Reducing the waste of fresh avocados from Kenya into the Netherlands by using the Iceberg model

Final Report

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Version: 2
Date: 24/06/2023
Subject: Graduation Thesis
Commissioner: Woody Maijers
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Forward

I want to thank Mr. Woody Maijers from the bottom of my heart for giving me the chance to investigate avocado waste. Additionally, I am very grateful for my supervisor Marinus van Haaften and my commissioner Woody Maijers's guidance and assistance throughout the research process. This study has been shaped in part by their invaluable suggestions and knowledge. I'd like to thank my fellow student Yatao Lu for helping me arrange the interview and for regularly sharing information with me. I appreciated the businesses and people who agreed to the interviews. Finally, I want to thank my family and friends for their unwavering support.

Summary

Avocados imported from Kenya are recently questioned due to their quality and results in waste. The objective of the project is to investigate what factors make fresh avocados imported from Kenya unconsumable in the supply chain part from wholesale/importer to retail in the Netherlands by doing a literature study and executing surveys. This report explored the issue of unconsumed avocados in the supply chain, analyzing the various factors contributing to waste and proposing potential solutions.

Interviews with wholesalers and retailers revealed that approximately 5% to 6% of imported avocados were wasted.

For the patterns, oversupply emerged as a significant issue, with wholesalers importing more avocados than they could manage efficiently. This led to storage facility shortages and compromised temperature control, impacting avocado quality and shelf life. Handling large volumes in a short period increased the likelihood of human errors, while avocado damage, both internally and externally, rendered them unsalable. For the structural factor, the imbalanced supply and demand dynamics, with avocado production outpacing demand growth, contributed to unsold inventory and waste. Inefficient logistics practices, such as delayed container deliveries, resulted in avocados ripening during transit. Lack of effective communication throughout the supply chain hindered inventory forecasting and coordination of the ripening process.

The profit-first mentality prevalent in the industry prioritized short-term financial success and inventory control over waste reduction and sustainability. Consumer behavior, including an emphasis on avocado appearance and perfectionism, reluctance to accept suboptimal avocados, and lack of knowledge about best-before and used-by dates, also contributed to waste. Consumer buying experience and the frequency of avocado purchases were additional factors influencing waste.

Understanding these trends and factors can inform strategies and interventions to reduce avocado waste in the supply chain, benefiting both the industry and the environment. Drawing from the findings, this report recommends strategies to address the problem, including improved forecasting, efficient logistics, and consumer education. By implementing these measures, the aim is to optimize avocado distribution, minimize waste, and promote a more sustainable and efficient supply chain in the avocado industry.

Keywords: unconsumed avocados, waste, supply chain, oversupply, internal damage, dry matter content, logistics practices, consumer preferences, structural factors, mental factors

Contents

1. Introduction

The avocado is one of the most significant fruits with a high nutritional value; it is grown and consumed all over the world. It was first cultivated in the islands of the West Indies and Central America. However, it is currently grown in tropical and subtropical areas of the world (Ahmad & Danish, 2022). The dominant variety grown today is the Hass avocado, a Guatemalan race with pebbled black skin (CBI, 2023). Kenya is the eleventh-largest exporter in the world and the seventh-largest producer of avocados worldwide. The Hass variety's commercial, marketable production is estimated to be between 60,000 and 90,000 metric tonnes (produced on 7,500 hectares). In 2019, exports totaled 63,300 metric tonnes, Europe receives 60 percent of avocado exports (the Netherlands, France, Spain) (Snel et al., 2021). For the Netherlands, Kenya is also an important main supplier country. In Kenya's avocado export market, approximately 15% of the avocado waste occurs between the farm and the consumer. Harvesting (7%), packaging (5%), and sea shipment (3%), are the most affected by losses. However, the actual volume of market losses (both wholesale and retail) is significant but poorly understood (Snel et al., 2021). ERP (Europe Retail Packing) and FairTrasa are companies that import exotic fruits including avocados from Kenya. They are interested in the potential of applied research to reduce waste and improve the quality in this production chain. This project aims to understand the factors that lead to avocado waste from wholesaler to retailer in the Netherlands by using the iceberg model (Trubetskaya, Scholten, & Corredig, 2022). This research project is part of the SIA project FORQLAB and linked to the Dutch SIA project Voorkomen Voedselverspilling.

The iceberg model shows the different levels of abstraction that can be applied to a situation or organization, starting with the observable events and moving on to the underlying patterns that cause them, the supporting structure, and finally the mental models that an organization uses. The underlying structures that cause the observed events and problems are compared to an iceberg (Trubetskaya et al., 2022). In this way, these companies can gain useful information on how to improve avocado quality and reduce waste.

The objective of the project is to investigate: What factors make fresh avocados imported from Kenya unconsumable in the supply chain part from wholesale to retail in the Netherlands by doing a literature study and executing surveys. The research questions are shown below.
Main question:
What are the factors that make fresh avocados imported from Kenya unconsumable in the supply chain from wholesale to retail in the Netherlands?
Sub questions:

1. What is the current situation of (unconsumable) fresh avocados imported from Kenya in the supply chain from wholesale to retail in the Netherlands?
2. What are the trends leading to (unconsumed) fresh avocados imported from Kenya in the supply chain from wholesale to retail in the Netherlands?
3. What is the structural factor behind (unconsumed) fresh avocados imported from Kenya in the supply chain from wholesale to retail in the Netherlands?
4. What is the mental factor of (unconsumed) fresh avocados imported from Kenya in the

supply chain from wholesale to retail in the Netherlands?

This research started on 6 February 2023 and will end on 30 June 2023. The avocado supply chain from wholesalers to retailers in the Netherlands will be investigated. Wholesalers also include importers; retailers include large supermarkets and local fruit & vegetable shops. Avocados that already on the shelf of the supermarkets and shops are included. End consumers' purchasing preference will be included to find out the mental mode of wholesalers and retailers. Only fresh avocados will be focused on in this research. The reason of waste that happens in the end consumers (in the kitchen) will not be investigated. While other exotic fruits might experience similar circumstances and conditions, the main focus in this study will be on avocados.

The first chapter of this report, Introduction, introduces the background of this research, the problem statement, and the research questions. The second chapter, Literature, shows the former study related to fresh avocado waste. Chapter three shows the Methods for both the literature study and this research, as well as the method of analyzing data. Chapter four shows all of the findings from interviews and data analysis and answers the research questions. The discussion of the results provides a critical analysis of the results. The conclusion shows the main and most important findings of the research. Recommendations give suggestions to companies in the supply chain and further study. The sources of references are listed in the Reference. Questionnaires for surveys and data analysis are in the Appendix.

2. Literature review

In Europe, approximately 4% of fruits are wasted at the wholesale and retail levels (FAO, 2019). Specifically, around 2.5-5% of avocados are wasted at the retail level due to various reasons (Terry, Mena, C., Williams, A., Jenney, & Whitehead, 2011), resulting in only 80% of imported avocados reaching consumers' tables; the remaining 20% are classified as "category 2" or "industrial" and are not distributed to shops or supermarkets, a small amount of them (1~2%) can be converted into guacamole, while the rest would be used as biofuels (Soilmates, 2022).

The waste trends can be attributed to several factors. Firstly, there is an oversupply of visually appealing fruits favored by the industry, leading to the rejection of imperfect ones (Jedermann, Nicometo, Uysal, & Lang, 2014). Overproduction to meet sudden demands or fulfill large retailer orders also contributes to waste (Raak, Symmank, Zahn, Aschemann-Witzel, & Rohm, 2017). Retailers' inadequate demand forecasting, logistical issues such as lack of cold transportation and poor handling (Raut, Gardas, Narwane, & Narkhede, 2019), and destructive quality check processes for dry matter and oil content also lead to fresh avocado waste (Magwaza & Tesfay, 2015). Additionally, consumers' preference for ready-to-eat fruits with shorter shelf lives and avocados close to their expiration dates adds to the waste (Paillart & Woltering, 2019). Customers' purchasing behavior, like squeezing avocados to check their firmness may damage avocados (Stop squeezing avocados say producers, there are better ways to test ripeness.2018).

Structural factors play a role in driving these trends. Quality standards concerning class, maturity, size, and other additional requirements contribute to waste (CBI, 2022). Poor handling performance, resulting from employees' lack of knowledge, qualifications, and human errors, is another factor (de Moraes et al., 2022). The lack of coordination and information sharing in the supply chain hampers accurate supply and demand forecasts, making inventory management challenging (de Moraes et al., 2022).

Mental factors influencing individuals' responses to the situation include a profit-first mindset that prioritizes profitability over waste reduction (Mena, Terry, Williams, & Ellram, 2014). Consumers' perfectionism (Mukherjee, Mukherjee, & Iyer, 2021), improper picking behavior, and limited knowledge regarding the expiration dates of fruits (*Food waste and date marking.*2015) contribute to avocado damage. The desire for high direct product profitability, leading to low stock levels, also contributes to waste (Bookbinder & Zarour, 2001).

