

# Dutch Perspectives on Cultivated Meat

*From Textual Data Analysis to Serious Game Design*

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Kirsten Odenwald  
April, 2024

Delft University of Technology  
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*From Textual Data Analysis to Serious Game Design*

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*We Shall Escape the Absurdity of  
Growing a Whole Chicken in Order To  
Eat the Breast or Wing*

*Winston Churchill, 1931*



# Preface

With this thesis I'm reaching a milestone of my two master's degrees, marking the end of my time as a student at the TU Delft and Wageningen University. I'm pleased to have combined both masters, especially in this research, as I believe in the importance of integrating Science Communication with Technology. Many people don't know how to translate their great and complex ideas to the broader society, a challenge that is becoming increasingly relevant in today's world. I'm happy to have a thesis on a topic I've been interested in for years, dating back to my first year as a Bachelor's student in Life Science and Technology, where I gave a presentation about cultivated meat. The belief that this technology represents our future food industry made working on this thesis a joy, and I enthusiastically worked on it (almost) every day!

For this thesis, I aim to offer guidance on how to read this report. Given its nature as a combination of two master's degrees, it should be viewed as an integration rather than two distinct fields. Together, these fields provide a solution to a societal problem. This master thesis is an interdisciplinary work combining insights from food technology, communication design, and textual data analysis within the specific context of Dutch perspectives on cultivated meat. The interdisciplinary nature of this study shows the potential for collaboration between diverse fields to tackle complex societal challenges.

I want to thank all my supervisors, with special thanks extended to Art Dewulf and Éva Kalmár. Art, I am particularly thankful for your guidance in navigating textual data analysis in Python. Surprisingly, I found myself enjoying this aspect of the research. Your willingness to make time in your busy schedule to address my questions about the analyses has been valuable. Thank you for your patience and expertise throughout the time. Eva, thank you for the engaging discussions and brainstorming sessions on a wide range of topics, which have expanded my perspective on cultivated meat. I especially enjoyed our conversations about the political and policy implications surrounding cultivated meat. Thank you for your mentorship, insights, and collaboration throughout this process. Besides thanking my supervisors I would like to thank all my friends, family and CDI students who have supported me throughout the thesis. Your help through playing the game, reminding me to take breaks, proofreading my report, or simply being there for me, has been truly appreciated. It was extremely rewarding to receive positive feedback after playing the game, as people mentioned they were eager to learn more or wanted to play again. I loved involving others in my research, and I highly recommend fellow thesis writers to do the same. Conduct interviews, engage in games, initiate discussions surrounding your topic, and you may even end up enjoying your thesis.

*Kirsten Odenwald  
Delft, April 2024*



# Abstract

Cultivated meat emerges as an innovative food product with the potential to address the challenges of the conventional meat industry. Moreover, the technology proves to be a potential option for consumers seeking to align with ethical considerations without altering their dietary preferences. Despite its promise, one significant barrier is consumer acceptability, which may be influenced by factors such as the low awareness of cultivated meat, alongside other challenges such as pricing and production scalability. This novel food has become an emerging topic in both parliamentary and (social) media discussions. This study aims to uncover the perspectives of diverse stakeholders within the Dutch cultivated meat ecosystem, aiming to create an effective communication tool for increasing consumer awareness of cultivated meat.

To comprehend the tone of voice of different stakeholders, sentiment analysis was conducted on textual data from Twitter, newspapers, and parliamentary proceedings. The analysis revealed predominantly positive sentiments. Specifically, percentages below the neutral midpoint were observed at 20.4%, 26.7%, and 32.5% for each respective textual data source. Additionally, topic modelling analysis revealed prevalent frames across these documents, including positive perceptions related to animal welfare and climate change. However, concerns about changes in current farming practices generated negative frames, fostering polarisation between supporters and opponents of cultivated meat.

Beyond textual data analysis, semi-structured interviews were conducted with key stakeholders, shedding light on their varying tones of voices and frames concerning cultivated meat. The findings indicated that the industry pictures cultivated meat as equivalent to conventional meat, farmers view it as unnatural, parliamentary frames emphasise animal welfare and environmental benefits, and consumers' frames are influenced by demographic factors and political preferences. Based on insights from interviews and textual data analysis, a serious game was created to provide a user-friendly way of increasing awareness regarding cultivated meat and its complex stakeholder dynamics. This game serves to bridge the communication gap between experts and the public, facilitating an understanding of the societal implications of cultivated meat.



# Table of Contents

<b>1</b>	<b>Introduction</b>	<b>1</b>
1.1	Research Question . . . . .	3
1.2	Social and Scientific Relevance . . . . .	4
<b>2</b>	<b>Cultivated Meat Ecosystem in the Netherlands</b>	<b>5</b>
2.1	Consumer Perspectives on Cultivated Meat . . . . .	7
<b>3</b>	<b>Theoretical Framework</b>	<b>9</b>
<b>4</b>	<b>Methodology</b>	<b>11</b>
4.1	Textual Data Analysis . . . . .	11
4.1.1	Data Collection . . . . .	12
4.1.2	Data Preprocessing . . . . .	13
4.1.3	Exploratory Analysis . . . . .	13
4.1.4	Sentiment Analysis . . . . .	14
4.1.5	Topic Modelling . . . . .	14
4.2	Stakeholder Analysis . . . . .	15
4.2.1	Data Collection . . . . .	15
4.2.2	Interview Analysis . . . . .	15
4.3	Serious Game Design . . . . .	17
4.3.1	Refinement Through Iteration . . . . .	18
<b>5</b>	<b>Results</b>	<b>21</b>
5.1	Textual Data Analysis . . . . .	21
5.1.1	Exploratory Analysis . . . . .	21
5.1.2	Tone of Voice . . . . .	24
5.1.3	Framing . . . . .	27
5.2	Stakeholder Perspectives . . . . .	37
5.2.1	Industry . . . . .	37
5.2.2	Farmers . . . . .	39
5.2.3	Government . . . . .	40
5.2.4	Consumers . . . . .	42
5.3	Serious Game . . . . .	43
5.3.1	Gameplay Overview . . . . .	43
5.3.2	First Gameplay . . . . .	45
5.3.3	Second Gameplay . . . . .	47
5.3.4	Final Gameplay . . . . .	48
<b>6</b>	<b>Discussion</b>	<b>51</b>
6.1	Tone of Voice . . . . .	51
6.2	Framing . . . . .	52
6.3	Stakeholder Perspectives . . . . .	53
6.4	Serious Game . . . . .	55
6.5	Limitations . . . . .	56
6.6	Reflection on the Process . . . . .	58
<b>7</b>	<b>Conclusion</b>	<b>59</b>
7.1	Recommendations for Further Research . . . . .	60
7.2	Recommendations for Policy and Practice . . . . .	60
	<b>References</b>	<b>63</b>
	<b>Appendices</b>	<b>71</b>
A	Stopwords Table . . . . .	71
B	Interview Protocol . . . . .	72
C	Informed Consent Form . . . . .	75
D	Brainstorming Session . . . . .	79
E	Serious Game prototypes . . . . .	79

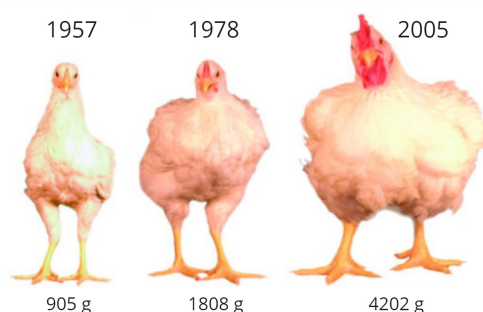
	E.1	Paper prototypes . . . . .	79
	E.2	Digital prototype . . . . .	80
F		Twitter Usernames . . . . .	81
G		Frequently Used Words . . . . .	82
	G.1	Twitter . . . . .	82
	G.2	News . . . . .	82
	G.3	Parliament . . . . .	82
H		t-SNE Scatter Plots . . . . .	83
	H.1	Twitter . . . . .	83
	H.2	News . . . . .	83
	H.3	Parliament . . . . .	84
I		NMF Topic Labels . . . . .	85
	I.1	Combined dataset . . . . .	85
	I.2	Twitter . . . . .	85
	I.3	News . . . . .	86
	I.4	Parliament . . . . .	86
J		Parliament Topics Area Plot . . . . .	87
K		Gameplay Setup . . . . .	88
	K.1	First Gameplay . . . . .	88
	K.2	Second Gameplay . . . . .	88
	K.3	Final Gameplay . . . . .	89
L		Game Progression . . . . .	90
	L.1	Second Gameplay . . . . .	90
	L.2	Final Gameplay . . . . .	90
M		Playing Cards . . . . .	91

# Introduction

The global population is projected to reach 9.7 billion by 2050 (Nations, 2019) and at present, as reported by the Food and Agricultural Organization (FAO), 815 million individuals globally require additional food (FAO, 2019). Meanwhile, meat serves as an important nutritional source for people worldwide and the global demand for meat is on the rise, with production having more than tripled over the past 50 years (Ritchie et al., 2023). Furthermore, urbanisation and increasing incomes in developing countries are projected to increase the global demand for animal products by over two-thirds by 2050 (Ritchie, 2017; Scherf et al., 2015). Taken together, these factors indicate a significant rise in the demand for animal products in the coming years (Tilman et al., 2011). However, the livestock industry is the source of numerous environmental impacts, with the most important one being climate change (McMichael et al., 2007). Currently, animal production is estimated to contribute 18% of the overall greenhouse gas (GHG) emissions (Steinfeld et al., 2006, Poore and Nemecek, 2018, Scherf et al., 2015), being the second-largest polluter after the electricity industry, and more polluting than the transportation industry (Heatable, 2023). This is especially true for the industry related to producing red meat. The Lancet's findings suggest that in order to establish an environmentally sustainable and healthy food system, it is imperative to reduce global red meat consumption by more than 50% (Willett et al., 2019).

In addition, the production of animal products uses enormous amounts of land. One-third of the Earth's habitable land surface and 80% of all agricultural land is directly or indirectly involved in livestock production. Nevertheless, this 80% of agricultural land contributes to less than 20% of the global calorie supply (Ritchie, 2017). Furthermore, around 40% of the harvested crops in the world are used as food for animals, even using only half of these crops the problem of world hunger can be solved (Leitzmann, 2003). Because of the increasing demand for animal products and land scarcity, livestock production contributes to biodiversity loss, deforestation, and wildlife habitat destruction (Ilea, 2008).

Besides the environmental consequences associated with animal production, there are concerns regarding human health, potential pandemics, and primarily the well-being of animals (Saatkamp et al., 2019, Yang and Hong, 2019, Di Pasquale et al., 2019, Spain et al., 2018). Eating meat necessitates slaughtering animals, presenting a morally questionable activity. Also, their living conditions are problematic, as the animals are often densely packed, driven by cost-effectiveness and compliance with norms in European and North American countries (Nierenberg, 2005). This results in insufficient space for waste disposal, increased vulnerability to diseases, and consequently, the extensive use of antibiotics (Hampton et al., 2021). Furthermore, breeding practices have led to commercially selected cattle, such as chickens that struggle with their weight (Zuidhof et al., 2014, Figure 1.1). This shows the unnatural practices of the conventional meat industry today, forcing the exploration of alternative methods.



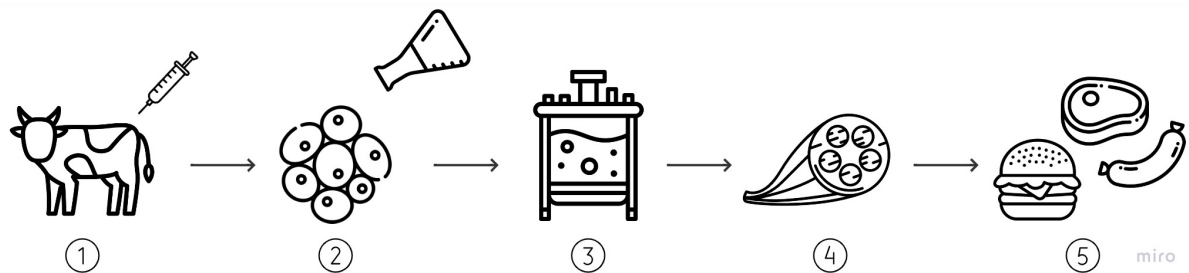
**Figure 1.1:** Changes in weight of 56-day-old chickens in the years 1957, 1978, and 2005. *Source* (Zuidhof et al., 2014).

The 'meat paradox,' as highlighted by Aaltola (2019), reveals a contradiction where many meat eaters recognise the significance of animal well-being yet continue to consume products that contribute to animal suffering. Certainly, plant-based meat alternatives are a potential solution. However, despite continuous technical improvements, their palatability, including factors such as appearance, mouth feel, and nutritional value, still differs from the consumers' standards of con-



ventional meat (Asgar et al., 2010). Furthermore, a small minority of consumers are inclined to either completely stop or significantly reduce their meat consumption for environmental reasons (Sanchez-Sabate and Sabaté, 2019).

Luckily, cultivated meat can offer a solution to the environmental downsides of conventional meat production and the ‘meat paradox.’ This is because cultivated meat is produced using cells extracted from a living animal, which are then cultivated in a bioreactor (Post, 2012, van der Weele and Tramper, 2014). Importantly, the animals do not undergo slaughter for the extraction of these cells. The schematic process is shown in Figure 1.2. This innovative food technology, alternatively known as in-vitro, clean, or cultured meat (Bryant and Barnett, 2019), is currently an important subject in policy discussions. The European Union legislator is actively developing a legal framework for introducing this product in Europe (Reg. (EU) 2015/2283 on novel foods). Nonetheless, the product must first receive approval from the European Food Safety Authority (EFSA) (Seehafer and Bartels, 2019). But while cultivated meat is currently not available in Europe, the product is already on the market for purchase in Singapore, the United States, and Israel.



**Figure 1.2:** The schematic process of cultivated meat production. 1) Harvest stem cells from a live animal through biopsy. 2) Add nutrient medium with growth serum to stem cells. 3) Growth of stem cells on the nutrient medium in a bioreactor. 4) Processing of muscle fibers and fat tissue. 5) Cultivated meat as the final product. *Created using the tool Miro.*

While cultivated meat presents a possible solution to address concerns about animal welfare, several challenges must be overcome before successful marketing, including high production costs and the need to scale up the process. Nevertheless, several studies suggest that consumer acceptance is the primary barrier hindering the success of cultivated meat (Onwezen et al., 2021, Slade, 2018, Zhang et al., 2021, Hocquette et al., 2015). Personal concerns about cultivated meat relate to safety issues, nutritional value, and sensory attributes like taste, texture, or appearance of the product (Laestadius and Caldwell, 2015). More societal concerns of the consumer regarding cultivated meat include the energy required for production, the end of conventional animal agriculture, and distrust in companies producing cultivated meat (Verbeke, Marcu, et al., 2015, Laestadius and Caldwell, 2015). Furthermore, there is a general concern among consumers that can disrupt their current way of living, often referred to as food neophobia, a person’s fear of new foods (Cox and Evans, 2008, Wilks et al., 2019). This is especially in relation to this product, as it is perceived as more disruptive than other novel foods (Hamlin et al., 2022).

Since the majority of consumers typically lack knowledge about food production (Connor and Siegrist, 2010), have false beliefs about the nutritional value of food (Lusk, 2019, Van Wezemael et al., 2014), and have conservative attitudes toward agri-food innovation (Cox and Evans, 2008, Siegrist and Hartmann, 2020), it is crucial to enhance their awareness of novel food technologies. Consumer acceptance is significantly influenced by consumer awareness and their understanding of new food technologies, as noted in multiple studies (Lusk, 2019; McCluskey & Swinnen, 2011; Rollin et al., 2011; Verbeke, Sans, & Van Loo, 2015). In this context, awareness often represents the initial steps toward embracing a novel technology (Rogers et al., 2003). However, when it comes to cultivated meat, the level of familiarity with this technology remains relatively low (Verbeke, Sans, & Van Loo, 2015). Besides, consumer awareness is surprisingly low on the negative environmental impact of conventional meat production (Hartmann & Siegrist, 2017). Taken together, increasing consumer awareness of cultivated meat can lead to an increase in consumer acceptance.

Crucial to increasing consumer awareness of cultivated meat is the provision of information, as indicated by multiple studies (Verbeke, Marcu, et al., 2015, Bekker et al., 2017, Wilks and Phillips, 2017, Bryant et al., 2019). These studies demonstrate that greater familiarity with cultivated meat corresponds to higher acceptance rates. Furthermore, Siegrist et al. (2018) and Bryant and Dillard (2019) observed a higher acceptance rate among participants to cultivated meat when provided

with a non-technical description of the product, as opposed to a technical one, due to a difference in perceived naturalness. Also, the nomenclature plays a role with Chong et al. (2023) finding that in Singapore, where the product is already available, people prefer the term “cultivated meat” over alternatives like “in-vitro meat”. Research has shown that framing information can alter the public’s perception and ‘tone of voice’ toward unfamiliar novel food technologies like cultivated meat (Kahan et al., 2009, Laestadius and Caldwell, 2015). The tone of voice is how the public’s feelings are expressed towards cultivated meat. Reframing the narrative to emphasise the positive aspects of cultivated meat can significantly influence consumers’ perceptions (Mancini & Antonioli, 2020). In summary, the perception of consumers toward cultivated meat can be influenced by the provision of information and how this information is presented to them.

Multiple channels exist through which consumers receive information, such as news or (social) media platforms like Twitter (currently known as X). However, these channels are susceptible to political influence, and conversely, (social) media can impact politics (Gilardi et al., 2022). Governments and (social) media wield significant influence, actively shaping perceptions around novel technologies like cultivated meat. Firstly, governments, as key decision-makers, not only determine the societal need for disruptive technologies such as cultivated meat but can also play a role in framing this technology (Lei et al., 2022). Secondly, (social) media holds particular importance, especially in today’s Europe, where most information is gathered through news platforms or social media (European-Parliament, 2023). Taken together, the government and social media play a significant role in the information provided about cultivated meat.

## 1.1 Research Question

The problem defined in this research is the increasing demand for animal products driven by a growing global population, urbanisation, and increased incomes. However, conventional meat production raises multiple environmental, ethical, and health concerns. This study centres on cultivated meat, an innovative technology designed to mitigate the drawbacks of conventional meat production. Despite its potential benefits, studies indicate that consumer acceptance remains a primary barrier, with low consumer awareness being a possible contributing factor. The acceptance could be influenced by the tone of voice and frames used by the parliament and social media channels. The research emphasises the need to increase consumer awareness through effective information provision, considering the impact of framing, with the acknowledgement of the influential roles of the parliament and (social) media. This problem definition leads to the formulation of the following research question:

**“What are the perspectives of different Dutch stakeholders regarding cultivated meat, and how can these perspectives be communicated to raise consumer awareness of cultivated meat?”**

Four specific research questions are formulated from this main research question:

1. What is the general tone of voice observed in social media, news and parliamentary discussions in the Netherlands regarding cultivated meat?
2. What are the general frames used in social media, news and parliamentary discussions in the Netherlands regarding cultivated meat?
3. Which specific frames are employed by key stakeholders within the cultivated meat ecosystem in the Netherlands regarding cultivated meat?
4. How can the findings from the three specific research questions be applied to develop a serious game that promotes consumer awareness and illustrates the complex dynamics among key stakeholders within the cultivated meat ecosystem?

The fourth specific research question is tackled with the outcomes of the first three questions in crafting a ‘serious game.’ A serious game integrates challenge-based activities with entertainment, emphasising problem-solving rather than focusing on entertainment (Walz and Deterding, 2014). Therefore, the research leads to designing a serious game making this a Design-Based Research (DBR). DBR, introduced in the early 1990s by Brown (1992), aims to bridge theory and practice in educational research by developing practical solutions to real-world problems. In this context, the

practical solution is the serious game developed to enhance consumer awareness of cultivated meat. This approach aligns with Dewey (1938)'s educational philosophy, as games allow for reaching a broad audience in an accessible and user-friendly manner. Furthermore, serious games can be an effective learning tool (Guillén-Nieto and Aleson-Carbonell, 2012). Consequently, the decision is made to create a serious game designed for a broad audience, providing a learning tool to offer an overview of cultivated meat and its complex ecosystem.

In the process of designing a serious game, the principles of game design from the book 'Triadic Game Design' (TGD) are used (Harteveld, 2011). This book underscores the significance of three key factors in a game: 'Reality,' 'Meaning,' and 'Play.' When crafting the game, it is essential to strike a balance among these factors while making design decisions. The insights gained from the first three specific research questions will inform the incorporation of 'Reality' into the game, laying the groundwork for the subsequent integration of 'Meaning' and 'Play.' With designing this serious game the fields of both Food Technology and Science Communication can be integrated, by offering a platform for communicating about the novel food technology cultivated meat.

## 1.2 Social and Scientific Relevance

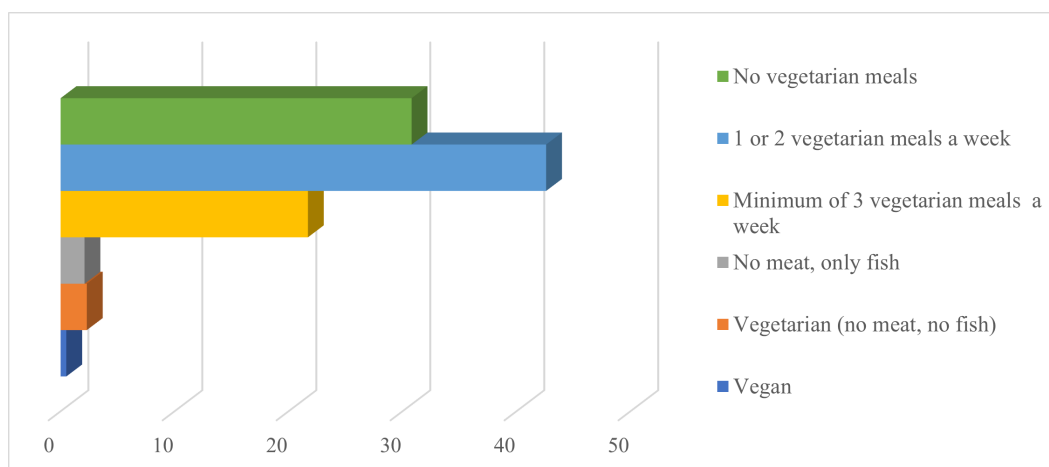
As previously mentioned, cultivated meat offers numerous advantages, including environmental sustainability and enhanced animal welfare, among other benefits. Nonetheless, the relatively low consumer acceptance and awareness of cultivated meat in the Netherlands presents a significant challenge. An exploration of diverse frames and tones of voices can provide a complete understanding of the cultivated meat ecosystem to consumers. Consequently, creating a tool that can raise consumer awareness and understanding of cultivated meat and its complex ecosystem, becomes beneficial. The social significance of this research lies in its potential to enhance these aspects, which is highly valuable when cultivated meat eventually reaches the market.

In addition to the social relevance of cultivated meat, this study also holds scientific significance. Notably, it addresses several knowledge gaps in the field. One identified knowledge gap relates to the absence of information about the specific frames that are used in the Dutch parliament and (social) media platforms, as well as the unknown tone of voice employed by these organisations. For example, in the realm of text analysis, an unexplored area is the tone of voice contained within Dutch tweets that feature the term 'kweekvlees,' which translates to cultured meat in Dutch. This presents an opportunity to gain insights into the public's tone of voice regarding cultivated meat in the Dutch context. Another important knowledge gap centres on the exploration of methods to motivate individuals to reduce their meat consumption, with an emphasis on strategies that promote environmentally friendly meat consumption behaviours such as the adoption of cultivated meat. This knowledge gap is highlighted by the research of Hartmann and Siegrist (2017).

The following chapter will present the case study delving into the cultivated meat ecosystem in the Netherlands. Within this case, specific concepts will be identified, and linked with theories explaining these concepts in the theoretical framework chapter. Subsequently, the research methodology will be outlined, leading to the presentation of results and discussion, addressing the specific research questions. The first two questions will be tackled through textual data analysis, the third question will be addressed through interviews, and the fourth question will involve the creation of a serious game. The conclusion section will provide a comprehensive response to the main research question.

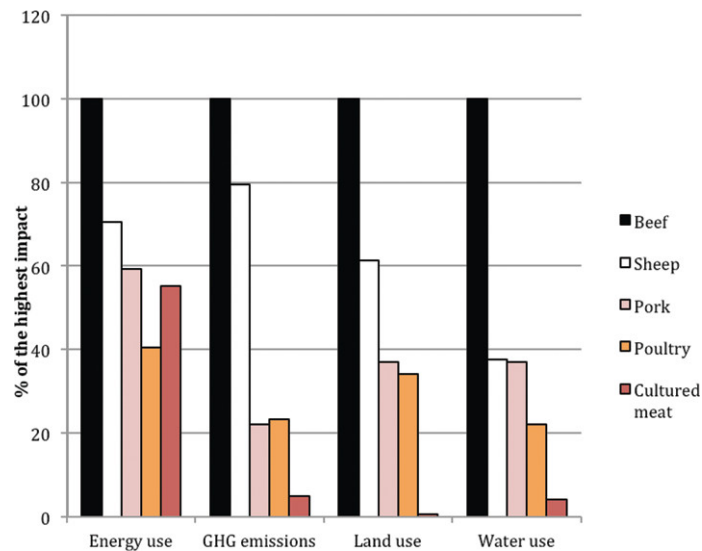
# Cultivated Meat Ecosystem in the Netherlands

The search for meat alternatives is driven by the rising costs of producing feed due to factors such as droughts brought on by climate change, the conflict in Eastern Europe (Ukraine), and unstable, high fuel and electricity prices (Chodkowska et al., 2022). These factors make it more expensive to produce conventional animal-based foods. Furthermore, alternative methods are necessary because of the high level of meat consumption in the population, particularly in the Netherlands. According to research by Wageningen University (Dagevos, 2020), the average meat consumption per person in the Netherlands is 39 kg annually. In contrast, dietary recommendations, such as those from the food pyramid ‘Schijf van Vijf,’ suggest a significantly lower meat intake, recommending no more than 500 g of meat per week (Voedingscentrum, 2020). This aligns with a yearly meat intake of less than 26 kg per year, indicating that the Dutch population consumes 33% more meat than recommended. As depicted in Figure 2.1, the percentage of the population abstaining entirely from meat is around 5% (CBS, 2024). Besides the high meat consumption of the population of the Netherlands, a significant portion of its land is dedicated to livestock. As previously stated, one-third of the Earth’s habitable land surface is dedicated to livestock production, but in the Netherlands, this percentage is even greater. Over 40% of the country is utilised for either cattle farming or cultivating crops for livestock. This is attributed to the fact that 55% of the nation’s land is classified as agricultural, and 80% of that agricultural land is used for livestock production (CBS, 2023a, CBS, 2023b). Consequently, choosing cultivated meat could serve as a viable option to ensure that the consumed meat is more environmentally and land-use friendly.



**Figure 2.1:** Consumption behaviour of Dutch population in the year 2023 (age above 18 years). *Source:* CBS, 2024.

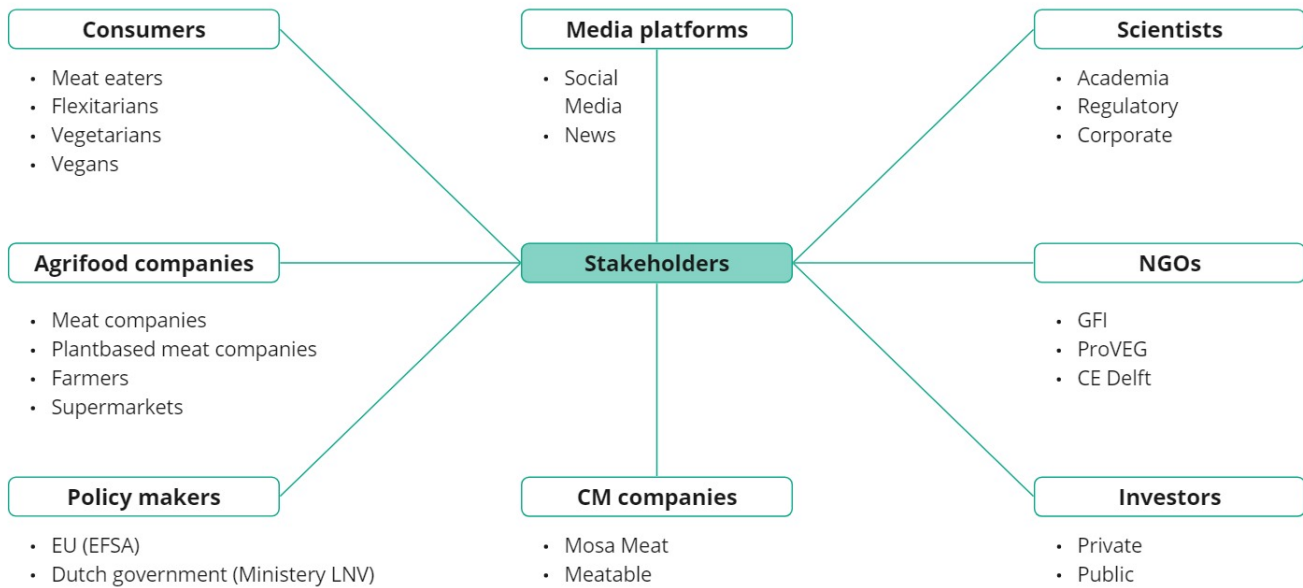
According to the Paris Agreement, decreasing GHG emissions is crucial to limit global warming to 1.5°C (UNFCCC, 2015). The benefits of cultivated meat are promising with early publications suggesting significant reductions compared with conventional meat production. These benefits consist of a 78-96% decrease in GHG emissions, a 99% decrease in land usage, an 82-96% decrease in water usage, and a 7-45% lower energy use (Tuomisto and Teixeira de Mattos, 2011). However, only the energy use for poultry production is lower as depicted in Figure 2.2. However, recent studies have shown variations in the performance of cultivated meat. Although it shows a reduced land and water footprint and lower GHG emissions compared to poultry, pork, and beef, the cultivated meat industry does exhibit higher energy consumption than the majority of conventional meat products, except for beef (Mattick, Landis, and Allenby, 2015, Lynch and Pierrehumbert, 2019). Nonetheless, the overall impact of emission reduction remains positive, especially when compared to conventional beef production. Also, it could substantially lower the need for animals in the meat production system, thereby addressing ethical concerns linked to industrial livestock operations (Ruby, 2012). The controlled environment of the production process could further lead to a reduction in human-animal interactions, reducing the risks of zoonosis and therefore pandemics (Datar & Betti, 2010).



**Figure 2.2:** Comparing the primary energy input, greenhouse gas emissions, land use, and water use of cultivated meat production with conventionally produced European beef, sheep, pork, and poultry per 1000 kg of edible meat, expressed as a percentage of the impacts of the product with the highest impact in each category. *Source: Tuomisto and Teixeira de Mattos, 2011.*

However, the ecosystem of cultivated meat reaches further than the environmental benefits, for example, the current cost of this technology is notably high, making the product unaffordable for many middle and low-income consumers (Lee Hyun Jung, 2020). Moreover, being a novel food product, it is subject to approval processes by the EFSA before it can enter the European market, therefore causing significant delays (Seehafer and Bartels, 2019). Furthermore, cultivated meat currently differs from conventional meat, and further technological advancements are needed to close the gap. Elements like fat content, structure, colour, flavour, and mouthfeel/juiciness require further development (Fidder and Graça, 2023). Also, there is an ongoing debate among religious authorities regarding whether cultivated meat meets Halal or Kosher standards (Izhar Ariff Mohd Kashim et al., 2023, Kenigsberg and Zivotofsky, 2020). Lastly, it faces competition from alternative options. Vegetarians appear to have a lower willingness to consume cultivated meat, as they perceive no necessity for it due to the availability of plant-based alternatives (Heidemann et al., 2020; Verbeke, Sans, & Van Loo, 2015). The increasing accessibility of cost-effective plant-based and cultivated meat alternatives could potentially influence their mutual acceptance (Circus and Robison, 2019). Given the shared interests of these industries, a viable solution might involve collaboration to produce hybrid meat, combining cultivated meat with plant-based proteins. In conclusion, the tone of voice toward cultivated meat within its ecosystem is not uniform.

