What does it take to close the loop? Lessons from a successful citrus waste valorisation business

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Received 9 August 2023
Revised 15 December 2023
Accepted 15 January 2024

Abstract

Purpose – In this case study, we examine how a citrus peel valorising company based in the Netherlands was able to adopt a circular business model while navigating regulatory, managerial, and supply chain-related barriers.

Design/methodology/approach – In-depth, semi-structured interviews with key personnel in the company, notes from field observations, photographs of the production process, and documents from a legal judgement served as data for this single, qualitative case study. Data were coded inductively using the in vivo technique and were further developed into four themes and a case description.

Findings – Results from our study indicate that the regulatory and political contexts in the Netherlands were critical to the company's success. Like in the case of most fruitful industrial symbioses, partnerships founded on mutual trust and economically appealing value propositions played a crucial role in ensuring commercial viability. Collaborating with larger corporations and maintaining transparent communication with stakeholders were also significant contributing factors. Lastly, employees' outlook towards circularity combined with their willingness to learn new skills were important driving factors as well.

Originality/value – In addition to expanding the scholarship on the adoption of circular business models, this research offers novel insights to policymakers and practitioners. It provides empirical evidence regarding the importance of public awareness, adaptable legislation, and harmonised policy goals for supporting sustainable entrepreneurship in the circular economy.

Keywords Food waste, Food processing by-products, Industrial symbiosis, Circular bioeconomy, Qualitative case study

Paper type Case study

The authors would like to thank Martijn Zieverink as well as all study participants for sharing their insights and allowing us to conduct field work. This research has been made possible with the support of the Dutch Province of Limburg.

British Food Journal
Vol. 126 No. 13, 2024
pp. 143-161
Emerald Publishing Limited
0007-070X
DOI 10.1108/BFJ-08-2023-0700

1. Introduction

As over eight billion of us prepare to share the limited resources our planet affords us, difficult questions about our continued sustenance are inevitable. With the area of arable land available to us remaining limited, stakeholders in the food system are compelled to seek out new ways to meet the world's dietary needs. To continue producing nourishing food while respecting planetary boundaries, the food system of the Anthropocene must endeavour to become frugal and innovative in its use of raw materials (Hadjikakou *et al.*, 2023; Rockström *et al.*, 2009; Willett *et al.*, 2019). It is perhaps this realisation that has generated immense interest in the concept of the circular economy among food businesses. Becoming circular entails designing systems that allow raw materials to be used to their full potential before they are discarded. However, "circularising" the food system comes with a unique set of challenges due to concerns regarding food safety and consumer preferences (James *et al.*, 2022; Rao *et al.*, 2021).

The circular economy and the bioeconomy are distinct concepts, each with several accepted definitions. Since this case study focuses on a European business, the European Commission's definitions for both concepts would be most relevant. In 2012, a publication by the Commission indicated that the bioeconomy encompasses "the production of renewable biological resources and their conversion into food, feed, bio-based products and bioenergy" (European Commission, 2012). In comparison, the circular economy is defined as a system that aims to minimise the generation of waste and maintain the value of products, materials, and resources for as long as possible (European Commission, 2015; Stegmann *et al.*, 2020). In recent years, there has been considerable interest to merge the two terms, leading to the birth of the "circular bioeconomy". Based on an in-depth literature review and interviews with involved actors, Stegmann *et al.* (2020) define the circular bioeconomy as a system that focuses on the "sustainable and resource-efficient valorisation of biomass via integrated, multi-output production chains while also making use of residues and wastes and optimising the value of biomass over time via cascading".

Implementing the circular bioeconomy model in the food system comes with several challenges. Unlike textiles, electronics, and certain kinds of biomass, food must be consumed within a relatively short period of time after harvesting. Once unsuitable for human consumption, it can be used for other purposes such as the production of animal feed, biofuel, or chemicals for industrial use. However, this way of utilising food materials has been proven to be less socially and environmentally sustainable compared to (re)using it for human consumption (Papargyropoulou *et al.*, 2014; Parsa *et al.*, 2023; Redlingshöfer *et al.*, 2020; Teigiserova *et al.*, 2020). Therefore, there is a strong interest in developing new ways of retaining food material within food supply chains for as long as possible. This has led to development of a new category of sustainable foods known as upcycled foods or value added surplus foods (Bhatt *et al.*, 2017; Spratt *et al.*, 2021). Generally, these are understood as products that use ingredients such as food processing by-products and foods that are not saleable in the market for various reasons (Spratt *et al.*, 2021). In contrast to recycling, the process of upcycling seeks to transform the material to become purer and better or of additional value to the society (Aschemann-Witzel *et al.*, 2023). Upcycling offers many advantages in comparison to other food waste management strategies. These include improving food security, transporting the surplus or by-products over shorter distances, and often, contributing to the production of healthier and low environmental impact food products (Moshtaghian *et al.*, 2021; Zhang *et al.*, 2021). Upcycled foods are based on the identical principles of value addition, waste utilisation, and resource efficiency, making them inherent to circular bioeconomy system (Aschemann-Witzel and Stangherlin, 2021).

While the merits of upcycling food surpluses and by-products have been well documented in literature, it is also known that establishing such an operation on a commercial scale is riddled with several barriers. Ada *et al.* (2021) and Bröring and Vanacker (2022) elaborate on

the organisational, economic, regulatory, technological, supply-chain management, knowledge, and product quality and availability related barriers that food businesses face while adopting a circular business model. Despite these challenges, some entrepreneurs have been able to successfully set up operations that valorise food waste into new food products. This case study focuses on one such company – PeelPioneers B.V (hereafter PeelPioneers) – based in the Netherlands.

The activities and ambitions of PeelPioneers (see section 3.2) fit within the scope of the circular bioeconomy definition discussed above, firmly establishing its position as a circular bioeconomy-embedded business. However, before diving into the specific case of PeelPioneers, it is important to reflect upon the challenges of establishing such a business. These challenges have been documented extensively in recent literature (Ada *et al.*, 2021; Bröring and Vanacker, 2022) and inform the theoretical framework of the study presented in this paper. With particular regard to businesses that valorise agricultural waste, Donner *et al.* (2021) posit that innovative bio-based technologies are often needed for enabling new conversion pathways that lead to the production of high added value products such as biomaterials, feed, food ingredients, and biomolecules. Logistical difficulties are commonplace due to the voluminous and heterogeneous nature of agricultural waste (Donner *et al.*, 2021). Regulations pertaining to these innovative technologies are often insufficiently developed or misaligned with broader sustainability goals, leading to uncertainty and conflicting incentives (Bröring and Vanacker, 2022; Golembiewski *et al.*, 2015; Van Lancker *et al.*, 2016). Time-consuming safety approvals of new products or technologies also impede the development of the circular bioeconomy (Collins *et al.*, 2020). Additionally, perishability and seasonality are inherent to many forms of biomass and become especially relevant when dealing with food and agricultural biomass. This leads to fluctuations in quality and availability and causes serious repercussions for the value generation process (Boehlje and Bröring, 2011; Leipold and Petit-Boix, 2018).

Economic barriers in this context are relatively well documented in literature (Bröring and Vanacker, 2022). Many bio-based industries require sizeable upfront investment but fail to attract investors due to the difficulties they face in achieving economies of scale (Blair *et al.*, 2017; Collins *et al.*, 2020; Donner *et al.*, 2021). As a result, few private investors show interest in the bioeconomy, leaving businesses to depend largely on public subsidies (D'Amato *et al.*, 2020; Reim *et al.*, 2019). Lastly, organisational culture and knowledge-related barriers impede the growth of many circular bio-based businesses as well (Bröring and Vanacker, 2022). These barriers are connected to the need for new knowledge and skills among employees, access to piloting or research facilities, and adjusting operations to new, innovative business models (D'Amato *et al.*, 2020; Orozco *et al.*, 2021; Reim *et al.*, 2019). While there is no paucity of literature describing the challenges of establishing a food business in the circular bioeconomy, not too many studies focus on how businesses are able to overcome barriers. This makes it important to document examples where entrepreneurs were able to establish a commercially successful business despite the existence of said barriers.