However, surveys and interviews should be conducted in the future to obtain the most up-to-date information due to a lack of literature specifically on the field of imported Kenya avocado supply chain in the Netherlands. Surveys or interviews should be conducted with Dutch avocado wholesalers and retailers who buy and sell imported Kenya avocados. The amount of avocados wasted in their businesses and the reasons for this will be investigated. Companies will also be required to verify the accuracy of the results of literature reviews.

Surveys on Dutch avocado consumers will also be conducted to find their opinion on buying sub-optimal avocados and their knowledge about best-before and used-by date.

Figure 1 depicted the conceptual model of fresh avocado waste, presenting a visual summary of the literature review findings. The model represents various stages of the avocado supply chain. The blue boxes indicate instances of waste occurring at the wholesale level, while the yellow boxes represent waste occurring at the retail level. The green boxes indicate waste occurring at both the wholesale and retail levels, while the red boxes signify waste resulting from consumers' behavior.

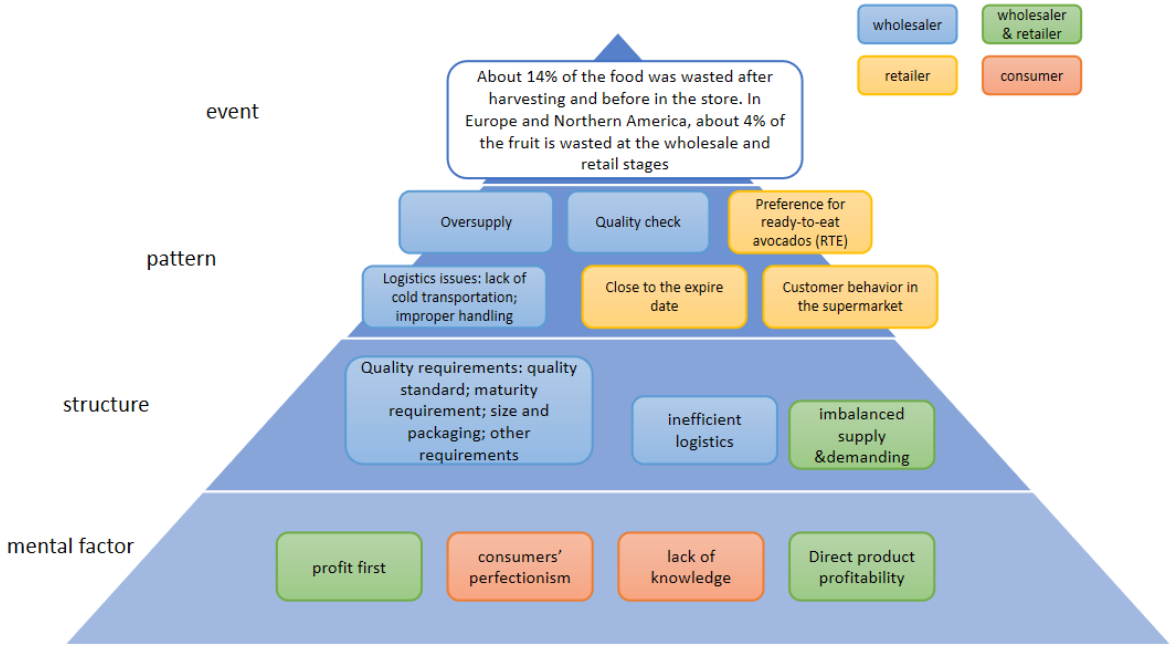

Figure 1 Iceberg model for avocado waste from the literature review

3. Methods

3.1 Methods for literature study

The topics literature was searched for can be found in the first column of the research model which is presented underneath in Figure 2. In this research accountability report, phase 1 in the research model was conducted. Literature on the use of the iceberg model, the fruit waste situation, and the processes of avocado wholesalers and retailers was checked to write a literature review.

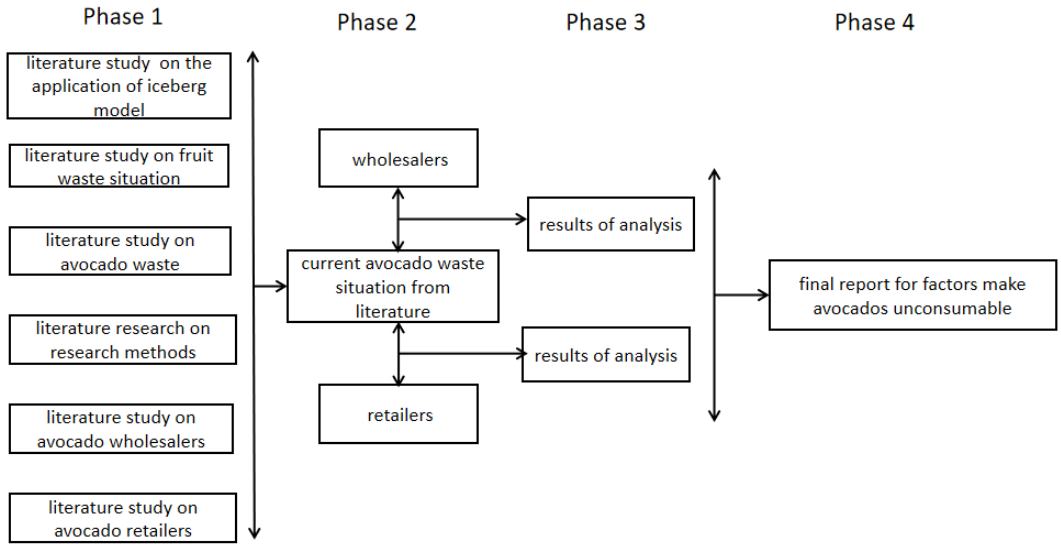

Figure 2 Research model

3.1.1 Search strategy

To find related information, Google Scholar, the Inholland library, and Google were used. Articles were selected of which the full text was available online. Peer-reviewed articles were chosen and screened for full-text availability. All the resources were published or uploaded after 2011. The most recent resource was prioritized. Articles were accessed through publishers Science Direct, Taylor & Francis Online, PDX Scholar, MDPI and Research Gate. The website RefWorks was used to collect all of the references. Only literatures related to food waste, fruit waste, and the fruit supply chain were investigated further.

The keywords 'Iceberg model AND food waste' and 'iceberg model AND systematic thinking' were searched to learn how the systematic thinking tool iceberg model works.

The keywords used to search for related information were shown in Table 1 to get the answer

to each sub-question. Keywords searched were come from each sub question.

Table 1 Keywords for sub questions

Research questions	Keywords
(unconsumed) fresh avocado waste situation	"avocado market" Netherlands
	"avocado production" Kenya
	imported avocado supply chain
	"avocado loss"
	“imported” soft fruit/ fresh fruit/ stone fruit
the trends leading to (unconsumed) fresh avocados	soft fruit waste reason
	"avocado loss" reason
	avocado "quality standard"
	avocado "supply chain" "quality management"
	soft fruit/ fresh fruit/ stone fruit “quality management”
the structural factor behind (unconsumed) fresh avocados	avocado wholesale Netherlands
	avocado inventory supply chain
	fresh soft fruit/ fresh fruit/ stone fruit inventory management
the mental factor behind (unconsumed) fresh avocados	consumer preference AND soft fruit
	fresh fruit supply chain management
	food waste
	fruit waste

Other information and documents related to the food waste project of FORQLab were provided by Commissioner Woody Maijers.

Grey literatures were used. Keywords ‘avocado waste AND Netherlands’, ‘Dutch market AND fruits’ were searched with Google, and results from some websites were referred to, include cbi.eu and bbc.com.

Manually using backward referencing, additional relevant studies were discovered due to the large range of linked topics and to avoid missing important studies. The reference lists of

primary papers, review articles, and symposium proceedings were cross-checked. Publications that described fruit supply chain loss were selected. The names of authors known to have conducted fruit supply chain loss research were used for further manual searches (forward and backward searching). During the search, five references were found and were backward referenced to locate relevant articles that had not yet been included.

3.1.2 Study selection and criteria

Articles on unconsumable avocados were collected and evaluated. Upon conducting the search, the titles and scope were checked to ensure that fruit loss was being discussed in the research. The abstracts were reviewed to ensure that fruit loss was investigated in the research. The articles were then thoroughly reviewed to ensure that the following inclusion criteria were met: 1) fruit loss in the post-harvest process or in the supply chain was referred to, and 2) full text was provided. For the requirement of exclusion criteria: 1) supply chain but not for fresh fruits or avocados; 2) supply chain but doesn't mention wholesale or retail part; 3) supply chain in developing countries.

3.2 Methodology

The methodology was designed to analyze both qualitative and quantitative data to identify and understand the causes of the avocado waste, as well as to quantify how the structural and mental factors impact the avocado waste. This methodology refers to Mena (2014)'s research. The literature review findings were presented during the interviews to seek confirmation. Wholesalers and retailers were queried about their agreement with the literature review findings and asked to provide explanations regarding how well these findings align with the present state of the avocado industry. Factors investigated from the literature were modified according to interviewees' information.