This lack of uniformity is apparent in varying political ideologies and demographic trends, further intensified by the rise of right-wing parties across Europe (Adler, 2023). These parties who tend to be more traditional, favouring the conventional ways of meat production, are influencing the political landscape. Many farmers in the Netherlands currently produce meat using traditional methods and often align with Christian beliefs, contributing to their conservative stance. Consequently, Christian political parties consistently secure the position of the Minister of Agriculture, Nature, and Food Quality, ensuring support between the government and farmers. Furthermore, specific segments of the population exhibit a greater tendency to embrace cultivated meat. Younger and more educated individuals, as indicated by Slade (2018), show a stronger willingness to explore this technology. This aligns with the fact that older individuals generally are less receptive to this new technology (Grasso et al., 2019). Research by Bredahl (1999) and Magnusson and Hursti (2002) revealed that younger and more educated individuals displayed a greater willingness to embrace technological food innovations. Nonetheless, while cultivated meat is not yet available in Europe, the Netherlands has taken significant steps to acknowledge the potential of cultivated meat. The Dutch government made a groundbreaking move in 2022 by investing 60 million euros in subsidies for cellular agriculture, marking the largest subsidy of its kind globally (GFI, 2023). This substantial investment reflects a noteworthy commitment from the government. It promotes transparency in research information, making it more accessible to a broader audience and thereby accelerating the advancement of cultivated meat technology. Figure 2.3 visually represents all the diverse stakeholders in the cultivated meat ecosystem in the Netherlands.



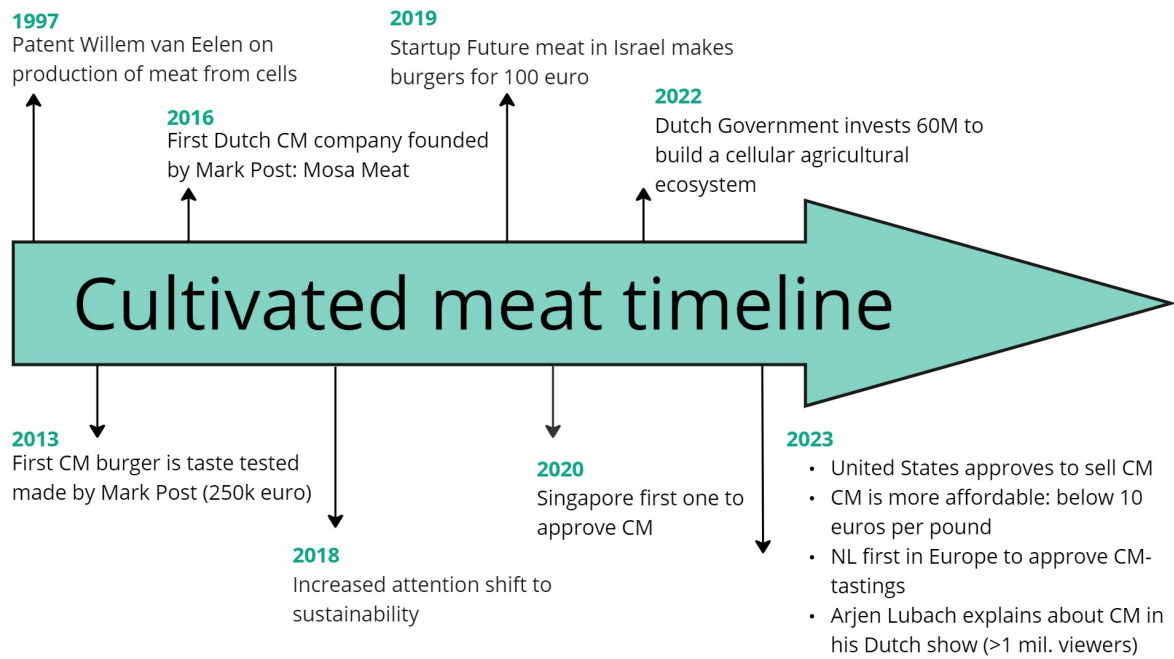
**Figure 2.3:** Ecosystem of cultivated meat in the Netherlands. *Created using the tool Miro.*

## 2.1 Consumer Perspectives on Cultivated Meat

As found in the literature, the initial reactions of European consumers to cultivated meat are feelings of disgust and perceived unnaturalness (Verbeke, Marcu, et al., 2015). Meanwhile, consumers in America and Asia are more likely than those in Europe to accept cultivated meat (Mattick, Landis, Allenby, and Genovese, 2015). These differences could be explained by the various social and cultural roles that animal agriculture serves in the various nations and cultures (Post et al., 2020), in addition to the fact that cultivated meat is already accessible in those regions. Furthermore, some European countries appear less inclined to embrace the positive aspects of cultivated meat. Italy, for instance, has proactively prohibited cultivated meat even before its introduction to the market (Times, 2023). The influential farming association Coldiretti has successfully advocated for the government’s decision to ban this product. Similarly, France exhibits a less favourable stance toward this technology (Ellenberg, 2023). One contributing factor to the resistance in these countries is their strong eating culture in comparison to the Netherlands (Hirschfelder et al., 2020). These circumstances enhance the likelihood of successfully launching a product like cultivated meat in the Netherlands.

However, a drawback in introducing cultivated meat in the Netherlands is the commonly used Dutch term ‘kweekvlees’, which directly translates to cultured meat. According to the previously mentioned study by Chong et al. (2023), this term is less preferred, and its usage can impact consumer acceptance. Certain food technologies, such as genetic modification also faced resistance, while others, like refrigeration and freeze drying, have gained widespread acceptance (Siegrist and Hartmann, 2020). Unlike in other fields, new *food* technologies don’t necessarily replace older ones. Therefore, there is less necessity for consumers to embrace innovations in food technologies. Nonetheless, the Netherlands has excelled in research on cultivated meat production, with a Dutch professor presenting the first cultivated meat burger in 2013. A decade later, in 2023, the first cultivated meat tasting is permitted, and notably, this milestone is currently exclusive in Europe to the Netherlands (Tweede-Kamer, 2023). The timeline of cultivated meat development is presented in Figure 2.4.





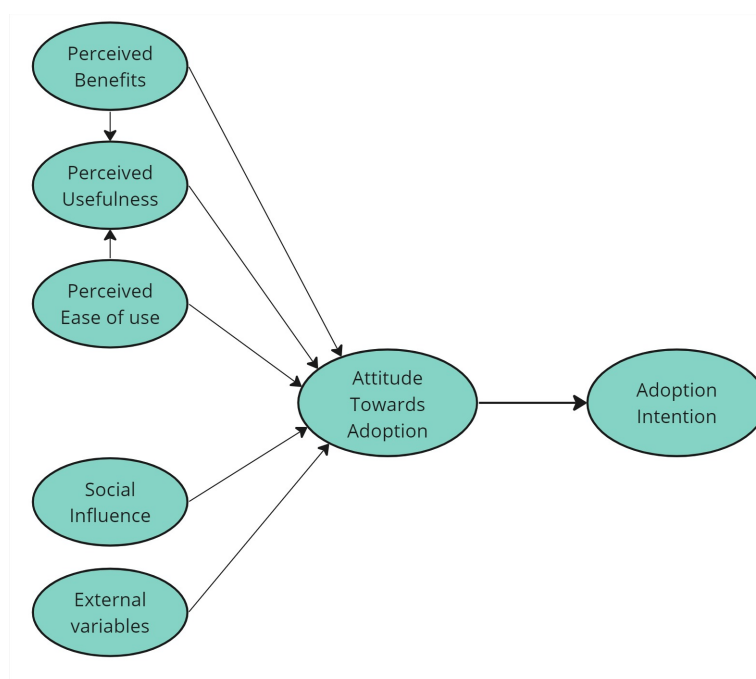
**Figure 2.4:** Cultivated meat timeline featuring key events, with a focus on developments within the Netherlands. *Created using the tool Miro.*

The cultivated meat tastings permitted in 2023 hold significant importance for consumer acceptance, allowing consumers to genuinely experience the product through smell, taste, and visual observation. This direct interaction of tastings contributes to an increase in consumer acceptance (Rolland et al., 2020). Although cultivated meat tastings can enhance consumer acceptance, the majority of individuals remain unaware of or have a limited understanding of cultivated meat. As previously noted, consumer acceptance is greatly influenced by awareness and comprehension of new food technologies. However, this does not imply that universal awareness would directly translate to acceptance and adoption of the technology.



# Theoretical Framework

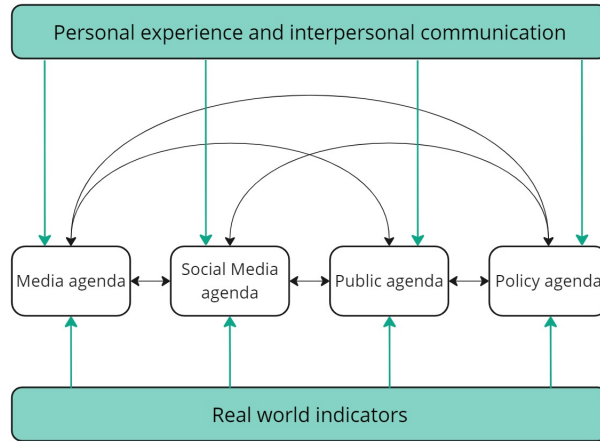
According to the theory of Consumer Acceptance of Technology (CAT), factors such as perceived usefulness, ease of use, perceived risks, and social influences play crucial roles in shaping consumers' attitudes toward a novel technology, such as cultivated meat (Kulviwat et al., 2007). The hypotheses of the CAT model state that a more favourable attitude toward adopting new technology is associated with higher perceived usefulness, ease of use, and benefits. Additionally, the model suggests that an increase in perceived ease of use or perceived benefits leads to an increase in perceived usefulness. Besides, the systematic literature review of Pakseresht et al. (2022) indicates at least seven factors affecting consumer acceptance of cultivated meat. These factors include public awareness & knowledge, risk-benefit perceptions, ethical & environmental concerns, emotions, personal factors, product properties, and alternatives & availability. From these factors, public awareness, perceived naturalness, and food-related risk perception were found to be the most important ones influencing consumer acceptance of cultivated meat. In the context of novel *food* technologies, the CAT theory is applied by integrating factors from the literature review. This integration serves as a framework to explain consumer acceptance of cultivated meat (refer to Figure 3.1).



**Figure 3.1:** The Consumer Acceptance of Technology (CAT, Kulviwat et al., 2007) model combined with factors affecting consumer acceptance according to Pakseresht et al. (2022). Created using the tool Miro.

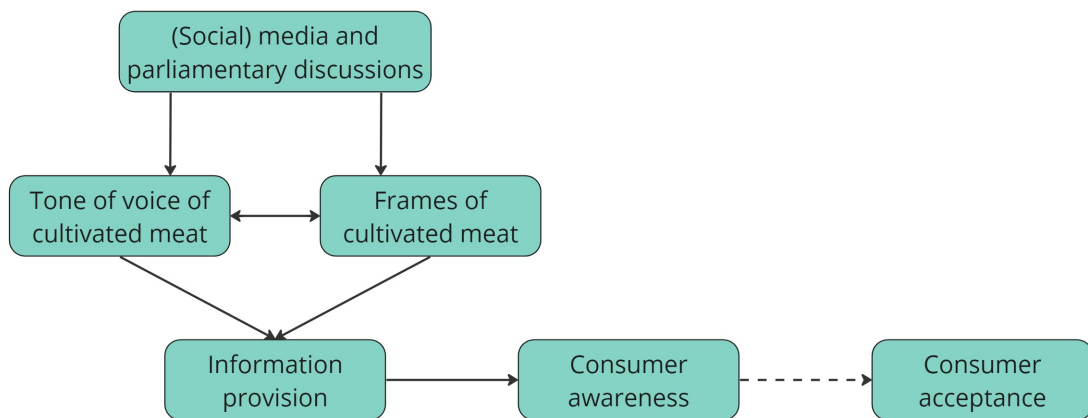
As mentioned before, the acceptance of consumers poses a significant barrier to the success of cultivated meat (Slade, 2018, Hocquette et al., 2015). Nevertheless, it's important to recognise that challenges in consumer acceptance extend beyond consumers themselves. According to the agenda-setting theory proposed by McCombs and Shaw (1972), media plays a crucial role in shaping public perceptions and influencing the political agenda. The media achieves this by pinpointing the issues or topics that garner the most attention, thereby becoming more accessible in our minds due to the substantial amount of time people spend seeing, listening, and reading about them (Gilardi et al., 2022). Through (social) media platforms, parliamentary messages or frames can be spread, making them more influential. Politicians can effectively communicate their priorities, initiatives, and key messages to the public by utilising these platforms (Haman and Školník, 2021). Additionally, engaging with the public on social media allows for a two-way communication flow, enabling the parliament to address concerns, gather feedback, and adjust its communication strategies based on the public's tone of voice. As suggested by Baumgartner et al. (2008), frames play a pivotal role in shaping the reader's tone. In this context, the term 'tone of voice' means how the public expresses their feelings towards cultivated meat through writing (Xu, 2020). The theory of political agenda

setting is shown in Figure 3.2.



**Figure 3.2:** Model of political agenda setting in the social media era. *Source: Albalawi and Sixsmith, 2015. Created using the tool Miro.*

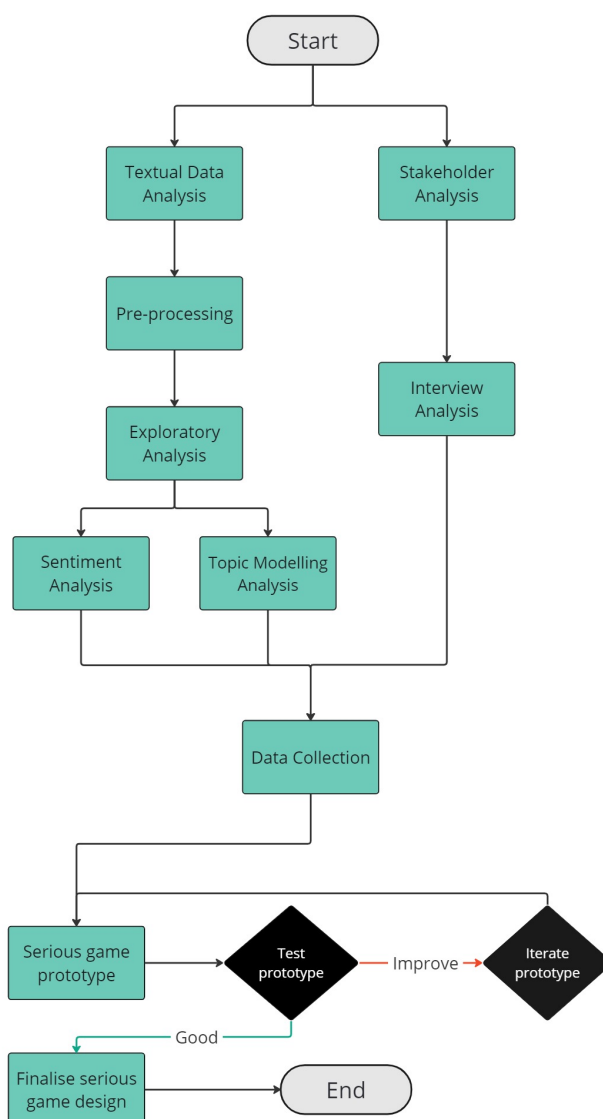
The agendas of the various entities can present different frames when discussing cultivated meat. These frames, in turn, shape consumers' tone of voice of cultivated meat. For example, many European consumers see cultivated meat as unnatural, which is widely portrayed on the internet and observable through image searches. These images play a role in framing. According to a study by ProVeg (2022a), the influence of images in the media on consumer perceptions of cultivated meat is significant. The study indicates that images depicting food-based pictures result in more positive opinions toward the product compared to lab-based images. Many images portray cultivated meat in a laboratory setting, often in a Petri dish, held by individuals wearing blue plastic gloves, or alongside test tubes. Re-framing this makes it possible to view it as a large-scale production process resembling more of a brewery operation. According to the study of Chong et al. (2023), 'the animal welfare/reduce animal slaughter' and 'reduce carbon emissions and global warming' were the frames that were found to increase acceptance, because these frames highlight the positive aspects of cultivated meat. Emphasising the positive frames of cultivated meat can help to positively influence consumers' perceptions and therefore, their tone of voice. To summarise, two theories are applied to explain the concepts observed in this research: the theory of CAT and political agenda setting. Using these two theories a conceptual framework is created (Figure 3.3).



**Figure 3.3:** The conceptual framework, informed by the CAT theory and theory of political agenda setting. The dashed line connecting consumer awareness to consumer acceptance signifies a relationship between the two, though it's not always the case. *Created using the tool Miro*

# Methodology

In addressing the research questions found in Section 1.1 and to operationalise the concepts outlined in the conceptual framework, the research methodology was drafted. This methodology includes several phases of Design-Based Research (DBR), incorporating textual data and stakeholder analysis. The insights gained from these analyses inform the Reality factor needed in the design of the serious game. The flowchart of the methodology is presented in the flowchart depicted in Figure 4.1.



**Figure 4.1:** Flowchart of the methodology of the research. *Created using the tool Miro.*

## 4.1 Textual Data Analysis

Natural language processing (NLP) methods were used to answer the first two specific research questions as outlined in 1.1. The concept of tone of voice was analysed with the help of a sentiment analysis. This analysis involves employing NLP techniques that attribute values to phrases and words, as described by Mullen and Collier (2004). Although it is important to note that the concepts differ, sentiment analysis could shed light on the tone of voice (Rita et al., 2022). Furthermore, to operationalise the concept of frames, two topic modelling techniques were applied and compared: Latent Dirichlet Allocation (LDA) and Non-negative Matrix Factorization (NMF)

topic modelling. With LDA topic modelling, each item in a collection of textual documents is represented in terms of an underlying set of topics, and each topic is further characterized as a set of topic probabilities (Blei et al., 2003). The underlying concept is that every document comprises a mix of topics, and each topic represents a distribution of words. In contrast, NMF breaks up a matrix into two lower-dimensional matrices, ensuring that all values in these matrices are non-negative. In the context of topic modelling, this means representing a document-term matrix as a product of two matrices—one capturing the distribution of topics in documents and the other representing the distribution of terms in topics (Hoyer, 2004). Interpretation played a vital role in this segment of the research since it aims to determine how effectively topic modelling can clarify the frames. Through iterations of the number of topics employed, the objective was to identify as many topics as possible that represent a frame. During this process, some topics were excluded as they did not relate to a frame. It’s important to note the difference between the concept of frames and topics. Nonetheless, the identified topics can serve as a method to discover the various frames used in discussions about cultivated meat.

#### 4.1.1 Data Collection

The NLP methods discussed above were used on various types of datasets. To examine the tone of voice and framing in social media, a Twitter (currently known as X) database was used, with tweets featuring the Dutch term for cultivated meat, ‘kweekvlees.’ However, Twitter data may not represent the sentiments of the ‘typical’ consumer, therefore Twitter serves as a platform for the Dutch public debate on cultivated meat rather than a direct reflection of consumers. Additionally, analyses for general media were conducted using news articles containing ‘kweekvlees.’ Newspaper articles from four distinct platforms, sourced through Nexis Uni (Wageningen (NRC, de Volkskrant, Trouw, and Telegraaf), were selected based on their significant number of articles on the topic (exceeding 50). The selection was also based on the diverse audience of these news platforms, spanning progressive and conservative views, right and left political orientations, and a range from more in-depth quality articles to those designed for the masses. To explain the tone of voice and frames used by the parliament, the dataset of parliamentary proceedings filtered on the term ‘kweekvlees’ was employed.

Before utilising the Twitter, news, and parliamentary datasets for analysis, it was essential to clarify the specific data intended for use in this research. The chosen analysis period extends from January 2010 to December 2022 to ensure uniformity across all datasets. Given that Twitter data comprises concise text with a maximum of 280 characters, it could be used as is for analyses without shortening. However, for the news and parliamentary datasets, the scenario was different due to their extensive text content. Conducting the sentiment analysis and topic modelling while ensuring relevance to the topic of cultivated meat then becomes challenging. In these cases, text blocks were created. Each block, limited to a maximum length of 1000 characters (equivalent to a paragraph of text), was extracted from the larger text. These blocks include the term ‘kweekvlees.’ Since a single article may mention this term multiple times, multiple blocks could be extracted, potentially resulting in more data points than initially selected. The blocks do not overlap each other, and if they do, the blocks are smaller than 1000 characters. However, a smaller block size was not selected, as it would result in the loss of significant information about the text regarding cultivated meat. Table 4.1 lists the datasets used for analysis after setting the time frame and filtering the blocks from the news and parliamentary datasets.

Dataset	Original Time frame	Original Data Points	Selected Time frame	Number of Blocks
Twitter	Jan 2007 - July 2023	31147	22439	Not applicable
Parliamentary proceedings	Jan 2010 - Dec 2022	91	91	117
Newspaper articles	Mar 2006 - Nov 2023	358	293	577

**Table 4.1:** Datasets used for analysis. The data selected for further analysis span from January 2010 to December 2022 (selected time frame). For the parliamentary proceedings and newspaper datasets, blocks are created.

### 4.1.2 Data Preprocessing

Now that the accurate data has been selected, preprocessing is necessary before performing the analyses. For sentiment analysis, the preprocessing steps are somewhat limited, given that the entire text can be used to analyse sentiment. However, it is needed to first choose a specific sentiment analysis model suitable for these datasets. Considering the short text segments from Tweets and blocks the choice of sentiment analysis should be tailored to short pieces of text. To identify a suitable sentiment analysis model, the website [Hugging Face](#) was used, an open-source community specialising in NLP methods. Filtering on the words ‘text classification,’ ‘sentiment,’ and ‘Dutch’ led to the discovery of multiple models. Sentiment scores were indicated with star ratings (1 to 5) or categorised as positive, negative, and sometimes neutral. The latter approach was preferred. Models were further evaluated based on their accuracy and the number of downloads on the website to ensure their quality. From this selection process, a model named ‘robert-v2-dutch-sentiment’ (Delobelle et al., 2020) was identified as the most suitable for sentiment analysis. This model is trained on book reviews and therefore applies to short pieces of text. The model provides scores for data points, indicating either positive or negative sentiments, with an accuracy of 92.9%.

For the analysis of topic modelling, further preprocessing of the data is necessary. The text in all datasets undergoes cleansing by converting the text to lowercase and removing special characters, punctuation, multiple white spaces, numbers and Dutch stopwords. Additionally, custom stopwords were incorporated into the list of Dutch stopwords, which varies per dataset due to distinct word use (Appendix A). For example, the parliamentary dataset frequently employs the term ‘minister.’ To further clean the Twitter dataset, retweets were excluded before topic modelling analysis to prevent potential misinterpretation of the data. These are excluded because the frequent retweeting of a particular tweet could potentially create a distinct topic. Additionally, mentions of usernames and links to websites are also removed from the Tweets.

Once the text was cleaned, the words were divided into individual substrings through a process known as tokenization, a step essential for further analysis. A library and a corpus were then constructed from these tokens. While LDA topic modelling could be directly applied, NMF topic modelling needed a prior TF-IDF (Term Frequency-Inverse Document Frequency) transformation. TF-IDF calculates the significance of a term in a document based on its frequency in the document and the document frequency across the entire corpus (Roelleke and Wang, 2008). This helps in identifying terms most relevant to a particular document. However, TF-IDF was not employed in LDA topic modelling to avoid the potential loss of semantic information. This was because LDA relies on word co-occurrence patterns to identify topics (Blei et al., 2003), and introducing TF-IDF values might downscale the importance of words, potentially leading to topics dominated by rare words.

Both the sentiment analysis and topic modelling analysis were performed using the Python libraries Natural Language Toolkit (NLTK, Bird et al. (2009)) and the Gensim library (Řehůřek and Sojka, 2010) in Google Colab Notebooks, a cloud-based platform for interactive computing. The different datasets were analysed both in separate Google Colab notebooks and together in an overarching notebook. For the latter notebook, the datasets were concatenated into a comprehensive dataset. In order to ensure that all datasets had a similar length when analysed together, a random sample was taken with the same character length to prevent the Twitter dataset from dominating the others due to its high amount of data points. Given that tweets have fewer characters than the blocks created from the various datasets (280 and 1000 characters), there were still more tweets, but they were of approximately the same length in magnitude.

### 4.1.3 Exploratory Analysis

Basic statistical analysis was conducted to gain insights into the datasets, such as the frequency of data points over time and the most common terms related to cultivated meat through the visualisation of word clouds. Additionally, to assess the similarity among different documents, a t-distributed stochastic neighbour embedding (t-SNE) analysis was conducted on the concatenated dataset. t-SNE was employed to visualise clusters of document groups and their relative proximities (Maaten and Hinton, 2008). A scatter plot was generated from the textual vectors in the corpus, where each point represents an individual document. The greater the distance between points, the less similarity exists between the corresponding documents. The data points on the scatter plot were grouped into clusters using a Hierarchical Density-Based (HDB) scan, which identifies clusters

in dense regions (Campello et al., 2013). The HDB scan does not require assigning every point to a cluster, treating some points as noise. To optimise each HDB scan, parameters were adjusted to ensure accurate cluster identification while minimising the risk of misclassifying clusters as noise. For instance, adjustments were made to parameters such as reducing the minimum cluster size from 150 data points to 100. The HDB scan transforms the space based on data density, leaving points in dense regions undisturbed while relocating points in sparse areas further apart. This exploratory phase contributes to subsequent sentiment analysis and topic modelling.

#### 4.1.4 Sentiment Analysis

The first specific [Research Question](#) is linked to the concept of tone of voice. To operationalise this concept, sentiment analysis was performed on both separate and concatenated datasets. In the context of sentiment analysis specific to the Twitter dataset, all tweets were utilised. Each tweet was treated as a distinct user expressing a unique sentiment, including cases where the tweet was a retweet. It's important to note that a data point, whether it's a Tweet or a block, showing a positive sentiment does not directly indicate a positive sentiment towards cultivated meat. Therefore, random samples were drawn after sentiment analysis for verification and additional tweets were generated to assess the reliability of the analysis on such tweets. The sentiment model assigns numerical scores to the data points, indicating either a negative or positive sentiment. These scores consistently surpass 0.5, as values below this threshold cause the switch to either positive or negative. Consequently, 0.5 was considered an approximate neutral threshold. However, for analytical purposes, this setup was not optimal. Therefore transformation was needed to help with interpretation. Negative scores were transformed to fall within the range of 0 to 0.5, while positive scores were kept within the interval of 0.5 to 1. For instance, a data point with an initial negative score of 0.9 would be transformed into a score of 0.1. This transformation results in normalised scores ranging from 0 to 1, with 0.5 representing the neutral midpoint. Subsequently, these normalised scores were visually represented in a plot, illustrating the identified tone of voice across various datasets. To ensure the noise of the data points disappeared and to show the yearly distribution of the normalised sentiment scores, the scores were grouped by year.

#### 4.1.5 Topic Modelling

The concept of frames is connected to the second specific [Research Question](#). To operationalise this concept, a range of topics (spanning from 4 to 32) were tested for each model and dataset. The goal was to identify the optimal number of topics that would allow for the interpretation of frames without becoming overly specific in light of the specific research question. Consequently, 16 topics were deemed the most interpretable. To improve the reproducibility of the analysis, a random state parameter was incorporated that was equal to the number of topics. Furthermore, a comparison was made between both topic modelling analyses (LDA and NMF) and the topics identified through NMF topic modelling were considered more interpretable. As a result, this analysis was selected for implementation in finding the most suitable frames. This could be due to the fact that NMF topic modelling is more effective with shorter texts like Tweets, whereas LDA is more suitable for longer texts such as complete articles (Chen et al., 2019). Given the utilisation of blocks instead of entire news articles or the complete text of parliamentary proceedings, NMF topic modelling is the chosen approach for investigating the frames present in the data. Following the identification of 16 topics through NMF topic modelling, the first five most common words in each topic were employed for their identification. These topics were then assigned labels that could be linked to a frame. Certain topics were excluded from consideration as they could not be associated with a frame. To facilitate the interpretation of the topics, the document most coherent with a given topic, referred to as TopTopic, was examined. The results of the topic modelling were visualised using tables including the topic interpretation, area plots, and Sankey diagrams.



## 4.2 Stakeholder Analysis

The third specific [Research Question](#) was answered by conducting semi-structured interviews with various key stakeholders in the cultivated meat ecosystem. These interviews aim to capture qualitative data from diverse perspectives and allow for the testing of tone of voice and frames derived from the quantitative analysis.

### 4.2.1 Data Collection

Among the interviewees were representatives from the Ministry of Agriculture, Nature, and Food Quality, political parties of both the pro and against stances on cultivated meat, farmers, cultivated meat companies, etc. In total, seven interviews were conducted and the interview questions can be located in the interview protocol ([Appendix B](#)). Each interview protocol was tailored for the specific stakeholder. Although these questions are presented in English, it's worth noting that six out of seven interviews were conducted in Dutch. Before each interview, the interview participants were requested to sign an informed consent form as shown in [Appendix C](#). This form addressed participants' consent regarding the recording of both sound and video, as well as their preference for anonymity or inclusion of names if quotations would be used. The informed consent form, along with the procedures for data collection, storage, and deletion, received approval from the Human Research Ethics Committee (HREC) of TU Delft. To respect the privacy preferences of certain participants who chose anonymity in quotes, all individuals were identified using numbers from 1 to 7. [Table 4.2](#) presents information about the participants and their roles in relation to cultivated meat.

Participant	Organisation or Role Description
Participant 1	Cultivated meat company
Participant 2	Farmer opposed to cultivated meat
Participant 3	Representative of the Ministry of Agriculture, Nature, and Food Quality
Participant 4	Non-profit organisation working on cultivated meat in Italy
Participant 5	NGO to bridge the gap between farmers and cultivated meat
Participant 6	Farmer supportive of cultivated meat
Participant 7	Representative of the municipality of Delft

**Table 4.2:** Participants and their roles in the cultivated meat ecosystem

To gather additional information, attempts were made to reach out to various organisations. However, not everyone was willing to participate in an interview. Nevertheless, some organisations agreed to respond to questions via email. The organisations willing to answer questions via email included one political party supporting cultivated meat, another political party with a more neutral stance, and an additional farmer opposed to cultivated meat. The inclusion of the latter was necessary because Participant 2, another farmer opposed to cultivated meat, was not familiar with the product. Additionally, an understanding of EFSA's perspective on cultivated meat was obtained from a scientific colloquium about cultivated meat organised by EFSA ([2022b](#)). To know the stance of the political parties within the House of Representatives on cultivated meat, a combination of sources has been used. Firstly, the dataset of parliamentary proceedings was employed. Additionally, to supplement this information, an examination of the motion regarding cultivated meat tastings was conducted (Tweede-Kamer, [2023](#)). Moreover, email exchanges were conducted with representatives from the political parties VVD and BBB, because both parties declined an interview, citing time constraints. Moreover, insights were found from the 'Grote Verkiezingsshow' podcast, as the presenter asked all parties about their thoughts on cultivated meat (Bregman and Frederik, [2023](#)).

### 4.2.2 Interview Analysis

Throughout the interviews, questions posed to the participants followed a semi-structured approach, aimed at gather comprehensive insights from each interviewee. The interview process began with general questions designed to determine the participant's role within the Dutch cultivated meat ecosystem and their opinion about the product. Subsequently, participants were asked about their perspectives on the ecosystem, exploring the dynamics among stakeholders and how they collaborate or deviate. The discussion also delved into aspects of consumer acceptance related to cultivated meat, as well as the frames found in their field. Participants were asked to share their

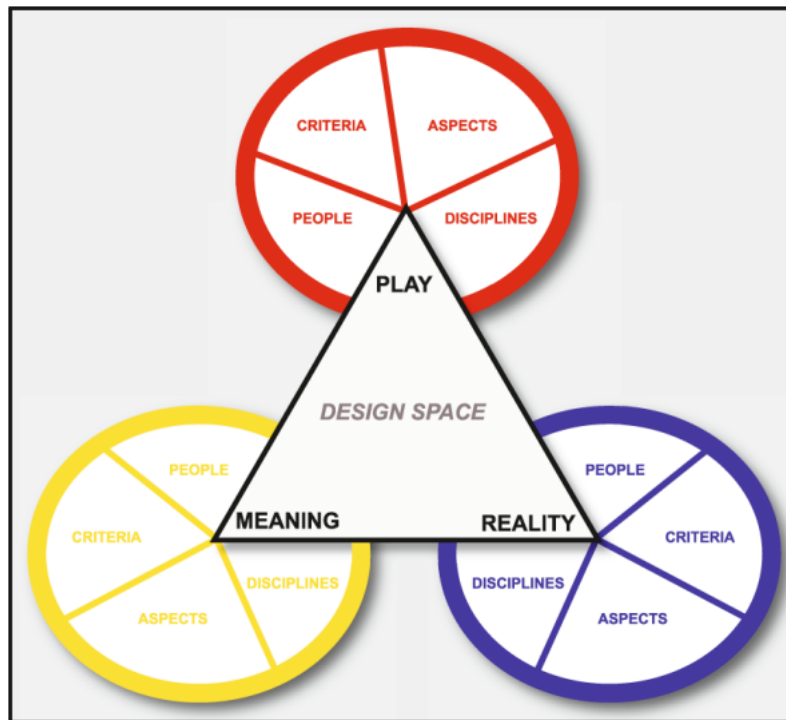


thoughts on the frames adopted by other stakeholders as well. These interviews served the purpose of understanding the participants perspectives on the product, identifying additional individuals for interviews, and gaining insights into their communication style and framing of cultivated meat.