2. The PeelPioneers case

2.1 Case selection

Our objective while studying the operations of PeelPioneers, a scale-up company that manufactures food and other high-value ingredients using citrus waste, was to identify factors that enable a food business to adopt a circular business model and overcome the barriers listed above. PeelPioneers employs what Vermunt *et al.* (2019) describe as a "resource recovery" model which is a type of circular business model focussing on the transformation of the residual value of resources into new forms of value. This model seeks to reduce the

environmental impact of industrial production systems by reducing the continuous demand for resources, closing material loops, and using waste streams as useful inputs to other products and processes (Bocken *et al.*, 2014). As per the archetyping system proposed by Henry *et al.* (2020), PeelPioneers' business model would be classified as "waste-based" with its innovation category being "industrial symbiosis". Such businesses seek to extract value from unexploited waste streams from an external organisation, relying mostly on innovative process-based solutions (Henry *et al.*, 2020). Industrial symbiosis is a concept from the field of industrial ecology wherein actors from (traditionally) separate industries collaborate to share materials, energy, water, and/or by-products to gain a competitive advantage (Chertow, 2000).

Three characteristics of PeelPioneers' operations informed our decision to study it. First, the business uses an upcycle strategy as opposed to the reuse, redistribute, recycle, reprocess, or resell strategies that are more common in the food sector (Huang *et al.*, 2021). This is especially true at the retail-consumer interface from where PeelPioneers obtains its raw material. Huang and colleagues' systematic review on the subject reveals that most retailers recycle their food surpluses by donating or selling them to producers of animal feed, biofuel, or compost (Huang *et al.*, 2021). Upcycling food waste from supermarkets to produce ingredients that can be used in the production of food products makes PeelPioneers' operations noteworthy. Second, alongside products such as oil and candied orange peels, the business produces dietary fibre from citrus waste. Dietary fibre can be used as a functional ingredient due to its potential to improve the nutritional profile of several food products such as bread, yogurt, various spreads, and plant-based milks. Consumption of dietary fibre is known to enhance faecal bulking efficiency, improve colonic fermentation, maintain insulin levels, lower postprandial blood glucose response, and attenuate blood cholesterol (Champ *et al.*, 2003; Fuentes-Zaragoza *et al.*, 2010). The fact that the fibre is produced by valorising food waste further enhances its relevance for the food manufacturing sector which seeks to constantly improve its own sustainability credentials. Finally, PeelPioneers' use of citrus waste was also a deciding factor in its selection. At 144 million metric tonnes of production per year, citrus is among the most popular fruit crops in the world (FAO, 2021, 2023). Around one-third of all citrus production undergoes some form of processing, making the management of citrus by-products a pertinent issue at the global level (FAO, 2023). Valorising citrus waste is known to be fraught with several organisational, regulatory, and market-related uncertainties (Ferrari *et al.*, 2016). The management of solid waste produced during the juice extraction process also presents a significant environmental burden because of its highly fermentable nature (Lin *et al.*, 2013; Satari and Karimi, 2018). With traditional waste management strategies such as incineration and landfilling being seen as environmentally unsustainable (Wei *et al.*, 2017), the citrus processing industry is pushed to work with alternative valorisation and disposal strategies. Given that PeelPioneers works with one such valorisation strategy, we posit that a case study on their operations would be of interest to researchers and practitioners in the field.

2.2 Case description

PeelPioneers was co-founded by three entrepreneurs in 2016 in Son, the Netherlands. The company received funding based on the founders' idea of valorising citrus peel waste from the food retail sector. The company extracts valuable compounds from citrus waste and transforms them into new products that are then sold to business customers for either further use in food, animal feed, cosmetic, or industrial applications. According to PeelPioneers, before their operations commenced in 2016, around 250 million kilos of citrus peels were being thrown away or incinerated in the Netherlands every year. This was seen as a valorisation opportunity by one of the founders who applied for a seed fund to set up the company.

Supermarkets in the Netherlands produce high volumes of orange peel and pulp waste because orange pressing machines have become ubiquitous in Dutch supermarkets. Customers have access to these machines and can operate them themselves. After the oranges have been pressed, the peel and pulp that remain behind (peels henceforward) are collected in a bin placed under the machine. Conventionally, these peels were classified as waste material and therefore legally ineligible for further use in the food sector. By leveraging their citrus processing technology and partnership with supermarkets and waste management company Renewi plc (hereafter Renewi), PeelPioneers appealed to the Ministry of Infrastructure and Water Management for these peels to be categorised as a raw material fit for use in the food industry.

In partnership with Renewi, PeelPioneers opened its first manufacturing facility in 2018. Renewi ensured that the waste was collected and transported to the manufacturing site in a safe and timely manner. At this point, the capacity of the processing line was around 40,000 kg citrus waste per day. PeelPioneers continued to reach out to more retailers to avail access to higher volumes of citrus waste. In 2021, following a €10 million investment, PeelPioneers' operations moved to a new premises in 's-Hertogenbosch in the Netherlands with the capacity to process 30,000 tonnes of citrus waste per year. Along with the production capacity, the employee numbers rose from 18 to over 35. As of 2022, participants shared that around 80% of Dutch supermarkets with a citrus waste stream delivered to them, with procurement lines stretching into Germany and Belgium. Supplying establishments pay the company a small fee to take their citrus waste.

At the time of data collection, PeelPioneers' valorisation process was organised as follows: waste is collected separately from retailer stores in plastic bags and transported by trucks in large bins which fit up to 200 kgs of peel. The bins are unloaded with a forklift into the station dock, which is when the processing starts. The first step includes tearing up the bags and manually emptying them. Then, employees visually inspect the peels, picking out any unwanted materials (e.g. other fruits and vegetables, cleaning towels or wipes, bottle caps). The peels are then washed and divided into zones. Peels that will be valorised into food products are separated from those meant for the production of oil and feedstock. In the food production zone, an additional round of washing takes place, followed by the mechanical removal of pulp cells, leaving only the albedo and flavedo (the orange and white part of the peel). The peel is then cut into 4–6 mm pieces that are sold to business customers (e.g. bakeries), who use them as an ingredient in confectionary. At a separate oil production line, peels are squeezed, and oil is separated from solids and water. When used as an ingredient, the cold pressed oil adds aroma, orange colour, and flavour. It is used by PeelPioneers' clients in food products such as muffins, yogurt, and beer, among others. The oil can be further concentrated and processed into the five-fold oil, which is also used in food applications that require the addition of a strong citrus aroma. In a separate process, D-limonene is also distilled from the oil and sold to businesses that use it in the production of cleaning agents. Animal feed in produced in an independent non-food zone.

A separate production line in the factory produces dietary fibre from the orange peels. Researchers were not allowed to access this part of the factory to safeguard the company's trade secrets. However, we were able to observe the end product – a white-coloured powder, devoid of the citrus odour and taste. During our visits to the factory, tests were underway to determine the range of applications for this fibre. At the time of writing this paper (March 2023), the company's website lists "Finix Citrus Fibre" as one of its saleable products and highlights sugar and fat reduction, binding, thickening, emulsifying, and water retention as its applications in the food and cosmetics sector. At the time of data collection, participants informed us that us that health claims regarding the fibre being recognised as a functional food were under investigation. Figure 1 illustrates the company's current supply chain.