3.2.1 Surveys on wholesalers

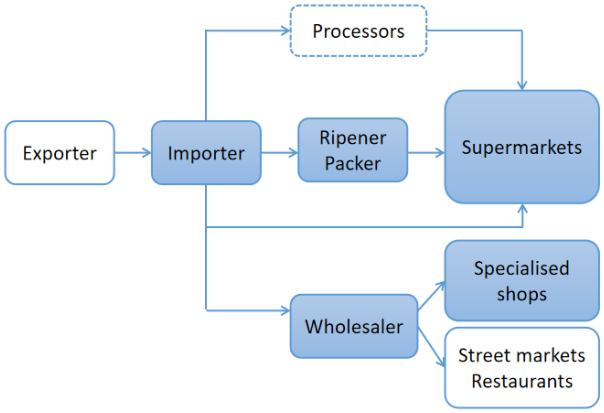

Figure 3 Market channels for avocados (CBI, 2023)

Figure 3 shows a simplified representation of avocado supply networks analyzed. The figure also illustrates the scope of the study, blue boxes are parts of the survey. Wholesalers in the Netherlands sometimes play the role as intermediaries between processors and retailers. However, most of the Dutch retailers buy imported avocados directly from importers. Here in this research, wholesaler was defined as wholesalers and importers, because in Dutch market, importers usually also act as wholesalers; and retailer was defined as supermarkets and local fruit shops, which are two main channels for people to buy avocados.

For the choice of interviewees, only wholesalers who bought Kenya avocados will be invited. The name list of these companies can be found by searching 'Dutch Kenya avocado importer' through Google. Three companies were introduced by the commissioner.

The definition of food loss and waste is based on EU FUSION (Food Use for Social Innovation by Optimizing Waste Prevention Strategies)'s definition of food waste (2016). According to FUSIONS, "Food waste is any food, and inedible parts of food, removed from the food supply chain to be recovered or disposed (including composted, crops ploughed in/not harvested, anaerobic digestion, bio-energy production, co-generation, incineration, disposal to sewer, landfill or discarded to sea)". Animal feed, biobased materials and biochemicals are not considered as food waste. Figure 4 illustrates the categories of food and inedible parts removed from the food supply chain according to EU FUSION.

Figure 4 Categorized food and inedible parts removed from the food supply chain (EU FUSION, 2016)

On 18/4/2023 and 11/5/2023, two interviews for the wholesaler were made. Two interviewees were the product developer from Natural's Pride, and the desk manager from Eosta. Both were online meetings through Teams. The interviews lasted about 1.5 hours. An email was sent to the businesses to see if they were willing to be interviewed and set up an appointment. A questionnaire was sent as the attachment, which was in the Appendix I. Companies were contacted if there is no response after one week. Assurances of anonymity were made.

3.2.2 Surveys on retailers

The original country of avocados in supermarkets and stores was checked to determine which stores have avocados from Kenya. Furthermore, wholesalers were asked in surveys if they are willing to provide information about their buyers so that more supermarkets and stores can be identified. Shop managers from these retailers were surveyed to obtain more information from retailers. Because they were always busy in the shop, this only lasted 5~10 minutes. In April and May, three interviews for shop managers (Dirk, Jumbo, Odin) were made in Delft. One of the supermarkets was mentioned by a wholesaler as their Kenya avocado buyer, and the other two were searched online to find they sell Kenya avocados. Surveys took place in the morning on workdays, and managers were asked if they are willing to share information about avocado waste in the stores. Questionnaire was in Appendix II.

3.2.3 Surveys on consumers

The purpose of conducting consumer surveys was not to specifically investigate waste at the end consumer level, particularly in the kitchen. Rather, these surveys aimed to uncover the psychological factors influencing the behavior of wholesalers and retailers based on consumer responses. The purpose of this survey is to understand consumers' purchasing habits and knowledge of best-before and used-by dates, so whether the avocados are from Kenya is unimportant. The survey was made with Google Forms and was distributed online, and the questionnaire (see Appendix III) was only sent to Inholland Yammer. The time duration was from 13/4/2023 to 13/5/2023. 110 respondents were collected in total.

3.2.4 Data analysis

The methodology employed in this study involved conducting a cross-tabulation analysis using IBM SPSS 26. The analysis incorporated several statistical tests and measures, including the chi-square test and correlation analysis. The cell statistics were based on observed counts, and the comparison of column proportions was performed using the z-test with adjusted p-values. The residuals were adjusted and standardized to account for potential confounding factors.

The total amount of respondents was 110, the sample size was enough for t test (Skaik, 2015). However, when doing the chi-square test, for most of the results, over 25% cells were less than 5. In this way, Likelihood ratio for chi-square test, and Kendall's tau-b were applied to investigate the significance and the extent of the impact (McHugh, 2013). 95% confidence interval was used in the analysis.

Subsequently, the adjusted residuals were examined and displayed in the analysis output, with the cell properties set to display three decimal places. The significance of the adjusted residuals was evaluated by comparing them to the critical value of 1.96, taking into consideration the standard deviation of the residuals. Furthermore, the p-value obtained

from the chi-square test was considered as an additional criterion for assessing the statistical significance of the findings. The correlation coefficient is a number that is used to assess the extent to which two variables are related (Table 2). The Kendall's tau-b value falls within the +1.00 to -1.00 range (Johari, 2013). The statistical analysis results were in Appendix IV.

Table 2 Strength value of Correlation Coefficient (Johari, 2013)

Size of correlation coefficient	**Strength of correlation**
.91 until 1.00 or -.91 till -1.00	Very strong
.71 until .90 or -.71 till -.90	Strong
.51 until .70 or -.51 till -.70	Moderate
.31 until .50 or -.31 till -.50	Weak
.01 until .30 or -.01 till -.30	Very weak
.00	No correlation

4. Results

The main findings are presented following 4 sub-questions, as well as the 4 levels of iceberg model: events, patterns, structures, and mental factors. Figure 5 depicted the conceptual model of fresh avocado waste, presenting a visual summary of the research findings. The model represents various stages of the avocado supply chain. The blue boxes indicate instances of waste occurring at the wholesale level, while the yellow boxes represent waste occurring at the retail level. The green boxes indicate waste occurring at both the wholesale and retail levels, while the red boxes signify waste resulting from consumers' behavior.

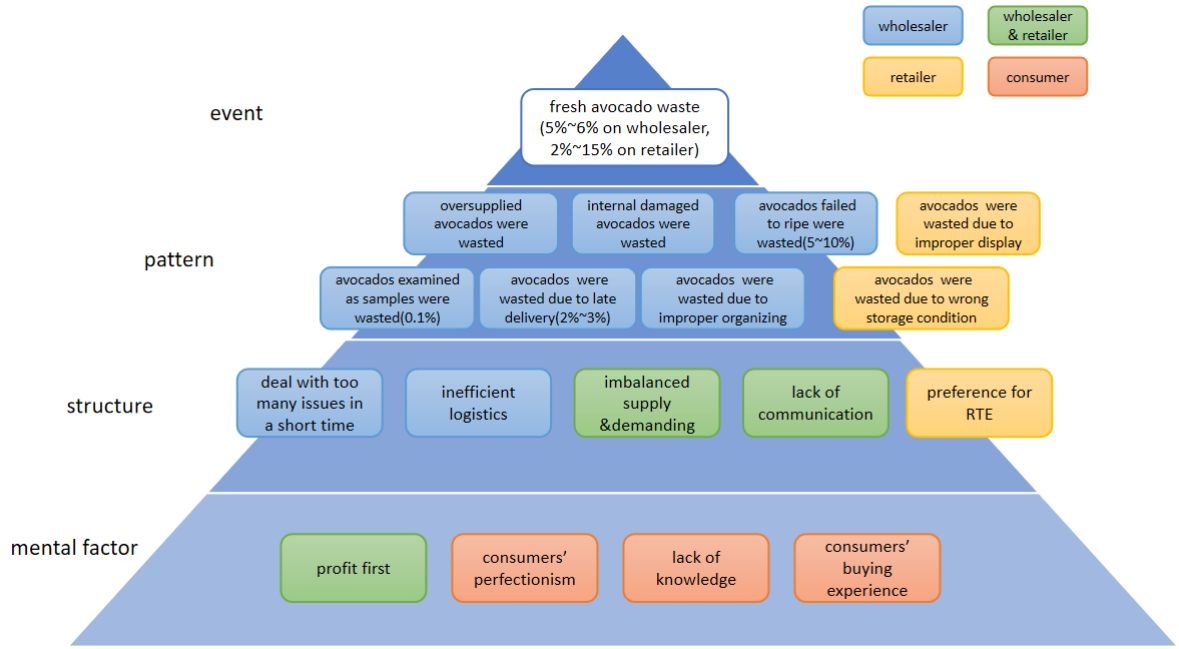

Figure 5 Avocado waste iceberg model

4.1 The current situation of unconsumable fresh avocados

Events represents the visible or explicit aspects of a situation, such as observable behaviors, actions, or events. It includes what can be easily observed or heard. In this research, events mean the current situation of unconsumable fresh avocados.

