Interventions to maximize public health among Dutch adolescents and young adults concerning nutritional supplement misinformation

Master thesis submitted to Delft University of Technology

in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

in **Complex Systems Engineering and Management**

Faculty of Technology, Policy and Management

by

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To be defended in public on November 4th, 2024

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Preface

As I wrap up this thesis to finalize my journey in the master's program of Complex Systems Engineering and Management at TU Delft, a wave of relief and gratitude overwhelms me. After struggling to find an exciting master's thesis after a gap year, I was lucky to find this subject, which has kept my interest throughout working on this thesis.

First and foremost, I would like to thank both of my supervisors. Lavinia, thank you for your dedicated support in my thesis; you helped me quickly set up my thesis and steer me in the right direction. Your dedicated interest in my thesis, all the meetings, and the feedback you provided really helped me during this journey. Caroline, I would like to thank you for helping me consider the execution and analysis of the methods. Without both of you, my thesis could not have looked the way it now does.

Also, I want to thank my family and friends for their support. They know the bumpy road I have had to be where I am now, personally and professionally. Their continuous support kept me going throughout the whole thesis process. Focusing on my thesis during the summer months, when many family and friends went away on holidays, was a real bummer sometimes. However, my parents kept pointing out that the end was near and motivating me to finish my thesis correctly. I would especially like to dedicate this thesis to my late grandfather, who has always motivated me to keep going at school and get the best out of myself. Even after passing away, the thoughts of his motivation and dedication have never left me. I will never forget one of his last words:

> *"Jelle je bent een Verbakel en die geven nooit op, dat mag je nooit vergeten"*

After concluding this thesis and my journey at the TU Delft, I will travel before finding and starting my first real job. I am eager to start traveling and my professional work life. To everyone reading this thesis, enjoy the read, and if you have any questions or want to talk, feel free to contact me. For anyone working on a thesis themselves, keep going; in the end, you will be filled with enjoyment and gratitude for finishing it!

Best wishes

Jelle Verbakel
Erp, September 2024

Executive Summary

Introduction and Research Approach

In the current era, there is a prevailing trend of improper dietary intake and a growing trend of social media usage. Given this growth in social media usage, the concern about misinformation, mainly health-related misinformation, is increasing. Social media plays an essential role in the prevalence and impact of health-related misinformation. More specifically, the concern of nutritional supplement misinformation and its effect on adolescents and young adults is growing and under-researched. Adolescents and young adults have unknown preferences, and current policies fail to address the problems associated with nutritional supplement misinformation. Understanding the specific preferences of adolescents and young adults and the socio-technical system is crucial to address the issue. Therefore, as the Dutch context has not been researched, this research explicitly addresses the problem of nutritional supplement misinformation among Dutch adolescents and young adults and aims to improve public health outcomes. The following research question was therefore developed:

> *'How can public health outcomes relating to supplement misinformation inside the complex system formed by social media platforms, public health agencies, and local governance be maximized?'*

This thesis thus aims to develop interventions and design requirements within the system of nutritional supplements, social media, and public health outcomes to maximize public health. The research deploys the Value-Sensitive Design (VSD) framework to address the issue. By first identifying the stakeholders and the associated stakeholders and later identifying their values, this research aimed to develop theoretically grounded and ethically sound interventions. Within the research phases of the VSD framework, structured literature reviews, stakeholder expert interviews, and a focus group with the target group were conducted.

The structured literature review primarily aimed to conceptually identify the socio-technical system, the involved stakeholders, and the expected values and risks within the system. Interviews and a focus group were conducted to see if the experts and the researched stakeholders experienced the expected risks and values. In this empirical phase, a thorough values analysis was conducted using co-occurrence analyses and a value map. The conclusions of both the value analysis and the focus group were compared to identify possible differences and similarities between the groups of stakeholders. After the main values to design for were identified, value hierarchies were utilized to develop design requirements. In the technical research phase, the design requirements were matched to the identified promising interventions to come to theoretically and empirically backed interventions.

Results

To fully address the socio-technical system, structured literature reviews were conducted to assess the influences in the system and investigate the institutional environment. The structured literature review was split into two parts to properly assess the influences on social media as well as the outside social media and industrial influences within the system. The comprehensive, structured analysis of the literature and the assessment of the institutional environment pointed out the complex nature of the system and its associated stakeholders, where social media algorithms also play a significant role.

While assessing the socio-technical system, the direct and influential stakeholders within the system were considered to identify possible interview participants. The interviews and the focus group identified the values, risks, value tensions, and possible interventions at stake in the system. This

extensive value analysis identified the main values to design for based on the interviews and the focus group. The main values to design for were awareness, expertise, (scientific) evidence-based, transparency, profit, effectiveness, safety, and regulatory compliance. In designing, the value of public health is paramount, and freedom of speech and choice must be considered.

Based on the identified values to design for and their context within the interviews, the value hierarchies led to the design requirements. The design requirements were then matched with the promising interventions. By including the stakeholder values, the interventions are theoretically sound. The most promising interventions identified in this thesis are certificating influencers, counter campaigns, educational campaigns, and an automated enforcement tool. This research sees all four interventions as suitable interventions to implement, where the extension to the certification of influencers and the counter campaigns are most suitable to deploy first. The research mainly showed the need for prevention interventions to boost awareness and consumer education concerning health and social media.