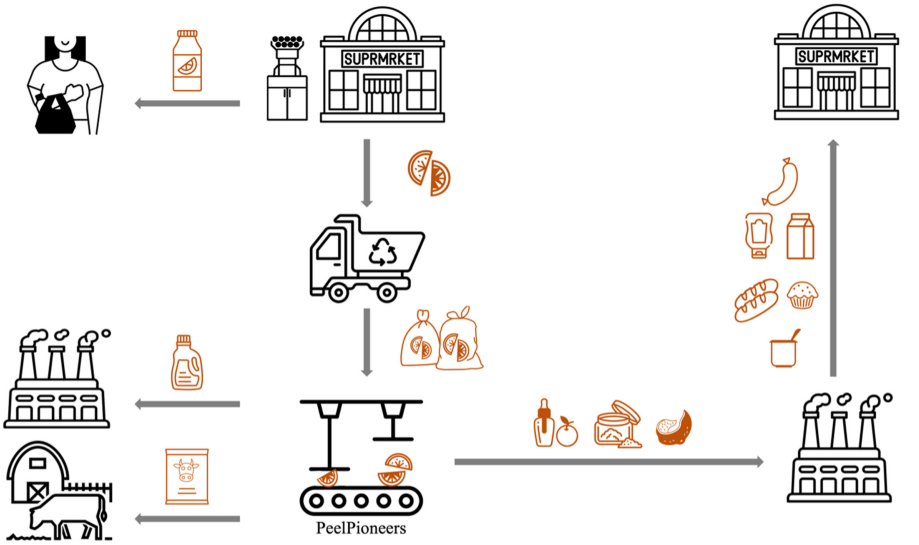

Figure 1.
PeelPioneers' supply chain

Source(s): Authors work

PeelPioneers' ambitions for the future include improving current production processes, experimenting with new ways of valorising citrus waste, and expanding operations to other European countries. The company's goal is to process all received peels into products that can be used for higher ranking valorisation activities such as food and pharmaceutical applications. The company's management wishes to expand operations to other European countries and is currently investigating the possibility of procuring orange and other citrus peels from industrial production sites for local processing. Other plans include the extraction of hesperidin, an antioxidant used in health foods due to its high phenolic content. Establishing higher valorisation routes of their own side streams such as sugar water and pectin is high on the agenda as well.

3. Methods

We conducted a single, explanatory, qualitative case study to examine the operations of PeelPioneers. As described by Yin (2009), case study is the most suited methodology when undertaking an in-depth examination of a contemporary phenomenon within its real-world context. Therefore, one of the main strengths of a case study is the ability to cover both the context and the phenomenon. As is typical to this method, we collected and analysed multiple forms of data. In-depth, semi-structured interviews with key personnel in the company, notes from field observations, photographs of the production process, and documents from a legal judgement served as sources of data.

3.1 Data collection

The starting point of data collection was the recruitment of interviewees, which was initiated by the first author through contact with an employee via email. To accurately capture the phenomenon, it was necessary to obtain multiple viewpoints. Therefore, a purposive sampling strategy, which relies on researchers' judgement in choosing participants based on

a set of characteristics, was seen as fitting (Etikan, 2016). Specifically, a maximum variation sampling strategy (Suri, 2011) was chosen in order to allow the phenomenon to be studied from as many different angles as possible. Our sampling strategy allowed us to select participants from various departments, including marketing, management, production, quality assurance, and research and development. Seven employees of the organisation were interviewed for this research. We do not provide additional details about the participants to ensure anonymity.

The questions asked during the interviews were informed by the literature discussed in the first section of the paper. Given the varied roles and expertise of the participants, the questions per interview differed. However, broadly, the aim was to identify how the company overcame the various barriers that are associated with setting up a food waste valorisation business. The Appendix provides as overview of the preliminary questions that were asked. Given the semi-structured nature of the interviews, participants were asked additional questions based on their answers to the preliminary questions. All interviews were conducted in-person in English and were recorded with the participants' consent and then transcribed *verbatim*.

Considering that case studies typically analyse data from multiple sources (Yin, 2009), notes and pictures taken while observing PeelPioneers' production process were also used as data. A third source of data were the legal judgements by the Dutch Ministry of Infrastructure and Water Management allowing PeelPioneers to use citrus waste to extract oil and produce animal feed at a commercial scale [1]. Data were collected by the first, second, and fourth authors via visits to PeelPioneers' factory in 's-Hertogenbosch in the Netherlands on three separate occasions between January and April 2022.

3.2 Data analysis

Interview transcripts, notes, photographs, and legal documents were coded inductively using the in vivo technique described by Saldana (2021), using the software Atlas.ti. *In vivo* coding is a data analysis technique where researchers assign descriptive or interpretive labels to data based on participants' own words and expressions, preserving the authenticity of their language. It is a bottom-up approach that captures rich, contextually meaningful codes directly from the data, enabling a nuanced exploration of participants' experiences and perspectives. The first round of coding generated 39 codes. This was followed by a subsequent round wherein related codes were grouped together into 12 categories. These categories were further developed into four themes as well as the case description. The first two authors independently coded the data and later collated their analyses. To support the findings, direct quotations have been utilised in appropriate cases, either unaltered or modified for the sake of clarity or confidentiality.

The study was reviewed and approved by the Ethical Review Committee Inner City Faculties of Maastricht University. Prior to conducting interviews, informed consent forms were signed by all participants. Personnel from the company had no influence on the analysis or the findings presented in this paper. Management was, however, asked for permission to use the company's and its partners' names in this paper.

4. Findings – factors enabling PeelPioneers' success

4.1 Regulatory and political situation

In September 2016, the Dutch government published "A Circular Economy in the Netherlands by 2050" – a document outlining how public and private actors would work towards achieving a waste free economy in the coming decades. In this document, it is acknowledged that existing waste management and other supporting regulations must be better adapted to

the circular economy concept if raw materials at the end of their life in one supply chain are to be better utilised in another (Government of the Netherlands, 2016). PeelPioneers' experience with the legal process to change the status of the citrus peels is indicative of this willingness to adapt. In 2017, the company appealed to the Knowledge Centre for Circular Economy of the Dutch Ministry of Infrastructure and Water Management to change the legal status of the peels from "waste" to "raw material for continued use". Two separate applications – one for use in animal feed and other for oil production – were submitted at the same time. The legal judgement document states that three factors were considered when assessing the application – certainty regarding the demand for the products that PeelPioneers would manufacture if the status change was approved, the lawfulness of such an approval, as well as the quality of the end product. The European Waste Framework Directive (Directive 2008/98/EC), the Dutch Environmental Management Act, and the third Dutch National Waste Management Plan were applied to assess whether the peels could be used as a raw material for continued use.

The legal process took place over 24 weeks and involved continuous communication between the Ministry and the company's representatives. Relevant participants informed us that despite the anxiety that comes with a critical step such as this one, they felt sufficiently supported and confident throughout the process. They shared that despite the European Union's (EU) legislation on the subject being complex and confusing, the Dutch implementation of it was accessible: *"European legislation on this topic is just hell. I mean, even for people with a high level of education, it's quite difficult to fully grasp what it says. And that's because it's so broad and needs to cover so many things. And so many people get to have a say. But when you take it all down to a national level, it worked pretty well (for us)."* Preparing the applications was described as a taxing process but was balanced by the positive and relatively fast outcome. PeelPioneers also benefitted from the appointment of a highly skilled legal consultant employed by Royal Haskoning DHV, one of the Netherlands' leading consultancy firms in the field of sustainable innovation and engineering.

