comprehensively globally with our peers. That is why communication is so important. You have to invite people, first explain what you're trying to do and then invite them to come along on the mission. So that's what were doing.

Interview #2 with Unilever
Date: 04/05/2020
Time: 14:00 - 14:30
Interviewer: Guilherme Monteiro Silveira
g.monteiro.silveira@student.rug.nl / gui_msilveira@hotmail.com
Interviewee: Remained anonymous.

Interview:

1. Could you provide a quick overview of how your daily tasks relate to sustainability?

Well, first of all, I must say that initially I am a plastic guy. I have a PhD in polymer science, so it starts there, that is why I was connected to these kind of topics. After doing a little bit of public research, I did my whole career at Unilever; starting at Foods, in ice cream to be precise. Then wider in foods, then completely cross-category across the business. And recently I moved back into, still the technical packaging role, but with a bit more responsibility in terms of strategy and communication in the Prestige area, which is a different segment, very specific segment in Unilever. The sustainability, in my case, is really day to day and it takes many forms. It can be, for example, a call I have after this is about technical qualifications of recycled plastics in China, which is a tricky one. But it is really talking about the technicality of it, but also the overall strategy about how to help the brand express their roadmap, communicate what they are doing, getting the right level of ambition, connect to the roadmap and what Unilever is coding out as ambition et

cetera. So it's really, almost I would say, eighty percent of my job is related in a way or another to sustainability. From technical things but also strategy and a leadership point of view.

2. In 2019, Magnum became the first ice-cream brand to use food-grade recycled plastic. Can you tell me a bit about this innovation?

I can tell a lot about that because I was the first contact point between Unilever and Sabic on this one. It takes quite some time to bring this kind of thing to life. It takes a lot of resilience and willingness. I remember the moment where we decided together with the VP from Sabic that we want to make that a reality, not only a project, not only something that would be cool to do but something we want to work together and bring to life. In this case it was not clear which application et cetera, but it was clear that food was the key target. And ice cream was the key target at this time. One of the reasons is that at this time I was not in this position for Prestige, I was cross-category, which is plastic leader. And I started my career in ice-cream, so it is quite natural that I sorted for an application in ice-cream. So that is why I approached them with this kind of proposal basically. And the idea was quite simple. It started by, on one side, we have trouble to recruit recycled plastic for many reasons in ice cream. One part of the reason is about food contact; of course we want to include recycled plastic, but we don't want to compromise at all on the quality or the safety. So we needed to be able to find a way to use recycled plastic in those applications which remained safe. But the other aspect is that the application in ice cream, specifically, requires very specific grade of polypropylene. So you can imagine that the typical basic criteria for this application is for frozen environments and you don't want the plastic to break. So it requires specific grade of polymer to be used. And, at the moment, what you find on the market from a mechanical recycling point of view, for polypropylene, you will find an average mix of different kinds of polypropylene. So it is really specific to polypropylene, because if you look at the applications of polypropylene, there is a great number of different grade and family within the polypropylene which all correspond to different applications, different technologies, et cetera. And for ice cream, we are basically at one of the edge of the development of polypropylene to get the right material with the best weight possible. So we have a lot of work to decrease the weight of the packaging and at the same time to have the right balance between stiffness and breakage. And basically if you bring any kind of recycled plastic it doesn't work because it will break. Even if you could have one which is satisfactory from a food grade point of view. So the challenge was

double, food grade and safety and, on the other side, was also having the grade that matched the performance that we require. And that's where the proposal that Sabic was working on at this time, which was only concept, was very appealing because it was basically going back to virgin quality of the polymer, being able to reproduce any kind of grade with the specificity that we want but safely recycling that feedstock, basically diverting the feedstock from fossil naphtha to plastic waste. And that's basically the moment where things started to click together, was realizing that what they were doing, not only was a new way of recycling, but it could answer this double challenge of safety and properties of the grade.

3. What impacts can Certified Circular Polymers (from chemically recycled plastics), used for products such as Knorr and Magnum, have on the plastic industry?