Contributions

This thesis has some scientific contributions and theoretical implications for the field of CoSEM, particularly considering the area of VSD. This research has shown that VSD can aid design in addressing a societal and policy issue, where VSD originally stems from technology design (Friedman et al., 2006). In addition, this thesis provides grounded interventions to offer novel perspectives in addressing nutritional supplement misinformation. Furthermore, the policies implied by the study are within the context of the Netherlands but could also be considered internationally. This thesis can also fuel the broader problem of health misinformation and other problems with nutritional supplements, as well as the discussion of the responsibility of social media platforms and other industrial stakeholders within the identified socio-technical system.

Future work

This research can serve as a base for future research on using VSD in a similar context and a base to further delve into the system of nutritional supplement misinformation on social media. The interventions proposed in this research were not validated, so future research could focus on involving expert stakeholders to refine the interventions further. As mentioned before, the proposed interventions are not yet specified and tested. Therefore, future research should focus on further specifying and appropriately testing the interventions in practice. The manner and responsibility of implementing the interventions should also be investigated.

Future research should also explore whether the conclusions and interventions from this research apply to a broader demographic and geographical scope. Lastly, future research should focus on misinformation and communication experts to assess their values concerning the socio-technical system to strengthen the conclusions of this research or seek alternative interventions.

Keywords: Value-Sensitive Design (VSD), Nutritional supplements, Social Media, Misinformation, Public Health

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1. Introduction

Social media exposes adolescents and young adults to significant nutritional supplement misinformation in their daily lives. Proper dietary intake is an increasing global concern. Public health organizations stress the importance of proper dietary intake as part of a healthy lifestyle. More and more people are turning to social media to gather information on nutritional supplements to apply to their everyday lives. The information on social media is concerning because a significant amount of nutritional and health information is misleading. As the misinformation can have detrimental effects on nutrition behavior, it is of utmost importance to address the issue by intervening in the overall system. This research aims to deploy a Value-Sensitive Design (VSD) approach to address the issue of supplement misinformation among Dutch adolescents and young adults. This chapter will first introduce the problem and current scientific context. Secondly, the chapter will pinpoint the gaps in scientific literature. Following, the research aim is introduced, which results in combination with the knowledge gap in the research questions. Hereafter, the link between this research and the master's program in Complex Systems Engineering and Management is explicitly stated. This chapter will end by providing an overview of the entire research document.

1.1 Problem Introduction

Proper dietary intake is considered a vital component of a healthy lifestyle. Public health organizations, such as the World Health Organization (WHO), emphasize the importance of a healthy diet in reducing the risk of various non-communicable diseases. For instance, a reduced risk of non-communicable diseases like cancer, cardiovascular disease, and early death is linked to eating sufficient fruits and vegetables (Aune et al., 2017). Despite these well-documented benefits, there is a growing global trend of inadequate dietary practices. This issue is not confined to the general population but is also prevalent in healthcare settings, indicating a widespread health problem (Molter et al., 2024).

Another increasing trend worldwide is social media usage. Social media usage worldwide has been ever-increasing, with 5.07 billion social media users out of the 8.10 billion world population in April 2024 (Kemp, 2024), equaling around 62.6 percent. This means that out of three people, nearly two use social media. Also, there has been an ever-growing increase in social media usage in the Netherlands, with 14.3 million people using social media in 2024 (Jonker et al., 2024). The Netherlands had around 17.9 million inhabitants at the start of 2024 (CBS, 2024), meaning 79.9 percent of Dutch people use social media. In addition, a growing variety of social media platforms are utilized to connect with others and for various other purposes, such as information gathering.

Social media has become a powerful tool that affects individuals' lifestyle choices and dietary intake (Nath et al., 2024). This surge in using social media in the context of online health-seeking behavior has been documented worldwide (Diviani et al., 2015; Jia et al., 2021; Sbaffi & Rowley, 2017). Social media's influence on lifestyle choices and dietary intake is significant, especially among adolescents who frequently use these platforms for dietary guidance (Md Jamri et al., 2023). Understanding how young adults utilize digital tools to shape their health behaviors is crucial and requires further research (Bratland et al., 2024).

1.1.1 Misinformation on Social Media

To better understand the issue related to the increase in the number of people looking for nutritional advice on social media, the issue of misinformation is explained. The prevalence of using social media for nutritional advice raises concerns, as false online information in the digital age is a growing issue, particularly regarding health and nutrition. Individuals often share health information online without proper verification, leading to the spread of false information. Social media algorithms can create echo chambers, exposing individuals to false information if individuals initially engage with misleading content (Zheng et al., 2024), exacerbating the problem of false online information. The definition of false information is mainly distinguishable between the intent of spreading the false information. Scholars have diverse definitions of misinformation and disinformation, and the exact definitions are always up for debate. However, the definition difference is adequately captured in Figure 1.1 and is in line with overall definitions (World Health Organization, 2022). Incomplete information can also be considered disinformation or misinformation based on the intent (Karlova & Fisher, 2013). Malinformation shown in Figure 1.1 will not be further discussed.