Transcripts were generated from the audio and/or video recordings of the interviews using the Word Transcribe tool. The recording was uploaded to a Word document, and the Word Transcribe tool aided in the creation of the transcripts. Given that Word does not produce flawless transcripts, a thorough review was conducted. Key information from these transcribed interviews, emails, and the EFSA colloquium was extracted and categorised into clusters using the tool Miro. Additionally, noteworthy quotes were singled out. The interview analysis highlighted insights shared by multiple stakeholders and identified key stakeholders within the Dutch cultivated meat ecosystem. According to most participants, these roles represented the most significant contributions. These roles serve as the foundation for the game, which is designed as a role-playing game where players assume one of the four roles in the cultivated meat ecosystem.

### 4.3 Serious Game Design

To answer the fourth specific [Research Question](#), the results from the previous questions are used to develop a serious game. With the outcomes of textual data and stakeholder analysis, the game was designed with the varied perspectives of different stakeholders about cultivated meat. The primary aim of the game is to enhance players' awareness of cultivated meat and show the complexity of the roles of different stakeholders in the cultivated meat ecosystem. When designing a serious game, it is important to delve deeper into the principles of game design with insights from the earlier mentioned book 'Triadic Game Design' (TGD, Harteveld, 2011). This book underscores the significance of three key factors in a game: 'Reality,' 'Meaning,' and 'Play.' When crafting the game, it is essential to balance these factors while making design decisions (Figure 4.2).



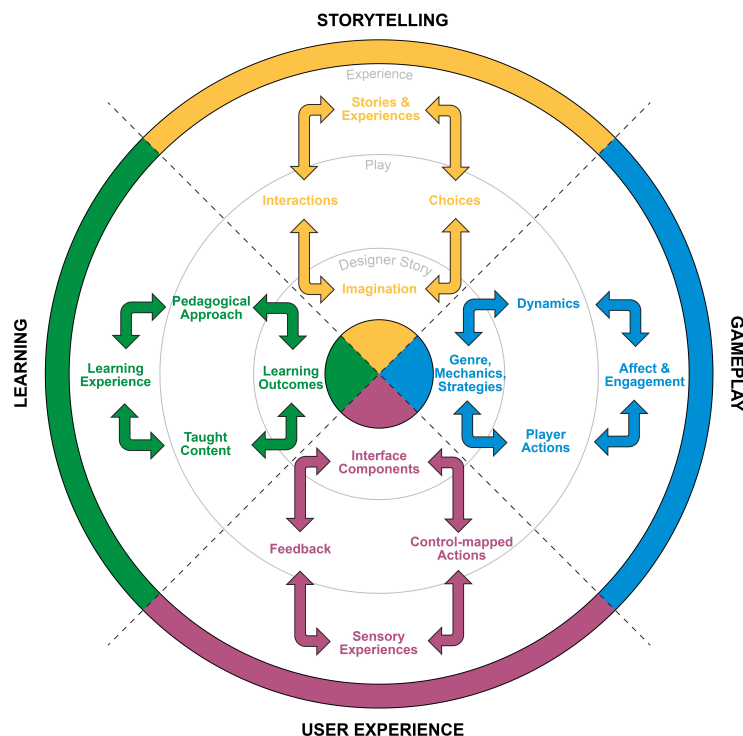
**Figure 4.2:** The design space of game design encompassing the three factors 'Reality,' 'Meaning,' and 'Play.' *Source:* Harteveld (2011).

The concept of 'Reality' within the context of serious gaming stresses a fundamental connection to the real world. In establishing this connection, frames were extracted from textual data analysis and insights from interviews with key stakeholders in the cultivated meat ecosystem were used. According to Harteveld (2011), there are different types of these connections defined as 'domains.' The one most fitting for this game is the domain of Public Policy. This domain gives players an understanding of the relationships among various variables (stakeholders) crucial in public policy. Harteveld's book states, "Such an understanding or 'awareness' is also used to educate the public about the dilemmas that the government is struggling with and to engage the public with the debate." The second concept, 'Meaning,' is tied to the learning outcomes for players. Similar to Reality, Meaning is associated with a specific domain called 'values.' The value targeted by this serious game would be 'knowledge'. It is crucial to note that the game would become meaningless if the world of Meaning is not linked to Reality. The final factor discussed is 'Play,' representing the fun element that makes the serious game an enjoyable experience. This particular game adopts the genres of role-playing and strategy, contributing to its engaging nature.

Initially, the focus was on identifying the target audience for the game. It became evident that the ideal audience would be potential Dutch consumers of cultivated meat, as they formed the focus group to raise awareness about the product. Therefore, the game was tailored for and played by this specific group. As mentioned in the literature, it is important to communicate about cultivated meat early, even before commercialisation, to enhance awareness and therefore possible acceptance (ProVeg, 2022b). Thus, engaging consumers early in the product development process was vital, and a serious game serves as a tool for this purpose. Given that the game was intended for the Dutch population, it was developed and played in the Dutch language.

### 4.3.1 Refinement Through Iteration

The first brainstorming session was organised with students from the master program ‘Communication Design for Innovation’ (CDI). The session began with outlining the problem background and articulating the game’s objective: to enhance consumer awareness of cultivated meat and its stakeholder dynamics. Drawing on the conceptual framework from ‘The Art of Serious Game Design’ by Djafarova et al. (2023), specific questions were posed during the brainstorming session. Questions such as: ‘Who is the player,’ ‘What type of game is it,’ and ‘Who or what does the player interact with during the game’ were presented on cards, as detailed in Appendix D. The conceptual framework, illustrated in Figure 4.3, shows the four quadrants representing the four serious game elements. The responses to these questions guided the development of the initial idea, which involved assigning different roles to key players in the cultivated meat ecosystem, including the farmer, the Ministry of Agriculture, Nature, and Food Quality, the cultivated meat company, and the consumer. Choosing different roles for players of the game aligns with the earlier mentioned principles of game Design by Harteveld, enhancing the element of Reality by establishing a connection to the real world. It also addresses ‘Meaning’ by providing knowledge about the diverse players in the cultivated meat ecosystem. Moreover, incorporating different roles elevated the factor of ‘Play,’ making the game more enjoyable.



**Figure 4.3:** The art of serious game design methodology circle. *Source: Djafarova et al. (2023).*

The conceptual framework proposed by Djafarova et al. (2023) identifies four key elements of serious games: learning, storytelling, gameplay, and user experience. Learning refers to the educational content integrated into the game, aiming to assist players in achieving specific learning objectives. In line with the game’s goal, these learning objectives are centred around developing knowledge of cultivated meat, aligning with the ‘Meaning’ domain described by Harteveld (2011). Additionally, one of the learning objectives involves gaining insights into the complex dynamics among key stakeholders within the cultivated meat ecosystem. This was tested by asking players about their existing knowledge of cultivated meat before starting the game, and during the post-game debrief, evaluating whether this changed. The second element of a serious game is storytelling, which entails the narrative surrounding the characters, setting, and goals (Djafarova et al., 2023). The results specify the narrative players encounter when starting the game, including details about characters, the setting, and the players’ goals. Gameplay involves how players engage with the game or with other participants, in this case as a role-playing game as in line with the genre of ‘Play’ from Harteveld. User experience encompasses the environment where players interact, facilitating communication within the game. This game was structured as a strategic card game which shapes the overall player experience.

Employing the insights from the initial brainstorming session, the first concept was formulated and subsequently discussed with supervisor Eva, who provided additional feedback. Given my emphasis on encouraging player discussions regarding their thoughts and choices throughout the game, this brainstorming session presented the idea of players having to make choices between two options, which they would then explain to other players. These chosen actions would carry specific consequences, making the player earn points that they would need to win the game. This first idea is depicted in the scribble found in Appendix E.1. However, a concern arose regarding my role as the game maker assigning points to consequences and potentially influencing the game too heavily in a specific direction. Consequently, the idea of awarding points was discarded, and the concept of individual goals for each player took shape. At the outset, players would be given their game cards outlining their unique goals within the game. With multiple phases during the game, players would receive new option cards, enabling decisions based on their amount of coins and CO2 blocks. In addition to the individual goals, there was an overarching goal of the players of minimising the emission of CO2 blocks in the game, as illustrated in scribble 2 in Appendix E.1. Subsequently, a digital prototype was developed using Miro (Appendix E.2.)

With the digital prototype ready, a meeting was arranged with the Serious Game Lab of the TU Delft to present the concept of the serious game. Given their extensive knowledge in this domain, I sought their input on certain aspects I was struggling with in developing the serious game. One specific challenge involved finding option cards for the consumer player, as their role was minimal in the beginning and would become more significant later in the game. As a consequence, other players could influence the consumer's choices, but the reverse was not feasible. As a result, in conversations with the Serious Game Lab, the decision was made to exclude the consumer player from the game. Nevertheless, it was determined that there can still be negative consequences for the other roles when not involving the consumers. Additionally, a decision was made to display all options for the players simultaneously, rather than presenting two options in each round. This adjustment aimed to enrich the strategic aspect of the game and promote increased discussion among players. For instance, the Ministry could request the farmer to make a choice benefiting them in the next round. Furthermore, given that not all players, like the farmer, had a shared goal of decreasing CO2 emissions, the decision was made to abandon the idea of a universal overarching goal. Instead, each player would have only their individual goal. Lastly, a discussion emerged regarding the game's name. I was considering whether to incorporate the name of the product, 'kweekvlees,' in the title. This consideration came from the thought of whether players would make the same choices if they were aware that cultivated meat could be the potential final product. Consequently, it was decided to no longer name the game 'Het grote kweekvleesspel'. Instead, after a brainstorming session with friends, the name 'Groenverdieners' was chosen. This name roughly translates to 'Green earners', highlighting that players in the game are encouraged to make environmentally friendly choices while also earning money. The term can also be associated with farmers who profit from raising cows that consume green vegetation. Furthermore, the name reflects the incorporation of CO2 into the game, representing something from which players can lose money, contrasting with the environmentally friendly theme.

Following the meeting with the Serious Game Lab, the initial physical prototype was crafted. This prototype was then employed in a playtest with the CDI students to assess the game's functionality. It is noteworthy that these students already possessed some knowledge about the product of cultivated meat, having participated in the earlier brainstorming session. The three roles in the game were named as follows: Berta de Boer (the farmer), Ab de Ambtenaar (the Minister of Agriculture, Nature, and Food Quality), and More for Meat (the cultivated meat company). Each player had an individual goal in the game, derived from the frames identified in the stakeholder analysis with the interviews. Consequently, they were provided with separate background stories: the farmer viewed cultivated meat as unnatural, the minister saw it as a potentially sustainable alternative in the protein transition, and the cultivated meat company operated under the frame of cultivated meat being equivalent to conventional meat. This initial prototype was crafted from basic cards and coins, with plans for refinement in the final gameplay. The primary aim of the first playtest was to evaluate the game's self-sufficiency. The results of this first gameplay can be found in the result section including the subsequent iterations.

Following the initial gameplay, an iterative process followed, leading to the emergence of the second prototype game design, which was then ready for testing. This iteration was tested with friends who hadn't participated in a prior brainstorming session and thus lacked prior knowledge about

the game. However, these friends were familiar with the concept of cultivated meat, as it had been discussed previously. Nonetheless, their input was valuable for further refinement of the game. The outcomes of this playtest and subsequent iterations are detailed in the results section.

Finally, the final design of the serious game was developed and tested by individuals who were both new to the game and had varying levels of awareness regarding cultivated meat. Participants in this phase were not briefed on the game's objectives beforehand, deliberately withholding information to measure consumer awareness of cultivated meat. Thus, at the outset of the game, participants were asked to describe cultivated meat in one sentence. Responses varied, with one participant being knowledgeable about the product, another being unfamiliar, and a third having incorrect associations with it. Participants then engaged in gameplay, after which final iterations were implemented to enhance the game's effectiveness.

After the game, a debriefing session was conducted to assess if the game's objectives were met. Open-ended questions were asked to the players to stimulate discussion about the game, such as asking about the ease or difficulty the players experienced in selecting certain cards. This question aimed to measure the perceived complexity, accentuating the need for players to collaborate just like in real-world dynamics. Moreover, participants were questioned about their knowledge, specifically how their understanding of cultivated meat evolved during the game and what their perceptions of cultivated meat were. This aimed to determine if the game successfully increased consumer awareness and provided participants with accurate information. Additional questions were tailored to the outcomes of the game; for instance, if one player achieved their individual goal at the expense of another player, participants were asked for their thoughts on such outcomes.

# 5 Results

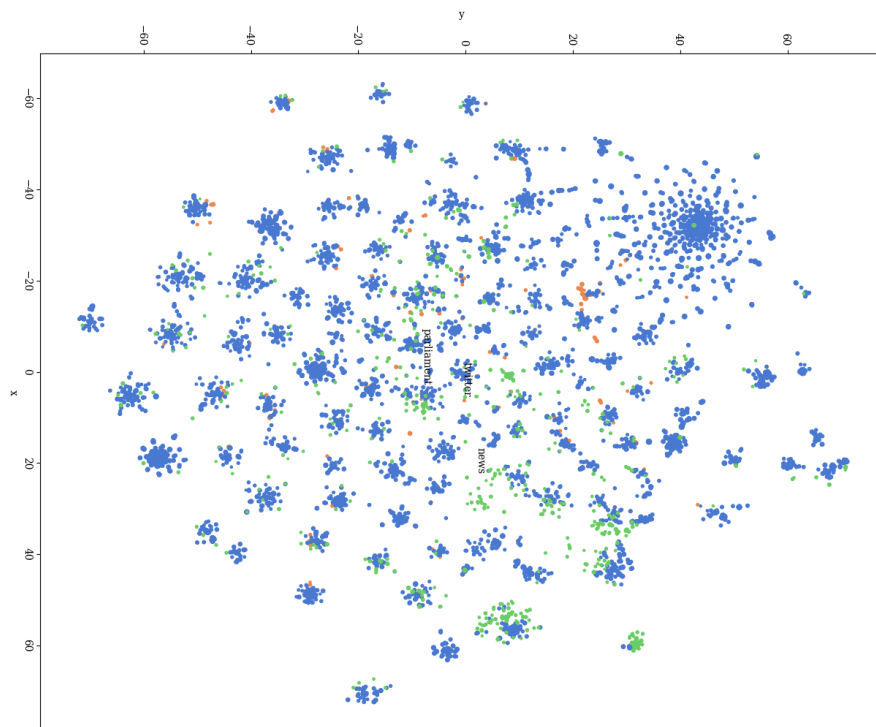
The purpose of this results section is to address the specific research questions outlined in the introduction. For an overview, refer to Section 1.1 to review the research questions. In the following subsections, the specific research questions are addressed one by one. Initially, a textual data analysis was carried out to provide insights into the first two specific research questions, focusing on tone of voice and frames.

## 5.1 Textual Data Analysis

Prior to addressing the specific research questions regarding tone of voice and framing, firstly general statistical analysis was conducted to provide a broad view and deepen insights into the datasets.

### 5.1.1 Exploratory Analysis

The social media dataset from Twitter, the parliamentary proceedings dataset, and the general media's newspaper articles dataset were employed. Before conducting sentiment analysis and topic modelling, the datasets underwent examination for their statistical characteristics. Before addressing the datasets separately, a t-SNE scatter plot was generated containing the data points from the three datasets combined. For the Twitter dataset, only original tweets were used to avoid the potential separation of clusters caused by retweeted tweets. The resulting scatter plot is depicted in Figure 5.1.

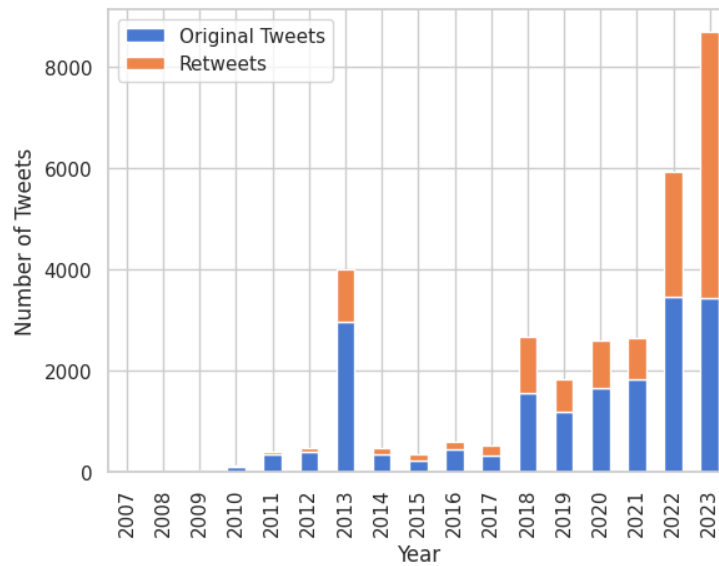


**Figure 5.1:** A t-SNE plot of the three datasets combined: Twitter (blue), news (green), parliamentary proceedings (orange).

The t-SNE plot indicates that the three datasets are uniformly distributed across the entire scatter plot rather than being confined to specific regions. This uniform distribution is advantageous for comparing the datasets in terms of topic modelling, as they share the same region on the scatter plot. However, the dominance of the Twitter dataset is evident, encouraging further exploration of each dataset individually.

## Twitter dataset

The Twitter dataset consists of 31,147 tweets of which 18,125 are original tweets (no retweets). Figure 5.2 illustrates the annual distribution of tweets.



**Figure 5.2:** Tweet distribution over the years, including both original tweets (blue) and retweets (red). Note: the year 2023 contains tweets from January to July.

As shown in the figure above, there is a notable peak in the number of tweets in 2013, primarily attributed to the introduction of the first cultivated meat burger, featured on international television by Dutch researcher Mark Post in London. After 2013, the tweet volume remained relatively low until 2018, when again an increase in tweets was observed. This increase may be linked to heightened awareness regarding the environmental impact of meat consumption, influenced by a combination of global initiatives like the Paris Climate Accord, population growth, and a growing preference for alternative protein sources. Website links attached to these tweets revealed this connection. Additionally, two events in the Netherlands in 2018 related to cultivated meat contributed to this peak (NRC.nl, 2018). Firstly, the Dutch Food and Consumer Product Safety Authority (Nederlandse Voedsel en Waren Autoriteit, NVWA) prevented a tasting of cultivated meat in March 2018. The second event involved an artist named Koert van Mensvoort, who led an art project centred around cultivated meat. Furthermore, a substantial peak in total tweet activity is shown in 2023, only spanning seven out of twelve months. This increased attention could be attributed to factors such as the approval of cultivated meat sales in the United States, greater affordability of cultivated meat burgers (priced below 10 euros per pound, Hudson, 2023), and the approval by the government for cultivated meat tastings in the Netherlands.

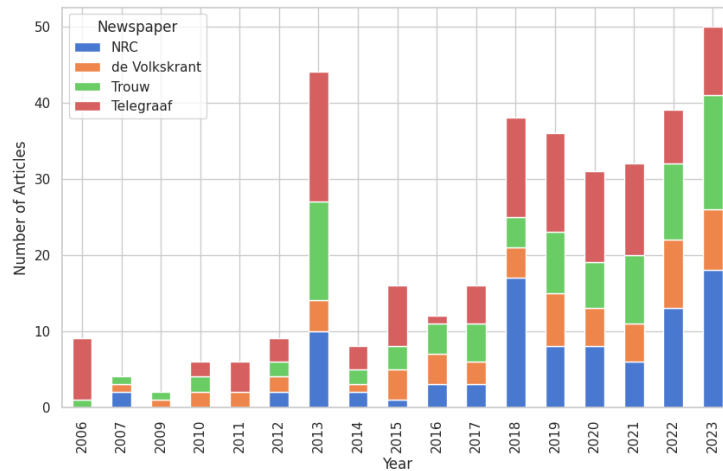
Beyond tweet quantity, exploring Twitter usernames (refer to Appendix F) provides insights into the individuals engaging in discussions about cultivated meat. Twitter accounts frequently tweeting about cultivated meat are associated with those providing information about the product ('kweekvleesinfo') or expressing a positive outlook on the cultivated meat industry compared to the conventional bioindustry (e.g., 'IngeStolkenburg,' 'Back2BasicsPII'). This suggests that a substantial number of tweets reflect a positive tone of voice toward cultivated meat. Another aspect of the Twitter data involves examining the most frequently used hashtags. To identify dominant hashtags, a Word Cloud is generated, as illustrated in Appendix G.1. The most frequently used hashtag in the Twitter dataset is #kweekvlees, followed by #nieuws, #vlees, #tegenlicht, #boeren, #klimaat, and #kringlooplandbouw (hashtags with more than 100 mentions). The hashtags found in this Word Cloud are generally associated with a positive tone towards cultivated meat, except for #klimaathysterie, and perhaps #boeren, which may have a more negative connotation in relation to cultivated meat.

The resulting scatter plot is depicted in Appendix H.1. The scatter plot showed a clear clustering of data points, showing the dataset's potential for topic modelling. However, the presence of 84 clusters indicates a considerable number of topics, with many being overly specific, often tied to particular events, similar tweets, or individuals. Therefore, the scatter plot's usefulness is compromised by the specificity.



## News Articles Dataset

Next to the social media, the general media dataset is explored. The news datasets encompass a collective of 358 articles, 93 from NRC, 117 from de Volkskrant, 86 from Trouw, and 62 from Telegraaf. The distribution of the yearly article frequency was illustrated in Figure 5.3.

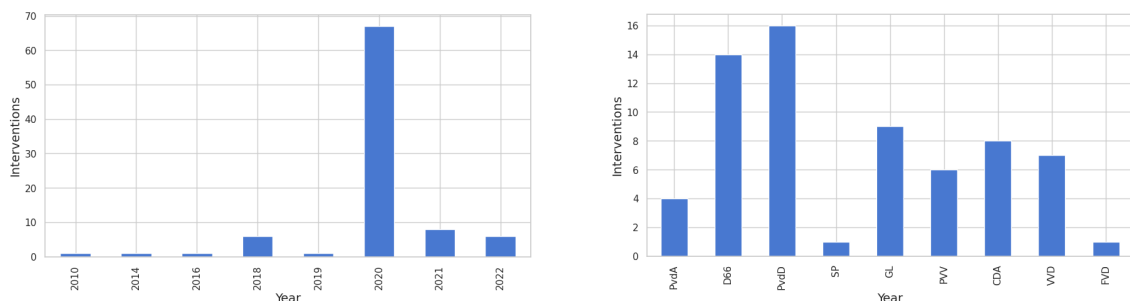


**Figure 5.3:** Number of articles per year including the term cultivated meat of the four newspapers NRC (blue), de Volkskrant (orange), Trouw (green), and Telegraaf (red).

The figure reveals a notable peak in 2013 for the newspapers, associated with the introduction of the first cultivated meat burger. With the exception of the newspaper de Volkskrant, all newspapers exhibit a rising trend in news articles leading up to 2023. Some demonstrate a peak in 2018, possibly linked to increased awareness regarding the environmental impact of meat consumption. In addition to the article count, Appendix G.2 illustrates the most frequently used words in the combined news dataset. The Word Cloud illustrates that the frequently mentioned words in newspaper articles refer to events in cultivated meat, including investments, the researcher Mark Post, and his company, Mosa Meat. This distinction contrasts with Twitter hashtags, which predominantly convey a specific tone of voice instead of an event. Additionally, the t-SNE plot in Appendix H.2 revealed an even distribution of the news article documents.

## Parliamentary Proceedings Dataset

In examining the tone of voice and frames employed by the parliament regarding cultivated meat, the dataset under analysis consists of parliamentary proceedings in the House of Representatives. A significant portion of these interventions (74%), occurred in the year 2020, indicating the political debate on cultivated meat within the House of Representatives during that period as shown in Figure 5.4a (Tweede-Kamer, 2020). The political parties that mostly discussed this topic were 'Partij van de Dieren' (PvdD) and the Democratic party D66 as shown in Figure 5.4b.



(a) Number of parliamentary interventions per year containing the term 'cultivated meat.'

(b) Number of interventions per political party containing the term 'cultivated meat.'

**Figure 5.4:** Analysis of parliamentary interventions about cultivated meat over time (a) and per political party (b).

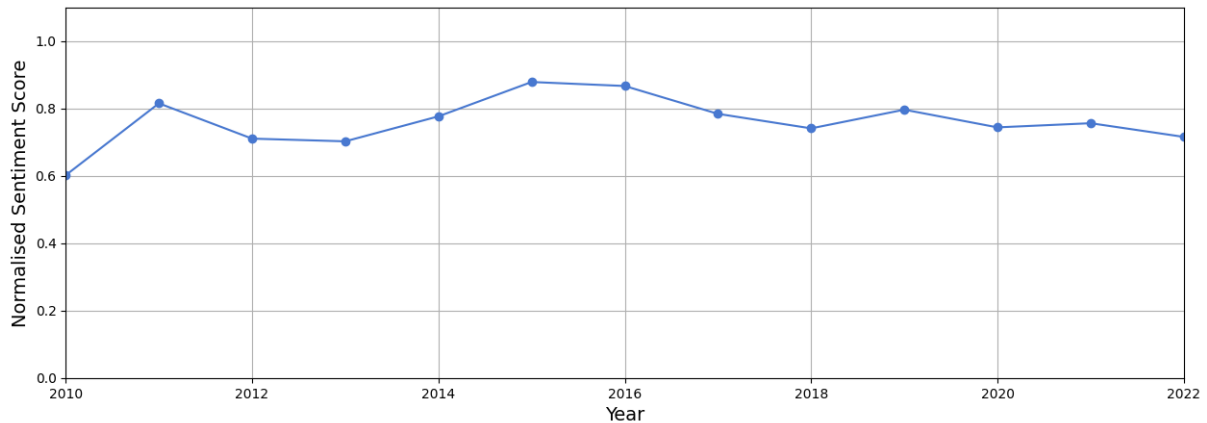
Once more, a Word Cloud was generated, as depicted in Appendix G.3. This Word Cloud differs from the previous two datasets, placing greater emphasis on research, production, and industry-related terms. Finally, from the t-SNE scatter plot, no clear clusters were found (Appendix H.3).

### 5.1.2 Tone of Voice

To address the first specific [Research Question](#), sentiment analysis was employed to explore the concept of tone of voice within the three datasets. Firstly, the combined dataset was investigated on its sentiment.

#### Combined Dataset

Sentiment analysis was conducted on the combined datasets of Twitter, news articles and parliamentary proceedings. The sentiment scores for the combined datasets are provided in [Figure 5.5](#).

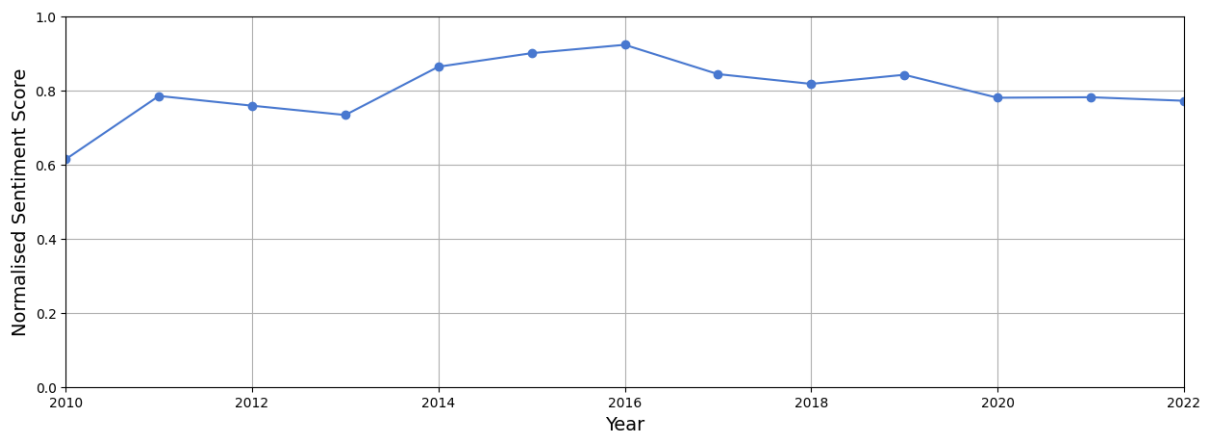


**Figure 5.5:** The normalised sentiment scores on the combined dataset. The normalised scores are grouped by year. A normalised sentiment score of 1 signifies a positive sentiment, while a score of 0 indicates a negative sentiment.

The figure displaying sentiment analysis results on the combined dataset reveals a rise in sentiment scores from 2010 to 2016, followed by a decline through 2022. Notably, Twitter has a dominant influence due to its higher volume of tweets compared to news and parliamentary proceedings documents. Consequently, the three datasets were analysed individually.

#### Social Media

For the sentiment analysis, the entire Twitter dataset was used, considering that retweets represent individuals expressing the same sentiment. Among the 31,147 tweets analysed, 6,341 (20.4%) conveyed a negative sentiment. This relatively low negative rate can be attributed to the low awareness of cultivated meat; individuals tweeting about it are more informed as they have read about it in, for example, progressive newspapers. This trend was also observable in the usernames of tweeters like 'kweekvleesinfo,' a channel providing information about the product as indicated in the exploratory analysis. The sentiment analysis, illustrating sentiment grouping per year on the Twitter data, is presented in [Figure 5.6](#).

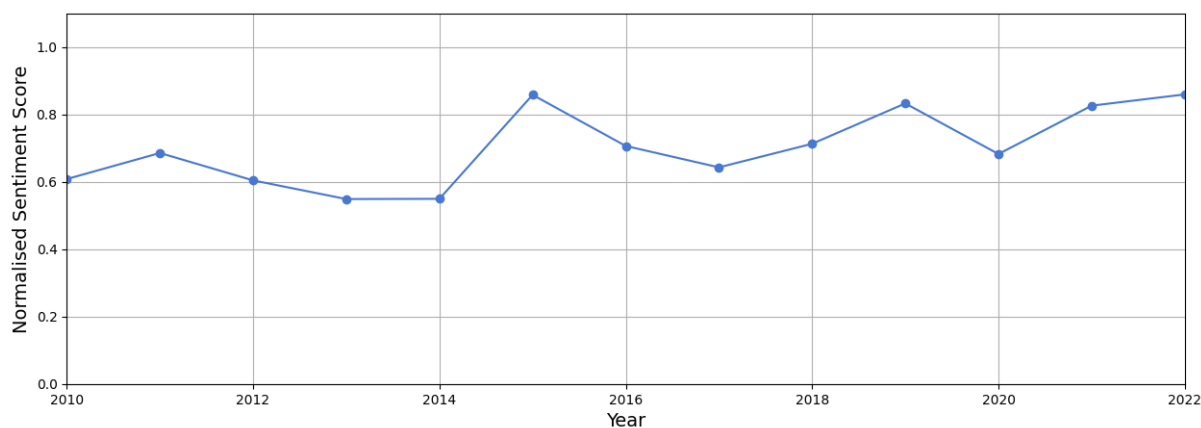


**Figure 5.6:** The normalised sentiment scores on the Twitter dataset, encompassing all tweets, including retweets. The normalised scores are grouped by year. A normalised sentiment score of 1 signifies a positive sentiment, while a score of 0 indicates a negative sentiment.