I think, for me, it's a game changing thing for many reasons. You have to consider a few things. First, you have to consider that, from a plastic point of view, plastic is a great material. At the moment, if you look at any material alternative in terms of use, in terms of carbon footprint, it is always winning basically. The only place where plastic is not winning is the end of life. We still have, a lot, a lot of plastic which is not going where it should go after use. And basically the more we can create an easier way to recycle plastic, the more chance to not have plastic in the environment, but, on the contrary, to be seen as a source of value as a feedstock. So from this point of view, being able to have a sort of direct replacement from fossil feedstock by plastic waste feedstock is also very impactful from this point of view. So I think it has the potential to be very impactful. There is a lot of but and if at this stage, because we still need to consider it as a, we are pioneering something there, it is the first time this is being done in the market, so it is the very beginning. And of course, there is many many reasons why it is still difficult to do at the moment from a technical point of view, from an efficiency point of view and from the cost point of view. But assuming that all of that can be solved, and can be improved, generation after generation basically, it's probably one of the best ways of recycling plastic because it can treat it as much more versatility in terms of different types of plastic it can accept in the recycling process because it is less demanding let's say, and at the same time, it is recreating virgin-like properties. That is very important. It is the only technology that allows you to do that; to recycle plastic with this kind of acceptance criteria – recycling stuff that mechanical recycling cannot treat for example, and at the same time regenerating, and this word is important, regenerating plastic in its virgin stages

with the same exact virgin property or same properties than virgin plastic. And that is why, for example, for my brand that I take care, REN, we even qualify this technology as infinity recycling technology because, for the first time, this kind of technology brings plastic into a very selective club of materials that have the potential to be infinitively recycled. And one of the key things that this technology is bringing to reach that, is the fact that you do not lose anymore the properties of plastic cycle after cycle, which is the case of mechanical recycling.

4. Do you believe using plastic waste as an input for production can increase its value?

Quite simple. At the moment the plastic which is used by Plastic Energy, but also more generally speaking by this type of technology, because you can see around that since the advancement from Sabic and Plastic Energy, there has been a lot of advancement from other polymer manufacturers, and basically all of them start with the same thing the source of the feedstock we want to use we would like to complement what currently mechanical recycling is using. And what does it mean, it means that the prepared feedstock for this kind of technology is feedstock which is currently not finding a great way or economical way to be recycled by mechanical recycling. Again, what does it mean, it means that at the moment this plastic has very very low or lethal value. Sometimes, even a negative value because you have to dispose it. And what is being done with it is at best is incineration with energy recovery. In some cases, this would be only incineration, and in worst case it would be landfill. And landfill is, of course, the direct door to environmental leakage. So from this point of view, of course it is bringing back value to this material because at this moment this material has the value which is negative, and it's regenerating it into virgin plastic with the same exact properties than the one you would get if you used fossil fuels feedstock.

5. Do you think this type of input-for-production reduces plastic waste?

It is already, because the plastic used for the feedstock is already diverted from incineration or landfill. So the one that is currently being treated by Plastic Energy, if this was not existing, the destination of this waste would have been landfill or incineration. So we have to keep precaution, of course, because at the moment we are still talking about facilities which are small and capacity of treatment which are small in comparison with the size of the trouble, let's be humble on that. But you need to start somewhere, and this pilot demonstrating that this technology is working is basically enabling to have more investment and to set up the right capacity for that.

6. How does the product ensure long-term health and well-being of stakeholders (including society and environment)?

If I look at it from a waste point of view, it is finding an alternative treatment for plastic waste, which is a good one, and basically avoiding plastic to end up in the environment. It is one more reason for plastic not to end up in the environment and it is one more incentive, economically, to do something with this resource and to consider plastic as a resource and not as waste. So that is on the side of the feedstock. On the other side, also accessing and reintroducing recycled plastic into applications with even further improved quality, enlarging the applications in which you can put plastic, recycled plastic like that, which at the moment you would not be able because of safety and health concerns.

7. Is there a feeling of responsibility of Unilever towards the well-being of its stakeholders?

Yes, I think so. I mean, it is explained in our purpose, the mission of a brand like Unilever is really to do business with sustainability. I think in one sentence if you put a summary of that is of course we are doing business because we want to do good but we also want to do right. And one is not going without the other one.

8. Are these circular polymers more expensive than virgin plastic made from natural resources? If so, why do you think Unilever has been committed to this innovation?