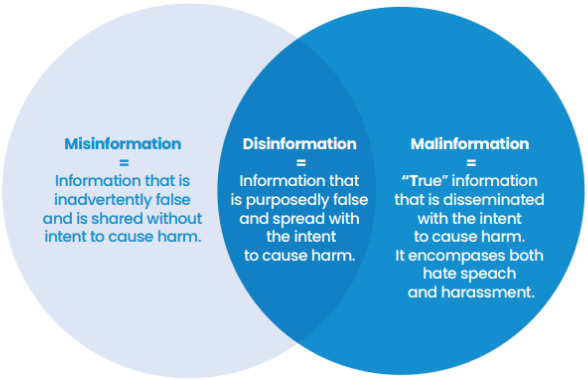


Figure 1.1 False information spectrum (World Health Organization, 2022)

Given the growing reliance on online sources for dietary advice, the prevalence of nutrition-related misinformation poses a significant problem. Dietary advice is a common form of health misinformation amplified on social media platforms (Wang et al., 2019). The lack of quality control and peer review of nutritional information on social media platforms exacerbates the problem of misinformation (Azak et al., 2023; Kreft et al., 2023). In addition, studies have shown that a substantial proportion of nutritional advice on social media platforms like YouTube is misleading (Azak et al., 2023; Denniss et al., 2023). Posts with lower-quality nutritional advice often receive higher engagement than those with high-quality advice (Denniss et al., 2024), further exacerbating the problem of nutrition-related misinformation.

Digging deeper into nutrition misinformation, information on social media regarding nutritional supplements seems to be among the lowest quality of information compared to other nutrition-related topics (Denniss et al., 2024). A significant proportion of gym goers consume nutritional supplements (Goston & Toulson Davisson Correia, 2010; Mettler et al., 2020), mostly without specialized guidance and probably a lack of need for the supplements (Goston & Toulson Davisson Correia, 2010). This poses a risk to public health, as using supplements can pose significant health risks among individuals (Herriman et al., 2017). Individuals could potentially even replace conventional health therapies by using alternative supplementation, which could jeopardize their health (Banović Fuentes et al., 2024). In addition, many people have misconceptions about supplementation (Wafi et al., 2024).

To provide social media users with a reliable source of knowledge, more trustworthy information on healthy eating from qualified health professionals is needed (Wu et al., 2024). Individuals must navigate this information landscape and assess the information's reliability. This is challenging due to the conflicting nutrition information on social media, which is positively related to confusion among individuals (Ngo et al., 2023), which possibly annuls the effect of public health efforts (Lynn et al., 2020). In addition, trust in the information from specific authors on social media correlates with students' adoption (Peša Pavlovic et al., 2023). This fact is problematic, as source trustworthiness is correlated with the likelihood of adopting dietary practices (Ruani et al., 2023), especially among young adults who exhibit unique preferences and behaviors.

The increasing prevalence of nutrition-related misinformation on social media and the challenges in navigating and assessing this information highlight the need for more reliable dietary advice from qualified professionals. Addressing this issue requires understanding the dynamics of information dissemination and trust on social media platforms, where freedom of speech is also a significant value. The issue can be addressed multi-sided; various methods to battle unreliable online content have been considered in the literature, but the most effective means have not been identified (Borges Do Nascimento et al., 2022). Various stakeholders could improve the social media nutrition information landscape, where policymakers play a crucial role by developing multi-sided approaches to address nutrition-related misinformation (Westberry et al., 2023). Health literacy should also be considered as it significantly affects the evaluation of online health information (Diviani et al., 2015). The following section will follow up on the current role of policymakers in combating misinformation.

1.1.2 Current Misinformation Policies

Policymakers have not ignored this growing concern about the spread of misinformation on social media. The COVID-19 crisis has heightened concerns about health disinformation and misinformation globally. Among others, disinformation and misinformation regarding health behavior influence vaccine hesitancy during public health crises (Borges do Nascimento et al., 2022). Therefore, public health organizations and governments are more interested in battling (the effects of) disinformation and misinformation. The WHO has designed a toolkit for its member states to use in designing policies mitigating the effects of disinformation and misinformation (World Health Organization, 2022). However, this toolkit is non-binding advice, as the WHO cannot impose policies on its member states. A governing body that can create binding policies is the European Commission (EC), which has taken steps to combat (health) misinformation.

The EC's first step was implementing the Code of Practice on Disinformation. This self-regulatory code of practice addresses the spread of online disinformation and fake news and was signed by significant industry businesses like Facebook (European Commission, 2018). In 2022, the code of practice was strengthened following the EC’s guidance of May 2021 (European Commission, n.d.-d). At the end of 2018, the action plan against disinformation was presented by the EC, which included the creation of the European Digital Media Observatory (EDMO) (European Commission, n.d.-c). EDMO is an independent research community that focuses on combating false information. In 2020, the Digital Education Action Plan (2021-2027), which includes improving digital literacy teaching in the education system of member states, was adopted by the European Union (EU) (European Commission, n.d.-a). Lastly, the Digital Services Act (DSA) was implemented to primarily safeguard the users' fundamental rights in the digital space (European Commission, n.d.-b). The Digital Services Act binds major digital platforms to combat false information on the platforms themselves.