The graph illustrates an overall positive trend in sentiment within the Twitter dataset, consistently maintaining a normalised sentiment score above 0.6 throughout the years. This suggests a generally positive sentiment compared to a negative. The initial lower scores in the early years could be attributed to the limited tweets about cultivated meat, as highlighted in the exploratory analysis. The limited number of tweets in the early stages implies that a few tweets could have a substantial influence on the data depicted. However, after 2013, marked by the introduction of the first cultivated meat burger, the data indicated a general increase in the normalised sentiment score, reaching its peak around 2016. As awareness of the product grows among a broader audience, there might be a shift in sentiment, as demonstrated by the decline in sentiment scores from 2016 onward in the figure. To validate the accuracy of the sentiment scores provided by the model, random samples were drawn for verification after the analysis. Additionally, a set of challenging tweets was generated to assess the model’s response to more complex input.

### General Media

In addition to social media, sentiment analysis was employed to discern the tone of voice in general media, involving newspaper articles containing the term for cultivated meat. The analysis involved examining blocks of content from these articles, totalling 577 documents. Figure 5.7 illustrates the sentiment of the news datasets from the four newspapers, totalling a negative sentiment in 26.7% of the news documents.

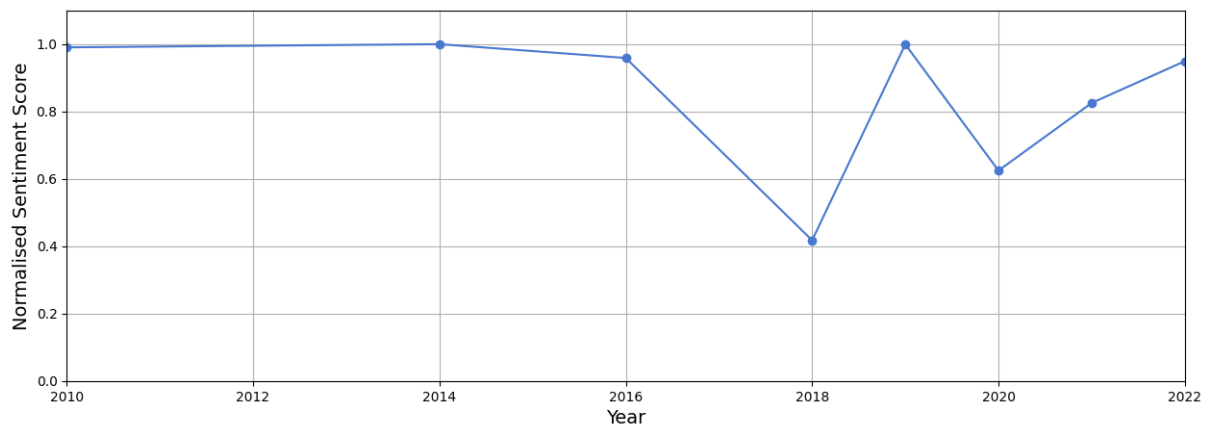


**Figure 5.7:** The normalised sentiment scores on the newspaper dataset. The normalised scores are grouped by year. A normalised sentiment score of 1 signifies a positive sentiment, while a score of 0 indicates a negative sentiment.

The total negative sentiment score in newspapers is higher than that observed in the Twitter dataset, although it remains mainly positive. As highlighted in the exploratory analysis, the newspaper data is more focused on events rather than on sentiment which could assign this difference. Moreover, news articles tend to adopt a more neutral tone of voice compared to the expressive nature often found in tweets. Overall, the sentiment scores from the newspaper dataset revealed an upward trend in total normalised sentiment scores from the years 2010 to 2022.

### Parliament

To gain insights into the parliament’s tone of voice, the parliamentary proceedings dataset was employed. Among the 117 blocks, 38 registered a negative sentiment score (32.5%). This percentage is notably higher compared to the Twitter dataset. This difference may be attributed to the higher awareness levels of parliamentary officials, who are generally well-informed about a subject during debates. Additionally, it’s important to highlight that the sentiment model was trained on smaller text segments, while blocks of text were used for this parliamentary analysis. The sentiment analysis results for the parliamentary dataset are presented in Figure (5.8).



**Figure 5.8:** The normalised sentiment scores on the parliamentary proceedings dataset. The normalised scores are grouped by year. A normalised sentiment score of 1 signifies a positive sentiment, while a score of 0 indicates a negative sentiment.

The figure lacks a clear representation of sentiment trends over time, primarily due to the majority of data being concentrated around the 2020 debate. Consequently, the data is centred on this specific period, leading to an uneven distribution of sentiment scores across different years, given the grouping of data by year. Thus, the data heavily relies on the years 2018 to 2020, making it less reliable. Especially, up until the year 2018, the parliamentary dataset lacked substantial data on cultivated meat, as highlighted in the exploratory analysis. Consequently, the trend observed during this period may not offer significant value. Nonetheless, there is a noticeable overall increase from 2018 to 2022. Given the ambiguity in the sentiment scores presented, a closer examination of the data was conducted. The analysis focused on different political parties based on their sentiment, as interpreted by the researcher. It was observed that the political parties FVD and PVV expressed a negative stance towards cultivated meat. In contrast, all other parties exhibited a more positive sentiment, with some expressing concerns but not outright opposition to the product. This exploration aims to provide a more detailed understanding of the sentiments expressed by various political entities.

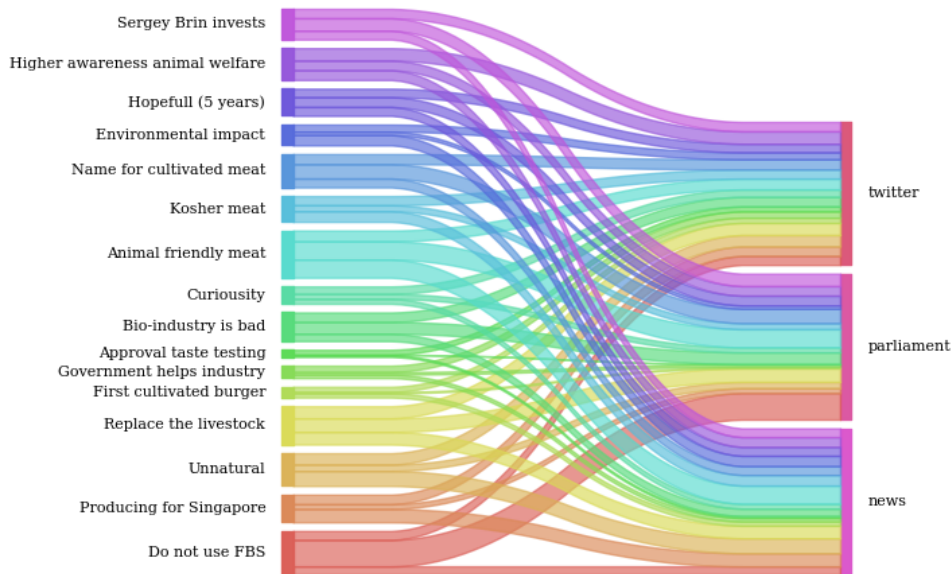
This enables us to answer the first specific [Research Question](#). In social media, the tone of voice is predominantly positive. This may be attributed to the fact that individuals knowledgeable about cultivated meat populate this online community. Similarly, the general media exhibits a largely but slightly less positive tone, as it tends to focus more on events rather than opinions, often adopting a more neutral tone. Lastly, the parliament’s sentiment levels are lower but still mainly positive. This could be due to the higher awareness levels among parliamentary officials. Nonetheless, most political parties appear to recognise the benefits of cultivated meat.

### 5.1.3 Framing

To address the second specific [Research Question](#), NMF topic modelling was employed to explore the concept of framing within the three datasets. Initially, the three datasets were collectively analysed through topic modelling. This approach was adopted because the combined dataset allowed for topic modelling, as demonstrated in the t-SNE HDB scan from the exploratory phase.

#### Combined Dataset

NMF topic modelling was conducted on the combined dataset, and the resulting topic names are detailed in [Appendix I.1](#). Using the identified topic names from the 16 topics, a Sankey diagram was created to visually represent the relevance of each topic to specific datasets (see [Figure 5.9](#)).



**Figure 5.9:** Sankey diagram illustrating the 16 topics found with NMF topic modelling and their occurrence to the specific datasets.

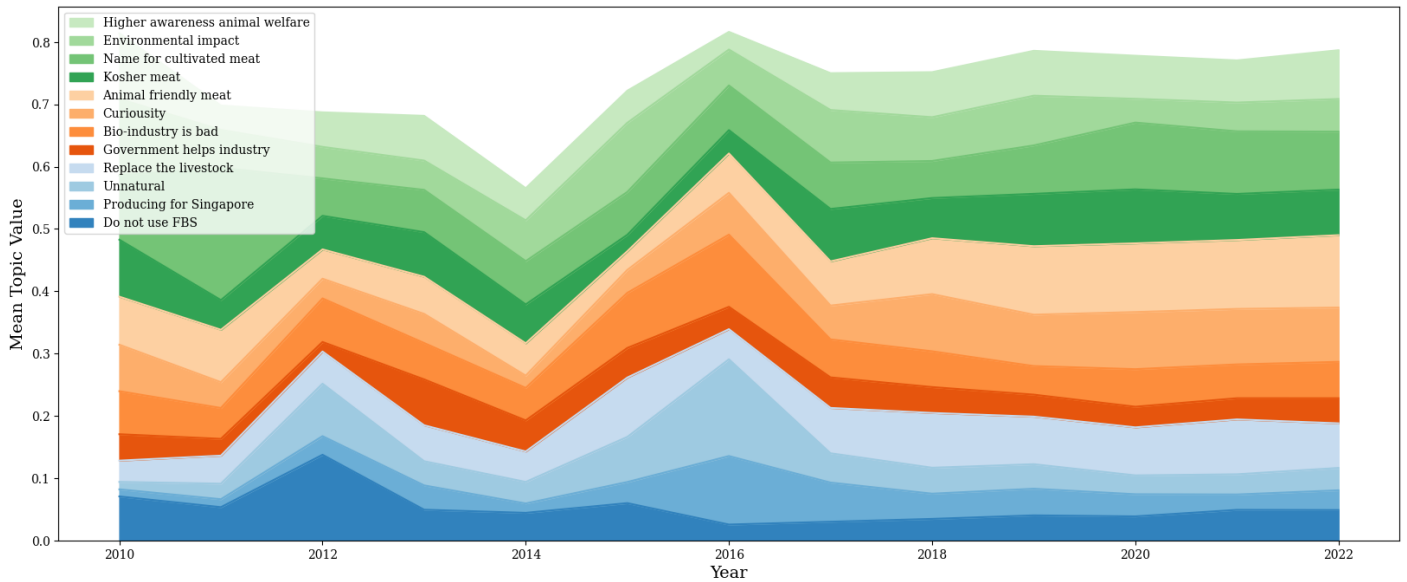
The Sankey diagram illustrates that certain topics were more relevant to a specific dataset than others. For instance, the ‘Do not use FBS’ (fetal bovine serum) topic showed a stronger association with the parliamentary dataset, indicating potential parliamentary concerns regarding the utilisation of FBS. However, the majority of topics demonstrated a relatively even distribution across different datasets, indicating that no particular topic was distinctly relevant to a specific dataset. This implies that each topic was discussed in every dataset, underscoring a shared use of topics. Consequently, an independent examination of the datasets through NMF topic modelling was conducted and is presented in the subsequent chapters.

Before delving deeper into these individual datasets, a table was crafted using the identified topics to illustrate the interpretation of each topic. This included the document most closely associated with it (TopTopic) and the decision to include or exclude the topic. The decision was made based on whether the topic aligned with a frame (included) or an event (excluded). Topics were also excluded if no clear framing content was identified. The crafted table is presented below ([Table 5.1](#)).

Topic Name	Topic Interpretation	TopTopic (document most coherent with the topic)	Include
Do not use FBS	Cultivated meat uses FBS and therefore it is an outdated idea (achterhaald idee)	“absolute zekerheid, dat dat foetaal kalfsserum niet meer gebruikt wordt voor de productie van kweekvlees. Dan gaat wat ons betreft het licht op groen.” - PvdD	Include
Producing for Singapore	The Netherlands produces cultivated meat for Singapore.	De Nederlandse ontwikkelaar van kweekvlees Meatable gaat varkensvleesproducten maken voor de lokale markt in Singapore.	Include
Unnatural	Cultivated meat is unnatural	” We eten al duizenden jaren vlees. Dat is heel natuurlijk. Kweekvlees is iets onnatuurlijks.” - PVV	Include
Replace the livestock	Cultivated meat can replace the livestock	”Veestapel weg door kweekvlees” - NOS article	Include
First cultivated burger	First cultivated meat burger presented (2013).	Dé kweekhamburger, de eerste ter wereld, gaat de markt op. In mei richtte hij er met hoogleraar Mark Post een bedrijf voor op, Mosa Meat.	Exclude
Government helps industry	The cultivated meat industry needs help from the government to improve their product.	goed vestigingsklimaat voor kweekvleesondernemers door ze te helpen met de benodigde wetgevingstrajecten; verzoekt de regering tevens experimenteerruimte te bieden voor kweekvlees voor veilige en gezonde marktintroductie(s)	Include
Approval taste testing	Taste testing of cultivated meat is now possible in the Netherlands (2022).	Zorg er simpelweg voor dat experimenten zijn toegestaan. Dat is nodig voor de productontwikkeling. Sta het proeven van kweekvlees onder gecontroleerde omstandigheden toe	Exclude
Bio-industry is bad	Cultivated meat can solve the downsides of the current animal industry.	perverse effecten van de huidige dierhouderij niet weggenomen zouden kunnen worden door over te stappen op kweekvlees, zoals verlies aan biodiversiteit, CO 2 -uitstoot, stikstoofuitstoot, fosfaat, dieronvriendelijkheid en slachthuizen	Include
Curiosity	People want to try out cultivated meat.	Kweekvlees is er, laat ons het proeven!	Include
Animal friendly	Cultivated meat is real meat but then produced in an animal-friendly way.	Wat een doorbraak voor diervriendelijk vlees!	Include
Kosher meat	Cultivated meat is kosher.	”Kweekvlees is koosjer” via @NOS	Include
Name for cultivated meat	The name for cultivated meat (kweekvlees) does not sound tasty.	Kweekvlees klinkt nu ook al behoorlijk naar...	Include
Environmental impact	In the future cultivated meat will be used positively for the environment.	voor een biefstuk van kweekvlees in de toekomst 96 procent minder broeikasgas kan vrijkomen dan voor een gewone	Include
Hopefull (5 years)	Within 5 years the cultivated meat burger is on the market.	Start-up wil binnen vijf jaar betaalbaar kweekvlees (2016)	Exclude
Higher awareness animal welfare	The awareness for animal welfare increases	”Over twintig jaar vragen we ons af hoe we ooit zo barbaars hebben kunnen zijn om dieren te slachten”...	Include
Sergey Brin invests	Google Founder sergey brin invests in cultivated meat	Google-miljardair Sergey Brin is financier van kweekvlees Universiteit Maastricht: Sergey Brin	Exclude

**Table 5.1:** Interpretation of topics found with NMF topic modelling on the combined datasets (Twitter, news, and parliamentary proceedings), the document most corresponding to the topic (TopTopic), and the inclusion of the topic.

As shown in this table, four of the 16 topics were excluded as they could not be allocated to a frame as they were events in time. From the remaining topics, it was found that three topics were against cultivated meat, and nine were in favour of cultivated meat. The three topics used negatively towards cultivated meat are ‘Do not use FBS,’ ‘Unnatural,’ and ‘Name for cultivated meat.’ From the included topics, a time distribution is presented in the form of an area plot (see Figure 5.10).



**Figure 5.10:** Average scores of the 16 topics across the timeline in the concatenated dataset.

This plot underscores the significance of specific topics over time. Nevertheless, it doesn't suggest a clear hierarchy of relevance among the topics depicted in this plot. Each topic appears to maintain a comparable level of importance, indicating a balanced distribution of thematic significance throughout the observed period. Therefore, this is another reason why an independent examination of the datasets through NMF topic modelling is conducted in the chapters below.

### Social Media

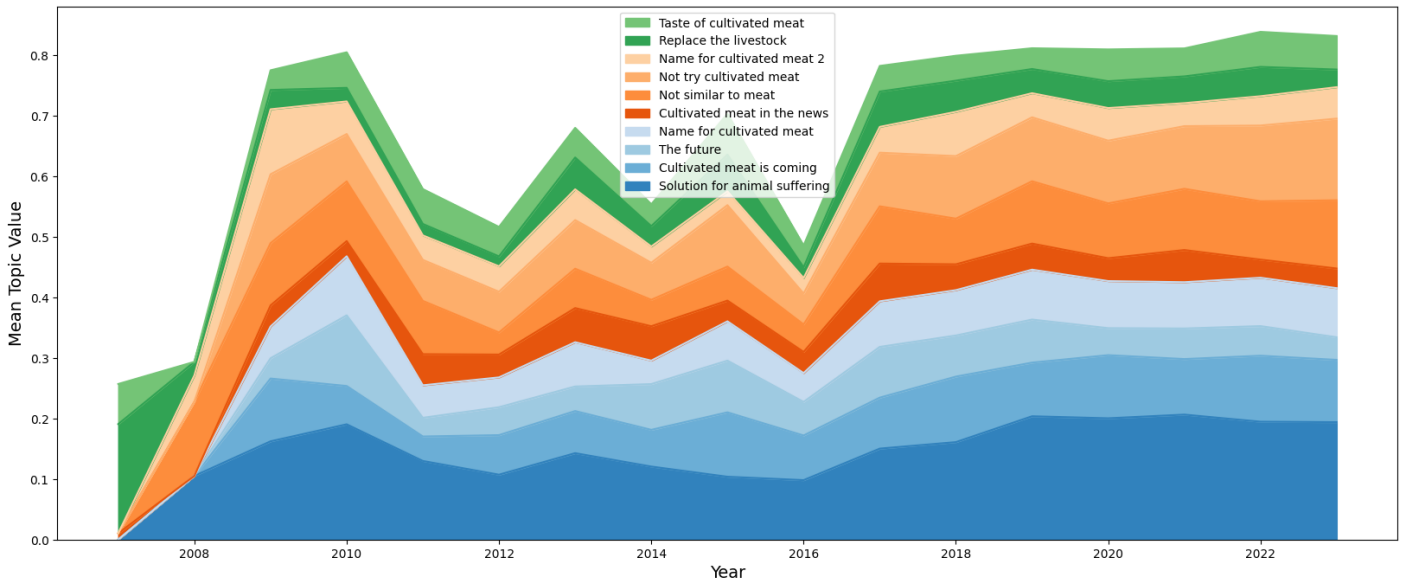
The frames employed in social media were identified using the Twitter dataset through NMF topic modelling. The 16 distinct topics were labelled with topic names, which can be found in Appendix I.2. The interpretation of these 16 topics, along with information such as the TopTopic and the inclusion or exclusion status, is outlined in Table 5.2

Topic Name	Topic Interpretation	TopTopic (document most coherent with the topic)	Include
Cultivated meat cookbook	First cultivated meat cookbook is on the market (2014).	Werelds eerste Kweekvlees Kookboek verschijnt	Exclude
Solution for animal suffering	Cultivated meat is a solution for unethical animal welfare practices.	Kweekvlees gaat het worden, goed voor mens en dier	include
Soon cultivated meat	The first cultivated meat burger will soon be coming to the Netherlands.	Kweekvlees is binnenkort beschikbaar!	Include
The future	Cultivated meat is the future.	Dit is ook de toekomst.. Wow!	Include
Sergey Brin invests	Google founder Sergey Brin invests in cultivated meat (2013).	Google-oprichter Brin financier kweekvlees: Mede-Google-oprichter Sergey Brin is de tot nu toe anonieme financier	Exclude
First cultivated burger	First cultivated meat burger from the lab presented in London made in Dutch laboratory (2013).	Hamburger van kweekvlees uit Nederlands laboratorium	Exclude
Name for cultivated meat	The word 'kweekvlees' does not sound appetising.	Kweekvlees, alleen het woord is al gruwelijk	Include
Cultivated meat in the news	Cultivated meat is a trending topic in the news.	Kweekvlees in het nieuws: check	Include
Not similar to meat	Cultivated meat is not the same as real meat.	kweekvlees echt vlees ???? Het is chemische rotzooi lamlul !!!	Include
Wins price for burger	Dutch laboratory wins a price with cultivated meat	Sabre Awards voor Coebergh, Fleishman, Edelman en Nederlands kweekvlees: Holmes Report heeft gisteren in Londe	Exclude
Not try cultivated meat	I would not eat cultivated meat	Wie wil dat kweekvlees eten dan? Ik in ieder geval niet	Include
Hopefull (5 years)	Within 5 years there will be affordable cultivated meat on the market (2015).	Binnen vijf jaar betaalbaar kweekvlees op de markt	Exclude
Cultivated meat from Maastricht University	Professor from Maastricht University makes the first cultivated meat burger.	Wereldprimeur: de laboratoriumhamburger van kweekvlees	Exclude
Name for cultivated meat 2	Cultivated meat sounds repulsive and scary.	Klinkt toch niet:"3 biertjes en een schaalpje kweekvlees	Include
Replace the livestock	The livestock will disappear because of cultivated meat.	Veestapel weg door kweekvlees	Include
Taste of cultivated meat	Is cultivated meat tasty?	Kweekvlees, maar is 't lekker?	Include

**Table 5.2:** Interpretation of topic names from NMF topic modelling on the Twitter dataset, the document most corresponding to the topic (TopTopic), and the inclusion of the topic.



This table shows that 6 out of the 16 topics were excluded due to their association with events, making them unsuitable for categorising within a frame. Among the remaining 10 topics, 4 (the topics of ‘Name for cultivated meat’ 1 and 2, ‘Not similar to meat,’ and ‘Not try cultivated meat’) conveyed a negative perspective on cultivated meat. This number of negative stances exceeded what was observed in the tables for the news and parliamentary proceedings datasets, as detailed below. This is interesting when considering the sentiment analysis, which identified the highest positive sentiment in the Twitter dataset. One explanation could be that Twitter, being a platform where opinions are often expressed more, showed stronger sentiments due to the shortness of tweets, as opposed to the relatively less expressive nature of news articles and parliamentary debates. Consequently, both negative and positive perspectives on cultivated meat have a more noticeable expression in the Twitter dataset. Figure 5.11 illustrates the occurrence of the included 10 topics that could be assigned to a frame over time.



**Figure 5.11:** Area plot of the average scores for included topics over time of the Twitter dataset.

As shown in the area plot, the majority of topics exhibited a consistent area of mean topic scores over time. However, the topic ‘Solution for animal suffering’ displayed a rising trend, progressively increasing from 2016 onwards. This suggested a heightened awareness of the topic related to animal suffering in tweets, potentially signalling an increased awareness that cultivated meat could serve as a solution to problems with animal suffering.

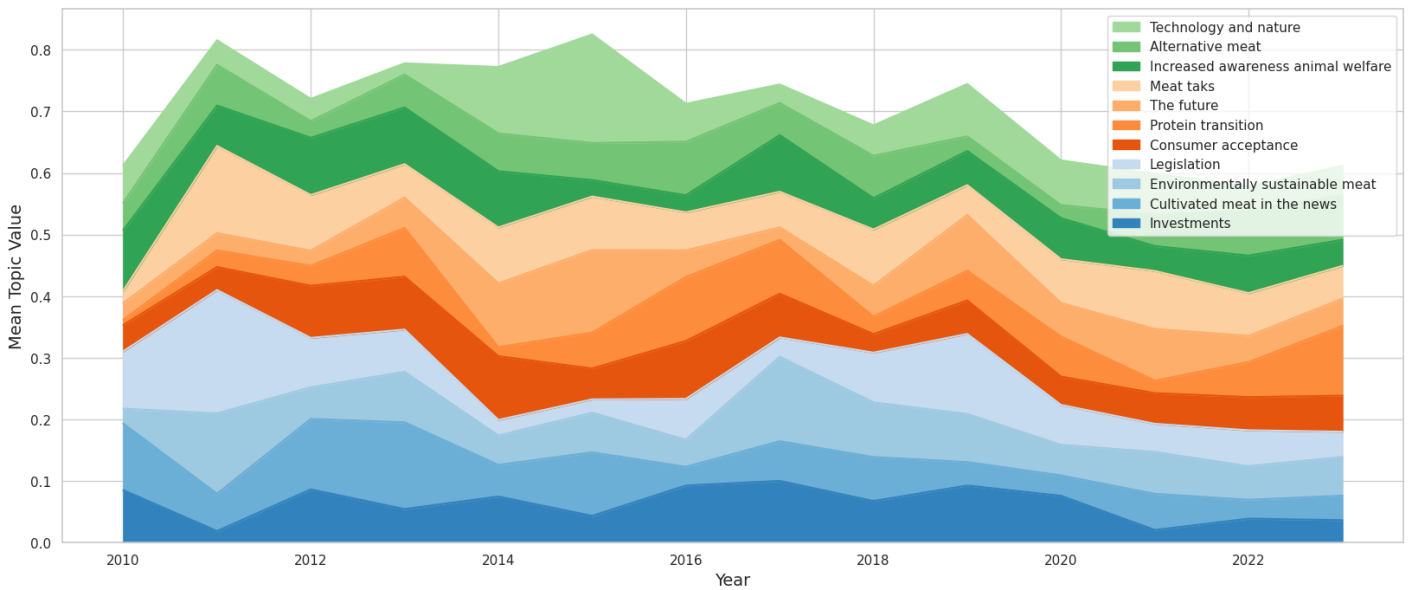
### General Media

In addition to social media, an analysis of the general media was conducted using topics derived from the news dataset. Through NMF topic modelling, 16 topics were identified and labelled, as presented in Appendix I.3. The interpretation of these 16 topics, as outlined in Table 5.3, was required for subsequent investigation.

Topic Name	Topic Interpretation	TopTopic (document most coherent with the topic)	Include
Investments	Multiple big investors put their money on the innovation cultivated meat	Branson and Gates investeerden in het Amerikaanse Memphis Meat, dat in 2016 de eerste gehaktbal van kweekvlees presenteerde voor 1.200 dollar (975 euro).	Include
Cultivated meat in the news	Cultivated meat is a trending topic in the news	Wij bepalen wat er in de uitzending komt, niet Post. Wij kozen voor het contrast tussen echt vlees en kweekvlees, om nou ook nog het uitstapje te maken naar het verschil tussen kweekvlees en vegetarische producten, dat was in onze ogen offtopic.	Include
Environmentally sustainable meat	Cultivated meat has many environmental advantages in contrast to conventional meat production	vleesproductie verantwoordelijk voor 18% van de wereldwijde uitstoot aan broeikasgassen. Daarnaast neemt het vee 10% van de jaarlijkse verswaterconsumptie voor zijn rekening. Kweekvlees steekt daar aanzienlijk gunstiger bij af	Include
Meatable investments	The Dutch cultivated meat company meatable has raised millions of investments	Het Delftse kweekvleesbedrijf Meatable heeft ruim 30 miljoen euro aan nieuwe investeringen opgehaald.	Exclude
Legislation	The cultivated meat industry needs the governments to help with legislation to move forwards	daarna moeten alle EU-lidstaten instemmen met toelating van het product op de markt. Volgen Shapiro staat deze wetgeving de commerciële ontwikkeling van kweekvlees in de weg.	Include
Consumer acceptance	People are not waiting for something like cultivated meat	Desondanks denkt twee derde van de deelnemers niet dat we in de toekomst geen dieren meer hoeven te doden voor vlees. Heffing op hamburger 'oneerlijk	Include
Singapore approves	Singapore is the first country to sell cultivated meat (2020).	Singapore als eerste akkoord met kweekvlees	Exclude
Protein transition	Cultivated meat can be a helpful product for the protein transition.	Er wordt overal ter wereld gewerkt aan alternatieven die nóg een stap verder gaan. Denk aan het namaken van kaas met dierlijke eiwitten en het kweken van vlees.	Include
The future	Cultivated meat is the future.	voeding hun visie geven op ons voedsel in de toekomst. Onder hen zijn Mark Post, de maker van de eerste hamburger van kweekvlees	Include
Meat tax	Due to cultivated meat a tax can be added to conventional meat, a difficulty for the farmers	Met een vleestaks helpen we vooral de buitenlandse boer”, waarschuwt ook CDA-Kamerlid Derk Boswijk	Include
Increased animal welfare awareness	The awareness of consumers regarding inhumane methods of the conventional bioindustry is increasing	Ik denk dat we het op een dag heel raar vinden dat we ooit dieren doodden om te eten.	Include
Alternative meat	Cultivated meat can be an alternative option just like insects or plant-based options	We zijn eerder geneigd om een burger van kweekvlees, peulvruchten of insecten te eten.” Insecten zijn het minst favoriet als alternatief.	Include
Refer to ...	Documents with referral or links to other articles (words: 'see', 'original', and 'page').	Bekijk de oorspronkelijke pagina: pagina 8, pagina 8, pagina 9	Exclude
Meatable to Singapore	Meatable wants to sell in Singapore because it is not yet possible in Europe	Amsterdam Kweekvleesbedrijf Meatable gaat met het Singaporese ESCO Aster zijn in de fabriek gemaakte varkensvlees produceren.	Exclude.
Technology and nature	Nature and technology should work together, not against each other.	Daarom denk ik: we moeten niet terug naar de natuur maar voorúit naar de natuur.” Next Nature	Include
Link to PDF	Documents with referral to a PDF including the words 'link, and 'PDF'	Link naar PDF Link naar PDF Link naar PDF	Exclude

**Table 5.3:** Interpretation of topic names from NMF topic modelling on the news dataset, the document most corresponding to the topic (TopTopic), and the inclusion of the topic.

The interpretation table for topics identified in the news dataset reveals the exclusion of 5 topics. Among these, three were excluded because they were associated with events that could not be allocated to a frame, while two were excluded due to being topics that referred to other articles, featuring links to external sources such as article pages or PDF files. Out of the remaining 11 topics, 2 topics exhibited a negative stance toward cultivated meat, specifically labelled as ‘Consumer acceptance’ and ‘Meat tax.’ These topics delved into concerns about low consumer acceptance and fears of a potential tax on conventional meat. Notably, when compared to the Twitter dataset, the topic interpretations in the news dataset appeared less direct and more nuanced. This nuanced interpretation is likely attributed to the news being more neutral in contrast to the more straightforward nature of tweets. This difference can also come from the use of NMF topic modelling, which is better suited for shorter text pieces like tweets, while the text segments in the news dataset resembled the size of a paragraph. The timeline of topic scores for each topic is illustrated in Figure 5.12.



**Figure 5.12:** Area plot of the average scores for included topics over time of the news dataset.

The figure illustrates that the mean values for most topics remained relatively constant over time, showing minimal fluctuations. Nonetheless, the topic ‘Cultivated meat in the news’ exhibited a notable spike in the area around 2013, corresponding to the launch of the burger.

### Parliament

Finally, NMF topic modelling was applied to the parliamentary proceedings dataset to identify frames used by the parliament. The topics including their labels are presented in Appendix I.4, and their interpretation is provided in Table 5.4.