To hire skilled personnel and set up a supply chain and basic infrastructure, PeelPioneers, next to the co-founders' own investments, availed funding from various sources at the provincial, national, and European levels. The political will to transition to a circular economy in the Netherlands and in Europe made these funding sources available to a start-up company. A co-founder mentioned that the circular economy being in the limelight gave them the opportunity to speak about their business idea at various national events. This ultimately helped the company gain recognition and funding. Some relevant funds, grants, and investors that the company has received investments and endowments from include the European Circular Bioeconomy Fund, Brabantse Ontwikkelings Maatschappij (the Brabant Development Company), Stichting Doen (The Doen Foundation, funded by Dutch lotteries), Climate-KIC International Foundation, ABN AMRO Bank, Rabobank, het Nationale Groenfonds (The Dutch National Fund for Green Investments) and the Top Sector Energy Grant initiated by the Dutch Ministry of Economic Affairs. PeelPioneers raised money for their operations in multiple rounds, starting with several thousand euros at the very beginning, followed by €1 million seed capital, and most recently €10 million early venture capital. Participants believed that having access to Dutch and European funding instruments, expertise, and innovation sandboxes has played a critical role in the company's success so far.

Participants were cognisant of the advantage their political environment affords them. One of the founders shared that having access to such resources also comes with a certain responsibility: "*We're in a very privileged position because the Netherlands is a very wealthy country. We can afford to look at these things. In poorer countries, people often struggle to meet their basic necessities so they cannot spend too much time thinking about what they are going to do with the waste they produce. I think we have a role to play there. We can afford to experiment and through that, show what is possible*".

4.2 Meeting food safety requirements

Food safety is one of the major barriers when valorising waste into new food products. In order to obtain permission to use citrus peels from supermarkets and restaurants, PeelPioneers had to provide detailed information regarding how risks such as pesticide contamination and biological spoilage would be dealt with throughout their operations. Assessors considered the nature and origin of the peels, procedures involved in valorisation, as well as the application of the resultant substances.

Like any other food business operating in the European Union, PeelPioneers is obligated to follow various requirements laid down by the EU General Food Law (EC/178/2002). Specifically, the legal judgements mentions that the company's operations must adhere to regulations EC/1829/2003 and EC/1830/2003 requiring food and feed to be free from genetically modified organisms, directives EC/2007/13 and EC/2007/68 on the reporting of allergens [2], regulation EC/1334/2008 prescribing rules regarding the use of certain food flavourings, regulation EC/1881/2006 which sets the maximum levels for contaminants in certain foodstuffs, and EC/396/2005 on maximum residue levels of pesticides. In addition, the importance of following the HACCP principles as recommended by the World Health Organisation in the Codex Alimentarius was highlighted. Employees working on food safety and quality assurance at PeelPioneers shared that following these requirements while working with citrus peels was achievable and not any more complicated than with other kinds of (non-valorised) raw materials. However, given their unusual source, the company works together with an accredited laboratory, an independent inspection company, a panel of food safety experts, as well as the Dutch food safety authority to develop and maintain a robust food safety management system. This was taken into consideration by the Ministry while assessing the status change application.

The presence of pesticides in the citrus peels is among PeelPioneers' biggest food safety hurdles. By developing measures such as a sampling and testing strategy, an early warning system, and a recall protocol, the company was able to convince the Ministry of its ability to manage the contaminant. Private food safety standards play an important role in helping PeelPioneers comply with food safety regulations as well. Participants mentioned that they were busy preparing for certification against the FSSC 22000 and ISO 22000 standards so as to gain the trust of their customers and meet market requirements. The legal judgement also acknowledges the company's efforts to improve its food safety and quality credentials by showing willingness to get certified. As of January 2023, PeelPioneers' operations are certified against the FSSC 22000 standard.

4.3 Collaborative partnerships

Since its inception, PeelPioneers has focused on developing collaborative partnerships with relevant actors in its supply chain. Study participants spoke extensively about the importance of creating value for all involved partners and developing relationships that are rooted in mutual trust. They described how a successful collaboration with Renewi – the company in charge of collecting and discarding citrus peels from supermarkets and hospitality establishments across the country – was critical for their own success.

Regarding their strategy while approaching Renewi, one of the co-founders explained: "*We looked at what kind of problem we could solve for them. Because approaching someone with 'I can solve your problem' is a much better strategy than simply saying 'we should cooperate'*". Renewi struggled with fermenting the peels due to their high acidity but could not refuse to take them from customers because it would hamper business relations. Therefore, PeelPioneers' offer to valorise the peels helped Renewi's operations. Additionally, they were able to leverage Renewi's expertise and position to get supermarkets and hospitality establishment on board as well: "*We offered them (Renewi) a potential business proposition, saying if we work together on an exclusive*

basis, then you're the only party in the Netherlands that can offer the peel owners a way to dispose of their peels in a more sustainable way while helping fulfil their corporate social responsibility". This proposition was received with much enthusiasm by peel owners because next to sustainability credentials, it also offered an interesting economic avenue. Sending the peels to PeelPioneers, even if at a small fee, was cheaper than paying Renewi to ferment them in a digestor or sending them to the incinerator. Even before the company applied for the status change, several supermarkets had provided a letter of intent declaring their interest in the partnership.

Another important partnership for the company was the one with their first major buyer. By cooperating with International Flavors & Fragrances Inc (hereafter IFF), PeelPioneers was able to convince the Ministry that its products have market demand. An important player in the flavour and fragrance additive business, IFF's interest in the sustainably produced citrus oil cemented the relevance of such a product in the food and cosmetic sectors. This collaborative partnership approach extends into other aspects of the business as well. For example, a participant mentioned about the ongoing talks with Zumex – the company that manufactures the juice pressing machines which have become ubiquitous in Dutch supermarkets – regarding the possibility to enclose the peel collecting unit of the machine. This would allow for an improvement in the quality of the peels by keeping other waste products out of the bins. Such a collaboration would give Zumex the opportunity to contribute to the sustainable valorisation of the waste created as a result of their machine's use. Participants holding senior positions PeelPioneers also expressed great interest in partnerships that facilitate the exchange of knowledge and the replication of their business model in other contexts.

4.4 Personnel skills and outlook towards sustainability

Most interviewed employees showed a strong interest in the concepts of circularity and sustainability. Some spoke about how they felt a sense of responsibility towards their children as well as the next generation at large and were hence keen on applying their skills towards building a waste free society: "*I know I cannot save the world. But I can try to do my best using what I have. And if everybody does that, I think we will all be a little better off*". Those involved in hiring shared that next to being interested in sustainability, potential employees must also be willing to learn new skills and adapt to doing things differently compared to their previous jobs. One participant elaborated on this as follows: "*We look for a certain kind of proactivity while hiring. There's so much going on all the time, so employees need to be able to think for themselves. It's not that we want everyone to have an entrepreneurial mindset, but we do need our colleagues to ask a lot of questions."*

The economic and social aspects of sustainability were also brought up frequently. While environmental sustainability inspired the business idea, interviewed employees thought of it as an insufficient driving factor for the business on its own. Being able to scale-up, maintain a steadily growing revenue, and create new jobs was considered to be as important as reducing the environmental impact of discarding citrus peels. One of the founders elaborated on this as follows: "*Many people think that circularity is this cute, green fad but we see it as something that can create a lot of economic value. Through our company, at least 40 people earn their wages by processing orange peels. These jobs did not exist before. Through our business, we show that a circular 'economy' is actually possible!"*

Regarding the social aspect of sustainability, the discussion focussed on training workers to apply their skills in a way that matches the demands of a circular business. While employees with a higher level of education were thought of as important, those engaged in manual jobs were also considered critical to the company's operations. In a way, next to circulating raw material, personnel's skills in other sectors or jobs were being "upcycled" and applied in a new, circular context.