The interviews with two wholesalers and three retailers inquired about the percentage of wasted avocados in the company. The wholesalers indicated that approximately 5% to 6% of imported avocados cannot be sold, and this figure varies depending on different seasons and the countries of origin. During May, June and July, there tends to be a higher possibility of avocado overproduction and oversupply. For the quality of avocados from different supply countries, Peru and Chili were still at the best level, Kenya was now improving, and its quality was already as good as Columbia and Tanzania. However, Kenya's supply volume is still insufficient to meet the significant demand.

Two of the three supermarket managers who were interviewed stated that there were hardly any avocados on the shelf that couldn't be sold. Less than 2% of the avocados that arrived at

the supermarket can't be placed on the shelf. However, this answer was questioned by wholesalers. According to their estimate, about 10%~15% of fresh avocados in the supermarket weren't bought by customers and became unconsumable due to being too ripe.

For avocados that were not suitable for sale, some supermarkets would donate avocados with a damaged exterior but intact interior to a food bank, which helped to reduce waste. In wholesalers, avocados with good internal quality would be sent to other side industries, like avocado oil. Although these avocados can't be considered as waste, they cannot be consumed as fresh fruit in the supermarkets.

4.2 The patterns leading to (unconsumed) fresh avocados

On the pattern level, it involves identifying patterns, trends, or recurring themes that emerge from the surface-level observations. It requires a deeper analysis to recognize the connections and regularities.

4.2.1 Oversupplied avocados were wasted

In relation to the reasons behind the presence of unconsumed fresh avocados, oversupply emerges as a significant contributing factor. According to the interviews for wholesalers, during certain seasons, wholesalers imported excessive volumes that surpass their capacity to manage them promptly. Consequently, the surplus led to storage facility shortages, preventing fresh avocados from being stored at optimal low temperatures prior to ripening. Additionally, the handling of large volumes within a short time frame increased the likelihood of human errors. With the pressure to process and distribute the avocados efficiently, mistakes in sorting, packing, or storing can occur. Such errors further contribute to the portion of avocados that remain unconsumed.

4.2.2 Damaged avocados were wasted

Another cause of unconsumed fresh avocados was internal & external damage. Based on the interview, exposure to low temperatures during transportation or nutrient deficiencies can result in darkening or greying of the avocado's internal portion. When such discoloration occurs, these avocados were deemed unsalable. Occasionally, avocados would be returned by retailers due to bad quality, often stemming from internal diseases that were undetectable by machines, which developed during transport.

The external of fresh avocados on the shelf were not damaged by consumers' picking behavior, as most individuals refrain from squeezing or handling avocados excessively during the selection process. According to the interviews on supermarket managers, most of the waste in the store was caused by a delivery issue, which caused avocados to have external damage like bruises and thus could not be sold.

4.2.3 Avocados failed to ripe were wasted

Dry matter content presents another issue. Fresh avocados with a dry matter content lower

than 21% were likely to fail in ripening. Consequently, they were not subjected to ripening facilities and become unfit for consumption. Within the avocados placed in ripening facilities, approximately 5% were wasted due to variations in ripening rates, with overripe avocados rendering them unsuitable for consumption. The increasing preference of consumers for ready-to-eat avocados had resulted in a higher number of avocados being ripened to their optimal maturity level, thereby increasing the likelihood of ripening failures.

4.2.4 Avocados examined as samples were wasted

A minimal proportion of imported avocados (less than 0.1%) remain unconsumed because of rigorous quality inspections. A small sample was extracted from each container to assess firmness and dry matter. These losses were relatively insignificant and can be considered negligible.

4.2.5 Avocados were wasted due to late delivery

Later delivery may be rejected by retailers, and the process of returning these rejected avocados to the warehouse could make avocados ripe during transport, and then unsuitable for sale. Logistics-related waste accounts for a maximum of 2% to 3% of the overall avocado wastage. While this percentage may seem relatively small in comparison to other factors contributing to waste, addressing these logistical challenges is crucial for minimizing avoidable losses and ensuring the delivery of high-quality avocados to consumers.

4.2.6 Avocados were wasted due to improper organizing

Improper organizing within the supply chain can lead to increased return rates and waste. While additional requirements like possessing an organic certificate, minimizing plastic packaging, and displaying the retailer's own label were imposed, they do not directly cause improper organizing. However, improper organizing can contribute to human errors, such as incorrect labeling and packaging, which in turn can lead to higher return rates. Wholesalers could accommodate an additional 20 distinct packaging specifications demanded by various retailers. Human errors, such as incorrect labeling and packaging, also contributed to return rates. However, this issue was easily rectified, resulting in minimal waste.

4.2.7 Avocados were wasted due to improper display

If avocados are not displayed attractively or are not easily accessible to customers, they may go unnoticed or appear less appealing, resulting in slower sales. According to the observe, consumers didn’t always pick avocados underneath. During the interview, a wholesaler also mentioned that in the supermarket, if the avocados underneath were not well-arranged or appear less fresh compared to the ones on top, customers may perceive them as less appealing and choose avocados from the upper layers instead.

4.2.8 Avocados were wasted due to wrong storage condition

The storage condition in supermarkets could lead to waste, because the best storage conditions for fresh avocados, especially for ready-to-eat avocados, should be in refrigerators, while most of supermarkets only put them under room temperature.

4.3 The structural factor behind (unconsumed) fresh avocados

At structural level, the emphasis switches to the underlying systems, structures, or processes that underlie the patterns and trends that are visible. It entails comprehending the organizational dynamics, frameworks, and mechanisms that shape the overt actions or occurrences.

4.3.1 Deal with too many issues in a short time

Dealing with a multitude of issues in a limited time can overwhelm wholesalers and retailers, making it challenging to prioritize effectively. As a result, important tasks may be neglected, leading to problems such as quality issues and an increase in human errors. Additionally, the burden of multiple issues can hinder effective communication between wholesalers and retailers.

4.3.2 Inefficient logistics

Inefficient logistics practices often result in wastage, particularly when it comes to the transportation of avocados. One of the primary challenges is the delay in container deliveries, which can lead to the ripening of avocados during transit. This prolonged transportation time adversely affects the quality of the avocados, resulting in a significant decline in their overall freshness and market value. However, during the interviews, wholesaler didn't mention how many extra days were they taking compared with normal delivery.

4.3.3 Imbalanced supply &demanding

In recent years, avocado production had increased by 15% to 20%, while the demand in Europe had only risen by 5% to 8%. The global growth in avocado production had exceeded the growth in demand. Although wholesalers anticipated this trend, they failed to reduce waste by ordering fewer supplies from growers. During the interview, a wholesaler said, "it's not we want to purchase less, it's the growers want to sell more to us". The contractual relations may play an important role in the business, but the wholesaler didn't tell about their contract. Growers faced high costs associated with farming, compelling them to continually push large volumes of avocados into the market. Conversely, wholesalers attempted to boost sales volume to retailers by offering more promotions to attract consumers to redress the imbalance, hoping to increase sales volume and draw customers. However, because of the potential risk of unsold inventory, retailers weren't always willing to accepting excessive quantities of avocados. The intention behind this circumspect approach is to prevent monetary losses and keep a healthy profit margin.

Through the entire avocado supply chain, there were significant challenges caused by the mismatch between the rising supply and the relatively slower growth in demand. Avocados that were not immediately consumed or sold run the risk of spoiling, increasing wastage and harming the bottom lines of both growers and wholesalers. Furthermore, unstable pricing due to imbalanced supply and demand dynamics could make it more difficult for growers to realize reliable and favorable returns on their investments.

4.3.4 Lack of communication

The primary challenge lay in establishing effective communication across different segments of the supply chain, including avocado growers, wholesalers, and retailers. The conflict between growers and wholesalers arose from growers' desire to maximize profit. These challenges resulted in inaccurate inventory forecasts, but the mistakes could still be mitigated. Retailers were vital to the control of supply and demand. Wholesalers could address issues with excess stock by postponing orders while they look for alternative customers. Better coordination of ripening processes was made possible by improved communication between retailers and wholesalers. Delivering avocados at the right level of ripeness, extending their shelf life, and lowering the risk of spoilage were all benefits of adjusting the ripening process based on consumer demand.

4.3.5 Preference for RTE

Retailers had diverse criteria for fresh avocados concerning their size and firmness. Approximately 40% of all avocados were categorized as ready-to-eat. RTE avocados have a shorter shelf life compared to unripe avocados. If not properly managed and consumed within the required timeframe, they can spoil quickly, leading to higher levels of waste at both retail and consumer levels. In addition, if demand for RTE avocados fluctuates or the supply chain is disrupted, there is the potential for oversupply and subsequent waste if avocados are not sold or consumed in a timely manner. Also, RTE avocados require higher proficiency in ripening techniques, making it more prone to failures when ripening them to the desired ready-to-eat maturity, thus resulting in more wastage.