Topic Name	Topic Interpretation	TopTopic (document most coherent with the topic)	Include
Solution to problems bio-industry	Cultivated meat can be a solution to many problems with the conventional meat industry	te maken met een vee-industrie die in Nederland eigenlijk tegen de milieugrenzen aanloopt. We hebben de enorme stikstofproblematiek, die ook een gevolg is van de ammoniakuitstoot. We hebben wekelijkse misstanden in slachthuizen. Kweekvlees biedt enorme kansen. Er is minder landbouwgrond nodig en minder water.	Include
Replace livestock	Animals will still be used even if cultivated meat is on the market.	Ik wil alleen zeggen dat dieren ook een rol hebben in de circulaire landbouw. Die blijven ze wat mij betreft houden.	Include
Successful	Cultivated meat can only be successful if it's affordable with a more appealing name.	Wil kweekvlees echt in de smaak gaan vallen bij de consument, dan zal er een betere naam gevonden moeten worden en zal de prijs fors moeten dalen.	Include
Do not use FBS	Cultivated meat should not be produced if it uses fetal bovine calf serum.	absolute zekerheid, dat dat foetaal kalfsserum niet meer gebruikt wordt voor de productie van kweekvlees. Dan gaat wat ons betreft het licht op groen	Include
Plant-based alternative	Investing in cultivated meat is unnecessary, the focus should be on plant-based proteins	er moet meer worden ingezet op plantaardige eiwitten.	Include
Transparency of industry	Cultivated meat companies are not transparent in their way of working.	Ik heb het wel over de intransparantie gehad. Daar gaat het over. Het is allemaal volstrekt mistig en het gaat over het bewaren van bedrijfsgeheimen.	Include
Price	Cultivated meat is too expensive so shift focus away from it now.	Het is veelbelovend, maar de productie is nog duur. Als dat grotere schaal krijgt, dan kan de prijs naar beneden. Het zal veilig, betaalbaar en voedzaam moeten zijn.	Include
Safety	It is important to know if cultivated meat is safe before launching the product.	Het gaat ook om iets waarvan je zeker wilt zijn dat het je gezondheid niet raakt. Het ligt echt bij de bedrijven zelf om dit aan te tonen.	Include
Name for cultivated meat	Another name should be found for 'kweekvlees'.	kweekvlees, of iets waarvoor we een andere naam moeten bedenken. Is heer ook bereid om na te denken over het beschikbaar stellen van een innovatiebureau?	Include
EFSA approval	The companies bear the responsibility for the EFSA procedure.	ik vind hierbij tegelijkertijd dat er ook een verantwoordelijkheid is voor bedrijven zelf als zij dit soort zaken willen doen. Zij moeten dan zelf de stappen zetten	Include
Government helps industry	The government should help cultivated meat companies by making rules.	goed vestigingsklimaat voor kweekvleesondernemers door ze te helpen met de benodigde wetgevingstrajecten	Include
Plant-based medium	Cultivated meat can be produced without FBS, but with a plant based medium.	dat kalfsserum is helemaal niet meer nodig; het kan ook op een plantaardige manier.	
Safety bioindustry	There are also food safety risks with conventional meat production.	Een stal, maar ook een slachthuis, zeker met de bandsnelheden en de bezoedeling die er dagelijks plaatsvindt, is niet de meest voedselveilige omgeving.	Include
Animal friendly	Cultivated meat is a climate and animal-friendly way to produce meat.	dat kweekvlees een positieve bijdrage kan leveren aan het verlagen van de effecten op dierenwelzijn van de wereldwijde vleesconsumptie	Include
Polarisation	There are many different opinions about the product cultivated meat.	Ik ben zelf in dat rondetafelgesprek op zoek gegaan naar de controverses die er eventueel zouden kunnen zijn rond kweekvlees	Include
Production	Transparency is needed about production and what is inside the product.	Ook hier geldt: laat zien hoe het productieproces eruitziet.	Include

**Table 5.4:** Interpretation of topic names from NMF topic modelling on the parliamentary proceedings dataset.

A challenge was encountered during the interpretation of topics using topic modelling, mainly due to the temporal clustering of the majority of documents around the 2020 debate. This resulted in topics often being closely intertwined with one another, making it more challenging to differentiate and exclude them. However, also when using 8 topics for NMF topic modelling difficulties were encountered in interpretation, given the concentration of documents around a specific moment in time. Moreover, the absence of explicit events related to certain topics made it difficult to exclude any, as all seemed to be allocated to a specific frame. As a consequence, none of the 16 topics were excluded, and among them, two exhibited a negative connotation towards cultivated meat.

The topic labelled as 'Successful' held a negative undertone, reflecting concerns about the product's potential lack of success upon market launch. This stemmed from factors such as pricing or naming issues, which were also found in other topic labels (specifically, the negative frames 'Name for cultivated meat' and 'Price'). Another negative topic identified was 'Replace livestock,' indicating concerns among individuals who feared that the introduction of cultivated meat to the market might not align with current farming practices. Moreover, the frame 'Plant-based alternative' suggests that there is no necessity for cultivated meat, as a vegan diet offers a solution considering environmental and animal welfare concerns.

The topics identified in this dataset predominantly focused on research, industry practices, and product safety as commonly debated areas on cultivated meat by the parliament. Key discussions included the transparency and responsibility of the cultivated meat industry, the necessary research for optimal production, and concerns regarding product safety. However, taken together, the data from this topic modelling analysis lacked reliability primarily because it was concentrated around a single moment in time. Consequently, the area plot does not provide substantial insights and is included in Appendix J for reference.

## Comparing Datasets

When comparing the three different datasets based on their identified frames, interesting patterns were found. For instance, the frame ‘Replace livestock’ reappears in both the Twitter and parliamentary proceedings datasets, suggesting a common concern. Similarly, in the news dataset, a similar concern is observed with the frame labelled ‘meat tax.’ underscoring a common frame across all three datasets. This shared frame revolves around the fear concerning changes in current farming practices.

Furthermore, two other frames were observed in all three datasets, encompassing both animal welfare and climate change frames. This indicates a correlation between discussions on cultivated meat and concerns related to animal welfare and climate change, suggesting cultivated meat as a potential solution to these issues. The fact that these frames were found across all three datasets suggests an association between cultivated meat and broader issues related to the ethical treatment of animals and environmental sustainability relevant to all three datasets.

In the context of the Twitter dataset, frames were found that delve into the specific product properties of cultivated meat. These frames focus on aspects like taste and willingness to try, as represented by the frames ‘Taste cultivated meat’ and ‘Not try cultivated meat.’ Additionally, Twitter users exhibit a heightened concern about the name ‘kweekvlees,’ with two frames allocated to this term. The abundance of tweets expressing discontent with the term suggests a notable sensitivity to the name associated with cultivated meat among Twitter users.





In the news dataset, a distinct frame centres around the government, emphasising the need for legislation to support the cultivated meat industry. Interestingly, a similar frame is identified in the parliamentary dataset. This dual perspective reflects the news dataset’s focus on legislative aspects concerning cultivated meat and the parliament’s role in shaping its trajectory. Moreover, both the Twitter and news datasets share a common frame that expects cultivated meat as the future. This shared frame in both datasets reflects a widespread perception and discussion of cultivated meat as a crucial aspect of the future landscape.

Finally, within the parliamentary dataset, the identified frames highlight specific concerns related to safety, transparency in the industry, and EFSA approval. Additionally, there is a frame found expressing the potential polarisation surrounding this product. This dataset reveals distinct concerns, showcasing the parliament’s focused attention on the future trajectory of this product and the decisions it needs to make.

In conclusion, the comparison of the three datasets, Twitter, news, and parliamentary proceedings, shows both patterns and distinctions in the identified frames associated with cultivated meat. The answer to the second specific [Research Question](#) regarding the framing concept is now addressed. These frames have been detailed in the dataset-specific tables presented earlier and further compared across the datasets.

## 5.2 Stakeholder Perspectives

In this chapter, we explored the perspectives of diverse stakeholders to address the third specific [Research Question](#). The key stakeholder groups identified included the industry, farmers, government, and consumers. Figure 5.13 provides an overview of the stakeholder analysis and the insights into this question. Further details about the content of this figure are elaborated below.

	Stakeholders	Frame	Tone of Voice	Quote
	<b>Industry</b>	Cultivated meat is equivalent to conventional meat	Highlighting the benefits of cultivated meat (mostly the environmental and animal welfare benefits)	"We focus most on the kitchen; so, a sausage in a pan and not a petri dish in the lab. That's why we call it cultivated meat instead of cultured meat." ~ Participant 1
	<b>Farmers</b>	Cultivated meat is unnatural compared to real meat	Sceptical towards cultivated meat	"I am very sceptical about that because cultivated meat cannot be tasty, and I do not believe that it emits low CO2 or consumes little water." ~ Participant 2
	<b>Government</b> Political parties <u>Pro</u>	Cultivated meat is beneficial for the environment and animal welfare	Highlighting the benefits when comparing with current bio-industry practices	"The livestock in the Netherlands is far too large. Cultivated meat is an excellent long-term alternative when it comes to reducing the environmental impact of livestock farming, with minimal use of water and land and minimal greenhouse gas emissions." ~D66
	<b>Government</b> Political parties <u>Con</u>	Cultivated meat is unnatural and unsafe (cancerous)	Sceptical/patronizing	"There's already pressure to want to influence everything. You're not allowed to eat meat anymore. We've been eating meat for thousands of years. That's very natural. Cultivated meat is unnatural." ~ PVV
	<b>Consumers</b>	7 frames influenced by demographic factors and political preferences	These different frames give rise to different tones of voices	Not applicable

**Figure 5.13:** Stakeholder analysis overview, presenting identified frames, tones of voice, and quotes extracted from interviews. Created using the tool Miro.

### 5.2.1 Industry

A deeper understanding was desired into the cultivated meat industry, including the tone of voice and frames often used by them. Therefore, an interview was conducted with Participant 1, who is employed in a Dutch cultivated meat company. Participant 1 emphasised the critical importance of making cultivated meat burgers more affordable for a broader audience to truly impact the meat industry. Therefore, scaling up practices is currently the industry's primary focus. According to Participant 1, their product's taste has already been developed in the past few years comparable to conventional meat.

Before large-scale production of cultivated meat becomes feasible, approval by the European Food Safety Authority (EFSA) is required. Participant 1 mentioned that European companies specialising in cultivated meat have not yet submitted their dossiers to the EFSA. The same applies to the Netherlands, which, despite being a leader in cultivated meat research in Europe, has not submitted its already prepared report. The approval process firstly involves EFSA and subsequently the European Commission, requiring a majority of the votes for it to be accepted. Nevertheless, according to Participant 1, this could be complicated by the influence of the rising right-wing parties less supportive of cultivated meat in Europe. Given the current limitations in Europe, the



company of Participant 1 is redirecting its focus to selling the product in Singapore and the United States.

Nonetheless, research still goes on in the Netherlands, where cultivated meat tastings are being prepared to validate its comparability to conventional meat with possible consumers of the product. These tastings aim to enhance the product and align it more closely with consumer expectations. To further increase consumer acceptance, an alternative explored is the production of a hybrid meat form partly plant-based and partly cultivated meat. This approach aligns with both markets' goals of reducing greenhouse gas emissions and improving animal welfare. The hybrid form addresses taste concerns associated with some plant-based products while benefiting from lower emissions compared to cultivated meat alone.

Regardless of these efforts, a significant obstacle identified by Participant 1 is the limited awareness and understanding of cultivated meat among the public. Many individuals harbour unnatural feelings toward it. To overcome this, the industry aims to frame cultivated meat as real meat, showcasing it in familiar contexts like sausages in a pan or burgers on a plate, steering away from lab-centred images. This strategy faces challenges during media coverage, as journalists often prioritise showcasing labs over the final product, primarily because the production process is more novel than the final product itself. That is also the reason why their company refers to cultivated meat as 'gecultiveerd vlees' instead of 'kweekvlees'. Despite current low consumer awareness and acceptance, Participant 1 believes that as societal awareness grows about the ethical treatment of animals, cultivated meat will become increasingly appealing to consumers in the future.

*“We focus most on the kitchen; so, a sausage in a pan and not a petri dish in the lab. That’s why we call it cultivated meat instead of cultured meat.”*

Participant 1

Shifting the focus to Italy, which appears to be one of the European countries resistant to cultivated meat, an interview was conducted with Participant 4. This individual is associated with a non-profit organisation focused on cultivated meat in Italy. Participant 4 pointed out that the farming lobby, Coldiretti, played a pivotal role in legislation against cultivated meat in Italy. Coldiretti has significant influence due to its size, making it advantageous to secure their support during elections, as assisting them can translate into more votes for a political party. Coldiretti also distributed flyers about cultivated meat, highlighting the use of bioreactors in its production, while conveniently excluding the fact that bioreactors have already been in use for an extended period. These flyers carry significant influence as many people still lack understanding about the process of cultivated meat production. The frame they use is the one that cultivated meat is synthetic and more related to chemistry than actual food. Participant 4 highlights that the primary challenge lies in providing accurate information about cultivated meat to the public, allowing them to form their own opinions rather than solely relying on information disseminated by farmers through their flyers.

Participant 4 is concerned that Italy might set an example for other European farmer associations, prompting them to follow in their countries, as already seen in France and Austria. Should this happen, gaining approval for cultivated meat from the European Commission and securing majority votes across countries could become more challenging. Nevertheless, Participant 4 believes that if EFSA grants approval, Italy may find itself almost forced to remove its law against cultivated meat. Fortunately, the Green Party in Italy supports cultivated meat, but it finds itself outnumbered by right-wing parties, mirroring the situation where scientists advocating for cultivated meat are outnumbered by farmers. Additionally, Italy, much like the Netherlands, is experiencing an ageing population. The proportion of older individuals is growing in comparison to the younger demographic. According to Participant 4, these older individuals tend to hold more conservative views, making them more resistant to the adoption of cultivated meat.

Finally, Participant 4 noted that at present, cultivated meat mostly attracts private investors. Nevertheless, a more favourable scenario would involve government investment, similar to the approach adopted by the Netherlands. The reason behind this is that government investment would lead to open-source information about the product, thereby enhancing research. This, in turn, would facilitate product improvement and reduce production costs, ultimately making cultivated meat more affordable for the broad audience.

Information from the EFSA colloquium about cultivated meat was used to gather qualitative data about this organisation (EFSA, 2022a). The EFSA plays a crucial role in providing independent



scientific advice on matters related to food safety. This advice is instrumental in offering sound scientific guidance for making final legislative or regulatory decisions, ultimately ensuring food safety for European consumers. For novel food items such as cultivated meat, the industry is required to submit an application for authorisation before introducing their products to the EU market. As of now, no application has been submitted to EFSA specifically requesting scientific advice on cultivated meat. It's important to note that EFSA maintains a neutral stance on cultivated meat and operates as an independent platform responsible for reviewing research on this subject, refraining from taking a supportive or opposing stance.

### 5.2.2 Farmers

To gain insights into the Dutch farmers on their viewpoints on cultivated meat, two farmers were interviewed. One of whom was unfamiliar with cultivated meat (Participant 2), and another who expressed interest in investing in cultivated meat (Participant 6). Additionally, another farmer, who held opposition to cultivated meat but was already knowledgeable about the product, was contacted via email. Furthermore, an individual from an NGO that invests in farmers aspiring to transform their farms into cultivated meat farms was interviewed (Participant 5).

Participant 2, initially unfamiliar with cultivated meat, expressed scepticism about the product after receiving an explanation. They believe consumers prefer to know the origin of their products and would prefer cultivated meat from a farmer rather than a lab. Participant 2 emphasised the positive perception consumers have of the meat quality from farms compared to supermarkets, indicating a potential lack of interest in cultivated meat as the consumers would like to know where the product comes from. Furthermore, when talking about the animal welfare frame of cultivated meat, Participant 2 stated that in most cases the farming practices differ from shown advertisements like those of Wakker Dier. Taken together, Participant 2 does not foresee collaboration with cultivated meat companies in the future. However, Participant 2 highlighted the considerable pressure farmers face from governmental regulations, leading them to consider transitioning to more sustainable practices like biological farming.

*“I am very sceptical because cultivated meat cannot be tasty, and I do not believe that it emits little CO<sub>2</sub> or consumes little water.”* Participant 2

As Participant 2 was initially unaware of cultivated meat, an additional farmer opposing the product was contacted via email. This farmer also expressed scepticism about the product, considering it an unnecessary way to encourage dietary change. Concerns were raised regarding the nutritional value, as well as the perceived ultra-processed nature of the product with numerous additives. The farmer also noted the energy-intensive production process and the continued necessity of animals for the initial cell extraction, expressing doubts about consumer willingness to adopt cultivated meat while it remains more expensive than conventional meat.

To get insights into the gap between farmers and the cultivated meat industry, an interview was conducted with Participant 5. Their organisation assists Dutch farmers in transitioning their farms to cultivated meat production by providing access to relevant technology and cultivated meat companies. Participant 5 underscores the importance of involving farmers early in the process, promoting collaboration instead of opposition, as farmers already possess the essential characteristics for meat production. This approach is believed to accelerate cultivated meat production and minimise resistance from the farmers. Participant 5 mentioned that approximately 10% of the farmers are open to the idea, particularly those who are higher educated and younger. The 90% of more resistant farmers might be attributed to the conservative stance among many Dutch farmers, often linked to Christian beliefs (Kleis, 2021). Another factor contributing to farmer resistance is the concern that the cultivated meat industry could negatively impact their conventional meat products. However, despite the majority of farmers expressing reservations about cultivated meat. Participant 5 observed that lobbying efforts are not as strong as in other European countries. Participant 5 also acknowledges the influence of the government as individuals currently holding influential positions in politics tend to be less receptive to cultivated meat. This could be because these influential positions are mostly covered by those who are older and more conservative. Furthermore, Participant 5 believes it is currently less meaningful to seek consumer opinions since cultivated meat is not yet available in the market. Therefore consumers cannot form opinions based on seeing or tasting the product making it even more important to implement the cultivated meat tastings. Consequently, Participant 5 thinks that because the product is not yet on the market, misinformation circles around cultivated meat.

*“The misinformation about cultivated meat is a chicken and egg story. Because the product doesn’t exist yet, consumers cannot experience it, so consumer acceptance is pointless.”* Participant 5

Finally, an interview was conducted with Participant 6, a farmer who is more supportive of cultivated meat. Although Participant 6 does not represent the majority of farmers, constituting only 10%, exploring the perspectives of this farmer is still intriguing. Currently, Participant 6 sustains sufficient income through meat sales from farming, allowing him to invest in cultivated meat for the future. Participant 6 aspires to generate enough income from cultivated meat, ultimately reducing the scale of their existing meat production. In addition, Participant 6 is enthusiastic about informing fellow farmers about cultivated meat’s potential by delivering lectures, emphasising that it can be viewed as an opportunity rather than only a negative development. Participant 6 recognises the unsustainable nature of current meat production methods and sees cultivated meat as one of the viable solutions within the next decade. Notably, even Participant 6’s daughter pointed out:

*“Look Dad, you’re going to have to change eventually.”* Participant 6

However, Participant 6 believes that an alternative name should be adopted for the product instead of the Dutch term ‘kweekvlees.’ They think that this current term may not motivate consumers to purchase the product. Nevertheless, Participant 6 expresses confidence that the availability of cultivated meat tastings will contribute to increased acceptance, although the responsibility for this lies with the cultivated meat companies. Currently, Participant 6 faces challenges in obtaining permits from the municipality as the product is novel and there are no established legislations or rules. According to Participant 6, farmers in the Netherlands are slightly more progressive than those in Italy and France, aiding the introduction of the product in the Netherlands.

At present, Participant 6 is collaborating with a Dutch cultivated meat company, actively researching the most efficient and environmentally friendly cells from his cows. The focus is on identifying cells that grow optimally and have minimal environmental impact. In addition to cells, the collaboration is also exploring the most suitable proteins for the growth medium of cultivated meat cells. Ideally, these proteins should not be essential for human consumption, optimising the use of available proteins. While considering potential places for selling cultivated meat, such as restaurants and supermarkets, Participant 6 finds the product suitable for food festivals that prioritise sustainable meat sourcing. However, they underscore that the crucial aspect right now is to gather support from fellow farmers for the product of cultivated meat.

### 5.2.3 Government

Through discussions with Participant 3 from the Ministry of Agriculture, Nature, and Food Quality, I gained valuable insights into the government’s role in the cultivated meat industry. According to Participant 3, collaboration with farmers is crucial by involving them early in the process and sharing ideas about the product. This collaboration is deemed crucial, as a product like cultivated meat has the potential to provoke protests from farmers. Besides, collaboration is needed since cultivating meat can be carried out on the farmers’ premises. Participant 3 notes that farmers in the Netherlands exhibit a more progressive stance compared to their counterparts in other European countries. The lobby against cultivated meat is not as strong in the Netherlands as in these countries. Additionally, Participant 3 believes that the launch of the product in Singapore and the United States can positively influence acceptance in the Netherlands and across Europe when this is successful. They argue that the already established presence of cultivated meat in these countries may contribute to higher consumer acceptance. Furthermore, Participant 3 highlights the lack of food culture in the Netherlands compared to countries like Italy, suggesting that the integration of cultivated meat would be more feasible in the Dutch context.

*“We need farmers because not only can production take place on their land, but collaboration is crucial for successfully launching cultivated meat.”* Participant 3

In the discussion with Participant 3 regarding consumer acceptance, they stated that it is premature in the cultivated meat development phase to assess consumer acceptance. Currently, the primary focus is on obtaining approval for the safety of the product. However, Participant 3 underscores the significance of keeping consumers informed about developments in this domain, ensuring they have clear expectations regarding the product’s progress and anticipated timelines. Moreover,

Participant 3 notes the substantial influence of the media on consumer acceptance. They highlight the impact of media outlets, with left-leaning sources like de Volkskrant and right-leaning sources like the Telegraaf, the latter being more opposed to cultivated meat, in shaping consumer perspectives.

To understand the stance of Dutch political parties on cultivated meat, various parties were examined. Firstly, the liberal centre-right party VVD and the democratic centre-left party D66 put forth a motion to approve cultivated meat tastings. It was apparent from this motion that both parties were advocating for the support of cultivated meat. The motion garnered support from all other parties, including the Christian parties, except for the PVV and FVD, both of which are right-populist parties (Tweede-Kamer, 2023). Notably, BBB (a conservative right party representing farmers) expressed support for the motion, although their stance on the product was not explicitly stated in the ‘Grote Verkiezingsshow’ podcast (Bregman and Frederik, 2023). To clarify, contacting the BBB via email proved insightful. A representative of the party mentioned its belief in the free market dynamics: if there is a demand for the product, the market will respond accordingly. The representative clarified that if consumers express a desire for the product, they are not opposed to its production. However, the party BBB adopts a more nuanced perspective on cultivated meat, acknowledging some potential drawbacks associated with it. Despite these considerations, they do not stand against its development.

In correspondence with a representative of the VVD via email, they expressed the view that innovation plays a pivotal role in the ongoing agricultural transition. The VVD considers cultivated meat as an example that can facilitate this transition in a sustainable manner. However, they mention the importance of preserving individuals’ freedom to choose their dietary preferences, whether it be conventional, cultivated, or plant-based meat. According to the representative of the VVD, significant barriers exist, including the challenge of aligning legislation with novel products, as industry research and innovation often outpace government regulations. Additionally, they identify consumer acceptance as another barrier, noting the importance of providing clear information about the product and its functionality.

The frames mostly employed by pro-cultivated meat parties revolve around animal welfare and sustainability benefits. Conversely, parties opposing the product use frames emphasise its unnatural characteristics, potential safety concerns including links to cancer, and the fear of losing familiar aspects of daily life, such as meat consumption. These opposing frames, particularly from parties like the PVV, were found in the parliamentary proceedings dataset. The recent increase in PVV votes since the elections of 2023, implies a growing faction in the House of Representatives against cultivated meat. However, given the pro-cultivated meat stance of other parties, the topic might become a discussion point during coalition negotiations, possibly leading to a consensus that includes the PVV supporting cultivated meat.

Moreover, insights from the farmer interviews highlighted the necessity for farmers to obtain permits from municipalities. To delve deeper into this aspect, an interview was conducted with the municipality of Delft (Participant 7) to view their perspective on cultivated meat. The discussion revealed that the municipality currently has limited plans for cultivated meat, as it is not yet a prominent issue in their portfolio. This lack of focus on cultivated meat makes it challenging for farmers to secure the necessary permits. However, the municipality does play a role in assisting startups with fundraising and financing their business.

Participant 7 thinks it is important to avoid direct competition between conventional and cultivated meat. They recommended refraining from terms like ‘clean meat’ for cultivated meat. Additionally, Participant 7 stressed the current priority of reducing the price of cultivated meat to increase impact and noted the necessity for supportive legislation and laws. Participant 7 views cultivated meat as one of various alternatives, including insects, algae, and other plant-based protein sources, for the protein transition. Participant 7 highlighted the significance of receiving a positive association with cultivated meat upon its introduction to the Dutch market, focusing on its favourable aspects without downgrading conventional meat.

*“It is important not to position conventional meat and cultured meat directly against each other to prevent polarisation.” Participant 7*

#### 5.2.4 Consumers

As outlined by the majority of participants, consumers play a crucial role in the process, although their significance is somewhat diminished at this particular stage. This is not only because consumer perspectives are expected to shift towards a more environmentally and animal-friendly viewpoint in the coming years, but also because it is illogical to inquire about consumer opinions on a product that is not yet available in the market for them to experience. Additionally, given that I, as the researcher, have a network primarily consisting of younger individuals, my discussions would be limited to a select group. Consequently, it is more practical to rely on broader consumer panels to obtain comprehensive insights.

Multiple panels have been conducted to measure consumer acceptance of cultivated meat. For instance, a panel conducted by ABN-AMRO (2021) involved 1017 participants. The results revealed that 42% of the panellists would consider consuming cultivated meat if the taste is satisfactory, while 23% were undecided, and 35% would probably or definitely not eat cultivated meat. This study also highlighted that the name for cultivated meat does not sound appealing and could discourage consumers from trying the product. Another panel conducted by the right-leaning newspaper Telegraaf surveyed their readers on the statement ‘cultivated meat is a good alternative.’ Astonishingly, 76% of the 3595 participants disagreed (Telegraaf, 2023). Given that Telegraaf’s readership leans towards the political right, their disagreement with cultivated meat is somewhat expected. These consumer panels indicate that a substantial portion of the population is not yet ready for cultivated meat, but the groundwork is laid. Nonetheless, once consumers develop feelings of fear towards a new product like cultivated meat, it is challenging to change this as such reactions are not easily dispelled with facts.

## 5.3 Serious Game

In this results section concerning the serious game, I delve into the exploration of the fourth specific [Research Question](#). This question centres on the development of the game, which is based on insights found from textual data analysis and stakeholder perspectives gathered from interviews. The goal of the game is to provide a tool for consumers to promote awareness and to show the complexity of dynamics between stakeholders within the cultivated meat ecosystem. Firstly an explanation of the game will be provided, including the specific results from textual data and interview analyses used for game design.

### 5.3.1 Gameplay Overview

Before delving into the various iterations and games played, let's first establish an overview of the final game design. This will provide clarity on the game before exploring the evolution. The game, titled 'Groenverdieners,' is structured as a role-playing, strategy game, a genre chosen to enhance the 'Play' factor of the game design described by Harteveld (2011). In this game, three roles are played, reflecting key stakeholders identified in the stakeholder analysis. The first role is that of the governmental figure, represented by 'Ab the government official' (Ab de Ambtenaar in Dutch), who carries the role of Minister of Agriculture, Nature, and Food Quality. The second role is portrayed by a farmer (Berta de Boer) and the third player represents the cultivated meat company, referred to as More for Meat (MfM). Consequently, the game requires a minimum of three players, with a maximum capacity of nine players. Ideally, players are grouped into teams of three whenever feasible. The game typically spans around 45 minutes as observed in the gameplay phases.

At the outset of the game, the game rules are used to set the stage, explaining the landscape within which the players will navigate. This includes sketching the three different roles within the game, their potential implications and alliances, and roughly outlining each player's goals. Additionally, the current status of cultivated meat, situated as not yet accessible in Europe with a prototype in development, is explained. By setting this stage, the game incorporates the storytelling element as explained by Djafarova et al. (2023) in the art of serious game design. Following this description, players select their desired roles. Subsequently, all players receive their personal goal cards corresponding to their chosen roles. These cards show complete insights into their respective roles and outline the specific goal needed to win the game. The governmental role aims to minimise CO2 emission blocks, the farmer's objective is to maintain their farm and achieve financial stability by collecting 10 money coins, while the cultivated meat company strives to successfully introduce cultivated meat to the market and collect 5 money coins. To track their progress, players receive money and CO2 meters as indicated on their goal cards, using these tools to illustrate their trajectory throughout the game. The players must achieve their personal goals within six rounds, indicated with six years. They begin by positioning the starting pawn on the first year of the timeline. The setup of the game is shown in Figure 5.14.



Figure 5.14: An overview of the final game design setup.



The game operates as a strategic card game, where players select option cards during gameplay. These option cards entail consequences that remain unknown until chosen. Initially, these cards are placed with their choice side facing up, revealing their white side. The coloured side, which represents the consequences, remains concealed, leaving players unaware of the potential outcomes of their choices. Each player has nine of these option cards available to them. An example of these option cards for each player is shown in Figure 5.15.



**Figure 5.15:** Examples of the front side of the playing cards (white, representing options) and the back side (coloured, depicting consequences) for the three players: Ab (red), Berta (green), and More for Meat (blue).

These option cards were crafted based on insights from both textual data analysis and stakeholder analysis. Through these analyses, prevalent frames were identified, which inform the creation of personalised goal cards for each player in the game. For instance, in-depth interviews revealed farmers' scepticism towards cultivated meat production, which is reflected in their personal goal cards. Additionally, farmers expressed feeling increasingly pressured by the government to adopt greener practices, a sentiment also integrated into their personal goal card. Further insights from parliamentary proceedings data highlighted frames related to research, driving the inclusion of cards supporting investment in innovative technologies such as cultivated meat, or investment in alternatives for meat. Additionally, feedback from social media data indicated a lack of appeal in the product's name, leading to the incorporation of a card suggesting consideration for a new name for the Dutch 'kweekvlees.' Real-life events, such as the approved motion of cultivated meat tasting and potential EFSA approval, are also reflected in the option cards. Furthermore, mostly the interview with the participant from the cultivated meat company provided insights into possible choices, which helped with the creation of the MfM option cards. Additionally, discussions around farmer meetings regarding new green technologies inspired the inclusion of the option card for Berta to attend such a meeting. The final set of nine option cards for each player including the consequences is presented in Appendix M.

During the game, two additional cards are introduced to provide further insights into cultivated meat. One of these cards becomes available when the farmer chooses the option card to attend a meeting on green farming practices. In this scenario, the MfM player explains the concept of cultivated meat, as detailed on the card's consequence side, thereby educating the players about this technology during gameplay. The MfM player explains this with the help of the provided text and figure on this cultivated meat process card. The other additional card regards a choice available to the MfM player. This card involves a marketing strategy, whereby the MfM player can opt to explore different marketing approaches by opening the marketing strategy card. This card presents three distinct options for marketing the product to consumers, each linked to frames identified in the study by Bryant and Dillard (2019). The MfM player selects one of these marketing strategies and gains insight into the various frames used in the media.

The game includes six rounds (indicated as years) during which players strive to achieve their personal goals. These rounds are structured into five steps.

1. The first step involves selecting one of the option cards. Players can discuss this choice with their team members (if playing with more than three players). Once chosen, the option card is placed in front of the player.
2. In the second step, players execute the action specified on their option cards, starting with player Ab, followed by Berta, and then MfM. If necessary, players pay the required amount of money coins. The card's content is then read aloud to all players, and its consequence is revealed as the card is flipped over. If the action results in CO<sub>2</sub> emission, CO<sub>2</sub> coins are added to the CO<sub>2</sub> meter.
3. Step three encompasses the income phase and CO<sub>2</sub> emission phase. Each player receives the money indicated for this round and emits the corresponding amount of CO<sub>2</sub> as indicated on their CO<sub>2</sub> and money meters.
4. The fourth step involves a discussion phase where players negotiate what they require or don't require from other players in the subsequent round.
5. Finally, in step five, players advance the pawn to the next year. The game concludes once all six rounds have been completed.

The game instructions are provided in a separate document encompassing the rules, setup, personal goal cards for each player, all option cards, and additional marketing strategy and cultivated meat process cards. These instructions represent the final game design. However, achieving this stage involved a series of iterative refinements through multiple interactions and gameplay sessions. Initially, the game was tested with CDI students, followed by iterations. Subsequently, the game underwent further testing with friends, followed by additional iterations. Finally, the refined game was played with the intended target audience, and their feedback was used to make final suggestions for game iteration. These gameplay and iterations are explained further below.

### 5.3.2 First Gameplay

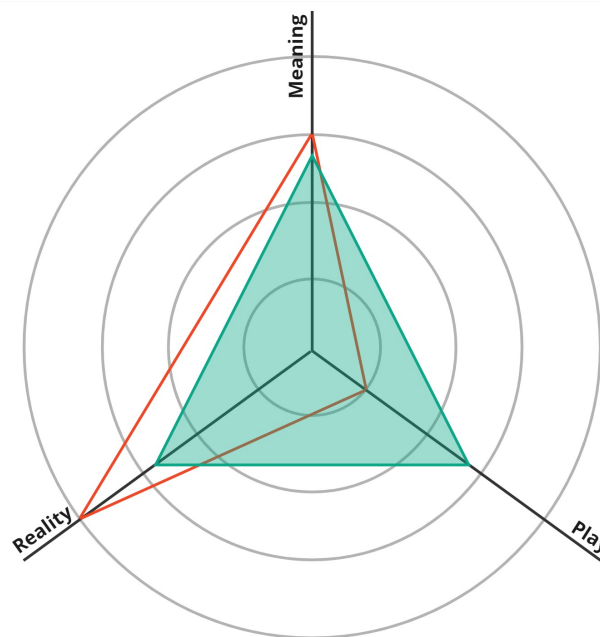
Prior to the start of the first gameplay with CDI students, the first version of the rules of the game and the personal goals of the players were established. For the player assuming the role of the Ministry of Agriculture, Nature, and Food Quality (referred to as Ab), the objective was to restrict CO<sub>2</sub> emissions to fewer than 10 blocks. The farmer (referred to as Berta) aimed to maintain ownership of her farm and avoid selling it to the government. The cultivated meat company's goal (represented by More for Meat, abbreviated as MfM) was to introduce its cultivated meat product into the Dutch market.