5. Discussion

In this study, we identified factors that enabled the success of a start-up company employing a circular business model to valorise citrus waste. Our findings illustrate that a combination of factors internal and external to the business were instrumental in its commercial success. By juxtaposing empirical evidence against theoretical ideas on the subject, our study strengthens existing literature on the strategies used by food businesses to establish themselves in the circular bioeconomy. However, it is imperative that we point out that the specific circumstances and opportunities described in this paper are particular to the context in question and may not apply directly to circular businesses in other industries or parts of the world. All the same, our objective while conducting this research was not to establish generalisability. Instead, we aimed to materialise a piece of the larger circularity puzzle; to build a bridge between purely theoretical propositions and a full-fledged hypothesis that can be tested empirically and generalised to different contexts. Like most case studies (Piekkari and Welch, 2018), our research serves as an intermediate step in the pursuit of generalisation rather than an end in itself. Nevertheless, some observations from our study merit a deeper embedding in extant literature in order to explore their broader relevance. In this section, we use the example of PeelPioneers to explore what it takes to close material loops and establish a successful circular food business.

5.1 The Dutch approach to circularity

In recent years, the circular economy concept has featured prominently in many high-level policy documents in the Netherlands. This enthusiasm for it trickles down into Dutch society in several ways including the media (Calisto Friant *et al.*, 2022; Russell *et al.*, 2020), higher education curricula (Kirchherr and Piscicelli, 2019; Kopnina, 2018), as well as subsidies for businesses and seed funds for start-ups (van Langen and Passaro, 2021). This was an important external factor that enabled PeelPioneers to publicise and grow their business. As seen with PeelPioneers' partner organisations, even if this push for circularity does not translate into all businesses changing the way they operate, it certainly makes them enthusiastic about supporting and cooperating with value chain actors engaged in it.

This blossoming interest in circularity is a result of seeds sown several decades ago. Cramer (2022) attributes the Netherlands' present-day affinity for the circular economy to a 40-year track record of addressing matters connected to the subject. Being geographically ill suited to landfilling, the Netherlands has devised several policy measures to dispose of waste in other ways since the 1970s (Cramer, 2022; Martens and Spaargaren, 2005; Reike *et al.*, 2018). Extended producer responsibility, eco-design, and cradle-to-cradle design are concepts that pre-date the circular economy in the Netherlands (Cramer, 2022). As a result, when the EU and various international organisations started promoting the concept a decade ago, Dutch businesses and policymakers had blueprints in place already. Emphasis on recycling and reuse of material across a broad range of industries has also created a workforce that is well adjusted to the skill, knowledge, and ethical expectations related to circularity. This observation is reflected in other studies as well. For instance, van Langen and Passaro (2021) analyse the numerous urban and regional green deals made in the Netherlands which played an important role in creating awareness about the circular economy and mobilising governmental action. Similar to PeelPioneers' business model, economic benefits associated with circularity are greatly emphasised in these deals.

Industries like textile (Reike *et al.*, 2018), construction (Zhang *et al.*, 2020), logistics (Van Buren *et al.*, 2016), defence (Soufani *et al.*, 2018), and plastic (Leslie *et al.*, 2016) are at the forefront of the circular transition in the Netherlands. Relative to materials from these industries, food is a new focus. However, as evidenced by detailed action plans and participation in international projects on the topic, it has quickly become a top priority (Government of the Netherlands, 2016;

Planbureau voor de Leefomgeving, 2017). These reports treat food waste as a distinct form of biomass which allows room for special considerations connected to consumer safety. This is apparent in the legal judgements analysed as part of this study as well. The public, bureaucratic, and technical expertise related support that PeelPioneers received can be observed in other cases too. Schagen *et al.* (2022) describe how media attention combined with support from the Ministry of Agriculture and Food Quality, top research institutions in the country, and consumers played a pivotal role in the success of Kipster and Herenboeren – two other circular food businesses in the country.

Circular economies cannot be governed using a one-size-fits-all approach (Cramer, 2022) and therefore, replicating the Netherlands' ecosystem in other contexts may not yield identical results. It is, however, possible to adapt best practices to the economic, social, and political conditions elsewhere. Tested methods to advance the circular economy that have worked in the Dutch context include creating synergies between various policy domains, highlighting the economic benefits of circularity, adapting legislation to business needs, and encouraging partnerships and knowledge exchange among value chain actors.

Learning opportunities can be identified from the shortcomings of the Dutch approach as well. Lack of specific policy targets, failure to address the free-rider problem, government abstinence from implementing strong legal instruments, and lack of measures to divert waste streams from incinerators have been identified as factors impeding the realisation of circularity targets (van Langen and Passaro, 2021; Piras *et al.*, 2018; Reike *et al.*, 2023). Additionally, the Netherlands Environmental Assessment Agency has identified that efforts to achieve certain circularity targets such as reduction in food waste volumes and improved material efficiency across industries are lagging considerably (Planbureau voor de Leefomgeving, 2017, 2022). Publications from the agency also highlight that most circular economy initiatives in the country focus largely on recycle and repair strategies (Planbureau voor de Leefomgeving, 2022). In comparison, rethink' and reuse strategies requiring wider societal change are largely ignored.

5.2 Value creation and stakeholder engagement

Engaging stakeholders through robust value propositions allowed PeelPioneers to establish a commercially successful citrus waste valorisation business. Without partnerships with various actors in their supply chain, it would have perhaps been impossible for the company to overcome the regulatory and other bureaucratic barriers it faced in its early days. Salvioni and Almici (2020) posit that companies working with circular business models should focus on sharing their circularity goals with suppliers to align values and ensure sustainable procurement. Regarding the engagement of industry partners and investors, they suggest sharing the company's strategic objectives and ensuring compliance with the principles of fair competition and transparency. By fostering employee engagement and investing in skill development, Salvioni and Almici (2020) indicate that innovative processes and circularity-aligned work culture can be established. Lastly, cooperating and engaging in long-term dialogues with relevant government bodies and knowledge institutions is recommended. PeelPioneers' stakeholder engagement strategy closely matches these ideas.

Reike *et al.* (2018) propose that circular businesses engage their stakeholders by offering six value types – sustainability, economic, political, ecological, social, and safety and quality. PeelPioneers offers one or more of these values to their stakeholders in exchange for their cooperation. It offers its customers sustainability value through its products. It generates economic and social value by creating jobs and helping suppliers fulfil their corporate social responsibility. Given the nation and EU wide spotlight on the transition to a circular economy, public institutions and investors derive political value by engaging with the company. Ecological value, which is linked to the benefits created for the natural

environment, is observed in the company's relationship with Renewi. Lastly, safety and quality value is offered to legislators and competent authorities who are responsible for protecting consumer health. It was not surprising to see this level of stakeholder engagement in our case study since circular business models inherently operate within intricate networks of interdependent but autonomous actors, necessitating cooperation, communication, and coordination (Antikainen and Valkokari, 2016).

PeelPioneers' partnership with large multinational corporations – IFF, Renewi, and various retail chains across the country – is worth discussing here as well. In their paper examining entrepreneur-corporation partnerships in the circular economy, Veleva and Bodkin (2018) elaborate on the benefits of such partnerships. They highlight that larger corporations can gain reputation, sustainability credentials, and economic benefits by partnering with entrepreneurs employing circular business models. In turn, entrepreneurs are able to leverage green technologies and ideas to valorise waste streams to create highly marketable products (Veleva and Bodkin, 2018). Such partnerships also allow circular businesses to achieve economies of scale while slowing down (if not closing) material loops for corporations.

6. Concluding remarks and implications

In this article, we identify the circumstances and strategic decisions that have enabled a medium-sized Dutch enterprise to valorise citrus waste at a commercial scale. We found that the regulatory and political contexts in the Netherlands were instrumental in the company's success. Our analysis indicates that the Dutch government has been able to adapt the demanding and at times nebulous requirements of EU General Food Law and the Waste Framework Directive to business needs without compromising consumer or environmental safety. Like in the case of most fruitful industrial symbioses, partnerships built on mutual trust and economically attractive value propositions were important to the establishment of functioning supply chains and commercial viability. Partnering with larger corporations and engaging stakeholders through continued and transparent communication also emerged as contributing factors. Additionally, positive employee outlook towards circularity combined with willingness to learn new skills drive the business forward in its trajectory.