Delving into The Netherlands, the Dutch government has a strategy to combat disinformation, called: ′Rijksbrede strategie effectieve aanpak van desinformatie' (Bruins Slot & van Huffelen, 2022). This strategy mainly focuses on combating disinformation by strengthening the public debate and mitigating its effects. The strategy primarily focuses on disinformation and does not explicitly mention nutrition-related aspects. In addition, the Netherlands is implementing the Digital Education Action Plan (2021-2027) by redesigning the curriculum at all educational levels. In 2024, the SLO presented the concept design of the central goals of education, including digital literacy as a central goal for the first time (Teunis, 2024). The central goal of digital literacy in the concept design includes goals related to building skills to combat the effects of disinformation (Kampman et al., 2024).

In conclusion, the current measures included in policies are mainly related to overall disinformation. The policies can also combat misinformation but primarily combat disinformation. The policies partly cover health misinformation as some policies are related to combating disinformation in the context of health crises or infectious diseases. The toolkit provided by the WHO does not seem to be incorporated into EU and Dutch policies. As this toolkit is not used in the Netherlands and the policies are lacking to address misinformation specifically, there is still a need to design relevant policies and interventions for the Netherlands to address the effect of nutrition-related misinformation.

1.2 Knowledge Gap

Understanding young adults' preferences and nutritional behaviors is crucial for policymakers to design effective strategies that promote nutrition literacy and improve health outcomes (Bratland et al., 2024). However, several critical gaps remain in the current research and policy frameworks addressing nutrition misinformation. Future research on online nutrition information should focus on social media (Denniss et al., 2023).

While social media is a primary source of information for many adolescents and young adults, adolescents and young adults are under-investigated regarding online nutrition-seeking behavior (Jia et al., 2021), particularly considering nutritional supplements. Current research lacks a detailed exploration of the specific values adolescents and young adults use to assess online health information (Sun et al., 2019; Sbaffi & Rowley, 2017). Understanding the interplay between adolescents and young adults, social media platforms, and industrial stakeholders is crucial to addressing the issue of nutritional supplement misinformation. Additionally, most existing research has focused on the United States, the United Kingdom, and Australia, highlighting the need for studies in the European context (Sbaffi & Rowley, 2017; Sun et al., 2019). Expanding research into the Netherlands is necessary to develop specific solutions to adress nutritional supplement misinformation while targeting Dutch adolescents.

Also, there is a lack of interventions to tackle the effects of nutritional supplement misinformation. Few scientific papers propose specific, tested interventions to tackle misinformation spread (Wang et al., 2019). More interdisciplinary research is necessary to provide sociotechnical perspectives and theory-driven empirical evidence (Li et al., 2019), mainly to tackle the value tensions and conflicts emerging from anti-misinformation policies. Future research should employ a mix of methodologies to capture a broader understanding of the issue (Ngo et al., 2023) while particularly capturing the value complexity of the relevant actors involved. Identifying effective ways to combat the effect of nutritional misinformation remains a significant challenge (Wang et al., 2019), requiring an interdisciplinary approach to develop effective strategies (Chou et al., 2020).

Where effective interventions are still missing, policies are also lacking to address the issue. Current EU and Dutch policies mainly focus on health disinformation, not misinformation, and most are still in early development in the Netherlands. Where experts express the need for effective governmental regulations to address content on social media (Engel et al., 2024), there is a specific need to address nutritional supplement misinformation among Dutch adolescents and young adults through targeted interventions in the system of social media and public health.

Despite the increasing prevalence of nutritional supplement misinformation on social media, research explicitly targeting the Dutch population, particularly adolescents and young adults, is scarce. Addressing this gap is crucial for developing effective, context-specific interventions. The subject and the related system are still under-researched and require an interdisciplinary approach, where deploying a value-sensitive design approach has not been considered in previous literature. The underlying mechanisms of stakeholders must be identified to solve potential value tensions and develop solutions, as diverse stakeholders have different values. In conclusion, there is a significant need to explore interventions to address the effects of nutritional supplement misinformation among Dutch adolescents and young adults, as current interventions fail to target supplement-related misinformation.

1.3 Research Aim

In response to the identified knowledge gaps, this research aims to develop interventions tailored to the Dutch context, specifically targeting adolescents and young adults. By employing a Value-Sensitive Design (VSD) approach, this study seeks to create effective interventions that address supplement misinformation, considering the Netherlands' unique socio-technical dynamics and stakeholder values. This is achieved by incorporating various methodologies to provide policymakers and system designers with conceptual, empirical, and theoretical guidance. Due to ethical research considerations, the research aims to focus on the higher ages of adolescents (16 years and older) and young adults. The first goal is to map the complex socio-technical system related to public health, social media, and nutritional supplements to understand the system dynamics and the stakeholders involved. This understanding guides the system's assessment of stakeholder dynamics and relevant stakeholder values. Later, the research aims to describe the most essential value conflicts and tensions within the context of the complex system related to mitigating supplement misinformation. For the context of this research, all forms of untrue information are referred to as "misinformation." This study focuses on the effect of the information in the system, excluding the intention of spreading false information. Lastly, this research aims to develop design requirements and interventions to mitigate the adverse effects of supplement misinformation. Due to time constraints, this thesis will not attempt to identify exact policies or interventions but rather develop design requirements and bases for interventions to consider. In this sense, the conclusion of this thesis will not be the complete solution to combat the effects of nutritional supplement misinformation but rather a guide on what sort of interventions to employ in the system.