The first game was played with students from the CDI master's degree program, all of whom had previously participated in the brainstorming session. The first prototype was utilised for this gameplay session. Details regarding the first gameplay setup can be found in Appendix K.1. During this session, it became evident that the balance between money and CO<sub>2</sub> coins was not optimal. Both MfM and Berta had excessive money, giving them advantages in decision-making, while player Ab had insufficient money. Consequently, for the subsequent iteration, it was decided to adjust the money balance within the game. Players would now begin with varying amounts of money, reflecting the reality that the government typically possesses more financial resources than individual farmers. Additionally, certain choices within the game would now have higher or lower costs based on gameplay dynamics. This adjustment aimed to enhance gameplay and align with both the 'Play' and 'Reality' aspects of the design space for game design, as proposed by Hartevelde (2011).

Following the initial gameplay, adjustments were made to the players' goals. This revision was driven by the realisation that some goals were either too challenging or too easily achievable, as observed during the first gameplay session. For player Ab, achieving a CO<sub>2</sub> level below 10 during the game proved too difficult. Consequently, it was decided that although the CO<sub>2</sub> level could surpass 10 during the game, it must ultimately be reduced to 10 or lower by the end of the game. Conversely, player Berta's goal was too easy to accomplish; simply maintaining ownership of the farm was insufficiently challenging. To address this, it was determined that in addition to maintaining ownership of the farm, Berta must also end the game in a stable financial position with a

minimum of 10 money coins. Similarly, the objectives for the MfM player were revised. In addition to launching the cultivated meat product, MfM must also finish the game with a minimum of 5 money coins to ensure a balanced and engaging gameplay experience.

During this gameplay session, it became evident that the option cards were closely tied to reality, but this came at the expense of the ‘Play’ factor. Thus, there was an imbalance, with an excess of realism and a deficiency of playfulness (refer to Figure 5.16). Consequently, the cards underwent further alterations to enhance their playability while still maintaining a connection to reality. Additionally, based on insights gained from this initial gameplay, it was decided to provide players with more complete information about the game environment, beyond just their individual cards. For example, more about the other players and what they can or cannot do in this game. This additional context enables players to better understand their position within the game, facilitating informed decision-making before engaging in the first discussion.



**Figure 5.16:** The radar diagram illustrating the balance of the three key factors of serious game design (Reality, Meaning, and Play, Hartevelde, 2011). The green area indicates an even balance between these factors, and the red area indicates an uneven distribution as observed in the first gameplay. Created using the tool Miro.

Next, the progression of the game and the decisions made by the players are noteworthy. What’s intriguing is that the game varies each time it’s played due to the impact of the choices on both individual players and others. For instance, during this gameplay, Ab’s initial decision was to assist Berta in making her farm more environmentally friendly. This had a direct and beneficial effect on both Ab and Berta. However, Berta’s first choice to sell a significant portion of her products resulted in immediate financial gain but also introduced additional CO2 blocks into the game, which wasn’t favourable for Ab. Throughout the initial round, it was apparent that Ab and Berta often collaborated or clashed, while the third player, MfM, remained somewhat in the background. This trend persisted throughout the game, driving adjustments to include MfM more actively in interactions with other players the next game. To achieve this, additional cards were introduced and existing ones were modified to enhance MfM’s engagement with other players, prioritising playability over strict commitment to reality.

From this initial gameplay session, it also became evident that having someone to lead the game, myself, present during the game is crucial. Not only does this ensure smooth gameplay, but it also allows for real-time feedback collection, which proved to be useful. Additionally, my presence aided players in understanding how to initiate the game effectively. Once underway, the game flowed smoothly and was enjoyable to play according to the CDI students. However, they expressed a wish to have a clearer understanding of the duration of each game phase. Consequently, it was decided to replace the term ‘round’ with ‘year’ to provide a more tangible sense of time progression within the game, also more related to Reality. As such, the game spanned five years, during which players must achieve their goals. Certain steps within the game may require more time to



complete; for instance, the EFSA application process now spans two years instead of one. Moreover, it became apparent that providing an additional explanation about cultivated meat would be beneficial. Consequently, it was decided that attending the lecture would prompt an explanation of cultivated meat through the unveiling of a card for the farmer.

At the end of the game, the CDI students remarked that the game had a strong foundation, but suggested that some adjustments to the distribution of CO<sub>2</sub> coins and money would enhance its balance. They observed a balance issue between realism and playability, indicating a preference for more playfulness while still appreciating the meaning value derived from the game's complexity of the cultivated meat industry. Nonetheless, they expressed enjoyment in playing the game, noting that it underscored the necessity of collaboration with the farmer, which is a reflection of real-world dynamics.

*“It quickly becomes clear that you have to work together with the farmer”*

### 5.3.3 Second Gameplay

After the first gameplay, the game underwent additional iteration, resulting in the creation of new cards. These adjustments were integrated into the setup for the second gameplay session with friends, as depicted in Appendix K.2. Unlike the CDI students, these friends were not briefed on the game's objectives as they had not participated in the brainstorming sessions; however, they were familiar with the concept of cultivated meat. The game was played with six players, with two players assigned to each role. This setup facilitated engaging discussions between the pairs of players, resulting in a significantly improved gameplay experience compared to the first session which was played with 3 CDI students. The gameplay proved to be highly enjoyable and informative as stated by the players. All five rounds were completed, and the decisions made by all three roles are documented in Appendix L.1.

*“I really enjoyed playing, and even after the game, I continued to think about it!”*

The second gameplay proved different from the first, particularly due to financial challenges faced by Berta, the farmer, which significantly influenced her decision-making. These difficulties prompted her to protest against the government due to excessive sanctions, making it financially difficult to implement environmentally friendly farming practices without enough money. This dynamic added an intriguing layer to the game. Furthermore, MfM's involvement was more prominent compared to the initial gameplay. They relied on support from Ab and the farmer, while also offering assistance to the farmer. This encouraged a sense of collaboration among all three players, although they also worked against each other. The players enjoyed the distinct roles and expressed a desire to prolong the game even after the ending. Consequently, an additional round, extending the game to six years, was introduced as an iteration. Additionally, an extra card was added for each player, increasing the total from 8 to 9 option cards per player for the final gameplay session.

Throughout the game, there were instances where it was challenging to determine which cards affected specific players. To address this issue, it was decided to modify the cards by incorporating colours and bold text to highlight references to other players or specific terms used (such as EFSA or cultivated meat tasting). Moreover, another iteration is when a player selects an option and flips over the card, the reverse side features a different colour, thus indicating to the player that they have played that particular card.

One drawback observed in the game was the lack of clarity regarding each round and the actions to play in which order. In the initial setup, players were required to make a choice, carry out that choice (including paying or receiving coins), engage in discussion, and then commence the next round with each player receiving the money they earned or the CO<sub>2</sub> they emitted. However, players suggested that it would be more logical to first receive their roundly coins for all actions before engaging in discussion. Consequently, this sequence was adjusted in the game rules.

During and after the game, a discussion arose about cultivated meat, particularly focusing on the various roles within the cultivated meat ecosystem. This unplanned discussion was interesting, considering that it was not explicitly intended by the game design. Players mentioned that they gained insights from the game, despite their preexisting knowledge of the product. Therefore, the

factor of Meaning was evident in the game, highlighting its relevance to reality. Because according to Harteveld (2011), when Meaning is linked to Reality, the game is not meaningless.

*“The game was also really based on reality, that was fun.”*

Moreover, the players expressed their enjoyment of the game, noting that they found the diverse roles fascinating and thoroughly engaged themselves in their respective characters. They particularly enjoyed the collaborative aspect of the game.

*“You really had to collaborate together which was a very enjoyable aspect.”*

Out of the three player roles, only the MfM player successfully achieved their goal, while Berta and Ab came close. The game lasted approximately 45 minutes, with a slow start initially, but picked up speed as players became more focused on achieving their personal goals.

#### 5.3.4 Final Gameplay

Using the final game design developed after the second gameplay session, the game was played with the intended target audience, potential consumers of cultivated meat. This group consisted of three teachers from a Dutch secondary school. Unfortunately, there wasn't enough availability to play with the desired six participants. The setup of this final gameplay can be found in Appendix K.3. Before initiating the game, each participant was individually asked about their understanding of cultivated meat using the question 'What is cultivated meat?.' They were instructed to write their responses on paper. The player taking the role of Ab mentioned being unfamiliar with cultivated meat and expressed scepticism about its taste because of the name 'kweekvlees.' The player in the role of Berta, provided an inaccurate description of cultivated meat, suggesting it was related to DNA or genetically modified organisms. The third player, representing the role of MfM, identified cultivated meat as meat from the lab, demonstrating the most accurate understanding among the three players. The players completed six rounds which took them approximately 45 minutes. Details about the progression of the final gameplay can be found in Appendix L.2.

During the final gameplay, it became evident that playing with three players didn't foster as many discussions as when playing with six. However, it remained an engaging experience, and the players expressed that they had gained valuable insights. This feedback was gathered during the post-game debriefing, where players were asked if they had learned anything. Following this, they were prompted with the open-ended question, 'What did you learn?' The player in the role of Ab, who had no prior knowledge, mentioned that they now understand what cultivated meat is, explaining the process of growing meat from cow cells without the need to slaughter the animal. The player who had previously held incorrect beliefs about cultivated meat also acknowledged this new understanding. This player mentioned learning about the extensive processes involved in bringing cultivated meat to market, highlighting the complexity and the necessity of collaboration among various stakeholders. They stated,

*“It's a complex puzzle to get cultivated meat on the market. But because of the game, you see the need to work together. Luckily, we quickly figured that out.”* Player Berta

Indeed, this observation was true, as this game presented a different dynamic compared to the previous one. In this game, players Ab and Berta swiftly collaborated, unlike in the second gameplay where they initially competed against each other. This collaboration facilitated both players in achieving their respective goals. However, MfM did not manage to attain their goal as the attention of the other players was primarily focused on each other. Consequently, the MfM player experienced a sense of time pressure towards the end of the game. The players expressed appreciation for understanding the duration involved in launching a new product and the necessity of thinking forward, particularly since certain decisions needed input from other players.

*“I thought cultivated meat had something to do with DNA or GMOs, but you grow cells into meat, how interesting!”* Player Ab

Player MfM remarked that they believe the game accurately mirrors the real world. This could indicate that the 'Reality' element discussed in the book by Harteveld (2011) is represented in the game. This player suggested that playing the game multiple times could also be interesting, as it allows exploration of the various paths stakeholders could take to successfully introduce cultivated meat while ensuring the satisfaction of all parties. It raises questions about the outcomes resulting from different choices made as a government, farmer, or startup.

*“As the government, you can state that farmers should adopt greener practices, but in the game we saw how effective it can be when the government helps them with this. The farmers can invest more in sustainable solutions independently, rather than feeling pressured.”* Player MfM

At the end of the game, player Ab repeated their aversion to cultivated meat, particularly its name. They indicated they wouldn't try this product due to its unappealing and somewhat frightening sound. This stance highlights the difference between consumer awareness and consumer acceptance, demonstrating that awareness alone doesn't guarantee acceptance. Nonetheless, the players' understanding of the product and the complexity of the cultivated meat ecosystem did improve. They reported gaining knowledge about the product itself and the complicated relationships between various stakeholders in the industry. This suggests that the 'Meaning' element of game design was integrated into this game and that knowledge, as discussed in Harteveld's book, has been enhanced. This indicates that the goal of the game was achieved, addressing the fourth specific [Research Question](#).

The players mentioned final potential refinements for the game, which could be considered for future updates. One suggestion was introducing options for the MfM character, similar to those available to players Berta and Ab, enabling them to compete against each other. Currently, Berta has the ability to protest, benefiting herself but negatively impacting Ab. Whereas Ab could opt to ally with the meat lobby or exert pressure on Berta. However, it would be intriguing to introduce the possibility that the option cards of the players could also have a negative effect on MfM. Additionally, the MfM player currently lacks the option to negatively impact the other players. It would be interesting to introduce another card allowing MfM to make a decision that negatively affects one of the other players. For instance, MfM could choose a farm or cows belonging to a different farmer than Berta, thus eliminating the possibility of collaboration with Berta and making it harder for Berta to earn the high income needed to reach their personal goal. Another potential iteration could be extending the duration of the game, given the players' expressed desire to continue playing. However, this extension should maintain the time pressure experience. To achieve this, more option cards should be generated. This approach would ensure the game remains engaging and enhances the 'Play' element of game design.



# Discussion

In this chapter, I delve into a discussion of the results obtained in the course of this research. A brief overview of the key findings will be provided, the interpretation of these findings, a reflection on the theoretical framework guiding this study, and the limitations encountered. Firstly, a recap of the results is provided to answer the main research question: “What are the perspectives of different Dutch stakeholders regarding cultivated meat, and how can these perspectives be communicated to raise consumer awareness of cultivated meat?”

The study examined the tone of voice and framing used by the Dutch parliament, media, and social media regarding cultivated meat. The results indicated a mixed tone, with social media predominantly positive, general media neutral, and the parliament being primarily positive but to a lesser extent. The data also revealed common frames in Twitter, news, and parliamentary proceedings datasets, highlighting concerns about farming practice changes, animal welfare, and climate change. The study involved interviews with stakeholders, revealing that industry frames cultivated meat as equivalent to conventional meat, farmers view it as unnatural, parliamentary frames emphasise animal welfare and environmental benefits, and demographic factors and political preferences influence consumers’ frames. These different frames gave rise to different tones of voice. Lastly, a serious game was developed based on these findings, which was effective in raising consumer awareness about cultivated meat.

## 6.1 Tone of Voice

To derive meaning from these results and address the research questions, I begin with the results from the first specific research question regarding tone of voice. Literature suggests that emotionally charged messages tend to be retweeted more rapidly and frequently compared to neutral ones (Stieglitz and Dang-Xuan, 2013), and if these messages are negative they spread even faster (Antypas et al., 2023). Therefore, it was expected that social media would show a lower positive tone of voice compared to news and parliamentary data, attributing this to the possible accelerated spread of negative messages through retweets. However, the results contradicted these claims and revealed that Twitter exhibits a higher positive sentiment. This could be caused by the fact that those engaging in the topic may already have knowledge about cultivated meat, being in a niche community that frequently shows positive sentiments, as was found in the Twitter usernames. Especially when compared with other datasets, Twitter demonstrated a higher positive sentiment. The parliamentary dataset, on the other hand, displayed the highest percentage of sentiment scores below the neutral midpoint (32.5%), implying a more pessimistic tone, possibly due to higher awareness among this audience. Politicians engaging in parliamentary debates may have prior knowledge, contributing to a more critical perspective. Furthermore, politicians often use a more nuanced and analytical tone. Nevertheless, despite these factors, the overall tone of voice remained largely positive. Lastly, the news dataset portrayed mostly positive sentiment but is less positive than Twitter, as newspapers generally adopt a more neutral tone. Overall, the sentiment across all three datasets mostly leaned towards positivity, suggesting a generally positive tone of voice towards cultivated meat, answering the first specific [Research Question](#).

These findings offered a new perspective on the tone of voice within the Dutch discussion about cultivated meat, revealing a more positive sentiment than initially expected. However, the low level of awareness among the audience may influence these results significantly. ProVeg (2022b)’s study, conducted among 750 respondents, sheds light on this limited awareness. The results indicate that only 16% of participants possessed an accurate understanding of cellular agriculture, with less than 2% demonstrating a good understanding of the term. A significant portion (57%) showed no awareness, and 15% had incorrect knowledge, associating it with plant-based products or preparing methods. This reveals a substantial gap in public awareness about cellular agriculture.

## 6.2 Framing

In addition to the findings on the tone of voice, the identification of frames used by different entities added significance to the second [Research Question](#). The frames presented in the various datasets encompass both similarities and differences, with each dataset revealing a varying number of frames. Across all three datasets, common frames emerged, specifically those addressing animal welfare and climate change. These frames carry a positive connotation in relation to cultivated meat (Weinrich et al., 2020), aligning with the ethical and environmental concerns expressed by individuals who view cultivated meat as a solution. This overall frame was also highlighted in the systematic literature review conducted by Pakseresht et al., 2022, where ethical and environmental concerns stand out among the seven frames identified for consumer acceptance. Customers' perceptions of cultivated meat, as indicated by Weinrich et al., 2020, are largely influenced positively by concerns about animal welfare and the environment. Additionally, Mancini and Antonioli, 2019 demonstrated that consumers are more willing to accept meat alternatives and pay a premium price when motivated by ethical concerns. This research finding showed that 26% of participants typically reduce their meat intake due to concerns about animal welfare. Moreover, Dupont and Fiebelkorn, 2020 found that consumers perceive cultivated meat as ethically acceptable. Given that the frame related to ethical and environmental concerns was consistent across all three datasets, it appeared to be a relevant and influential frame universally. This may clarify the previously explained high positive sentiment, as these frames contribute positively towards cultivated meat. In essence, the Dutch discussion on cultivated meat was frequently linked to frames that have a favourable impact on the product's acceptance.

However, in addition to frames positively linked to cultivated meat, there was also a common negative frame across all three datasets. This frame raised concerns about changes in existing farming practices. This concern has gained relevance in recent years, overlapping with increased protest actions by farmers in the Netherlands and across Europe (Blenkinsop et al., 2024), as they perceive government-mandated changes as unjust. Consequently, this frame was present in all three datasets. People fear that cultivated meat might replace traditional livestock, eliminating conventional methods of meat production. Coupled with the implementation of a meat tax, individuals feel compelled to opt for alternative choices, encouraging a sense of imposition. This situation could worsen the polarisation between supporters and opposers of cultivated meat, as it becomes a discussion point for this division, as found as a frame in the parliamentary dataset. Such polarisation does not help in the acceptance of products like cultivated meat.

In addition to concerns about changes in current farming practices, the datasets revealed further concerns captured in various frames. Specifically, the Twitter dataset highlighted heightened worries among users regarding the product properties of cultivated meat. This aligned with existing literature that highlights the significance of product properties such as price, sensory appeal, and healthiness as pivotal factors influencing food choices (Malek et al., 2019, Scheibehenne et al., 2007). Especially attributes like price and taste play a crucial role in shaping preferences for novel foods (Barrena and Sánchez, 2013), such as cultivated meat. Therefore, ensuring that the product properties of cultivated meat align with consumer expectations is crucial for a successful market. This aligns with the Consumer Acceptance of Technology (CAT) theory, which focuses on the influence of perceived benefits (such as taste or price) on attitudes toward the adoption of new technologies. Moreover, two negative frames in the Twitter dataset focused on the name 'kweekvlees' and the perceived lack of appeal associated with it. This observation aligned with findings in the literature, where Bryant and Barnett (2019) indicated that terms like 'clean' and 'animal-free' meat produce more positive attitudes compared to terms like 'lab-grown' or 'cultivated' meat, with the latter term translating to 'kweekvlees.' Therefore, adopting a more appealing name such as 'diervriendelijk vlees', may contribute to the success of cultivated meat as well. However, this might distance farmers further from the product, suggesting that their current products are not considered animal-friendly.

The parliamentary dataset highlighted the importance of product safety, industry transparency, and EFSA approval with responsibility by the industry. It appeared that the parliament's focus is not on consumer acceptance but on ensuring the safe introduction of the product to the market while placing the responsibility on the cultivated meat companies. In contrast, the news dataset prioritised consumer acceptance in a frame and advocated for parliamentary legislation to support the cultivated meat industry. This is a contradiction, with the parliament taking a hands-off approach while the news frames parliamentary intervention. This dynamic is interesting, given



the influential role of media in shaping public perceptions and influencing the political agenda, as outlined by the political agenda-setting theory (Gilardi et al., 2022). Consequently, this difference may have future implications for politics, as media involvement could impact policies favouring the cultivated meat industry. This is already evident, as the Dutch government invested 60 million euros in subsidies for cellular agriculture (GFI, 2023), aligning with the theory that the media influences political agendas.

### 6.3 Stakeholder Perspectives

Interviews were conducted to gain in-depth insights into the stakeholders within the cultivated meat ecosystem in the Netherlands and to address the third specific [Research Question](#). These interviews explored the perspectives of the key stakeholders, namely the industry, farmers, government, and consumers. Beginning with the industry stakeholder, the industry's tone of voice centred around highlighting the advantages of cultivated meat, particularly on aspects such as animal welfare and ecological benefits. These factors have been identified as significant positive drivers influencing consumer attitudes toward cultivated meat (Weinrich et al., 2020). The industry was observed to frame cultivated meat similarly to conventional meat, potentially influenced by literature suggesting that the 'same meat' frame evokes more positive reactions from consumers compared to the 'high tech' frame (Bryant and Dillard, 2019). However, despite this industry perspective, the 'high tech' frame has been prominently featured in media coverage. This was indicated by the interviewed participant from the cultivated meat company who regularly interacts with journalists. According to the company, this is inevitable due to the newsworthy nature of the technologically advanced aspects of cultivated meat. Importantly, this media emphasis could influence the 'social influence' factor of the CAT theory, with individuals reading about this framing in the news and subsequently adopting it. Social influence plays a role in shaping attitudes toward adopting novel food technologies as outlined by this CAT theory.

Examining the perspective of farmers, an overall tone of scepticism toward cultivated meat emerged. The majority of farmers expressed reservations, viewing this alternative as unnatural. Instead, they argued that their traditional meat products and production methods are more natural compared to cultivated meat. This tone of voice was found with approximately 90% of the farmers, as revealed by one of the participants. This could be attributed to factors such as the farmers' Christian background and older demographic. These factors could contribute farmers to be less receptive to this new technological development, as in line with (Grasso et al. (2019)). However, given that many interview participants highlighted the importance of involving farmers in the process and collaborating with them, it was challenging that their stance was negative towards the product. Therefore, providing educational lectures about the product, as suggested and done by Participant 6, could assist farmers in recognising the benefits of adopting cultivated meat to their farms.

Regarding the government's stance on cultivated meat, distinct frames and tones of voices emerged, reflective of both supportive and opposing parties. Supporters of the product used frames related to animal welfare and environmental benefits, employing a tone of voice that underscores these advantages in comparison to the conventional meat industry and its associated drawbacks. While most parties shared this perspective, those in opposition to cultivated meat perceived the product as unnatural and unsafe, similar to those expressed by farmers. Their sceptical tone suggested concerns about the product, including the perception of it being unsafe or even cancerous. Furthermore, they addressed a patronising tone, asserting that they were being deprived of the choice to consume conventional meat due to the influence of left-leaning elites. This diversity in governmental frames and tones reflects the broader societal discussion and polarisation surrounding the acceptance of cultivated meat. The current political landscape, marked by the rise of conservative and right-wing parties, poses additional challenges to the successful marketing of cultivated meat (Adler, 2023).

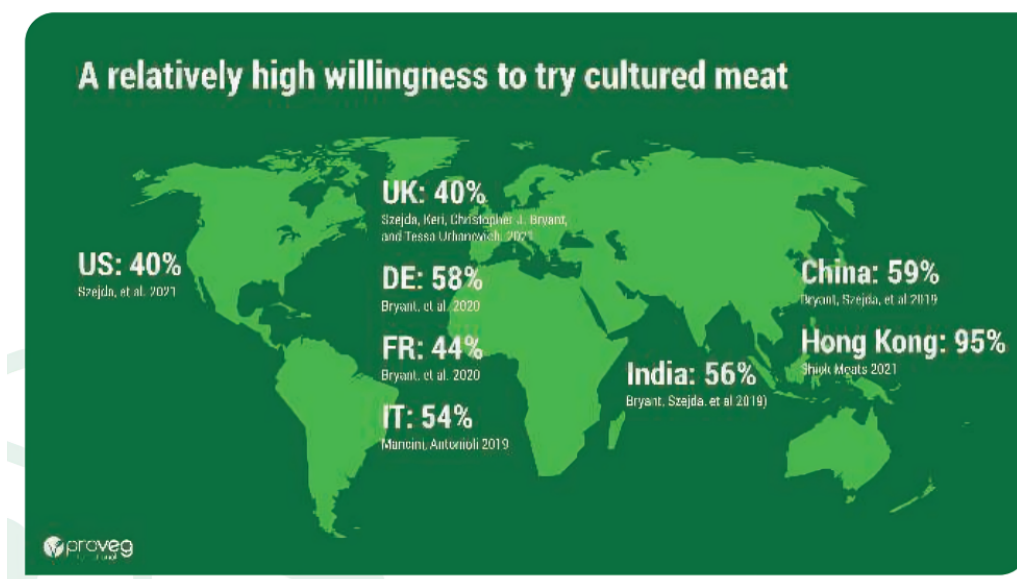
While the first three stakeholders were investigated using interviews, consumers were not individually interviewed due to the diverse range of opinions and frames within this group, making it challenging to capture the collective opinion through a single person. Additionally, consumer frames toward the product are significantly influenced by demographic factors and political preferences, as evidenced by the results. However, this contradicts the study conducted among Dutch consumers by Rolland et al. (2020), where only the education levels and meat consumption habits emerge as relevant factors affecting acceptance. Furthermore, when reexamining the theories incorporated into the theoretical framework, the Consumer Acceptance of Technology (CAT) theory

was used in understanding consumer acceptance of new technologies (Kulviwat et al., 2007). As highlighted in the introduction, the literature underscores the pivotal role of consumer awareness in consumer acceptance. Enhancement of the CAT theory is logical when acknowledging that the ‘attitude toward adoption’ concept tends to increase with heightened awareness. Notably, as found in the interview results, consumer acceptance becomes relevant only when individuals can physically experience the cultivated meat product—seeing, tasting, and smelling it. Consequently, this theory may not apply to technologies that are not yet visible in the market, such as cultivated meat that is not yet available for purchase. Therefore, it is proposed to modify the theory to focus on Consumer Acceptance of ‘Visible’ Technologies.

In the context of Dutch consumers and their attitudes toward cultivated meat, two studies were identified in the literature. One, involving 200 Dutch citizens, concluded that positive information about personal and societal benefits enhances willingness to try cultivated meat (Rolland et al., 2020). Additionally, this study highlighted that awareness of cultivated meat is the primary predictor of acceptance. Another study, involving 200 Dutch students, found that the provision of positive information fosters favourable attitudes towards cultivated meat (Bekker et al., 2017). These findings align with the Consumer Acceptance of Technology theory discussed in the theoretical framework.

Another study finds that consumers in Europe are less inclined to accept cultivated meat when compared to other continents (Figure 6.1, ProVeg, 2022b). Approximately 50% of people in the EU might be willing to try cultivated meat. However, individuals over the age of 50 show only a 20% willingness to try it, while those below 30 already exhibit an 80% willingness. Research also shows that younger and more educated individuals, as indicated by Slade (2018), show a stronger willingness to explore this technology. This aligns with the fact that older individuals generally are less receptive to this new technology (Grasso et al., 2019). Given the ageing population in Europe (Eurostat, 2024), the larger older demographic, currently wielding more political influence, is likely to resist cultivated meat. Consequently, the shift towards acceptance may hinge on the openness of new generations in the years to come.

This shift can also be influenced by the fact that the cost of conventional meat will likely come under scrutiny due to its implications for animal welfare and negative effects on the environment. There is a possibility that conventional meat prices will increase in the future, while cultivated meat prices may decrease as production processes are optimised. Initially, cultivated meat might be available to elite consumers or high-end restaurants, similar as seen now in Singapore, before becoming more accessible to a broader audience as production processes are optimised. Conclusions from the ProVeg (2022b) study are that personal benefits, followed by societal benefits, would be the key factors influencing people to embrace cultivated meat. Additionally, effective communication is deemed crucial before commercialisation, focusing on the necessity of using neutral terminology and images to convey the advantages of cultivated meat.



**Figure 6.1:** The willingness to try cultivated meat globally. *Source: ProVeg (2022b).*



## 6.4 Serious Game

Based on the findings from both the textual data analysis and stakeholder analysis, a serious game was developed. This game underwent several iterations and multiple gameplay sessions. In total, three rounds of gameplay were conducted: one involving CDI students, another with friends, and the final round with the target group. From these games, the fourth specific [Research Question](#) was addressed. Feedback from players across all rounds and the debriefing session after the final round indicated that participants acquired a deeper understanding of cultivated meat. The role-playing aspect of the game facilitated learning about the various stakeholders within the cultivated meat ecosystem, as well as their relationships and dynamics.

When aligning the designed serious game with the principles outlined in serious game design (as discussed by Hartevelde (2011)), the concept is analysed through three factors: ‘Reality,’ ‘Meaning,’ and ‘Play.’ In reviewing the first factor, reality, it was determined that the most suitable domain for this game was Public Policy. This decision was based on the fact that the game provided players with insights into the relationships among various stakeholders within the cultivated meat ecosystem. These insights were used to educate players about the complex dilemmas faced by governments, as defined by the field of public policy. The frames identified through textual data analysis and stakeholder analysis were used to define the reality concept, shaping the environment within which players engaged themselves. Additionally, this environment facilitated the storytelling and user experience aspects of the game, as it helped establish the setting, characters, and objectives from the beginning. According to Djafarova et al., 2023’s conceptual framework, storytelling is evident in the player’s interactions and choices, a prominent feature of this game. Furthermore, the user experience is evident in the environment where the players interact, facilitating communication within the game. Many players expressed the game’s connection to real-world scenarios, which they found particularly appealing, underscoring the game’s ability to reflect reality.

Incorporating Meaning into the game design was crucial to link to reality, as otherwise, the game would become meaningless, a concept outlined in Hartevelde’s book. This connection to reality was essential as meaning was linked to the learning outcomes of the game, which, in turn, were connected to real-world scenarios. In this serious game, the value of knowledge was targeted, as the objective was to enhance understanding throughout gameplay. In the game debrief, it was evident that the final players achieved this objective as they gained a deeper understanding of cultivated meat and the ecosystem involving various stakeholders. This emphasis on knowledge also aligns with the learning quadrant identified in one of the four quadrants of the conceptual framework presented in Djafarova et al. (2023)’s study on the art of serious game design. As found in the debrief the players acquired knowledge through gameplay, forming the learning experience, while the learning outcomes represent the specific educational goals of the players. The players did reach the learning goals, affirming the effectiveness of the learning experience and outcomes in fostering engaging educational experiences within serious games, as highlighted by Breuer and Bente (2010). In conclusion, the game effectively facilitates player learning.

The third aspect of game design centred on the element of Play, which also connects to the gameplay element of the methodology circle by Djafarova et al. (2023). This proved challenging to implement across various iterations, as indicated by the radar diagram depicted in the results section (5.16). The game was mostly based on reality, posing difficulties for players to engage in the play element of the game, given the complexity of real-world problems. Consequently, adjustments were made during iterations to enhance the game’s playability. For instance, incorporating distinct roles with unique goals for players enhanced the element of play, encouraging strategic thinking to accomplish these goals. The strategic aspect enhances the game’s engagement by increasing complexity, therefore increasing gameplay (Weibel et al., 2008). Moreover, fostering collaboration and problem-solving among players enhances the playability of the game, leading to effective learning and an enjoyable experience (Cooney and Darcy, 2020). In conclusion, all three factors of Hartevelde’s book and the four factors of the art of serious game design (Djafarova et al., 2023) were integrated into the final game design.