4.4 The mental factor of (unconsumed) fresh avocados

Mental factors refer to the conscious or subconscious assumptions, beliefs, and values that individuals hold about a system (Maani & Cavana, 2007). These mental factors can greatly impact how individuals interpret and respond to external stimuli and situations, ultimately influencing their actions and behaviors.

4.4.1 Profit first

Based on the interviews, both wholesalers and retailers frequently put short-term financial success and inventory control ahead of thinking about the long-term effects of waste and its effects on the environment and society. The "profit-first" mentality was a common name for this emphasis on short-term financial gains. The emphasis on immediate sales goals and maintaining high on-shelf availability that resulted from the profit-first mentality sometimes came at the expense of taking waste reduction strategies into account or adopting sustainable practices. In order to ensure availability, wholesalers and retailers prioritized stocking larger quantities of products, even if doing so increased the likelihood of waste due to expiration or a lack of demand.

4.4.2 Consumers' perfectionism

According to the interviews with the two wholesalers, despite the avocados' good internal quality, retailers were unwilling to accept them. There might be less waste if retailers would take these kinds of avocados. The questionnaire was also used to see people's buying preferences for sub-optimal avocados.

Based on the data analysis (Appendix IV), there is a significant association between the importance of avocado appearance and the likelihood of purchasing sub-optimal avocados with a guarantee. The results suggest that individuals who place higher importance on avocado appearance are less likely to purchase sub-optimal avocados, even with a guarantee of edibility and taste. There was no significant relation between the important of avocado appearance and the knowledge of best-before and used-by date, which means people who prefer good-looking avocados are not that likely to purchase sub-optimal avocados even they know these avocados still can be eaten. However, those who find appearance somewhat important are more willing to purchase sub-optimal avocados if a guarantee is provided. Respondents who do not prioritize avocado appearance as very or somewhat important have a stronger tendency to "Be sure to buy it" when a quality guarantee is provided, compared to those who prioritize appearance as very or somewhat important. The level of importance placed on appearance does not appear to have a significant impact on the purchasing decision for those who do not consider it that important.

4.4.3 Lack of knowledge

The statistical analysis (Appendix V) conducted, which involved chi-square tests and adjusted residuals, provides strong evidence of a significant association between familiarity with the best-before date and used-by date and the likelihood of purchasing suboptimal avocados. The findings indicate that individuals who are familiar with these dates are more likely to purchase sub-optimal avocados in the past. Conversely, individuals lacking knowledge of these dates are less likely to make such purchases.

The analysis of the crosstab examining the relationship between individuals' willingness to purchase sub-optimal avocados and their knowledge of the best-before and used-by dates reveals interesting findings. Specifically, individuals who possess knowledge of the best-before date demonstrate a higher likelihood of considering the purchase of suboptimal avocados. However, among those who are aware of the used-by date, the "Maybe" group stands out with a notably lower inclination to buy sub-optimal avocados.

4.4.4 Consumer's buying experience

Based on the scientific analysis (Appendix VI), there is a significant association between the frequency of buying avocados and the occurrence of purchasing avocados that were not in the best condition. The results suggest that individuals who buy avocados more frequently are more likely to have purchased avocados in sub-optimal conditions.

Statistics

How much of a discount would make it worth your while to purchase sub-optimal avocados over perfectly ripe ones? Please give the number.

N	Valid	103
	Missing	7
Mean		36.17
Median		35.00
Std. Deviation		18.693

Picture 1 Mean and Median of people's ideal discount

In the statistical analysis, participants' responses were examined to the question regarding the discount required for them to purchase sub-optimal avocados instead of perfectly ripe ones. Out of the total sample size of 110 respondents, 103 provided valid responses, while 7 responses were missing. Picture 1 showed the results. Both Mean and Median showed that consumers' ideal discount for sub-optimal avocados was around 35%.

Based on the interviews conducted, wholesalers highlighted that consumer purchasing behavior was influenced by avocado promotions. Additionally, the timing of the promotion was found to be a significant factor. It was observed that consumers were more inclined to purchase avocados at the beginning of the month when they had just received their salary and had higher disposable income. In contrast, towards the end of the month, consumers may have had limited disposable income, resulting in lower profitability for promotions conducted during that period.

Using Porter's value chain, Picture 2 demonstrated where wastes occur in wholesalers, Picture 3 demonstrated where wastes occur in retailers ,as well as partially displaying the amount of waste at various positions. By checking each stage of the value chain, these images provide a comprehensive understanding of where waste occurs and offer insights into the magnitude of waste at various positions.

Wholesaler	Inbound logistics	Production/operations	Outbound logistics	Marketing and sales	Customer services
Primary activities	• purchasing fresh avocados form Kenya • checking the samples • sending avocados to ripening facility	• quality check • grading • ripening • packaging	• sending fresh avocados to buyers • managing warehouses • organizing transportation logistics • coordinating with retailers	promoting and selling avocados to potential buyers. The wholesaler may engage in marketing activities such as advertising	• offering prompt support • handling customer inquiries and complaints • providing information on avocado quality, availability, and pricing
Wastes	• oversupplied avocados were wasted • avocados examined as samples were wasted	• internal damaged avocados were wasted • avocados failed to ripe were wasted(5~10%) • avocados were wasted due to wrong packaging(minimal waste)	• avocados were wasted due to late delivery(2%~3%)		

Picture 2 Porter value chain for wholesalers

Retailer	Inbound logistics	Production/operations	Outbound logistics	Marketing and sales	Customer services
Primary activities	• purchasing avocados from wholesalers • sending avocados to their supermarkets	• quality check • putting avocados on the shelf • checking the inventory level	• distributing avocados to customers • managing inventory levels • ensuring timely restocking of avocados	• advertising, creating attractive displays, and running promotions or discounts to encourage avocado sales	• assisting customers in finding avocados • answering their queries • addressing any concerns or complaints
Wastes	• avocados were wasted due to late delivery(2%~3%)	• avocados were wasted due to wrong storage condition		• stalled avocados were wasted(2~15%)	

Picture 3 Porter value chain for retailers

5. Discussion

5.1 The current situation of (unconsumable) fresh avocados

According to the literature review, the most common way for unsaleable avocados to be disposed of was as biofuels or in landfills (Soilmates, 2022). The interview with wholesalers revealed a different approach, repurposing unsaleable avocados into side products like avocado oil or guacamole. These strategies represent distinct ways of managing avocados. In the Netherlands, the recycle percentage of wastes is high (Aramyan & Valeva, 2016), so the landfill method may not widely used. Wholesalers recognized the potential to salvage these avocados which don't have internal damage, deriving alternative uses and commercial value. Landfill are defined as food waste, while side products are not waste, so in practice the waste level was lower than expected.

About the amount of waste happened in the supermarket, shop managers and wholesalers gave out different answers. But they didn't give reason for the difference.

5.2 The trends leading to (unconsumed) fresh avocados

According to Jedermann's (2014) research, wholesalers' desire to satisfy retailers' urgent requirements was the primary cause of oversupply. However, based on the interview, it appeared that both the growers and the wholesalers contributed to this issue. The growers wanted to sell as many avocados as possible, so they pushed the bulk of the supply to the wholesalers. Therefore, growers' and wholesalers' combined actions and motivations result in oversupply. The problem of oversupply was a result of growers' efforts to increase sales and wholesalers' efforts to meet retailers' demands without taking the dynamics of the market's demand into account.

The impact of quality checks on waste generation was found to be significantly lower than suggested by the literature (1~5% vs about 0.1%) (Terry et al., 2011). This observation can be attributed to the fact that the literature referenced was published in 2011, whereas the current practices predominantly employ non-destructive quality assessment methods. Consequently, only a minimal quantity of avocados was subjected to destructive testing as samples. The widespread adoption of non-destructive techniques has resulted in a substantial reduction in the number of avocados being discarded during the quality checking process (Olarewaju, Bertling, & Magwaza, 2016).

The literature suggests that consumers have been observed to potentially squeeze avocados, leading to damage (Stop squeezing avocados say producers, there are better ways to test ripeness.2018). However, during the observation of Dutch consumers in the supermarket and interviews conducted with shop managers, no instances of consumers squeezing avocados were observed or reported. It is possible that the previous studies capturing instances of avocado squeezing involved specific contexts or situations that were not representative of

the typical consumer behavior in Dutch supermarkets or the specific stores where observations were conducted.

5.3 The structural factor behind (unconsumed) fresh avocados

The literature review indicated that staff's lack of knowledge can contribute to improper handling behavior and, subsequently, avocado waste (de Moraes et al., 2022). However, the interviews conducted with wholesalers presented a different perspective. Contrary to the literature, the primary reason for human error identified during these interviews was the overwhelming workload faced by staff within a limited time frame. In busy seasons, human errors were more likely to happen. While lack of knowledge may still be a factor in human errors, interviews with wholesalers revealed the immediate impact of time constraints and workload on the occurrence of errors. The importance of completing multiple tasks in a short period of time took precedence over the role of knowledge gaps in avocado waste generation.