Yes, a lot. And the commitment is again what you want to do. If you want to create the solution that you need, you need to accept that there is a tax for it. If you look at many articles that have been published, several times they were reassuring this activity as Unilever – magnum, knorr and REN skincare, pioneering with Sabic. And the word pioneer was coming back several times. And I think it takes this kind of spirit, and part of this pioneering is to accept that, step one – you will pay more, you will have to finance it differently, you have to get the value out of it differently too. But the idea is to create a path for this technology to exist, to develop, to grow and to reach a moment where it is also economically viable. And one of the things is also when we do this kind of thing, it is also looking if there is a path for this technology to become more cost viable.

9. Does Unilever have any awareness programs with waste collection companies to improve consumer disposal?

In developed countries, there are already infrastructures in place and we are working with these stakeholders in this area to improve the guidelines to improve recycling. I think the big focus is that in October 2019, there was a re-pledging of the packaging sustainability strategy, where one of the additions was that we want to support, to collect and to recycle more plastic than what we put on the market. And of course this means working a lot with waste management companies, and there is, of course, more and more contact with them.

Interview #3 with Unilever
Date: 15/05/2020
Time: 18:00 – 18:30
Interviewer: Guilherme Monteiro Silveira
g.monteiro.silveira@student.rug.nl / gui_msilveira@hotmail.com
Interviewee: Remained anonymous.

Interview:

1. Could you provide a quick overview of how your daily tasks relate to sustainability?

I think that at least eighty percent, and I could even justify one hundred percent, are related to sustainability, because most part of Unilever's packaging agenda nowadays is related to reducing or improving the impact of the packaging on the environment.

2. In 2019, Magnum became the first ice-cream brand to use food-grade recycled plastic. Can you tell me a bit about this innovation?

At the same time Magnum came out with this material, Knorr pots that are sold to restaurants also came out with this material. It is a polypropylene that is chemically recycled, which is provided by Sabic. The plastic when is recycled goes under a process of decomposition, at Plastic Energy before going to Sabic, which forms something called pyro oil. The pyro oil then goes to Sabic in a gigantic cracker and then transformed into polypropylene, in the case of Magnum and Knorr. This polypropylene is what was used to make the pots for Knorr and Magnum. Magnum was the first ice cream brand to do this. Knorr was also the first brand within Food Service to use

chemically recycled polypropylene. It was an important breakthrough for our brands. I know that Sabic also has grades of polyethylene, but I am not sure we currently buy polyethylene from Sabic.

3. What impacts can Certified Circular Polymers (from chemically recycled plastics), used for products such as Knorr and Magnum, have on the plastic industry?

I think they are fundamental for the implementation of a circular economy, because, specially for the food industry, and specially for polyolefin – polyethylene and polypropylene, it is very hard to obtain recycled material that is food grade. This is because polyethylene and polypropylene are very hard to, simply put, clean for it to be clean enough to be used for food applications another time. So, this has not been done in great scale, you also need an isolated plastic supply chain, and it is very hard to do and you can't do it in large amounts. That's why chemical recycling is important, specially polyethylene and polypropylene, because it is possibly the only one to scale these polyolefin that are food grade. And without this you can't move the industry. At least for this part of these two polymers, in the direction of a circular economy. And these two polymers are important because they are, together with PET and PVC, which Unilever doesn't use anymore PVC, but PET, polyethylene and polypropylene are the three polymers most used for packaging in the world. So in order for you to move you need to scale this.

4. Do you think this type of input-for-production reduces plastic waste?

Of course, that is the whole idea. That is why I mentioned the importance of this for the circular economy. If you can increase the consumption for this plastic, the whole idea is, if you can, in the case of Unilever, we have the intention to reduce the consumption of virgin plastic. For that, the idea is to use more recycled plastic. Increasing the quantity of, or the demand for recycled plastic, the value and price of recycled plastic will rise. The demand for raw materials, which is collected plastic, will increase. The value of plastic waste will increase because there is a market for that, and increasing the value of waste you can create a market for waste. With that, and increasing this value, there will be more interest in collection, and more interest in collection will lead to more plastic collected, and the more collected, the less plastic goes into the environment. These are the gears that are needed to move to generate demand and to generate collection.

5. Do you believe using plastic waste as an input for production can increase its value?

Yes, like I said before, if you increase demand, you increase the value of recycled plastic. And increasing this value, you increase the interest for there to be collection of this waste.