With the integration of key factors into serious game design confirmed, it’s important to highlight the significance of the game itself regarding the goal of increasing consumer awareness. While there are various methods to communicate information about cultivated meat, the literature indicates that games offer an accessible and user-friendly approach, serving as effective learning tools (Guillén-Nieto and Aleson-Carbonell, 2012). Games have the potential to reach a diverse audience,

which is particularly relevant considering the broad scope of the target group, containing Dutch consumers. This is especially true among meat-eaters who exhibit low levels of understanding regarding cultivated meat, as highlighted by the research conducted by ProVeg (2022b), with 64% of this group expressing no understanding. Consequently, increasing awareness among meat-eaters is essential, given not only their size in the population but also their low level of understanding. Given the importance of early communication about cultivated meat before its commercialisation (ProVeg, 2022b), a game could serve as a valuable tool for this purpose. However, games may not be as easily spread as other methods such as flyers or posters. Nevertheless, games can facilitate deeper understanding and learning, addressing the knowledge gap found among consumers. While games may not achieve widespread awareness as quickly as posters, they offer the unique advantage of allowing players to form their own opinions about the product. Unlike promotional materials aimed at increasing consumer acceptance, the goal of the game is not to convince opinions, as demonstrated by a player who didn't accept the product. Promotional materials might heighten polarisation, potentially isolating meat-eaters, and moving them away from the intended goal of the poster. Therefore, games offer a more engaging and informative platform compared to methods like posters, allowing players to delve deeper into the product and form their own perspectives. The game's inclusion of various images during the choice for a marketing strategy, further emphasises the importance of presentation in shaping consumer perceptions of cultivated meat. This was highlighted in another study by ProVeg (2022a) which focused on the role of images in consumer perceptions of cultivated meat. When participants were exposed to food-based images, compared to lab-based images, the participants more strongly agreed that the product was nutritious and tasty. In conclusion, the choice of how to present cultivated meat through an image is crucial for consumer acceptance.

To conclude the discussion on serious game design, it is valuable to compare the created game to existing ones similar to it. The game Groenverdieners can be described as independent when compared to others, although it shares similarities with a mix of different games. For instance, it resembles the cooperative game 'Pandemic,' where players work together towards a common goal. Similar to Pandemic, the serious game features distinct roles, each essential for success. Additionally, the game 'Saboteur' also employs different roles with unique objectives, with players collaborating within their roles while opposing those in other roles, blending elements of cooperation and competition. It's evident from the final game that introducing more competitive dynamics among players could enhance gameplay, a point stated in the results section. Lastly, the serious game shares similarities with the negotiation aspect of 'Koehandel,' where players negotiate with each other, reflecting the negotiation elements present in the Groenverdieners game.

Finally, concluding this discussion section concerning the integration of Science Communication and Food Technology in this Design-Based Research (DBR) is valuable. Designing and developing a serious game makes this research interesting for both fields, as it provides an interactive platform to communicate scientific information about cultivated meat. This platform goes beyond traditional communication methods, such as scientific papers or presentations, by immersing users in an engaging environment where they can actively explore and learn about cultivated meat. By incorporating the findings from textual data analysis and interviews, the game conveys the identified frames and stakeholder dynamics, while also addressing potential concerns that the general public may have regarding cultivated meat. This DBR approach aimed to bridge the communication gap between experts and the general public, fostering a nuanced understanding of the societal implications of cultivated meat from both Food Technology and Science Communication perspectives, thus addressing the main [Research Question](#).

## 6.5 Limitations

While the research questions have been answered, it is necessary to acknowledge the limitations of the research. For example, it's important to note that the applicability of the three datasets employed cannot be generalised to the entire Dutch population. While textual data analysis offers valuable insights, it inherently presents challenges in capturing the depth and nuances of human sentiment. Additionally, comparing the three datasets may introduce biases that need to be acknowledged, not only because of the number of documents (as Twitter dominates the dataset) but also because of the difference between the sorts of textual data from the documents. As opposed to Twitter, which frequently displays opinions not supported by research, the content in the parliamentary dataset is more nuanced and analytical. Furthermore, although highlighted earlier, it's worth reiterating that a limitation in comparing the three datasets stems from variations in the

length of textual data. Twitter data consists of brief tweets, often rich in sentiment, while the news and parliamentary datasets contain longer texts with a more neutral stance. In an effort to address this difference, both sentiment analysis and topic modelling analyses use shorter text blocks, with tweets limited to 280 characters and blocks extended to 1000 characters. This distinction in text lengths makes data comparison challenging and less reliable. Furthermore, the NMF topic modelling, which is more effective with smaller text segments, contributes to the complexity of the comparison process.

Specific to the parliamentary dataset, the data introduced a certain limitation to the study, stressing the importance of future research delving into alternative data sources for greater relevance and depth. The dataset's focus is mainly on a singular moment in time, namely the 2020 debate, which caused the frames less diverse and more challenging to interpret. Moreover, the limited amount of data points deepened the issue. Together it was challenging to determine sentiment trends over time. A more expansive and varied dataset could have offered a richer insight into the evolution of sentiments and diverse frames within the parliamentary discussions, enhancing the overall depth and applicability of the analysis.

During the data collection phase, the primary focus was on the term 'kweekvlees,' translated as cultured meat in Dutch, given its widespread usage in the Netherlands. This choice was made to align with the most commonly employed terminology in the country. However, it's essential to note that other Dutch expressions such as 'gecultiveerd vlees' and 'diervriendelijk vlees' are also utilised, particularly in a positive context by industry and research centres. Conversely, negative terms like 'lab vlees' or 'synthetisch vlees' are employed but were not considered in this research. Consequently, it's important to acknowledge that not all mentions on social media, news sources, or parliamentary discussions related to this product have been incorporated into this study.

As previously mentioned, the sentiment model employed is not optimised for longer, more neutrally-toned texts but more for tweets, as it is trained on book reviews. Consequently, this model may not be the most suitable choice. However, for consistency and to facilitate a direct comparison among the three datasets, the same sentiment model was employed. However, exploring alternative sentiment models particularly tailored for parliamentary and news contexts would have been valuable. Additionally, the sentiment analysis for Twitter data presented challenges, particularly when dealing with sarcastic or double-meaning tweets, as demonstrated by the generated examples. Thus, improving the reliability of sentiment analysis on the data may involve exploring and possibly training a more suitable sentiment model for the specific datasets.

For the interpretation of the results, it is crucial to distinguish between the concepts of tone of voice and sentiment, although sentiment analysis can offer insights into the tone of voice. Similar distinctions exist between the concepts of topics and frames. According to Ylä-Anttila et al. (2018), topics derived from topic modelling can be considered frames under certain conditions: 1) frames are operationalised as connections between concepts, 2) subject-specific data is chosen, and 3) topics are thoroughly validated as frames using a practical procedure. While the second criterion is met by selecting the term 'kweekvlees,' the first criterion is not applied, and the third one lacks a specific practical procedure, relying instead on the researcher's interpretation. Consequently, the absolute classification of the included topics as frames proves challenging according to the research, as the identification of topics as frames relies on the researcher's subjective perspective.

Besides the textual data analysis limitations, interviews to receive in-depth knowledge of the stakeholders also posed challenges, as the seven conducted interviews may not provide a complete understanding of an entire sector. Each participant may contribute unique perspectives, but it's essential to recognise that individual values may not fully encompass the broader dynamics of the sector as a whole. Furthermore, attempts to engage with all desired stakeholders were not entirely successful. For instance, there was a wish to interview specific political parties, but due to limited responses, this objective was not achieved. Additionally, efforts to connect with the plant-based industry proved challenging as they declined to participate in interviews, restraining the valuable insights into this sector. Similar challenges were encountered in the meat industry, where exploring their perspectives on cultivated meat would have been interesting as well. One participant highlighted the difficulty farmers faced in obtaining permits for cultivated meat, as they were not yet available from the municipalities. Consequently, an interview with a municipal representative was done, and Delft was chosen for this purpose. However, this may not have been the optimal choice, as Delft has limited interactions with farmers and primarily functions as an innovation centre.

Regarding the serious game, the limitations primarily stem from the iterative process of the design. Due to time constraints, additional iterations of the game were not conducted. Nonetheless, further iterations could have resulted in improvements to the game and allowed for more extensive testing of its effectiveness in educating players about cultivated meat. Another limitation is that the game can only be played once, as the consequences of option cards become known. However, one player proposed playing the game multiple times to experiment with various organisational strategies, and another player expressed interest in playing the game again. Furthermore, incorporating the consumer aspect more prominently would be valuable, as this stakeholder is essential despite being somewhat neglected in the final game version. Perhaps more option cards related to consumers and their impact on cultivated meat could be introduced. Moreover, the ideal number of players for optimal gameplay is six, as it facilitates discussion. Therefore, if the game is played with fewer than six players, additional elements should be added to stimulate discussion. Finally, incorporating option cards that increase player rivalry would enhance the game's competitive aspect and the Play element.

## 6.6 Reflection on the Process

This section explains the various unforeseen challenges encountered during the research. Firstly, the availability of news articles related to cultivated meat proved insufficient for the intended textual data analysis, necessitating the additional collection and therefore transformation of data, a task that presented its difficulties. Additionally, the parliamentary letters provided limited material for quantitative analysis. Adapting a sentiment analysis tool to Dutch data posed a significant obstacle, consuming considerable time. Moreover, the decision-making process between two topic modelling methods, LDA and NMF, proved time-consuming, with only a portion of the results utilised. Delving into textual data analysis proved to be an ongoing learning process, requiring multiple consultations with my supervisor at Wageningen, particularly due to my limited proficiency in Python. However, preparing for these sessions helped me to ask the right questions, which enabled me to progress after each meeting.

Due to the time-consuming textual data analysis process, I had limited time for game design, which proved to be more challenging than I had anticipated. Despite my initial enthusiasm for game creation, I began to question the wisdom of this decision. While I am pleased with the final outcome of the game, I wonder if using a different design tool would have been less stressful. Importantly, I found it valuable to involve others in the research, and therefore I engaged in game sessions, brainstorming, and interviews. Not only did it serve as a motivator to fix issues before these sessions, but it also encouraged my own reflection and thoughts on the process and the product cultivated meat. Although I couldn't interview everyone I had hoped to, I did manage to have really interesting discussions with some individuals, which I absolutely enjoyed. Therefore, I would encourage others working on their master's thesis to include as many individuals as possible, since it was really helpful for me.

# Conclusion

Cultivated meat can play a crucial role in ensuring sustainable future food production. In this research, the tones of voices and frames associated with cultivated meat among various stakeholders were investigated to answer the main research question: “What are the perspectives of different Dutch stakeholders regarding cultivated meat, and how can these perspectives be communicated to raise consumer awareness of cultivated meat?” It was discovered that these perspectives, characterised by their unique tones of voices and frames, vary among the stakeholders, highlighting the diverse viewpoints of the key stakeholders. To incorporate these findings, a serious game was developed to increase consumers’ awareness of cultivated meat and its stakeholder dynamics. This approach not only addressed the main research question but also served to integrate the fields of Science Communication and Food Technology.

This study revealed a generally positive tone of voice towards cultivated meat in Dutch discussions. Especially the social media source Twitter showed high positive sentiment scores. The parliamentary dataset exhibited the highest negative sentiment, possibly due to higher awareness among politicians. The news dataset also indicated mostly positive sentiment, however less positive than Twitter. Nonetheless, the low level of awareness among the audience may influence these results significantly. As shown by a study conducted among 750 respondents which revealed that the majority of the people (57%) showed no understanding of cultivated meat. In response to the first specific research question, it can be concluded that the overall tone of voice is mostly positive.

This research answered the second specific research question related to the frames used by different stakeholders in the Dutch discussion on cultivated meat. Common frames included animal welfare and climate change, which positively influence consumers’ perceptions of cultivated meat. However, a common negative frame raised concerns about changes in the bio-industry, which could lead to polarisation between the right and left. Concerns also emerged regarding product properties of cultivated meat, such as price and sensory appeal. Ensuring that these properties align with consumer expectations would be crucial for a successful market. Negative frames in the Twitter dataset focused on the name ‘kweekvlees’ and its perceived lack of appeal. Adopting a more appealing name, such as ‘diervriendelijk vlees’, may contribute to the success of cultivated meat. However, this name might introduce polarisation as it may imply that conventional meat is not animal-friendly. The parliament’s focus was on ensuring product safety, while the news dataset advocated for legislation supporting the industry. This difference could impact policies favouring the cultivated meat industry, as seen with the Dutch government’s investment in cellular agriculture.

The research investigated perspectives on cultivated meat from key stakeholders, including the industry, farmers, government, and consumers, through the use of interviews. The industry’s tone emphasised the advantages of cultivated meat, such as animal welfare and ecological benefits, which are positive drivers influencing consumer attitudes. However, the ‘high tech’ frame was prominently featured in media coverage. Farmers expressed scepticism towards cultivated meat, viewing it as unnatural and more natural than traditional meat products. This scepticism could be attributed to factors like Christian background and an older demographic. The government’s stance on cultivated meat was diverse, with supporters using frames related to animal welfare and environmental benefits, while opponents perceived the product as unnatural and unsafe. This diversity in governmental frames and tones reflects broader societal discussion and polarisation surrounding the acceptance of cultivated meat. Older and politically right-oriented individuals were less receptive to this new technology, and the shift towards acceptance may depend on the openness of new generations. Another study found that personal and societal benefits are key factors influencing people to embrace cultivated meat, and effective communication is crucial before commercialisation. The diverse found frames and tones of voices answer the third specific research question.



Early communication about cultivated meat is essential, and a serious game can help bridge the knowledge gap in an accessible and user-friendly way. The game design drew from the principles outlined in Hartevelt's book and achieved a balanced integration of the three factors: Reality, Meaning, and Play. Featuring diverse roles and frames derived from key stakeholders identified in stakeholder analysis and textual data analysis, the game offers Dutch consumers a chance to gain insight into cultivated meat and the complex dynamics among various stakeholders. The serious game design is independent but shares similarities with cooperative games like *Pandemic* and *Saboteur*. It features distinct roles for success and combines elements of cooperation and competition. However, introducing more competitive dynamics could enhance gameplay. This game holds potential as a valuable tool for raising consumer awareness about cultivated meat. Although not as easily spread as traditional promotional materials, the game allows players to form their own opinions about the product. This research fostered the integration of Science Communication and Food Technology in Design-Based Research (DBR). The game aims to bridge the communication gap between experts and the public, fostering a nuanced understanding of cultivated meat's societal implications. Following several iterations and gameplay sessions, the final game design was tested with potential consumers of cultivated meat who were unaware of the research. This final gameplay demonstrated that the game successfully enhanced players' awareness of cultivated meat and its stakeholder dynamics, addressing the final specific research question.

## 7.1 Recommendations for Further Research

An interesting follow-up study would involve delving into the Twitter dataset's usernames. This exploration aims to uncover the demographics of individuals contributing to the discussion, shedding light on the motives behind specific tweets. For instance, if the predominant Twitter usernames belong to farmers, it could potentially explain a distinct sentiment or specific frames prevalent within that group. By categorising usernames into groups such as farmers, researchers, industry experts, and political parties, a more nuanced analysis of sentiments within each subgroup becomes feasible. Of course, such an approach should be ethically approved by the commission, as it involves using data that could potentially be linked to specific individuals. Currently, the dataset doesn't provide a clear perspective, revealing only that the current Twitter usernames are likely individuals possessing a higher level of knowledge about the product, thus potentially reflecting a higher positive sentiment.

Exploring another route involves delving into the specific terms used for cultivated meat in the Netherlands, analysing the most positively perceived tones of voices associated with these terms. This approach aims to pinpoint the most favourable and culturally resonant term for cultivated meat before its official launch. Identifying and adopting a term that aligns positively with the target audience enhances the likelihood of successful reception and acceptance in the market, contributing to the effective introduction of cultivated meat to consumers.

Finally, in further research the effectiveness of the serious game could be evaluated to determine its potential for large-scale implementation. If the game proves ineffective, alternative communication tools should be considered, maintaining the objective of providing information rather than persuasion regarding cultivated meat. The emphasis should remain on raising awareness of the product without increasing polarisation. Existing literature suggests highlighting the benefits of cultivated meat while avoiding direct competition with the traditional meat industry. Additionally, careful selection of images is crucial in conveying the desired message effectively.

## 7.2 Recommendations for Policy and Practice

As I conclude this research I would like to address policymakers, the cultivated meat industry, and farmers interested in adopting cultivated meat. As for the first one, prioritising transparent communication and involving consumers from the initial stages is crucial if the government aims to increase consumer awareness and potential acceptance of cultivated meat. Building on existing literature, early engagement with consumers is key to fostering acceptance of novel food products. Therefore, initiating discussions and providing transparent information about cultivated meat is essential. A significant step in this direction could be allocating subsidies, such as the recent investment of 60 million into cellular agriculture. This investment facilitates open-source scientific research on cultivated meat, expediting its development and production.

Moreover, cultivated meat startups should consider rebranding cultivated meat products with consumer-friendly names if they successfully want to market their product. The term ‘kweekvlees’ fosters negative reactions and may hinder acceptance. Right now, cultivated meat companies use the terminology, ‘gecultiveerd vlees,’ although it’s advisable to explore alternative names that resonate with consumers. Avoid terms like ‘clean meat’ or ‘animal-friendly meat,’ which may further distance traditional meat eaters, and steer clear of technical terms like ‘in vitro’ or ‘lab meat.’ Early consumer engagement should be prioritised to ensure a smooth product launch and market acceptance. Additionally, it’s important to consider low-key informational campaigns focused on the benefits of cultivated meat, without directly criticising the traditional meat industry. Instead, focus on clarifying the environmental and animal-friendly practices without drawing direct comparisons. Avoid overly negative narratives about traditional meat production as this could distance meat-eaters from cultivated meat. Research indicates that the primary audience for cultivated meat comprises these omnivores, rather than vegetarians or vegans, presenting a significant opportunity for market penetration. Concluding, present cultivated meat as an intriguing option for consumers, highlighting its potential to reduce emissions and minimise animal harm, without making meat eaters feel morally judged or criticised.

To aid in reducing meat consumption in the Netherlands, cultivated meat could present a valuable solution. For this to materialise, startups and governmental organisations must initiate collaboration with farmers from the early stages of development. This could provide valuable insights and support, while also mitigating potential polarisation. For farmers seeking to adopt greener practices, collaborating with fellow farmers and presenting a unified case to the government can be valuable. Government support for sustainable initiatives is likely, especially given the increasing emphasis on environmental preservation. Additionally, farmers interested in exploring advanced cultivated meat production should consider partnering with cultivated meat companies or organisations in this field, such as Respect Farms. Respect Farms assists farmers in transitioning their farms to incorporate cultivated meat production, offering valuable expertise and support in the process. Collaboration can provide mutual benefits, especially for larger farms facing greater pressure from regulatory authorities to adopt sustainable practices. This proactive approach can facilitate the transition to greener farming methods while fostering innovation and collaboration within the agricultural sector. Based on the research outcomes and the serious gameplay sessions, collaboration among the diverse stakeholders within the cultivated meat industry is recommended to achieve a successful cultivated meat launch.





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# Appendices

## A Stopwords Table

Table A.1 displays the stopwords added per dataset. The Dutch stopwords incorporated in all the datasets are the following: ‘de’, ‘en’, ‘van’, ‘ik’, ‘te’, ‘dat’, ‘die’, ‘in’, ‘een’, ‘hij’, ‘het’, ‘niet’, ‘zijn’, ‘is’, ‘was’, ‘op’, ‘aan’, ‘met’, ‘als’, ‘voor’, ‘had’, ‘er’, ‘maar’, ‘om’, ‘hem’, ‘dan’, ‘zou’, ‘of’, ‘wat’, ‘mijn’, ‘men’, ‘dit’, ‘zo’, ‘door’, ‘over’, ‘ze’, ‘zich’, ‘bij’, ‘ook’, ‘tot’, ‘je’, ‘mij’, ‘uit’, ‘der’, ‘daar’, ‘haar’, ‘naar’, ‘heb’, ‘hoe’, ‘heeft’, ‘hebben’, ‘deze’, ‘u’, ‘want’, ‘nog’, ‘zal’, ‘me’, ‘zij’, ‘nu’, ‘ge’, ‘geen’, ‘omdat’, ‘iets’, ‘worden’, ‘toch’, ‘al’, ‘waren’, ‘veel’, ‘meer’, ‘doen’, ‘toen’, ‘moet’, ‘ben’, ‘zonder’, ‘kan’, ‘hun’, ‘dus’, ‘alles’, ‘onder’, ‘ja’, ‘eens’, ‘hier’, ‘wie’, ‘werd’, ‘altijd’, ‘doch’, ‘wordt’, ‘wezen’, ‘kunnen’, ‘ons’, ‘zelf’, ‘tegen’, ‘na’, ‘reeds’, ‘wil’, ‘kon’, ‘niets’, ‘uw’, ‘iemand’, ‘geweest’, ‘andere’.

Dataset	Added Stopwords
Twitter	‘gaat’, ‘etc’, ‘wel’, ‘maken’, ‘gaan’, ‘waar’, ‘komt’, ‘weer’, ‘moeten’, ‘jij’, ‘via’, ‘per’
Governmental Proceedings	‘minister’, ‘gepubliceerd’, ‘rondgezonden’, ‘heer’, ‘gaan’, ‘wij’, ‘motie’, ‘moeten’, ‘voorzitter’, ‘blz’, ‘zie’, ‘staatssecretaris’, ‘gaat’, ‘debat’, ‘vraag’, ‘wel’
Extra News Articles	‘zegt’, ‘wel’, ‘jaar’, ‘maken’, ‘komt’, ‘willen’, ‘moeten’, ‘gaat’, ‘gaan’

Table A.1: Added stopwords for the different datasets

## **B Interview Protocol**

The semi-structured interview questions in the interview protocol are shown below. Important to note is that the questions were adapted for each interview, taking into consideration the specific participant for the interview.

## Introduction

Thank you for being open to an interview. It will take approximately 30-45 minutes.

Have you read and signed the informed consent form? This form also indicates that your participation is entirely voluntary and you can withdraw at any time or choose to skip specific questions.

I am Kirsten, a student at TU Delft and Wageningen University. I am conducting a combined thesis on the topic of cultured meat. The aim of this interview is to obtain a comprehensive view of the various stakeholders involved in the cultured meat sector.

*Background information: The very first cultured meat burger was presented 10 years ago. However, this technology is not yet available for sale. For approval in Europe, the product must first be sanctioned as a 'novel food'. Consumer acceptance of cultured meat seems to be limited, and there are various perspectives and viewpoints when discussing this product. I would like to explore your vision within the cultured meat sector, from the perspective of your field of expertise.*

## General questions:

1. What is the role of your organization within the (Dutch) cultured meat sector, and what are the main objectives?
2. What is the current state of the cultured meat industry in Italy?
3. Do you think cultured meat will impact the food industry in the long term? If yes, how?

## Stakeholders within the cultured meat sector:

4. How do you perceive the current landscape of cultured meat (in the Netherlands), which parties or stakeholders are involved?
  - a. If the response about these parties is not broad enough: which other types of stakeholders might also have influence outside your sector? Show the image below.
5. How do these parties contribute to the development of the cultured meat sector, and how do they collaborate or work against each other?
  - a. Show the figure. Do you have anything to add to this figure?
6. What are specific challenges that different stakeholders face in promoting cultured meat?
7. How do you think traditional meat producers or farmers view the innovation of cultured meat? Do they see it as a new opportunity or as a threat?

## Consumer acceptance:

8. How do you envision the future of the cultured meat industry (in the Netherlands), and how is the Dutch consumer responding to it?

9. What are the main challenges for the acceptance of cultured meat (within the Dutch market), and are there any misconceptions that need to be addressed?

Frames/Perspectives:

It's interesting that different perspectives/frames on the product of cultured meat are visible in the media. For example, there's a perspective of the product being unnatural from the lab, or a perspective that it is real meat, or the perspective more focused on the benefits for the environment and animal welfare.

10. Do you think different perspectives are used within different institutions (governmental or academic institutions, private companies, etc.)?

a. If yes, what, in your opinion, are these different perspectives?

b. If no, which specific framework/perspective is used and why specifically that?

11. *Engage with the frame/perspective they mentioned, inquire further.* What are the potential effects of this framework on the cultured meat industry? How have the different entities influenced this (or been influenced by it)?

Closing:

13. How representative do you think your point of view reflects what is happening within your field of expertise?

14. Do you have suggestions for other individuals I should approach for their insights, even outside your field of expertise? People that are maybe more sceptical about cultured meat?

15. Is there anything else you would like to share or think is important to mention that has not yet been discussed?

Thank you for answering the questions.

## **C Informed Consent Form**

The unfilled informed consent form, signed by participants of the interviews, is displayed below. It comprises an opening statement, questions concerning consent, and a signature space.

## Consumer Acceptance and Travelling Facts of Cultivated Meat

Master Research – Kirsten Odenwald  
Delft University of Technology – Wageningen University and Research

### HUMAN RESEARCH ETHICS

#### Opening Statement

You are being invited to participate in a research study titled 'Consumer acceptance and travelling facts of cultivated meat'. This study is being done by Kirsten Odenwald from the TU Delft and Wageningen University under the supervision of dr. Éva Kalmár and prof.dr. Art Dewulf.

The purpose of this interview is to collect qualitative perspectives from diverse viewpoints within the cultivated meat industry, and will take you approximately 30 minutes to complete. The data will be used for explaining the complex ecosystem of cultivated meat and to develop a serious game for a master's thesis project, and potentially a publication arising from this. I will be asking your professional opinions on the cultivated meat industry from the perspective of your field of work.

As with any online activity the risk of a breach is always possible. To the best of our ability your answers in this study will remain confidential. I will minimize any risks by storing as minimal personal information as possible. If you wish to, your name will also not be included in the data.

Your participation in this study is entirely voluntary **and you can withdraw at any time**. You are free to omit any questions. After transcribing the interview, data recordings will be erased. At the end of the interview, you have the opportunity to request the removal of any statement or data to ensure that no sensitive or confidential information is included in the interview.

If you have any questions before or after the interview, please contact the responsible researcher at the following e-mail address: [k.n.odenwald@student.tudelft.nl](mailto:k.n.odenwald@student.tudelft.nl).



## Informed Consent Form

Please tick all the boxes with 'Yes' or 'No'.

PLEASE TICK THE APPROPRIATE BOXES	Yes	No
<b>A: GENERAL AGREEMENT – RESEARCH GOALS, PARTICIPANT TASKS AND VOLUNTARY PARTICIPATION</b>		
1. I have read and understood the study information dated [DD/MM/YYYY], or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.	<input type="checkbox"/>	<input type="checkbox"/>
2. I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason.	<input type="checkbox"/>	<input type="checkbox"/>
3. I understand that taking part in the study involves: an audio and video recording.	<input type="checkbox"/>	<input type="checkbox"/>
4. I understand that the study will end April 2024.	<input type="checkbox"/>	<input type="checkbox"/>
<b>B: POTENTIAL RISKS OF PARTICIPATING (INCLUDING DATA PROTECTION)</b>		
6. I understand that taking part in the study also involves collecting specific personally identifiable information (PII) with the potential risk of my identity being revealed. I understand that these will be mitigated by anonymising my personal data, such as name and email address, if I opt for that.	<input type="checkbox"/>	<input type="checkbox"/>
7. I understand that the following steps will be taken to minimise the threat of a data breach, and protect my identity in the event of such a breach: The transcribed interview data will undergo anonymisation, if requested, and the recordings will be removed.	<input type="checkbox"/>	<input type="checkbox"/>
8. I understand that personal information collected about me that can identify me, such as my name, which will not be shared beyond the research team if you request like that.	<input type="checkbox"/>	<input type="checkbox"/>
9. I understand that the personal data I provide will be destroyed at the end of the research.	<input type="checkbox"/>	<input type="checkbox"/>
<b>C: RESEARCH PUBLICATION, DISSEMINATION AND APPLICATION</b>		
10. I understand that after the research study the anonymised information I provide will be used in a thesis report and a potential scientific publication.	<input type="checkbox"/>	<input type="checkbox"/>
11. I agree that my responses, views or other input can be quoted anonymously in research outputs. If 'Yes', skip question 12.	<input type="checkbox"/>	<input type="checkbox"/>
12. I agree that my real name can be used for quotes in research outputs.	<input type="checkbox"/>	<input type="checkbox"/>
<b>D: (LONGTERM) DATA STORAGE, ACCESS AND REUSE</b>		
13. I give permission for the anonymised thesis report that I provide to be archived in the repository of the TU Delft and Wageningen University so it can be used for future research and learning.	<input type="checkbox"/>	<input type="checkbox"/>
14. I understand that access to this repository is open.	<input type="checkbox"/>	<input type="checkbox"/>

## Signatures

\_\_\_\_\_  
Name of participant

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date

I, as researcher, have accurately read out the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands to what they are freely consenting.

Kirsten Odenwald



22-11-2023

\_\_\_\_\_  
Researcher name

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date

Study contact details for further information: *Kirsten Odenwald*, [k.n.odenwald@student.tudelft.nl](mailto:k.n.odenwald@student.tudelft.nl)

## D Brainstorming Session

As discussed in the methodology, a brainstorming session took place with CDI students. The questions discussed during this session can be found [here](#) and two of the cards from the gameplay element are illustrated in Figure D.1.



Figure D.1: Brainstorm cards for the gameplay element from the Art of Serious Game Design. Source: Djafarova et al. (2023).

## E Serious Game prototypes

### E.1 Paper prototypes

The first ideas that were generated for the serious game were two scribbles as can be found in Figure E.1 and Figure E.2.

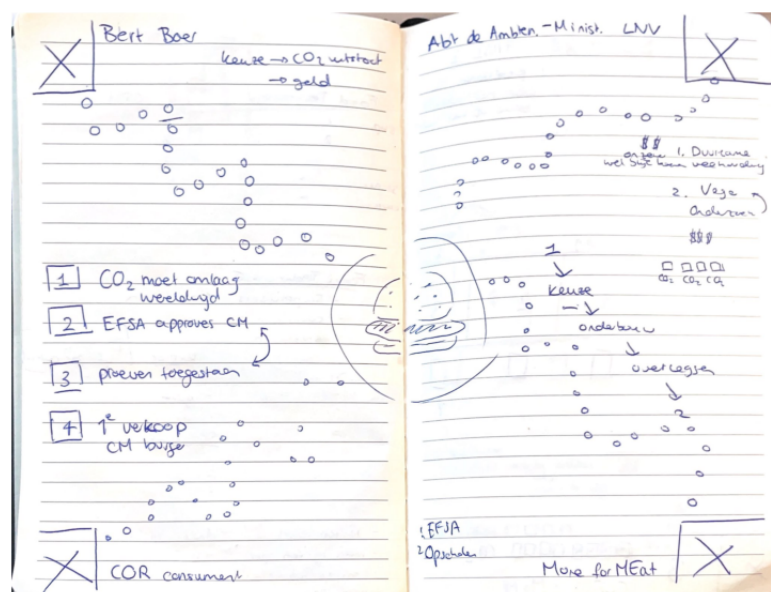


Figure E.1: The first idea for the serious game with score points per player.

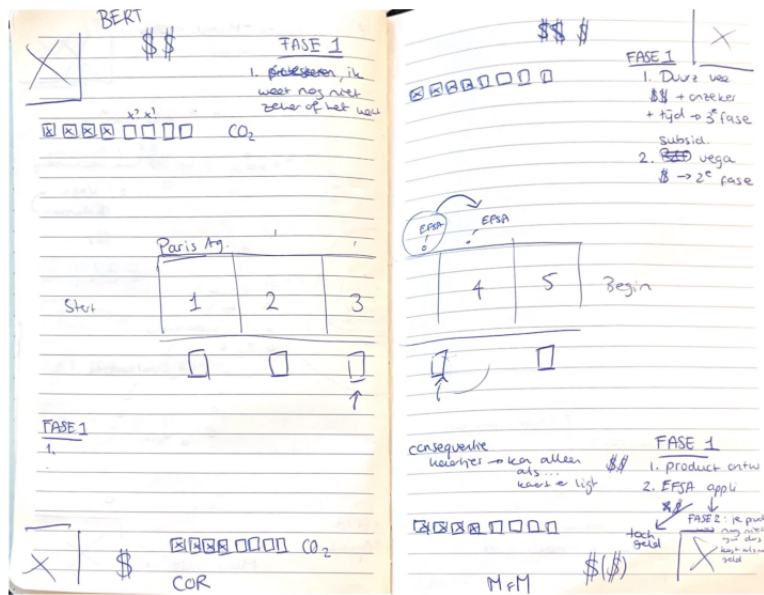


Figure E.2: The second idea for the game involves each player having a limit of 8 CO2 blocks that they must not exceed.

## E.2 Digital prototype

The first digital prototype was developed in Miro and shown in Figure E.3.