1.4 Research Questions

A thesis will be conducted to address the knowledge gap found in the literature and provide new insights into this area of research. The previous section stated that the research aims to address the knowledge gap. This research aim will be addressed by developing a central research question. The research will be structured to answer the main research question, which will be answered by going through several sub-research questions. All of these sub-research questions will contribute to answering the main research question. This subchapter will provide the main research and sub-research questions, as well as the logic behind the sub-questions, and their order.

'How can public health outcomes relating to supplement misinformation inside the complex system formed by social media platforms, public health agencies, and local governance be maximized?'

To address the main research question, three sub-research questions are formulated. These three sub-research questions will be answered to form an answer to the main research question. For every sub-question, an explanation is given.

SQ1: 'How does the socio-technical system related to supplement misinformation, public health, and social media function and who are the key stakeholders involved?'

First and foremost, an understanding of the underlying complex socio-technical system must be identified to address the main research question. The analysis will guide in assessing the stakeholders involved. Indirect and direct stakeholders in the system will be identified and evaluated per the VSD framework. Researching the complexity of the system and stakeholder dynamics is a crucial first step in identifying the design space. The sub-question will also identify the key values at stake in guiding the design of interventions addressing supplement misinformation in the identified system. The relation to these values and their prioritization will be identified in the next sub-question and will highlight the primary value tensions and conflicts that arise when designing within the identified system. These conflicts and tensions are later assessed on how they can be resolved and balanced in the design requirements and interventions.

SQ2: 'What are the main risks in this socio-technical system, and what values should be designed for?'

After a broad identification of the entire system with the involved stakeholders and values, the risks in designing in this system will be identified. First, based on the literature, the estimated risks will be constructed and validated through interviewing experts. Validating the estimated risks will show the actual risks in the system. The actual risks and values will identify the main values to design for, which will be highlighted to guide the design principles. Therefore, after validating the estimated risks, the main values will also be discussed. Accounting for the main risks and most important values is crucial in constructing valid design requirements and interventions.

SQ3: 'What specific design principles and strategies can be developed to integrate the identified values into interventions to maximize public health, targeting supplement misinformation among Dutch adolescents and young adults?'

After assessing all values, possible value tensions, and the main risks, the core design requirements for designing interventions in the identified complex system will be developed. An assessment will be made on how the design principles could lead to interventions to mitigate the effects of supplement misinformation on social media among Dutch adolescents and young adults. These interventions will be principles that can be later refined into practice. It is out of scope for this thesis to provide an answer on how to implement the proposed interventions due to time constraints. Answering this last sub-question will lead to the answer to the main research question.

1.5 Link to Study Program

The Master in Complex Systems Engineering and Management (CoSEM) aims to equip students with the skills to analyze, design, and manage complex socio-technical systems. This thesis perfectly aligns with these objectives by addressing the interplay between social media, public health, and supplement misinformation. This thesis uses a systems thinking approach to understand the interactions between social media platforms, public health, stakeholders, and information dissemination dynamics. Employing this approach together with VSD ensures the use of ethical social and stakeholder values in designing within the identified complex system, which is central to the master program. The research highlights the necessity of effective policy interventions and governance strategies to manage and improve complex systems. In conclusion, this research is inherently multidisciplinary, involving elements of social science, information technology, health sciences, and public policy. Therefore, it suits the Master's program in Complex Systems Engineering.

1.6 Thesis Outline

The introduction chapter set the stage for this thesis by outlining the problem, identifying the knowledge gap, and stating the research aim and questions while establishing the link to the CoSEM study program. The second chapter introduces the concept of Value-Sensitive design and details the overall research design, which includes a structured literature review, interviews, and a focus group. By deploying a structured literature review, the thesis proceeds with a systematic approach to identify the complexity of the system and the stakeholders involved. The next chapter includes the stakeholders' values according to the literature review and later validates these with interviews and a focus group. Also, the fourth chapter provides an overview of the estimated risks of the system. The interviews and a focus group validate the estimated values and risks. Based on the findings from the literature, a focus group, and interviews, the main values to consider in the design requirements and interventions are identified. The design requirements and identified possible interventions are discussed in the fifth chapter. The discussion chapter synthesizes the research findings, discusses limitations, and explores implications for public health and policy-making. The thesis concludes with a conclusion on the key findings and recommendations for future research.