In addition to making an empirical contribution to the scholarship on the circular economy, our findings have implications for policymakers as well. Creating public awareness about the circular economy, designing mechanisms to adapt legislation to business needs, harmonising the goals of various policy domains such as agriculture, waste management, and climate change, and facilitating knowledge and skill development can have far reaching positive impacts on a country's ability to support sustainability-focused entrepreneurs. Practitioners might benefit from this case study by adapting various strategies discussed in this paper to their own contexts. For example, as seen in the case of PeelPioneers, capitalising on unusual streams of raw material, engaging stakeholders through robust value propositions, and partnering with corporations looking to circularise their operations benefit entrepreneurs who can leverage innovative technologies or services.

Notes

1. The judgements (in Dutch) can be accessed via this link: https://www.afvalcirculair.nl/onderwerpen/afval/toetsing-afval/ (accessed 31 March 2023).
2. At the time of writing this paper, regulation (EU) No 1169/2011 on the provision of food information to consumers has replaced directives EC/2007/13 and EC/2007/68 with regard to the reporting of allergens

References

Ada, N., Kazancoglu, Y., Sezer, M.D., Ede-Senturk, C., Ozer, I. and Ram, M. (2021), "Analyzing barriers of circular food supply chains and proposing industry 4.0 solutions", *Sustainability*, Vol. 13 No. 12, p. 6812, doi: 10.3390/su13126812.

Antikainen, M. and Valkokari, K. (2016), "A framework for sustainable circular business model innovation", *Technology Innovation Management Review*, Vol. 6 No. 7, pp. 8-12, doi: 10.22215/timreview1000.

Aschemann-Witzel, J. and Stangherlin, I.D.C. (2021), "Upcycled by-product use in agri-food systems from a consumer perspective: a review of what we know, and what is missing", *Technological Forecasting and Social Change*, Vol. 168, 120749, doi: 10.1016/j.techfore.2021.120749.

Aschemann-Witzel, J., Asioli, D., Banovic, M., Perito, M.A., Peschel, A.O. and Stancu, V. (2023), "Defining upcycled food: the dual role of upcycling in reducing food loss and waste", *Trends in Food Science and Technology*, Vol. 132, pp. 132-137, doi: 10.1016/j.tifs.2023.01.001.

Bhatt, S., Lee, J., Deutsch, J., Ayaz, H., Fulton, B. and Suri, R. (2017), "From food waste to value-added surplus products (VASP): consumer acceptance of a novel food product category", *Journal of Consumer Behaviour*, Vol. 17 No. 1, pp. 57-63, doi: 10.1002/cb.1689.

Blair, M.J., Cabral, L. and Mabee, W.E. (2017), "Biorefinery strategies: exploring approaches to developing forest-based biorefinery activities in British Columbia and Ontario, Canada", *Technology Analysis and Strategic Management*, Vol. 29 No. 5, pp. 528-541, doi: 10.1080/09537325.2016.1211266.

Bocken, N.M.P., Short, S.W., Rana, P. and Evans, S. (2014), "A literature and practice review to develop sustainable business model archetypes", *Journal of Cleaner Production*, Vol. 65, pp. 42-56, doi: 10.1016/j.jclepro.2013.11.039.

Boehlje, M. and Bröring, S. (2011), "The increasing multifunctionality of agricultural raw materials: three dilemmas for innovation and adoption", *International Food and Agribusiness Management Review*, Vol. 14 No. 2, pp. 1-16.

Bröring, S. and Vanacker, A. (2022), "Designing business models for the bioeconomy: what are the major challenges?", *EFB Bioeconomy Journal*, Vol. 2, 100032, doi: 10.1016/j.bioeco.2022.100032.

Calisto Friant, M., Lakerveld, D., Vermeulen, W.J.V. and Salomone, R. (2022), "Transition to a sustainable circular plastics economy in The Netherlands: discourse and policy analysis", *Sustainability*, Vol. 14 No. 1, p. 190, doi: 10.3390/su14010190.

Champ, M., Langkilde, A.-M., Brouns, F., Kettlitz, B. and Collet, Y.L.B. (2003), "Advances in dietary fibre characterisation. 1. Definition of dietary fibre, physiological relevance, health benefits and analytical aspects", *Nutrition Research Reviews*, Vol. 16 No. 1, pp. 71-82, doi: 10.1079/NRR200254.

Chertow, M.R. (2000), "Industrial symbiosis: literature and taxonomy", *Annual Review of Energy and the Environment*, Vol. 25 No. 1, pp. 313-337, doi: 10.1146/annurev.energy.25.1.313.

Collins, J.E., Vanagt, T., Huys, I. and Vieira, H. (2020), "Marine bioresource development – stakeholder's challenges, implementable actions, and business models", *Frontiers in Marine Science*, Vol. 7, doi: 10.3389/fmars.2020.00062.

Cramer, J. (2022), "Dutch experiences powering the circular economy", in *Building a Circular Future: Ten Takeaways for Changemakers*, pp. 25-33, Amsterdam Economic Board.

Donner, M., Verniquet, A., Broeze, J., Kayser, K. and De Vries, H. (2021), "Critical success and risk factors for circular business models valorising agricultural waste and by-products", *Resources, Conservation and Recycling*, Vol. 165, 105236, doi: 10.1016/j.resconrec.2020.105236.

D'Amato, D., Veijonaho, S. and Toppinen, A. (2020), "Towards sustainability ? Forest-based circular bioeconomy business models in Finnish SMEs", *Forest Policy and Economics*, Vol. 110, 101848, doi: 10.1016/j.forpol.2018.12.004.

Etikan, I. (2016), "Comparison of convenience sampling and purposive sampling", *American Journal of Theoretical and Applied Statistics*, Vol. 5, p. 1, doi: 10.11648/j.ajtas.20160501.11.

European Commission (2012), *Innovating for Sustainable Growth : A Bioeconomy for Europe*, Publications Office of the European Union, LU.

European Commission (2015), *Closing the Loop - An EU Action Plan for the Circular Economy*, European Commission, Brussels.

FAO (2021), "Citrus fruit statistical compendium 2020", available at: https://www.fao.org/3/cb6492en/cb6492en.pdf (accessed 18 February 2024).

FAO (2023), "Citrus - commodity in focus", available at: https://www.fao.org/markets-and-trade/commodities/citrus/en/ (accessed 18 February 2024).

Ferrari, A., Morone, P. and Tartiu, V.E. (2016), "Tackling uncertainty through business plan analysis—a case study on citrus waste valorisation in the South of Italy", *Agriculture*, Vol. 6 No. 1, p. 5, doi: 10.3390/agriculture6010005.

Fuentes-Zaragoza, E., Riquelme-Navarrete, M.J., Sánchez-Zapata, E. and Pérez-Álvarez, J.A. (2010), "Resistant starch as functional ingredient: a review", *Food Research International*, Vol. 43 No. 4, pp. 931-942, doi: 10.1016/j.foodres.2010.02.004.

Golembiewski, B., Sick, N. and Bröring, S. (2015), "The emerging research landscape on bioeconomy: what has been done so far and what is essential from a technology and innovation management perspective?", *Innovative Food Science and Emerging Technologies*, Vol. 29, pp. 308-317, doi: 10.1016/j.ifset.2015.03.006.

Government of the Netherlands. (2016), "A circular economy in The Netherlands by 2050", available at: https://circulareconomy.europa.eu/platform/sites/default/files/17037circulaireeconomie_en.pdf (accessed 18 February 2024).