6. How does the product ensure long-term health and well-being of stakeholders (including society and environment)?

Through this process I just described, because the whole idea is to decrease the amount of plastic the ends up in the environment. If you can, through this material, generate demand, generate value for the recycled material and prevent it from going into the environment, it is how you can, first, prevent that this leaks. That by itself is a positive point for a major part of the stakeholders. You can also raise value for people in the chain that are bringing back this plastic that would turn into waste, bringing this back into the chain. So – collectors, the companies that will break down the material collected into oil, the companies that transforms the oil into plastic again, the companies that will use the plastic, all of them are stakeholders that are improving value. And regarding food grade safety for food, Unilever uses the highest quality and safety standards available. For example, Unilever always use the criteria or standards that are more demanding within the standards set out by the governments where we sell the product, or Unilever's own standards. So, if we sell something in a country that have safety or quality standards for consumers that are lower than Unilever's, we use our own standards. If it is higher than Unilever's, then we use the country's and review our own parameters. So the importance of food grade is directly linked to the safety of the consumer, or leakage into the environment which ultimately will also be linked with the health of the consumer. So the importance of food grade is totally to do with this, it is not only necessarily for the quality of the product in terms of taste, which could also be influenced – it is also a parameter, but also and most importantly it has to do with consumer safety.

7. Is there a feeling of responsibility of Unilever towards the well-being of its stakeholders?

Absolutely. If you observe Unilever's Sustainable Living Plan, you will see there are various pillars, and many of them are in respect to the well-being of stakeholders. They can be employees at the company, they can be people that consume the company's products, they can be customers who sell the products of the company, and all of these are related. For example, regarding plastic mixing, now that Unilever has the objective until 2025 to collect an amount of plastic equivalent to the amount of plastic it uses, we have done a lot of work to develop collection systems. And we

have a lot of concern and awareness to only do partnerships with companies, or entities and NGOs that do this collection that use the standards we judge to be necessary in relation to, for example, safety of the employees, well-being of employees, minimum wage, all of these things.

8. Are these circular polymers more expensive than virgin plastic made from natural resources? If so, why do you think Unilever has been committed to this innovation?

The President of Unilever has said this week, in a webcast for employees, that if the fact that this type of raw material is more expensive were an impediment for our sustainability plans, we would never have even started. So the fact that it is more expensive, and us using it anyways, shows that we find this an important factor for the product and we try to compensate the elevated cost saving in other areas, so we don't have to pass this cost on to the consumer. A second point regarding this is that, we believe, especially in relation to recycled plastics, that the fact it is more expensive is a situation happening currently, which in the last two months was aggravated with the reduction in price of virgin plastic in function of the reduction in oil prices, but regardless of that, one of the main factors for it to be more expensive is a question of scale. When recycled plastic increases in scale, becoming more common and more companies buying, generating even more scale, the tendency is for this price to decrease. In some specific cases, in certain geographic locations, recycled plastic is cheaper than virgin plastic. This is not the norm but already exists. But as the scale increases, this difference will disappear. Regardless of that, at this moment with the higher price, we are investing and the idea is to continue with this. We are committed to, in 2025, lowering by half the amount of virgin plastic used today. This means that, today Unilever uses seven hundred thousand tons of plastic, all virgin - so the idea is to reduce this in half. From these three hundred fifty thousand tons we aim to cut, one hundred thousand will be eliminated completely. And the difference, for the two hundred fifty thousand, is to implement recycled plastic. So this is the public commitment of Unilever that will be fulfilled until 2025.

9. Does Unilever have any awareness programs with waste collection companies to improve consumer disposal?

We have a few programs. Within Food Solutions, for example, there is a campaign called Please Recycle, which are guidelines for how consumers can dispose. This also happens differently according to each country. In some countries, we are obliged to follow. For example, in the UK

there is something called OPRL, which defines how you will identify in the packaging, depending on the material used, what is and how it should be disposed. So in this case Unilever follows the regulations of the country. In other places we build partnerships with companies that help identify this. In other places, we try show this in the simplest way possible. Now this topic about education is important because without it, without appropriate disposal, it makes the collection process difficult. It is very difficult for the consumer to learn and understand because in each country, and sometimes in the same country, each city has a different way of disposing specific materials. This can vary a lot, but it is very important. Unilever has to be locally aligned with local regulations, and we try to do this education ourselves, through information on packaging or information on the website, or other activities that we have planned to do in order for the consumer to understand. It is very hard for them to understand in function of the complexity that exists due to the collection systems that are different for specific and distinct materials. And we understand it is an obligation of companies to try to clarify this.