2. Methodology

This chapter outlines the qualitative research methods employed to address the research questions. The Value-Sensitive Design (VSD) framework guides the research, supplemented by literature reviews, expert interviews, and focus groups. In this chapter, the research tools are stated to provide insights into how the research questions are addressed. The overall framework used for this research is the VSD framework, supplemented by several qualitative research methodologies to address the research question and sub-questions. The overall research design will consist of structured literature reviews, expert interviews, and a focus group. This approach will allow for a thorough investigation of the system regarding supplement misinformation related to social media and public health. The ultimately developed design requirements and interventions to maximize public health will be validated by literature at a late stage in this research. In addition, this chapter includes a research flow diagram that shows the sequence of the research. This chapter will continue by explaining the VSD approach.

2.1 Value-Sensitive Design (VSD)

Value-Sensitive Design (VSD) is an established methodology that systematically integrates considerations of human values into the design process, the methodology was first introduced in the field of human-computer interaction. VSD is a theoretically grounded method that directs technology design while incorporating human and ethical values (Friedman et al, 2006). However, this view can be extended as technology in the context of VSD is a broad term that refers to the technology itself, the underlying organizational infrastructure, and its dynamics (Friedman et al., 2017). The word value within VSD is a broad term and is considered to be the values in life that are deemed important by people or groups of people (Borning & Muller, 2012).

In this research, VSD will be employed to develop design principles and interventions aimed at maximizing public health in the context of nutritional supplement misinformation on social media among Dutch adolescents and young adults. VSD is a tripartite methodology involving conceptual, empirical, and technical investigations. The VSD approach is iterative, meaning insights from the conceptual phase inform the empirical phase, which in turn shapes the technical phase, creating a continuous feedback loop. In Figure 2.1, the interrelations between the investigations and the continual feedback loop are graphically shown by Umbrello (2020). This multi-faceted approach ensures a comprehensive understanding of the values at stake, the stakeholders involved, and the technical mechanisms required to implement these values into the practical design of solutions. Other key features within VSD are that there is an emphasis on both direct and indirect stakeholders, as well as on the interaction relationship between technology and values (Borning & Muller, 2012). Justifications on why or why not to include certain stakeholders in the design process should therefore be legitimized (Friedman et al., 2017).

Conceptual Investigation

The conceptual investigation involves identifying and articulating the values relevant to the research context by investigating the relevant literature (Umbrello, 2020). Analytical, theoretical, and philosophically informed examinations of the main concepts and constructs under investigation all fall within the conceptual investigation (Friedman et al., 2017). In addition to articulating the values, the conceptual investigation also tries to analyze tradeoffs between values and investigates which values have more weight (Friedman et al., 2013) This investigation addresses the ethical considerations and stakeholder values pertinent to maximizing public health in the context of supplement misinformation.

Empirical Investigation

The conceptual investigation can only go so far; additional empirical evidence is needed to explore the concepts and constructs further. The empirical investigation examines the specific environment in which the technical system is situated (Friedman et al., 2017). Data is gathered from the stakeholders during the empirical investigation to include them in the design process and better understand their viewpoints, experiences, and values (Umbrello, 2020). Since empirical investigations can be deployed to all human activities, the full spectrum of quantitative and qualitative methods used in social sciences, like interviews, surveys, and experiments, can be applied (Friedman et al., 2013; Friedman et al., 2017). The empirical phase of this research involves qualitative methods to ensure a robust understanding of the context. The empirical investigation will focus on validating the conceptual phase and serve as the starting point for the technical investigation.

Technical Investigation

The technical investigation involves designing and prototyping interventions that embody the identified values. Technical constraints are derived in the technical investigation to determine whether the values investigated in the conceptual and empirical investigations are supported or restricted (Umbrello, 2020). The technical investigation can take two forms, the investigation of current technical systems and the proactive design of a technical system (Friedman et al., 2013; Friedman et al., 2017). In addition to designing technical systems, the technical investigation also includes testing and refining the design principles in real-world settings to evaluate their effectiveness. Design requirements will be derived by synthesizing insights from the empirical and conceptual data, focusing on creating interventions that align with the identified values and address the major value tensions and risks.

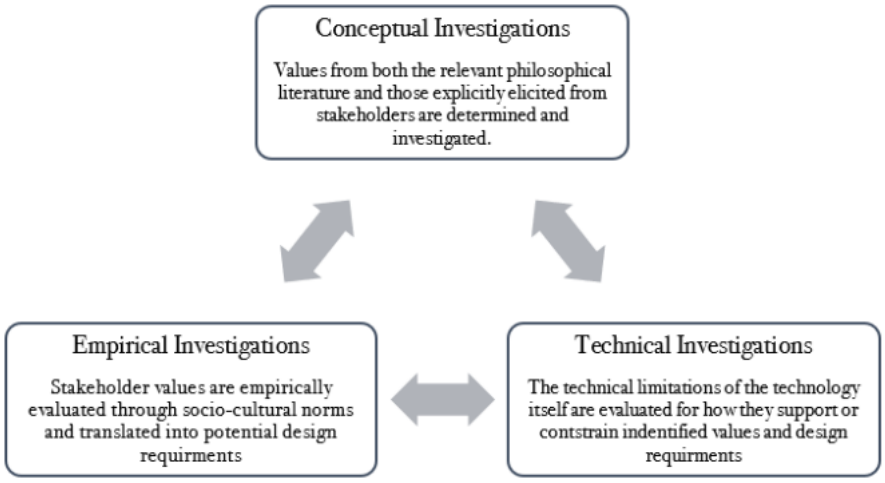


Figure 2.1 The recursive VSD tripartite framework (Umbrello, 2020)