Some specific details still remain undisclosed, such as the contractual dynamics among growers, wholesalers, and retailers; the additional time consumed as a result of delayed deliveries; and the organizational challenges faced during peak seasons for other soft fruits.

5.4 The mental factor behind (unconsumed) fresh avocados

The literature indicates that consumers exhibit a reduced inclination to purchase avocados with unappealing appearances. Avocados sent to supermarkets usually meet Class 1 standards, but minor external damage may occur during delivery and after they are placed on the shelf. The survey findings support this notion, revealing that individuals who perceive the appearance of avocados as less significant are more likely to buy sub-optimal avocados if they are assured of their quality. In contrast, those who consider appearance to be highly important or moderately important demonstrate a lower willingness to purchase such avocados. These results align with the hypothesis under investigation.

Compared to the literature, Direct product profitability (DPP) was found as a mental factor in the literature (Bookbinder & Zarour, 2001), but during the interviews for wholesalers and shop managers, no one mentioned it. Maybe this is the issue on retail sites, wholesalers and shop managers didn’t notice it a lot, but this should be further asked.

5.5 Research methods

The research method is subject to some limitations. Firstly, the sample size employed for the questionnaire was insufficient and lacked diversity. Limited to Inholland Yammer, the respondents primarily comprised students aged 18 to 24 years old. In that case, the findings derived from the data analysis cannot be generalized to the entire population of the Netherlands. It is important to acknowledge that these results merely reflect the perspectives of the respondents, and caution must be exercised when extrapolating the

outcomes for broader analysis. For the question "How much of a discount would make it worth your while to purchase sub-optimal avocados over perfectly ripe ones?" 7 answers were missing out of the 110 total. These respondents wrote a meaningless number, so this question was analyzed based on 103 responses.

During the interviews with two wholesalers, most of the answers provided were based on general insights related to avocados rather than specifically focusing on Kenya avocados. As a result, the direct applicability of the findings to Kenya avocados remains uncertain. Also, 3 interviews for shop managers all happened in Delft, which means the conclusion cannot be used to all supermarkets in the Netherlands

6. Conclusion

6.1 What are the factors that make fresh avocados imported from Kenya unconsumable in the supply chain from wholesale to retail in the Netherlands?

Structural and mental factor are the main factors that make fresh avocados imported from Kenya unconsumable in the supply chain from wholesale to retail in the Netherlands.
Unsold inventory and waste in the avocado industry on structural level have resulted from unbalanced supply and demand dynamics, as well as inefficient logistics practices. Avocado production has grown faster than demand, contributing to the problem. Delays in container deliveries have caused avocados to ripen in transit, exacerbating the problem. Inadequate communication throughout the supply chain has hampered inventory forecasting and ripening process coordination.

For mental factor, the profit-first mentality of the industry has prioritized short-term financial success and inventory control over waste reduction and sustainability. Consumer behavior has also contributed to waste, as evidenced by a focus on avocado appearance and perfectionism, a reluctance to accept suboptimal avocados, and a lack of knowledge about best-before and used-by dates. The amount of waste generated has also been influenced by factors such as the consumer purchasing experience and the frequency of avocado purchases.

6.2 What is the current situation of (unconsumable) fresh avocados imported from Kenya in the supply chain from wholesale to retail in the Netherlands?

The current situation of unconsumable avocados reveals various factors contributing to waste in the avocado supply chain. The interviews conducted with wholesalers and retailers showed that about 5%~6% of the imported avocados were wasted and the reasons behind their unconsumable. Oversupply, internal damage, inadequate dry matter content, and inefficient logistics practices were identified as key trends leading to unconsumed avocados.

6.3 What are the trends leading to (unconsumed) fresh avocados imported from Kenya in the supply chain from wholesale to retail in the Netherlands?

Oversupply emerged as a significant issue, with wholesalers importing in excess of their capacity to manage them quickly. This resulted in storage facility shortages and insufficient temperature control, affecting avocado quality and shelf life. Furthermore, handling large volumes in a short period of time increased the possibility of human errors in sorting, packing, and storing. Avocado damage, both internally and externally, was another major source of waste. Avocados were rendered unsalable due to exposure to low temperatures during transportation and undetectable internal diseases. Furthermore, improper ripening

and variations in ripening rates contributed to avocado waste. Logistical issues like late delivery and poor organization also contributed to waste, albeit to a lesser extent. In supermarkets, improper display and storage conditions exacerbated the problem, resulting in slower sales and customer preferences for avocados on top or in better display conditions.

6.4 What is the structural factor behind (unconsumed) fresh avocados imported from Kenya in the supply chain from wholesale to retail in the Netherlands?

Managing a large number of issues in a short period of time frequently overwhelms wholesalers and retailers, resulting in ignored tasks, quality issues, and increased human errors. Avocados ripened during transit due to inefficient logistics practices such as delayed container deliveries, compromising their freshness. The imbalanced supply and demand dynamics posed a significant challenge, as avocado production outpaced demand growth. This mismatch resulted in unsold inventory and increased waste, reducing growers' and wholesalers' profitability. The lack of effective communication throughout the supply chain hampered inventory forecasting and ripening process coordination, exacerbating waste. Furthermore, the preference for ready-to-eat avocados, which have a shorter shelf life, made it difficult to manage their timely consumption and avoid spoilage.

6.5 What is the mental factor of (unconsumed) fresh avocados imported from Kenya in the supply chain from wholesale to retail in the Netherlands?

The profit-first mentality prevalent in the industry often leads to prioritizing short-term financial success and inventory control over long-term considerations of waste and its impact on the environment and society. This focus on immediate sales goals and maintaining high on-shelf availability can hinder the implementation of waste reduction strategies and sustainable practices. Consumer behavior also played a significant role in avocado waste. Consumers' emphasis on avocado appearance and perfectionism often leads to a reluctance to accept suboptimal avocados, even if they are still edible. Lack of knowledge about best-before and used-by dates also influences purchasing decisions, with individuals familiar with these dates being more willing to purchase avocados in suboptimal conditions. Additionally, consumer buying experience and the frequency of avocado purchases contribute to avocado waste. Those who buy avocados more frequently are more likely to have purchased avocados in suboptimal conditions. Promotions and discounts also impact consumer behavior and waste. The timing of promotions, aligned with consumers' disposable income, can significantly influence purchasing decisions.

7 Recommendation

For both wholesalers and retailers, efforts should be made to address the lack of communication, the unbalanced supply & demand, and reduce waste in the avocado supply chain. By improving communication, aligning supply with demand, and educating consumers, the industry aims to optimize avocado distribution and ensure high-quality avocados reach the market. These measures will not only minimize waste but also contribute to a more sustainable and efficient avocado industry.

For further study, it is recommended to broaden the surveys to include not only students but also individuals from various demographics. Additionally, conducting interviews with supermarket managers from diverse regions in the Netherlands would yield valuable insights that can be extrapolated to a larger population. By incorporating a broader range of participants, the findings would be more representative and applicable to a wider audience. Also, the impact of Direct Profit Profitability could be further investigated by retailers; the contractual relationship between growers, wholesalers and retailers should be figured out.

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Appendix

Appendix I Questionnaire for the wholesalers

1. How many avocados are wasted in your company per day? What's the percentage?
2. What are the reasons for the waste (unqualified moisture/ lipids/ dry matter..)? And please rank them, from the most important to the least important
3. Do your customers have special requirements? For example: ready-to-eat/special packaging/information about the farmer/size…
4. What's the problem within Dutch avocado supply chain on the wholesale level? For example: the poor handling and operational performance/the inadequate or defective packaging/the lack of storage facilities/the lack of coordination and information sharing/the inadequate transportation systems/human errors…
5. Is there any problem happens in your inventory management? For example: overstock/wrong storage conditions
6. How's the logistics procedure works in your company? Is there any waste due to press/wrong temperature/human error…?
7. Do you think consumers' behavior like their preference on RTE/ perfectionism will impact avocado waste on the wholesale level? Is there any new trends or new behaviors you observed will have impact on the wholesaler?
8. What kind of waste do you think that may happens on the retail level?
9. Are you willing to tell me who are your major Kenya avocados buyers? Are you willing to provide the name so that I can contact them for my further study?

Appendix II Questionnaire for the retailers

1. How many avocados are wasted in this shop every day? What's the percentage of the waste?
2. What are the reasons for the waste? And please rank them, from the most important to the least important.
4. What kind of action will you do to reduce the avocado waste, like if wholesaler has too much in stock, or if the sales are going down but still many stock..?
5. How much percentage of the waste is because of consumers squeeze the fruit when they are picking?