Hadjikakou, M., Bowles, N., Geyik, O.,Conijn, J.G., Mogollón, J.M., Bodirsky, B.L., Müller, A., Weindl, I., Moallemi, E.A., Shaikh, M.A., Damerau, K., Davis, K.F., Pfister, S., Springmann, M., Clark, M., Metson, G.S., Röös, E., Bajzelj, B., Graham, N.T., Wisser, D., Doelman, J.C., Deppermann, A., Theurl, M.C., Pradhan, P., Stevanovic, M., Lauk, C., Chang, J., Heck, V., Ercin, E., Peng, L., Springer, N.P., Bouwman, A.F., Morais, T.G., Valin, H., Mason-D'Croz, D., Erb, K.-H., Popp, M.A., Herrero, M., Dumas, P., Zhang, X., Searchinger, T. and Bryan, B.A. (2023), "Mitigating risk of exceeding environmental limits requires ambitious food system interventions", available at: https://orgprints.org/id/eprint/51775/ (accessed 18 February 2024).

Henry, M., Bauwens, T., Hekkert, M. and Kirchherr, J. (2020), "A typology of circular start-ups: an Analysis of 128 circular business models", *Journal of Cleaner Production*, Vol. 245, 118528, doi: 10.1016/j.jclepro.2019.118528.

Huang, I.Y., Manning, L., James, K.L., Grigoriadis, V., Millington, A., Wood, V. and Ward, S. (2021), "Food waste management: a review of retailers' business practices and their implications for sustainable value", *Journal of Cleaner Production*, Vol. 285, 125484, doi: 10.1016/j.jclepro.2020.125484.

James, K., Millington, A. and Randall, N. (2022), "Food and feed safety vulnerabilities in the circular economy", *EFSA Supporting Publications*, Vol. 19 No. 3, p. 7226E, doi: 10.2903/sp.efsa.2022.EN-7226.

Kirchherr, J. and Piscicelli, L. (2019), "Towards an education for the circular economy (ECE): five teaching principles and a case study", *Resources, Conservation and Recycling*, Vol. 150, 104406, doi: 10.1016/j.resconrec.2019.104406.

Kopnina, H. (2018), "Teaching sustainable development goals in The Netherlands: a critical approach", *Environmental Education Research*, Vol. 24 No. 9, pp. 1268-1283, doi: 10.1080/13504622.2017.1303819.

Leipold, S. and Petit-Boix, A. (2018), "The circular economy and the bio-based sector - perspectives of European and German stakeholders", *Journal of Cleaner Production*, Vol. 201, pp. 1125-1137, doi: 10.1016/j.jclepro.2018.08.019.

Leslie, H.A., Leonards, P.E.G., Brandsma, S.H., de Boer, J. and Jonkers, N. (2016), "Propelling plastics into the circular economy — weeding out the toxics first", *Environment International*, Vol. 94, pp. 230-234, doi: 10.1016/j.envint.2016.05.012.

Lin, C.S.K., Pfaltzgraff, L.A., Herrero-Davila, L., Mubofu, E.B., Abderrahim, S., Clark, J.H., Koutinas, A.A., Kopsahelis, N., Stamatelatou, K., Dickson, F., Thankappan, S., Mohamed, Z., Brocklesby, R. and Luque, R. (2013), "Food waste as a valuable resource for the production of chemicals, materials and fuels. Current situation and global perspective", *Energy and Environmental Science*, Vol. 6 No. 2, p. 426, doi: 10.1039/c2ee23440h.

Martens, S. and Spaargaren, G. (2005), "The politics of sustainable consumption: the case of The Netherlands", *Sustainability: Science, Practice and Policy*, Vol. 1 No. 1, pp. 29-42, doi: 10.1080/15487733.2005.11907963.

Moshtaghian, H., Bolton, K. and Rousta, K. (2021), "Challenges for upcycled foods: definition, inclusion in the food waste management hierarchy and public acceptability", *Foods*, Vol. 10 No. 11, p. 2874, doi: 10.3390/foods10112874.

Orozco, R., Mosquera-Losada, M.R., Rodriguez, J., Adamseged, M.E. and Grundmann, P. (2021), "Supportive business environments to develop grass bioeconomy in Europe", *Sustainability*, Vol. 13 No. 22, 12629, doi: 10.3390/su132212629.

Papargyropoulou, E., Lozano, R., Steinberger, J.K., Wright, N. and Ujang, Z.bin (2014), "The food waste hierarchy as a framework for the management of food surplus and food waste", *Journal of Cleaner Production*, Vol. 76, pp. 106-115, doi: 10.1016/j.jclepro.2014.04.020.

Parsa, A., Van De Wiel, M., Schmutz, U., Fried, J., Black, D. and Roderick, I. (2023), "Challenging the food waste hierarchy", *Journal of Environmental Management*, Vol. 344, 118554, doi: 10.1016/j.jenvman.2023.118554.

Piekkari, R. and Welch, C. (2018), *The SAGE Handbook of Qualitative Business and Management Research Methods: History and Traditions*, SAGE Publications, California. doi: 10.4135/9781526430212.

Piras, S., García Herrero, L., Burgos, S., Colin, F., Gheoldus, M., Ledoux, C., Parfitt, J., Jarosz, D. and Vittuari, M. (2018), "Unfair trading practice regulation and voluntary agreements targeting food waste", available at: https://library.wur.nl/WebQuery/wurpubs/fulltext/448932 (accessed 18 February 2024).

Planbureau voor de Leefomgeving (2017), "Food for the circular economy", available at: https://www.pbl.nl/sites/default/files/downloads/PBL-2017-Food-for-the-circular-economy-2878.pdf (accessed 18 February 2024).

Planbureau voor de Leefomgeving (2022), "*Voortgangsbericht Circulaire Economie 2022*", available at: https://www.pbl.nl/uploads/default/downloads/pbl-2022-voortgangsbericht-circulaire-economie-2022-4470.pdf (accessed 18 February 2024).

Rao, M., Bast, A. and de Boer, A. (2021), "Valorized food processing by-products in the EU: finding the balance between safety, nutrition, and sustainability", *Sustainability*, Vol. 13 No. 8, p. 4428, doi: 10.3390/su13084428.

Redlingshöfer, B., Barles, S. and Weisz, H. (2020), "Are waste hierarchies effective in reducing environmental impacts from food waste? A systematic review for OECD countries", *Resources, Conservation and Recycling*, Vol. 156, 104723, doi: 10.1016/j.resconrec.2020.104723.

Reike, D., Vermeulen, W.J.V. and Witjes, S. (2018), "The circular economy: new or refurbished as CE 3.0? — Exploring controversies in the conceptualization of the circular economy through a focus on history and resource value retention options", *Resources, Conservation and Recycling*, Vol. 135, pp. 246-264, doi: 10.1016/j.resconrec.2017.08.027.

Reike, D., Hekkert, M.P. and Negro, S.O. (2023), "Understanding circular economy transitions: the case of circular textiles", *Business Strategy and the Environment*, Vol. 32 No. 3, pp. 1032-1058, doi: 10.1002/bse.3114.

Reim, W., Parida, V. and Sjödin, D.R. (2019), "Circular business models for the bio-economy: a review and new directions for future research", *Sustainability*, Vol. 11 No. 9, p. 2558, doi: 10.3390/su11092558.

Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin, F.S., Lambin, E.F., Lenton, T.M., Scheffer, M., Folke, C., Schellnhuber, H.J., Nykvist, B., de Wit, C.A., Hughes, T., van der Leeuw, S., Rodhe, H., Sörlin, S., Snyder, P.K., Costanza, R., Svedin, U., Falkenmark, M., Karlberg, L., Corell, R.W., Fabry, V.J., Hansen, J., Walker, B., Liverman, D., Richardson, K., Crutzen, P. and Foley, J.A. (2009), "A safe operating space for humanity", *Nature*, Vol. 461 No. 7263, pp. 472-475, doi: 10.1038/461472a.