2.1.1 Values

After considering the identified values, the values must be translated into design requirements. The design requirements outline specific properties, attributes, and functionalities that for this research are connected to the interventions. Research by van de Poel (2013) and Veluwenkamp and van den Hoven (2023) have outlined the concept of the values hierarchy, which is central to VSD in capturing practical purposes in a specification schema. This schema outlines the values, norms, and design requirements via a hierarchical structure, as depicted in Figure 2.2. Designers can transfer abstract values or basic moral notions via context-specific norms into design requirements through specifications with decreasing levels of abstraction thanks to the systematic representation of values and inferred

requirements (van de Poel, 2020). The value hierarchy's norms can impose various restrictions or recommendations on actions (van de Poel, 2013, 2020). In conclusion, establishing value hierarchies helps prioritize values based on stakeholder importance and ethical considerations, ensuring the design requirements align with the most critical values.

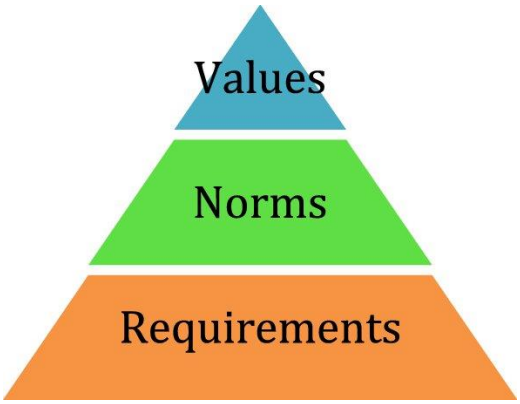


Figure 2.2 Value hierarchy (Veluwenkamp, & van den Hoven, 2023)

Throughout the VSD process, ethical considerations will be paramount. To guarantee that the interventions are morally and socially acceptable, the research aims to strike a balance between conflicting values, such as public health and freedom of expression. By employing the Value-Sensitive Design methodology, this research aims to create effective, value-aligned interventions to maximize public health in the context of supplement misinformation among Dutch adolescents and young adults. The VSD approach addresses the complex interplay of values within the socio-technical system of supplement misinformation, ensuring that the design concepts developed are not only technically sound but also ethically and socially responsible.

2.1.2 Limitations

A limitation of the framework is the conceptualization of the values, as values can have multiple exact meanings in the decomposition of the values. Conceptual engineering could aid in the conceptualization of the values and is an important task to improve the application of VSD, as design requirements depend significantly on the conceptualization of the associated value (Veluwenkamp & van den Hoven, 2023). Adding to this limitation, some values are unfairly considered to be universally applicable in VSD, where their conceptualization is context-specific and the context should therefore be considered (Borning & Muller, 2012). This research will aim to thoroughly explain all the values considered within the context, and the values will be considered context-specific to best overcome this limitation. Implementing a thorough conceptual engineering approach, however, will be outside of the scope of this research.

Another limitation of the application of the VSD for this research is that the exact interventions, monitoring, and testing are out of the scope of this research. This implies that this research will only partially grasp the use of the VSD. However, the VSD approach does not specify how to test and implement the interventions. In contrast, as stated by Friedman et al. (2017), within VSD, one should strive for progress and not for perfection. This limitation of the VSD framework can therefore be neglected and it will be up to further researchers to implement, test, and monitor the developed design requirements and interventions to strive for additional progress.

2.2 Overall Research Design

This section outlines the comprehensive research design that will be employed to achieve the research aim and objectives. Specific research (sub) questions were developed in the previous chapter to address the research objective and scientific research gap. Several questions require in-depth scientific knowledge or stakeholder values and expertise. Qualitative research methods are required to acquire in-depth scientific knowledge and expert expertise. Therefore, the research design is defined as a qualitative research methodology. The research design is structured into four main investigations: a systematic literature review, expert interviews with key stakeholders, a focus group with system users, and the design of interventions. Each phase is carefully planned to ensure robust data collection and analysis. Figure 2.3 shows an overview of the research. The following sections will explain the actual methods and explain which sub-question the given method will help to answer.

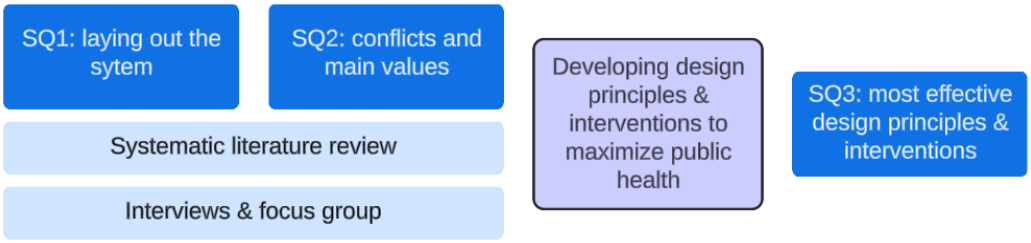


Figure 2.3 Research Overview

The VSD methodology will be integrated into the research design as explained in this section. The first phase will consist of the conceptual investigation, where a structured literature review will be deployed to identify existing research on supplement misinformation, social media, public health, and VSD. This will result in mapping the system and all relevant stakeholders involved. The second phase will consist of the empirical investigation. Interviews with key stakeholders will be conducted next to a focus group with adolescents and young adults. Value elicitation techniques are deployed to gain a deeper understanding of the identified values. Lastly, the third phase consists of the technical investigation, where based on previous findings the design principles and interventions are developed. As a final evaluation, literature will be considered to assess the discussed interventions.