Appendix III Questionnaire for the consumers

1. How often do you buy avocados from supermarkets?
a) Once a week or more
b) Once or twice a month
c) Rarely
d) Never

The definition of sub-optimal avocados in this research is overripe, underripe or bruised avocados.
2. Have you ever purchased avocados that were not in the best condition (e.g. overripe, underripe, bruised)?
a) Yes
b) No

3. If you answered 'Yes' to question 2, why did you choose to purchase the sub-optimal avocados?
a) They were cheaper than the ripe ones
b) They were the only ones available at the time
c) I didn't realize they were sub-optimal until I got home
d) Other (please specify) _____

4. On a scale of 1 to 5, how willing are you to purchase sub-optimal avocados if they were priced lower than the perfectly ripe ones?
a) 1 (not willing at all)
b) 2
c) 3 (neutral)
d) 4
e) 5 (very willing)

5. How important is the appearance of an avocado to you when making a purchase decision?
a) Very important
b) Somewhat important
c) Not important at all
d) Other_____

6. Would you be more likely to purchase sub-optimal avocados if the supermarket offered a guarantee that they would still be edible and tasty?
a) Yes
b) No
c) Maybe

7. How much of a discount would make it worth your while to purchase sub-optimal avocados over perfectly ripe ones?

_____

8. Do you know the meaning of ‘Best-before date’ and ‘Used-by date’?
a) Yes, I know both
b) No, I know either
c) I know the meaning of best-before date
d) I know the meaning of used-by date

The best before date is about the quality of the food, while the use-by date is about safety. You should not eat food past its use by date, but you can eat food past its best before date if it looks, smells and tastes fine.
9. On a scale of 1 to 5, how willing are you to eat avocados pass best-before date but still within used-by date?
a) 1 (not willing at all)
b) 2
c) 3 (neutral)
d) 4
e) 5 (very willing)

Appendix IV Data analysis: consumers' perfectionism and their willingness to purchase avocados

The objective was to determine if there is a significant relationship between these variables.

How important is the appearance of an avocado to you when making a purchase decision? * Would you be more likely to purchase sub-optimal avocados if the supermarket offered a guarantee that they would still be edible and tasty? Crosstabulation

			Would you be more likely to purchase sub-optimal avocados if the supermarket offered a guarantee that they would still be edible and tasty?			
			Yes	No	Maybe	Total
How important is the appearance of an avocado to you when making a purchase decision?	Very important	Count	15a	8b	13b	36
		Adjusted Residual	-3.728	1.771	2.872	
	Somewhat important	Count	48a	4b	8b	60
		Adjusted Residual	3.491	-2.426	-2.030	
	Not that important	Count	8a	3a	1a	12
		Adjusted Residual	.072	1.180	-1.098	
Total		Count	71	15	22	108

Each subscript letter denotes a subset of Would you be more likely to purchase sub-optimal avocados if the supermarket offered a guarantee that they would still be edible and tasty? categories whose column proportions do not differ significantly from each other at the .05 level.

Picture 4 Crosstab about Significance of appearance Willingness to buy with guarantee*

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	16.842[a]	4	.002
Likelihood Ratio	16.881	4	.002
Linear-by-Linear Association	8.946	1	.003
N of Valid Cases	108		

a. 2 cells (22.2%) have expected count less than 5. The minimum expected count is 1.67.

Picture 5 Chi-square tests results about Significance of appearance Willingness to buy with guarantee*

Based on the results (Picture 4), individuals who place high importance on the appearance of avocados are less inclined to purchase sub-optimal avocados, even when a guarantee is offered (adjusted residual = -3.728). Conversely, individuals who consider the appearance somewhat important show a significantly higher likelihood of purchasing sub-optimal avocados when a guarantee is provided (adjusted residual = 3.491). However, for those who do not consider the appearance of avocados that important, there are no significant differences in the likelihood of purchasing sub-optimal avocados when a guarantee is offered (adjusted residuals close to 0).

For the Chi-square test (Picture 5), the likelihood ratio indicates $p<0.05$. This means that there is evidence to suggest that the likelihood of purchasing sub-optimal avocados differs depending on the importance individuals place on avocado appearance.

Symmetric Measures

		Value	Asymptotic Standard Error[a]	Approximate T[b]	Approximate Significance
Ordinal by Ordinal	Kendall's tau-b	-.281	.088	-3.122	.002
	Spearman Correlation	-.307	.095	-3.322	.001[c]
Interval by Interval	Pearson's R	-.289	.090	-3.110	.002[c]
N of Valid Cases		108			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

*Picture 6 Correlation of Significance of appearance*Willingness to buy with guarantee*

Kendall's tau-b value is -0.281 (Picture 6), indicating a weak negative correlation between the two ordinal variables.

On a scale of 1 to 5, how willing are you to purchase sub-optimal avocados if they were priced lower than the perfectly ripe ones? * How important is the appearance of an avocado to you when making a purchase decision? Crosstabulation

			How important is the appearance of an avocado to you when making a purchase decision?			
			Very important	Somewhat important	Not that important	Total
On a scale of 1 to 5, how willing are you to purchase sub-optimal avocados if they were priced lower than the perfectly ripe ones?	Not willing	Count	10.000a	4.000b	.000a, b	14.000
		Adjusted Residual	3.241	-2.178	-1.418	
	Sometimes willing	Count	5.000a	7.000a	2.000a	14.000
		Adjusted Residual	.203	-.448	.405	
	Usually willing	Count	11.000a	17.000a	2.000a	30.000
		Adjusted Residual	.456	.144	-.911	
	Very willing	Count	8.000a	25.000a	4.000a	37.000
		Adjusted Residual	-1.864	1.814	-.072	
	Be sure to buy it	Count	2.000a	7.000a, b	4.000b	13.000
		Adjusted Residual	-1.464	-.132	2.405	
Total		Count	36.000	60.000	12.000	108.000

Each subscript letter denotes a subset of How important is the appearance of an avocado to you when making a purchase decision? categories whose column proportions do not differ significantly from each other at the .05 level.

*Picture 7 Crosstab about Significance of appearance*Willingness of buying*

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	18.625[a]	8	.017
Likelihood Ratio	18.130	8	.020
Linear-by-Linear Association	12.391	1	.000
N of Valid Cases	108		

a. 8 cells (53.3%) have expected count less than 5. The minimum expected count is 1.44.

*Picture 8 Chi-square tests results about Significance of appearance*Willingness of buying*

As Picture 7 shows, respondents who consider avocado appearance to be very important

(adjusted residual= 3.241) or somewhat important (adjusted residual=-2.178) show a higher tendency to be not willing to purchase sub-optimal avocados compared to those who consider appearance as not that important. Respondents who consider avocado appearance not that important (adjusted residual=2.405) show a higher tendency to be "Be sure to buy it" if there is a quality guarantee, compared to those who consider appearance very important or somewhat important.

The result of chi-square test (Picture 8) (Likelihood ratio<0.05) also showed a significant association between respondents' willingness to purchase sub-optimal avocados and their perception of avocado appearance when making purchase decisions.

Symmetric Measures

		Value	Asymptotic Standard Error[a]	Approximate T[b]	Approximate Significance
Ordinal by Ordinal	Kendall's tau-b	.294	.081	3.551	.000
	Spearman Correlation	.333	.091	3.636	.000[c]
Interval by Interval	Pearson's R	.340	.087	3.726	.000[c]
N of Valid Cases		108			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

*Picture 9 Correlation about Significance of appearance*Willingness of buying*

Kendall's tau-b value is 0.294 (Picture 9), indicating a weak positive correlation between the two ordinal variables.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	.559[a]	2	.756
Likelihood Ratio	.643	2	.725
Linear-by-Linear Association	.262	1	.609
N of Valid Cases	108		

a. 1 cells (16.7%) have expected count less than 5. The minimum expected count is 1.89.

Picture 10 Chi-square tests results about Significance of appearance Used-by date knowledge*

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	1.411[a]	2	.494
Likelihood Ratio	1.348	2	.510
Linear-by-Linear Association	.873	1	.350
N of Valid Cases	108		

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is 1.11.

Picture 11 Chi-square tests results about Significance of appearance Best-before date knowledge*

The result of chi-square test (Picture 10, 11) (Likelihood ratio>0.05) showed there's no significant association between their perception of avocado appearance and their knowledge about best-before and used-by date when making purchase decisions.

Appendix V Data analysis: consumers' knowledge and their willingness to purchase avocados

To see whether the knowledge about best-before and used-by date have influence, crosstab and chi-square tests were used.

Have you ever purchased avocados that were not in the best condition * Do you know the meaning of best before date Crosstabulation

			Do you know the meaning of best before date		
			Yes	No	Total
Have you ever purchased avocados that were not in the best condition	Yes	Count	76a	4b	80
		Adjusted Residual	2.437	-2.437	
	No	Count	24a	6b	30
		Adjusted Residual	-2.437	2.437	
Total		Count	100	10	110

Each subscript letter denotes a subset of Do you know the meaning of best before date categories whose column proportions do not differ significantly from each other at the .05 level.