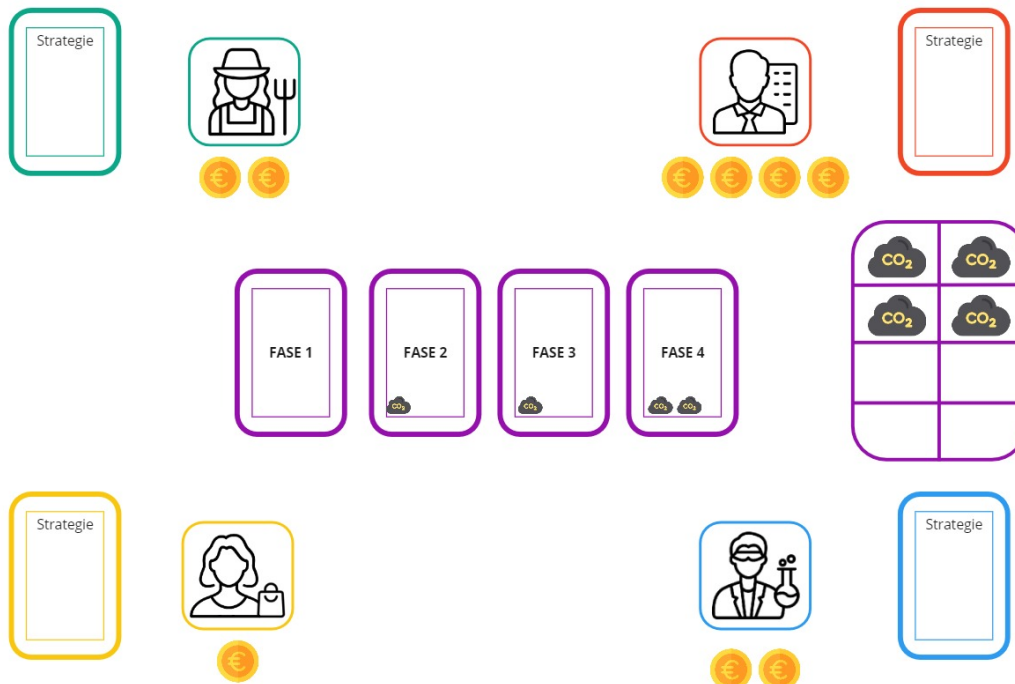
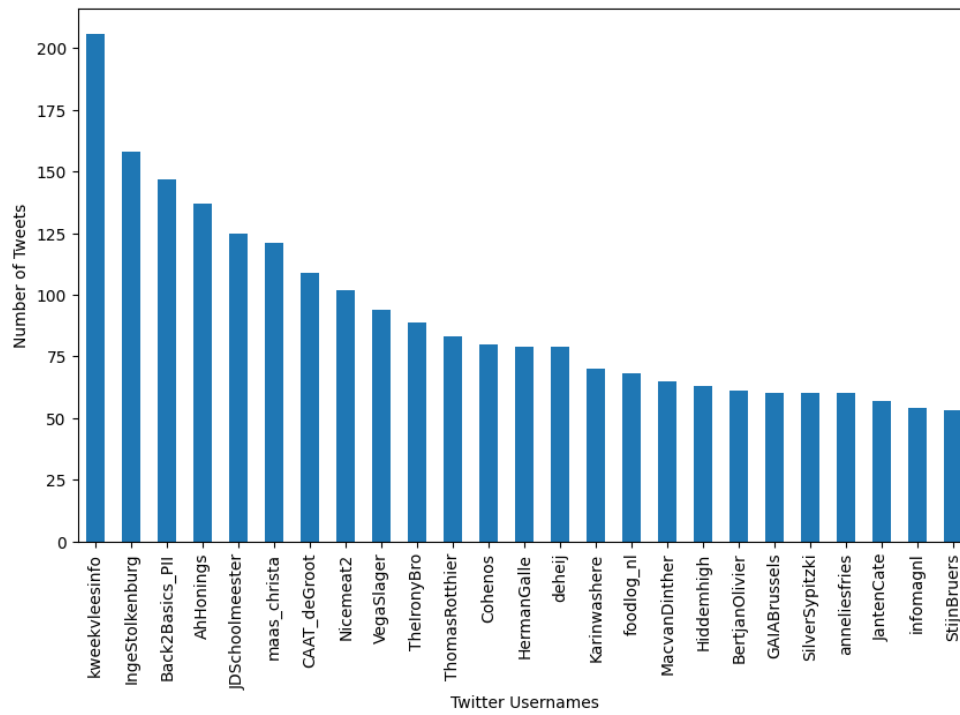


Figure E.3: The first digital prototype developed using the tool Miro.

## F Twitter Usernames

Figure F.1 shows the usernames mostly tweeting about cultivated meat on Twitter.



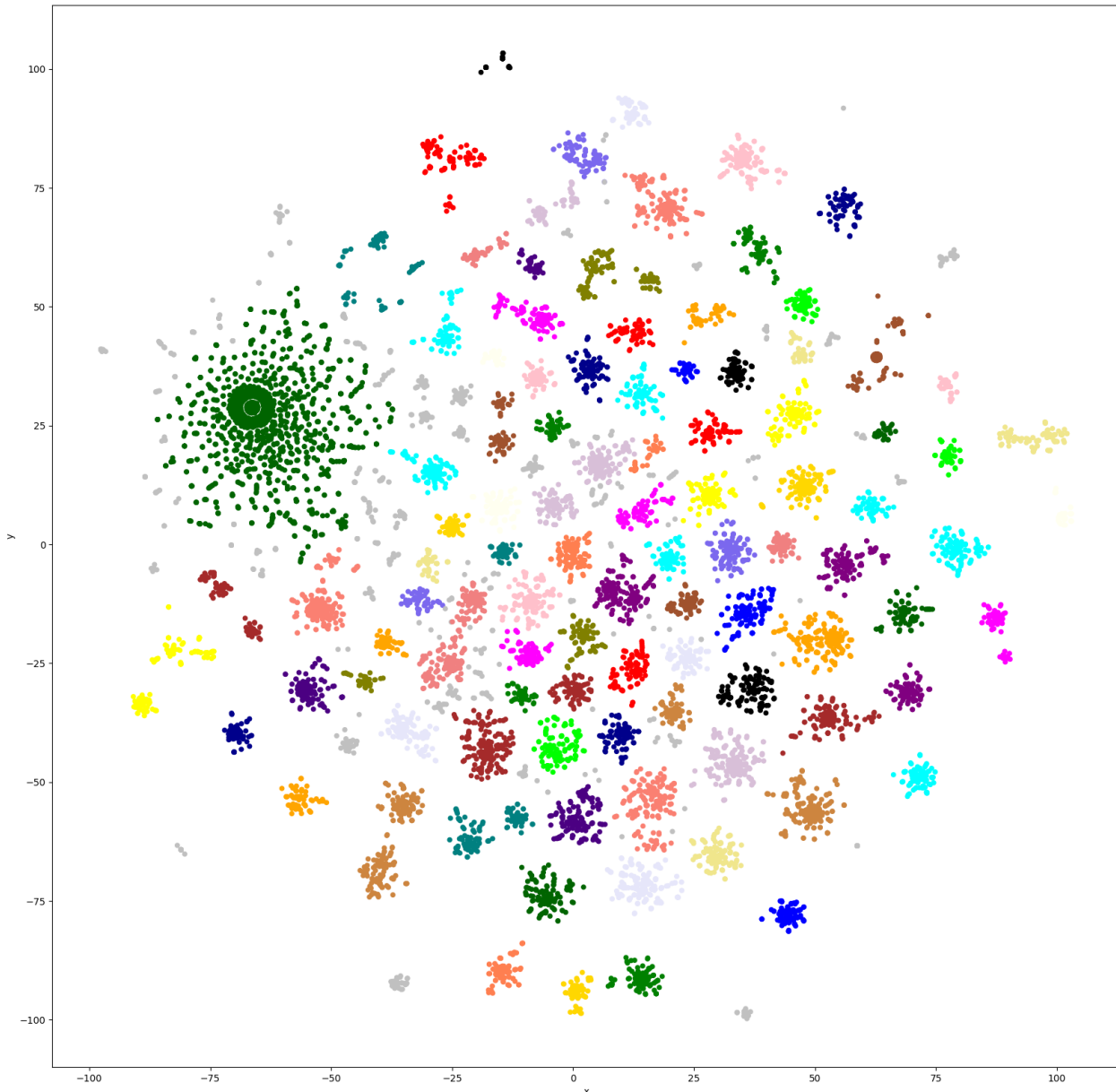
**Figure F.1:** Number of Tweets across various Twitter usernames.



## H t-SNE Scatter Plots

### H.1 Twitter

The t-SNE scatter plot highlights the clustering of data points, showing the dataset's potential for topic modelling as visible clusters are shown (Figure H.1). However, the presence of 84 clusters indicates a considerable number of topics, with many being overly specific. Furthermore, the prominent cluster on the left is associated with the term 'kweekvlees,' making it the largest due to its occurrence in every document.

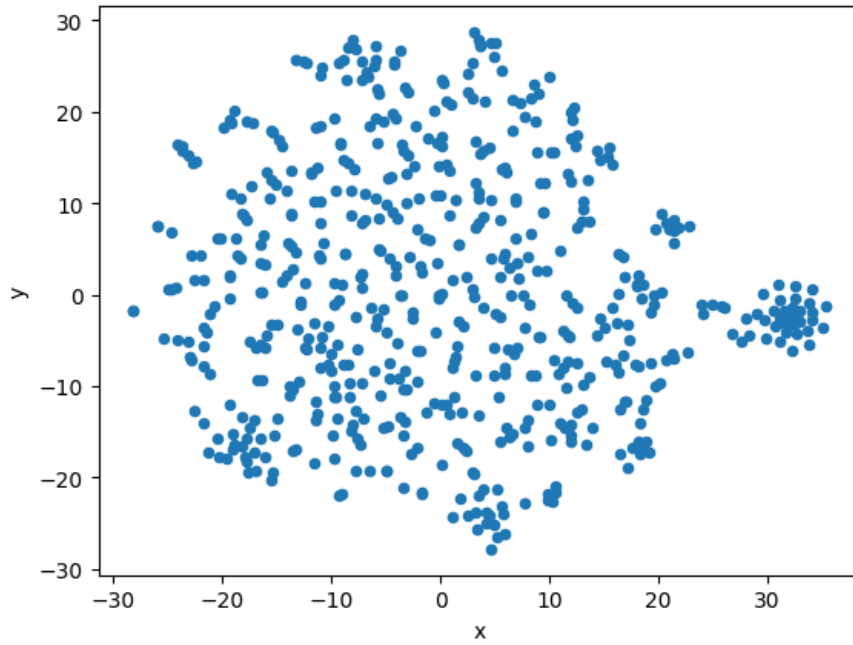


**Figure H.1:** The t-SNE scatter plot from data points of the Twitter dataset, with clusters by an HDB scan. This analysis exclusively involves original tweets, excluding retweets.

### H.2 News

The t-SNE scatter plot, before clustering with HDB, exhibits one distinct cluster on the right (Figure H.2). After applying an HDB scan it becomes clear that this cluster corresponds to the Dutch words for 'page,' 'original,' and 'look at.' This may indicate that these words are associated with hyperlinks leading to other articles or original content on different pages, forming this cluster of diverse news documents. The remaining data points are widely scattered, making it challenging to draw any further conclusions from this particular figure.

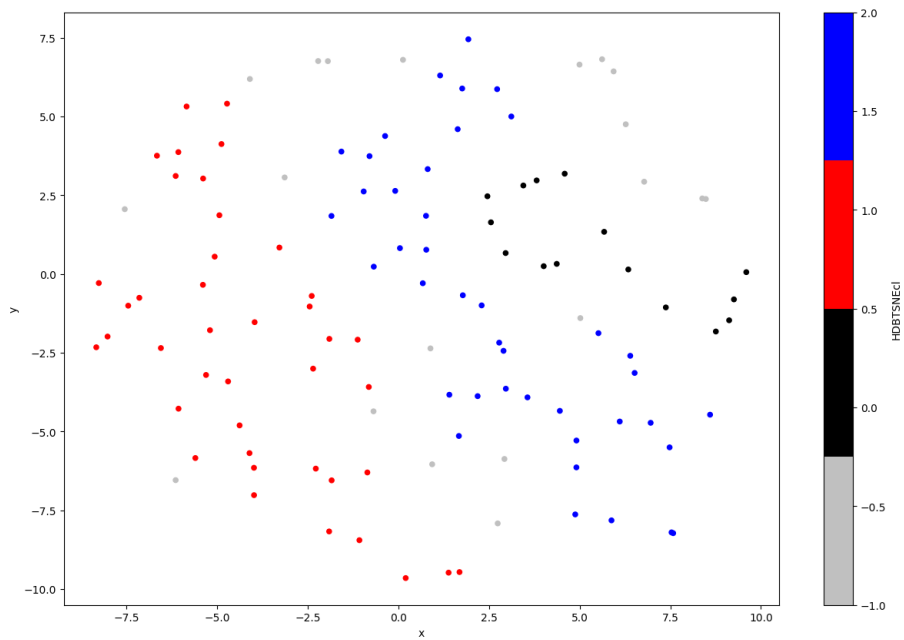




**Figure H.2:** A t-SNE scatter plot of the newspaper dataset including the four newspaper platforms.

### H.3 Parliament

The t-SNE scatter plot of the parliamentary dataset can be found in Figure H.3.



**Figure H.3:** A t-SNE scatter plot with clusters found with HDB of the parliamentary proceedings dataset with blocks.

## I NMF Topic Labels

### I.1 Combined dataset

The labels found with NMF topic modelling in the combined dataset is shown in Table I.1.

Topic Number	Topic Name	Words Indicating the Topic
Topic 1	Do not use FBS	'denk', 'insecten', 'achterhaald', 'idee', 'ontwikkeling'
Topic 2	Producing for Singapore	'nederlands', 'laboratorium', 'eet', 'hamburger', 'liever'
Topic 3	Unnatural	'eten', 'vlees', 'echt', 'gewoon', 'insecten'
Topic 4	Replace the livestock	'weg', 'nos', 'veestapel', 'supermarkt', 'vijf'
Topic 5	First cultivated burger	'vandaag', 'eerste', 'hamburger', 'zit', 'november'
Topic 6	Governments helps industry	'nederlandse', 'universiteit', 'maakt', 'dag', 'maastricht'
Topic 7	Approval taste testing	'lab', 'lekker', 'nieuw', 'weg', 'gerechten'
Topic 8	Bio-industry is bad	'eigenlijk', 'komen', 'dtv', 'gekweekt', 'stamcellen'
Topic 9	Curiosity	'laat', 'proeven', 'overheid', 'net', 'misschien'
Topic 10	Animal friendly meat	'supermarkt', 'echt', 'vind', 'diervriendelijk', 'gewoon'
Topic 11	Kosher meat	'hoop', 'markt', 'nieuws', 'koosjer', 'lees'
Topic 12	Name for cultivated meat	'klinkt', 'lekker', 'naam', 'vlees', 'alleen'
Topic 13	Environmental impact	'toekomst', 'mooi', 'productie', 'nieuws', 'week'
Topic 14	Hopefull (5 years)	'oplossing', 'humor', 'eten', 'nieuws', 'horrorscenario'
Topic 15	Higher awareness animal welfare	'dieren', 'vegetariër', 'eet', 'mag', 'toekomst'
Topic 16	Sergey Brin invests	'hamburger', 'maastricht', 'brin', 'euro', 'londen'

**Table I.1:** Used topic labels and corresponding words found with NMF topic modelling on the combined dataset (Twitter, news, and parliamentary proceedings).

### I.2 Twitter

The corresponding words indicating the topic for the Twitter dataset is found in Table I.2.

Topic Number	Topic Name	Words Indicating the Topic
Topic 1	Cultivated Meat Cookbook	'eerste', 'kookboek', 'november', 'werelds', 'singapore'
Topic 2	Solution for animal suffering	'goed', 'oplossing', 'nodig', 'minder', 'dierenleed'
Topic 3	Cultivated meat is coming	'burger', 'gemaakt', 'straks', 'nederland', 'insecten'
Topic 4	The future	'toekomst', 'voedsel', 'post', 'mark', 'onze'
Topic 5	Sergey Brin invests	'google', 'oprichter', 'brin', 'stak', 'sergey'
Topic 6	First cultivated burger	'hamburger', 'londen', 'gepresenteerd', 'laboratorium', 'gemaakt'
Topic 7	Name for cultivated meat	'woord', 'alleen', 'waarom', 'beter', 'vind'
Topic 8	Cultivated meat in the news	'nieuws', 'zie', 'orangesnacks', 'klimaat', 'nee'
Topic 9	Not similar to meat	'vlees', 'echt', 'alternatief', 'dier', 'smaakt'
Topic 10	Wins price for burger	'nederlands', 'laboratorium', 'investeert', 'nederlandse', 'bedrijf'
Topic 11	Not try cultivated maet	'eten', 'vlees', 'gewoon', 'minder', 'mag'
Topic 12	Hopefull (5 years)	'jaar', 'binnen', 'vijf', 'betaalbaar', 'markt'
Topic 13	Cultivated meat from Maastricht University	'maastricht', 'universiteit', 'wereldprimeur', 'maakt', 'naam'
Topic 14	Name for cultivated meat 2	'klinkt', 'nodig', 'achter', 'bloed', 'ongeboren'
Topic 15	Replace the livestock	'weg', 'gepresenteerd', 'veestapel', 'vandaag', 'londen'
Topic 16	Taste of cultivated meat	'lekker', 'nieuwe', 'eet', 'stukje', 'meat'

**Table I.2:** Topic labels and corresponding words found with NMF topic modelling on the Twitter dataset

### I.3 News

The corresponding words indicating the topic for the newspaper dataset is found in Table I.3.

Topic Number	Topic Name	Words Indicating the Topic
Topic 1	Investments	'boek', 'investeerders', 'shapiro', 'olie', 'bonen'
Topic 2	Cultivated meat in the news	'uur', 'hoogleraar', 'bbc', 'hele', 'burger'
Topic 3	Environmentally sustainable meat	'minder', 'uitstoot', 'ooit', 'duurzaam', 'energie'
Topic 4	Meatable investments	'euro', 'nederlandse', 'miljoen', 'boeren', 'waar'
Topic 5	Legislation	'shapiro', 'dieren', 'miljoen', 'mogelijk', 'onderzoek'
Topic 6	Consumer acceptance	'eten', 'lekker', 'toekomst', 'oplossing', 'wetenschap'
Topic 7	Singapore appropes	'singapore', 'leer', 'koe', 'eelen', 'mosa'
Topic 8	Protein transition	'koe', 'eiwitten', 'insecten', 'korteweg', 'speciale'
Topic 9	The future	'pagina', 'leven', 'toekomst', 'projecten', 'museum'
Topic 10	Meat taks	'duurzame', 'meat', 'procent', 'plantaardige', 'goed'
Topic 11	Increased awarness animal welfare	'vooral', 'stamcellen', 'spierweefsel', 'één', 'denk'
Topic 12	Alterntaive meat	'insecten', 'miljoen', 'nederland', 'cellen', 'alternatief'
Topic 13	Refer to ...	'pagina', 'bekijk', 'oorspronkelijke', 'eten', 'plantaardig'
Topic 14	Meatable to Singapore	'meatable', 'singapore', 'europese', 'post', 'wij'
Topic 15	Technology and nature	'mensvoort', 'koert', 'landbouw', 'next', 'technologie'
Topic 16	Link to PDF	'link', 'pdf', 'kip', 'waarom', 'procent'

**Table I.3:** Topic labels and corresponding words found with NMF topic modelling on the news dataset

### I.4 Parliament

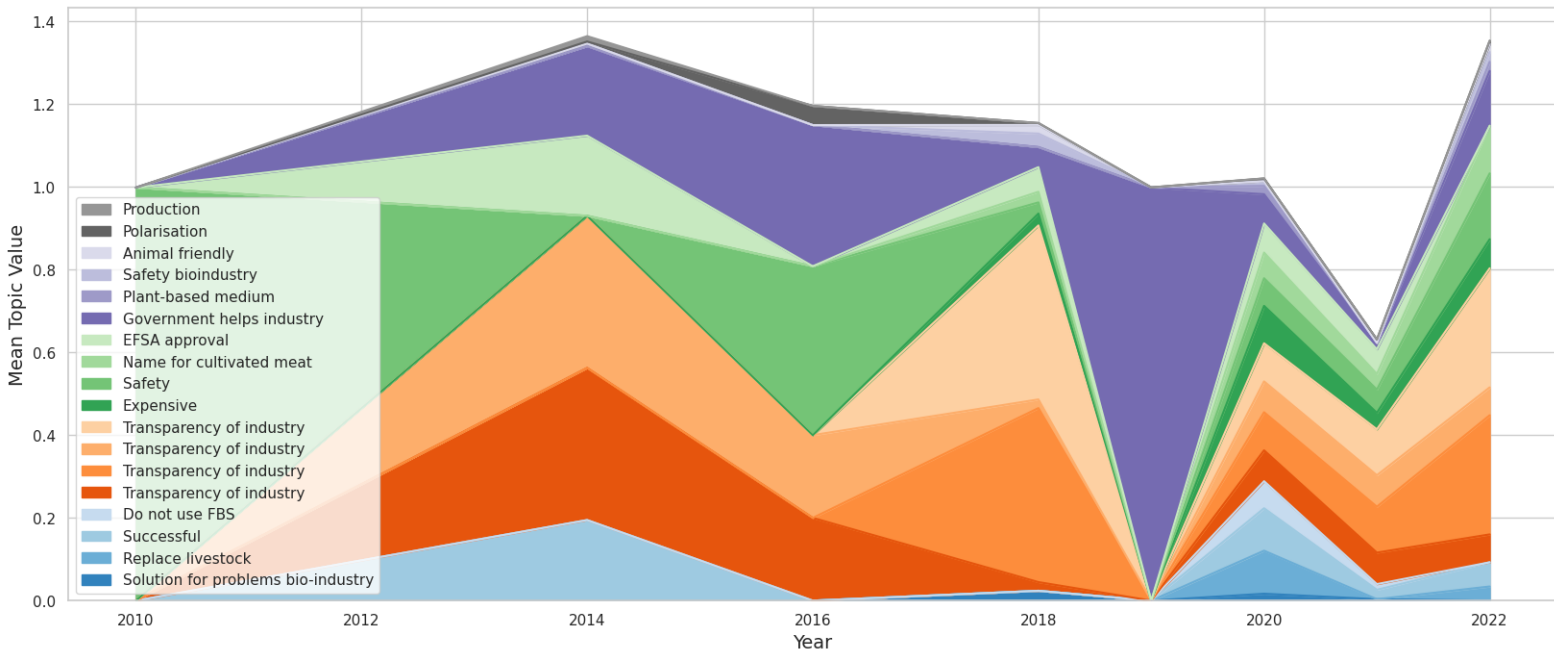
The corresponding words indicating the topic for the parliamentary proceedings dataset is found in Table I.4.

Topic Number	Topic Name	Words Indicating the Topic
Topic 1	Solution for problems bio-industry	'vlees', 'nederland', 'heel', 'goed', 'groot'
Topic 2	Replace livestock	'dieren', 'vlees', 'kalfs serum', 'nederland', 'maken'
Topic 3	Successful	'echt', 'maken', 'vlees', 'vind', 'dieren'
Topic 4	Do not use FBS	'kalfs serum', 'echt', 'dieren', 'heel', 'vlees'
Topic 5	Transparency of industry	'heel', 'nederland', 'vind', 'echt', 'kalfs serum'
Topic 6	Transparency of industry	'groot', 'vind', 'dieren', 'vlees', 'nederland'
Topic 7	Expensive	'vlees', 'nederland', 'dieren', 'groot', 'vind'
Topic 8	Safety	'maken', 'vlees', 'dieren', 'nederland', 'vind'
Topic 9	Name for cultivated meat	'nederland', 'vlees', 'maken', 'groot', 'dieren'
Topic 10	EFSA approval	'vind', 'heel', 'goed', 'kalfs serum', 'echt'
Topic 11	Government helps industry	'goed', 'echt', 'vlees', 'vind', 'dieren'
Topic 12	Plant-based medium	'maken', 'kalfs serum', 'groot', 'vind', 'goed'
Topic 13	Safety bioindustry	'groot', 'heel', 'dieren', 'kalfs serum', 'echt'
Topic 14	Animal friendly	'groot', 'nederland', 'dieren', 'kalfs serum', 'echt'
Topic 15	Polarisation	'goed', 'heel', 'maken', 'dieren', 'vlees'
Topic 16	Production	'vind', 'echt', 'maken', 'heel', 'goed'

**Table I.4:** Topic labels and corresponding words found with NMF topic modelling on the parliamentary proceedings dataset.

## J Parliament Topics Area Plot

The timeline (Figure J.1) illustrates the topics identified over time along with the mean topic score for each topic. The figure highlights that in 2020, during the cultivated meat debate, all topics exhibited similar relevance scores, as they were widely used during that period. Consequently, other data points are more scattered and less reliable due to the limited amount of data.



**Figure J.1:** Area plot of the average scores for included topics over time of the parliamentary proceedings dataset.

## K Gameplay Setup

### K.1 First Gameplay

Figure K.1 illustrates the setup of the first gameplay with the CDI students after two rounds of playing the game.

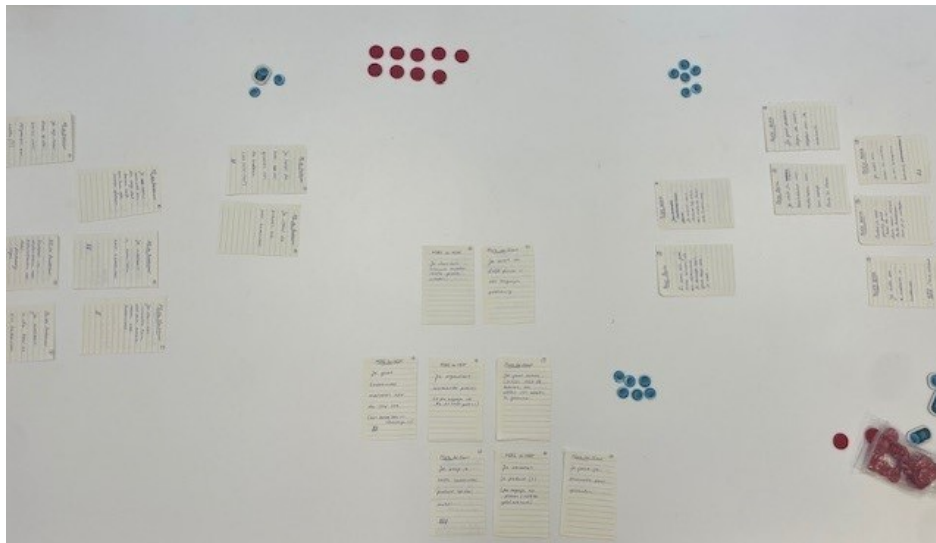


Figure K.1: The first gameplay setup after two rounds during the game with CDI students.

### K.2 Second Gameplay

Figure K.2 displays the setup of the second gameplay session with friends, showcasing the starting configuration of the game.

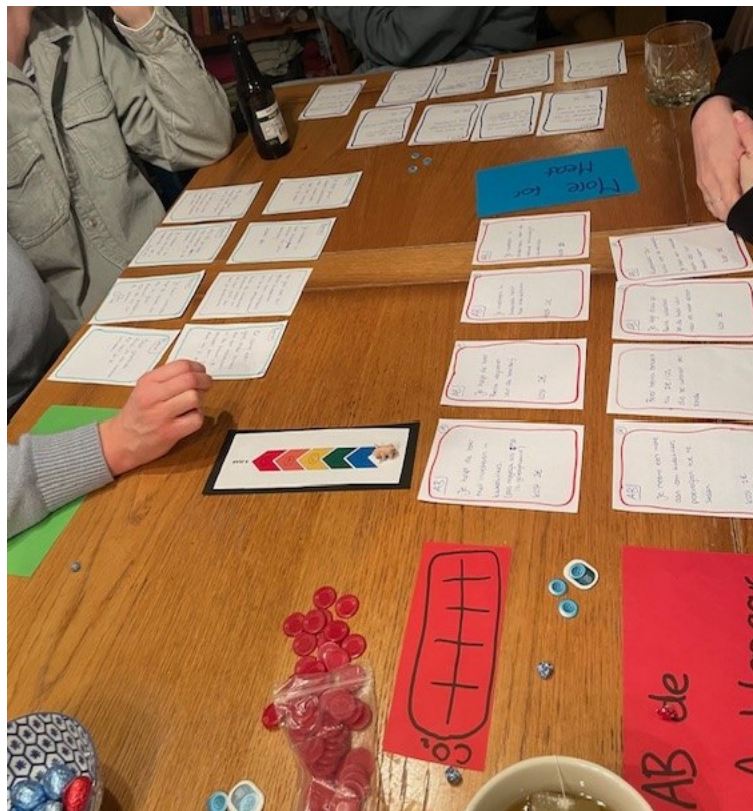


Figure K.2: The second gameplay setup at the beginning of the game with friends.

### K.3 Final Gameplay

The setup of the final gameplay is depicted in Figure K.3.



Figure K.3: The final gameplay setup at the start of the game with the intended target group.

## L Game Progression

### L.1 Second Gameplay

The decisions made during the second game played with friends are documented and presented in Table L.1. The table displays the cards selected by each player during the five rounds.

Round	Governmental Ab	Farmer Berta	More for Meat
Round 1	puts pressure on the farmer to become greener	goes to a farmers meeting about innovative green farming practices	improves the taste and texture of their product
Round 2	helps the farmers to become greener	make their cows available for cell research by MfM	starts the EFSA application
Round 3	approves cultivated meat tastings	goes demonstrating against laws by government	starts cultivated meat tastings
Round 4	helps farmer with cultivated meat investments	invests in cultivated meat	introducing cultivated meat on the market
Round 5	invests in research for cultivated meat	accepts a big offer to sell products	researches the cells of the cows of the farmer

**Table L.1:** Decisions of the three players in each round of the game played with friends (second gameplay).

### L.2 Final Gameplay

The choices made during the final game, which was played with teachers, are shown in Table L.2. The cards that each player selected during the course of the five rounds are displayed in the table.

Round	Governmental Ab	Farmer Berta	More for Meat
Round 1	helps the farmers to become greener to become greener	invests in solar panels on the farm	researches the cells of the cows of the farmer
Round 2	take money from the meat lobby	make their cows available for cell research by MfM	chooses a marketing strategy
Round 3	invests in research for cultivated meat	make land available for MfM	improves the taste and texture of their product
Round 4	puts pressure on the farmer to become greener	invest in biological farming practices	increase production facility on the land of farmer
Round 5	approves cultivated meat tastings	goes to a farmers meeting about innovative green farming practices	starts cultivated meat tastings
Round 6	helps the farmer with cultivated meat investments	invests in cultivated meat	starts the EFSA application

**Table L.2:** Decisions of the three players in each round of the game played with teachers (final gameplay).



## M Playing Cards

The Figures show the option cards of the three players, Ab (Figure M.1), Berta (Figure M.2), and More for Meat (Figure M.3).

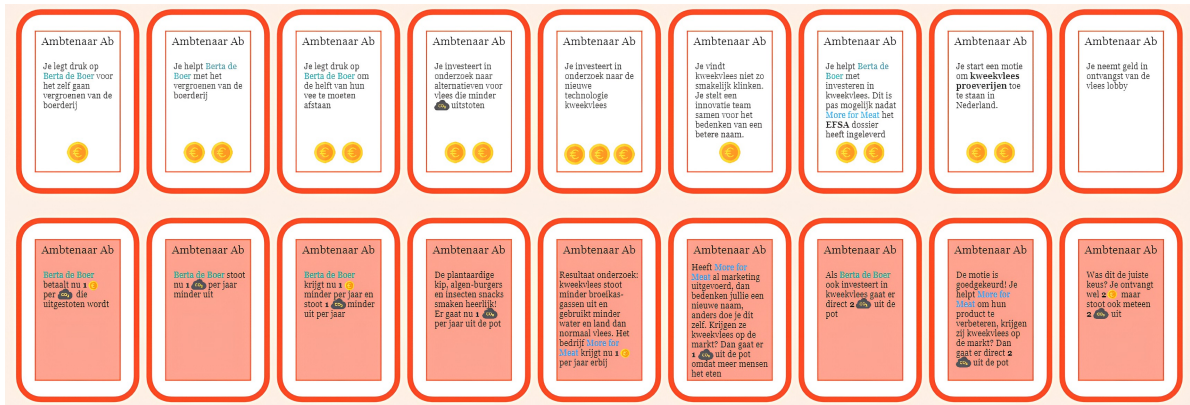


Figure M.1: Option cards and consequences for player Ab de Ambtenaar (governmental player).



Figure M.2: Option cards and consequences for player Berta de Boer (farmer player).



Figure M.3: Option cards and consequences for player More for Meat.