Russell, M., Gianoli, A. and Grafakos, S. (2020), "Getting the ball rolling: an exploration of the drivers and barriers towards the implementation of bottom-up circular economy initiatives in Amsterdam and Rotterdam", *Journal of Environmental Planning and Management*, Vol. 63 No. 11, pp. 1903-1926, doi: 10.1080/09640568.2019.1690435.

Saldana, J. (2021), *The Coding Manual for Qualitative Researchers*, SAGE, California.

Salvioni, D.M. and Almici, A. (2020), "Circular economy and stakeholder engagement strategy", SSRN Scholarly Paper, Rochester, NY, 15 October.

Satari, B. and Karimi, K. (2018), "Citrus processing wastes: environmental impacts, recent advances, and future perspectives in total valorization", *Resources, Conservation and Recycling*, Vol. 129, pp. 153-167, doi: 10.1016/j.resconrec.2017.10.032.

Schagen, O.M., Metze, T.A.P., de Olde, E.M. and Termeer, C.J.A.M. (2022), "Energizing a transformation to a circular bioeconomy: mechanisms to spread, deepen and broaden initiatives", *Sustainability Science*, Vol. 18 No. 3, pp. 1099-1115, doi: 10.1007/s11625-022-01249-1.

Soufani, K., Tse, T., Esposito, M., Dimitrou, G. and Kikiras, P. (2018), "A roadmap to circular economy in EU defence inspired by the case of the Dutch Ministry of Defence", *The European Financial Review*, *February–March*, doi: 10.17863/CAM.27365.

Spratt, O., Suri, R. and Deutsch, J. (2021), "Defining upcycled food products", *Journal of Culinary Science and Technology*, Vol. 19 No. 6, pp. 485-496, doi: 10.1080/15428052.2020.1790074.

Stegmann, P., Londo, M. and Junginger, M. (2020), "The circular bioeconomy: its elements and role in European bioeconomy clusters", *Resources, Conservation and Recycling: X*, Vol. 6, 100029, doi: 10.1016/j.rcrx.2019.100029.

Suri, H. (2011), "Purposeful sampling in qualitative research synthesis", *Qualitative Research Journal*, Vol. 11 No. 2, pp. 63-75, doi: 10.3316/QRJ1102063.

Teigiserova, D.A., Hamelin, L. and Thomsen, M. (2020), "Towards transparent valorization of food surplus, waste and loss: clarifying definitions, food waste hierarchy, and role in the circular economy", *Science of The Total Environment*, Vol. 706, 136033, doi: 10.1016/j.scitotenv.2019.136033.

Van Buren, N., Demmers, M., Van der Heijden, R. and Witlox, F. (2016), "Towards a circular economy: the role of Dutch logistics industries and governments", *Sustainability*, Vol. 8 No. 7, p. 647, doi: 10.3390/su8070647.

Van Lancker, J., Wauters, E. and Van Huylenbroeck, G. (2016), "Managing innovation in the bioeconomy: an open innovation perspective", *Biomass and Bioenergy*, Vol. 90, pp. 60-69, doi: 10.1016/j.biombioe.2016.03.017.

van Langen, S.K. and Passaro, R. (2021), "The Dutch green deals policy and its applicability to circular economy policies", *Sustainability*, Vol. 13 No. 21, 11683, doi: 10.3390/su132111683.

Veleva, V. and Bodkin, G. (2018), "Corporate-entrepreneur collaborations to advance a circular economy", *Journal of Cleaner Production*, Vol. 188, pp. 20-37, doi: 10.1016/j.jclepro.2018.03.196.

Vermunt, D.A., Negro, S.O., Verweij, P.A., Kuppens, D.V. and Hekkert, M.P. (2019), "Exploring barriers to implementing different circular business models", *Journal of Cleaner Production*, Vol. 222, pp. 891-902, doi: 10.1016/j.jclepro.2019.03.052.

Wei, Y., Li, J., Shi, D., Liu, G., Zhao, Y. and Shimaoka, T. (2017), "Environmental challenges impeding the composting of biodegradable municipal solid waste: a critical review", *Resources, Conservation and Recycling*, Vol. 122, pp. 51-65, doi: 10.1016/j.resconrec.2017.01.024.

Willett, W., Rockström, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S., Garnett, T., Tilman, D., DeClerck, F., Wood, A., Jonell, M., Clark, M., Gordon, L.J., Fanzo, J., Hawkes, C., Zurayk, R., Rivera, J.A., De Vries, W., Majele Sibanda, L., Afshin, A., Chaudhary, A., Herrero, M., Agustina, R., Branca, F., Lartey, A., Fan, S., Crona, B., Fox, E., Bignet, V., Troell, M., Lindahl, T., Singh, S., Cornell, S.E., Srinath Reddy, K., Narain, S., Nishtar, S. and Murray, C.J.L. (2019), "Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems", *The Lancet*, Vol. 393, 10170, pp. 447-492, doi: 10.1016/S0140-6736(18)31788-4.

Yin, R. (2009), *Case Study Research: Design and Methods*, 4th ed., SAGE, California.

Zhang, C., Hu, M., Yang, X., Miranda-Xicotencatl, B., Sprecher, B., Di Maio, F., Zhong, X. and Tukker, A. (2020), "Upgrading construction and demolition waste management from downcycling to recycling in The Netherlands", *Journal of Cleaner Production*, Vol. 266, 121718, doi: 10.1016/j.jclepro.2020.121718.

Zhang, J., Ye, H., Bhatt, S., Jeong, H., Deutsch, J., Ayaz, H. and Suri, R. (2021), "Addressing food waste: how to position upcycled foods to different generations", *Journal of Consumer Behaviour*, Vol. 20 No. 2, pp. 242-250, doi: 10.1002/cb.1844.

Appendix
Interview guide

Before starting the interview

(1) Introduction of interviewers

(2) Explain aim of the study

(3) Share information about data storage, anonymisation, and informed consent

(4) Assure participants of the confidentiality of their responses

(5) Enquire whether participants have any questions

Background information

(1) Can you briefly describe your role within the company?

(2) How long have you been with the company, and how do your previous professional experiences guide your role at PeelPioneers?

Logistical barriers

(1) Could you explain how the logistics of collecting citrus peels from your suppliers works?

(2) How do the perishable and variable nature of the raw material impact your operations?

(3) What are the benefits and disadvantages of valorising waste from a later stage in the supply chain?

Technological barriers

(1) In your experience, what technology-related challenges did the company encounter due to its innovative use of a waste stream?

(2) Was the technology developed in-house? Did you have to get regulatory approval or patents for your technology? If yes, can you describe the process?

(3) Was the technology you use developed to meet the specific needs of the raw material? Can you tell us about the challenges you experienced in achieving this?

Regulatory barriers

(1) What kind of permits did you need to obtain before you could start your operations?

(2) Can you describe the legal process for us?

(3) Would you consider the process accessible? Explain why/why not.

Economic barriers

(1) Who are the key investors in your business? What strategies were used to attract these investors?

(2) To what extent does the company rely on public subsidies for its operations, and how does this affect the business model and long-term sustainability?

Organisational culture and knowledge-related barriers

(1) What motivates you to work at this organisation?

(2) In what way are the skills required in a circular company such as yours different from any other business in the same sector?

(3) Do you require employees to have experience working in similar (circularity-related) roles before joining PeelPioneers?

(4) If different/new skills are required of the employees, how are they trained?

Conclusion

(1) Are there any additional insights you would like to share regarding overcoming the various barriers that are typical to a circular food business?

Closing remarks

(1) Express gratitude to the interviewee for their time and valuable input.

(2) Reiterate the confidentiality and anonymity of their responses.

(3) Explain the next steps in the research and how their contributions will be used.

(4) Share contact details.

Source(s): Authors work

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