*Picture 12 Crosstab about Buying experience*Best-before date knowledge*

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	5.940[a]	1	.015		
Continuity Correction[b]	4.264	1	.039		
Likelihood Ratio	5.233	1	.022		
Fisher's Exact Test				.024	.024
Linear-by-Linear Association	5.886	1	.015		
N of Valid Cases	110				

a. 1 cells (25.0%) have expected count less than 5. The minimum expected count is 2.73.

b. Computed only for a 2x2 table

*Picture 13 Chi-square test result about Buying experience*Best-before date knowledge*

Have you ever purchased avocados that were not in the best condition * Do you know the meaning of used by date Crosstabulation

			Do you know the meaning of used by date		
			Yes	No	Total
Have you ever purchased avocados that were not in the best condition	Yes	Count	73a	7b	80
		Adjusted Residual	3.525	-3.525	
	No	Count	19a	11b	30
		Adjusted Residual	-3.525	3.525	
Total		Count	92	18	110

Each subscript letter denotes a subset of Do you know the meaning of used by date categories whose column proportions do not differ significantly from each other at the .05 level.

*Picture 14 Crosstab about Buying experience*used-by date knowledge*

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	12.424[a]	1	.000		
Continuity Correction[b]	10.468	1	.001		
Likelihood Ratio	11.139	1	.001		
Fisher's Exact Test				.001	.001
Linear-by-Linear Association	12.311	1	.000		
N of Valid Cases	110				

a. 1 cells (25.0%) have expected count less than 5. The minimum expected count is 4.91.

b. Computed only for a 2x2 table

*Picture 15 Chi-square tests result about Buying experience*used-by date knowledge*

The statistical analysis, including chi-square tests (Picture 13, 15) and adjusted residuals (Picture 12,14), confirms a significant association between the two variables ($p<0.05$), indicating that familiarity with the best-before date and used-by date are related to the likelihood of purchasing suboptimal avocados. The adjusted residuals highlight an overrepresentation of individuals with knowledge of the best-before date who have purchased avocados in suboptimal conditions, while an underrepresentation is observed among individuals lacking such knowledge.

Symmetric Measures

		Value	Asymptotic Standard Error[a]	Approximate T[b]	Approximate Significance
Ordinal by Ordinal	Kendall's tau-b	.232	.107	1.914	.056
	Spearman Correlation	.232	.107	2.483	.015[c]
Interval by Interval	Pearson's R	.232	.107	2.483	.015[c]
N of Valid Cases		110			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

*Picture 16 Correlation about Buying experience*Best-before date knowledge*

Symmetric Measures

		Value	Asymptotic Standard Error[a]	Approximate T[b]	Approximate Significance
Ordinal by Ordinal	Kendall's tau-b	.336	.103	2.868	.004
	Spearman Correlation	.336	.103	3.708	.000[c]
Interval by Interval	Pearson's R	.336	.103	3.708	.000[c]
N of Valid Cases		110			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

*Picture 17 Correlation about Buying experience*used-by date knowledge*

Both Kendall's tau-b values (Picture 16, 17) indicating a weak positive correlation between the knowledge of best-before and used-by date and people's experience of buying sub-optimal avocados.

Crosstab

			Do you know the meaning of best before date		
			Yes	No	Total
Would you be more likely to purchase sub-optimal avocados if the supermarket offered a guarantee that they would still be edible and tasty?	Yes	Count	70.000a	3.000b	73.000
		Adjusted Residual	2.553	-2.553	
	No	Count	12.000a	3.000a	15.000
		Adjusted Residual	-1.581	1.581	
	Maybe	Count	18.000a	4.000a	22.000
		Adjusted Residual	-1.658	1.658	
Total		Count	100.000	10.000	110.000

Each subscript letter denotes a subset of Do you know the meaning of best before date categories whose column proportions do not differ significantly from each other at the .05 level.

*Picture 18 Crosstab about Willingness to buy with guarantee*Best-before date knowledge*

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	6.552[a]	2	.038
Likelihood Ratio	6.120	2	.047
Linear-by-Linear Association	5.338	1	.021
N of Valid Cases	110		

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is 1.36.

*Picture 19 Chi-square tests result about Willingness to buy with guarantee*Best-before date knowledge*

Crosstab

			Do you know the meaning of used by date		
			Yes	No	Total
Would you be more likely to purchase sub-optimal avocados if the supermarket offered a guarantee that they would still be edible and tasty?	Yes	Count	66a	7b	73
		Adjusted Residual	2.7	-2.7	
	No	Count	11a	4a	15
		Adjusted Residual	-1.2	1.2	
	Maybe	Count	15a	7b	22
		Adjusted Residual	-2.2	2.2	
Total		Count	92	18	110

Each subscript letter denotes a subset of Do you know the meaning of used by date categories whose column proportions do not differ significantly from each other at the .05 level.

*Picture 20 Crosstab about Willingness to buy with guarantee*Used-by date knowledge*

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	7.451[a]	2	.024
Likelihood Ratio	6.994	2	.030
Linear-by-Linear Association	7.067	1	.008
N of Valid Cases	110		

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is 2.45.

*Picture 21 Chi-square tests result about Willingness to buy with guarantee*Used-by date knowledge*

Similarly, the crosstab about people's willingness of buying sub-optimal avocados and their knowledge of best-before and used-by date (Picture 18, 20) showed that those with knowledge of the best before date are more likely to consider purchasing them. But for people who know the used-by date, the "Maybe" group (adjusted residual=-2.2) showed the lower possibility to buy sub-optimal avocados. The chi-square tests (Picture 19, 21) showed a significant association between two variables.

Symmetric Measures

		Value	Asymptotic Standard Error[a]	Approximate T[b]	Approximate Significance
Ordinal by Ordinal	Kendall's tau-b	.226	.095	2.072	.038
	Spearman Correlation	.235	.099	2.512	.013[c]
Interval by Interval	Pearson's R	.221	.102	2.358	.020[c]
N of Valid Cases		110			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

*Picture 22 Correlation about Willingness to buy with guarantee*Best-before date knowledge*

Symmetric Measures

		Value	Asymptotic Standard Error[a]	Approximate T[b]	Approximate Significance
Ordinal by Ordinal	Kendall's tau-b	.250	.097	2.392	.017
	Spearman Correlation	.260	.101	2.798	.006[c]
Interval by Interval	Pearson's R	.255	.103	2.736	.007[c]
N of Valid Cases		110			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

*Picture 23 Correlation about Willingness to buy with guarantee*Used-by date knowledge*

Both Kendall's tau-b values (Picture 22, 23) indicating a weak positive correlation between the knowledge of best-before and used-by date and people's willingness of buying sub-optimal avocados.

Appendix VI Data analysis: consumers' purchasing experience

How often do you buy avocados from supermarkets? * Have you ever purchased avocados that were not in the best condition Crosstabulation

			Have you ever purchased avocados that were not in the best condition		
			Yes	No	Total
How often do you buy avocados from supermarkets?	Once a week or more	Count	13.000a	2.000a	15
		Adjusted Residual	1.304	-1.304	
	Once or twice a month	Count	40.000a	3.000b	43
		Adjusted Residual	3.829	-3.829	
	Rarely	Count	27.000a	10.000a	37
		Adjusted Residual	.041	-.041	
	Never	Count	.000a	15.000b	15
		Adjusted Residual	-6.806	6.806	
Total		Count	80.000	30.000	110

Each subscript letter denotes a subset of Have you ever purchased avocados that were not in the best condition categories whose column proportions do not differ significantly from each other at the .05 level.

*Picture 24 Crosstab about Buying history*Buying frequency*

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	50.401[a]	3	.000
Likelihood Ratio	52.187	3	.000
Linear-by-Linear Association	32.421	1	.000
N of Valid Cases	110		

a. 2 cells (25.0%) have expected count less than 5. The minimum expected count is 4.09.

*Picture 25 Chi-square tests result about Buying history*Buying frequency*

Symmetric Measures

		Value	Asymptotic Standard Error[a]	Approximate T[b]	Approximate Significance
Ordinal by Ordinal	Kendall's tau-b	.489	.077	5.498	.000
	Spearman Correlation	.527	.084	6.450	.000[c]
Interval by Interval	Pearson's R	.545	.080	6.762	.000[c]
N of Valid Cases		110			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

*Picture 26 Correlation about Buying history*Buying frequency*

As Picture 24 showed, for participants who buy avocados once or twice a month, 40 reported purchasing avocados that were not in the best condition, while 3 did not. The adjusted residual value of 3.829 indicates a significantly higher proportion of individuals in this group who purchased sub-optimal avocados. The likelihood ratio chi-square value (Picture 25) is 52.187 with 3 degrees of freedom, also indicating a significant association ($p = .000$). The Kendall's tau-b value (Picture 26) is 0.489, indicating a moderate positive correlation between avocado purchasing frequency and purchasing avocados in sub-

optimal conditions (p = .000).