2.2.1 Literature Review

Structured systematic literature reviews will be deployed throughout the conceptual phase of the research. The first sub-question will be fully answered by literature, where the answer to the second research question will have a literature basis. The systematic literature review will identify the system, its main stakeholders, associated expected values, risks, and underlying mechanisms. It will also investigate whether prior scientific research has tried to identify the underlying system and whether VSD has been applied to related research. The systematic review will identify conceptual values and risks for the design requirements and interventions. The review will follow the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to ensure comprehensive and transparent reporting. This review will identify gaps in the current literature and provide a theoretical foundation for the identification of the socio-technical system and its related values and risks.

2.2.2 Interviews

Key stakeholder semi-structured interviews will be conducted with a selected group of stakeholders. The interviews intend to empirically gather values and risks to validate the expected values and risks

stemming from the literature in the conceptual phase of the research. The interviews allow for a deeper understanding of the values of the key stakeholders in the context of the identified system in SQ1. The empirically gathered values and risks gathered in the interviews will serve as the basis for identifying value tensions and risks in the system, which will be assessed in SQ2. In addition, the interviews will gather ideas about possible interventions as a basis for designing interventions in the technical phase of the research, where SQ3 will be answered. Empirically gathering intervention ideas for the technical phase is appropriate due to the expert background of the interviewees in relation to the identified system.

The participants will be selected by various means to gather different stakeholders. The interviews will be semi-structured, to allow for proper guidance throughout the interviews but allow for flexibility which could lead to the gathering of additional input from interviewees. The interviews will be recorded and later transcribed to be able to do a thematic analysis of the interviews. The interview transcripts will be analyzed using the software Atlas.ti which allows for rigorous analysis of the interviews. This thematic analysis will identify key values and patterns, as well as value tensions within the system. Thematic analysis is suitable as it allows flexibility in the interpretation of the results of the interviews.

2.2.3 Focus Group

To research the targeted research group in the identified system, a focus group will be conducted with young adults and adolescents above 16 who may or may not make use of supplements. As ‘users’ within a system are always key stakeholders, the focus group will target this stakeholder group simultaneously. The focus group will take place after the conceptual phase of the research and will partly validate the identified expected values and risks within the system. The results of the focus group will be compared to the interview results to see whether values align between the expert stakeholders and the key stakeholder group. This empirical phase of the research will support the analysis and give the ‘users’ a voice in the technical design phase of the research. The focus group will also be analyzed thematically by utilizing the Atlas.ti tool and will be conducted after the interviews to use the ideas for interventions mentioned in the interviews when discussing the interventions during the focus group.

2.2.4 Ethical Considerations

This research will strictly adhere to TU Delft's Human Research Ethics guidelines to ensure ethical conduct and proper data handling. The guidelines provide a framework for conducting research involving human participants in a manner that respects their rights and well-being. TU Delft requires any research conducted by researchers of the university who are related to human subjects to be in line with the ethical guidelines. Therefore, properly handling the participants' data and its implementation in the thesis are of primary concern within this research. The Human Research Ethics Committee (HREC) was contacted to assess and approve this research. The approval by the HREC was granted on 17/07/2024.

One of the fundamental principles of ethical research is obtaining informed consent from all participants. For this study, informed consent will be secured from all interview and focus group participants utilizing informed consent forms. The consent forms ensure that participants fully know the study's purpose, procedures, and potential risks. Following the HREC approval process, a data management plan was constructed with a data steward of the TU Delft to ensure responsible handling of participants' data. This ethical foundation will not only enhance the credibility and reliability of the research findings but also contribute to the broader goal of conducting socially responsible and ethically sound research.

2.3 Research Overview

The research overview will provide a summary of the entire research process, highlighting the connections between each phase of the research and how they collectively contribute to the development of the (policy) interventions. Figure 2.4 shows the flow of the research graphically utilizing a research flow diagram (RFD). The figure illustrates the sequential and iterative nature of the research process, highlighting the flow from conceptual investigation to empirical data collection, and finally to technical development and validation. Chapters 3 and 4 are broken down into 2 components in the RFD to highlight the distinction between the first conceptual phase of the research by structured literature reviews and the second empirical phase. After both phases, the technical phase will start as the interventions and design principles will be developed. Ideally, the technical phase leads back to the reiteration of the conceptual and empirical phases, which, for this research, is out of scope. Lastly, due to time constraints, this research does not validate the interventions and design requirements by utilizing validation interviews with the key stakeholders. This is unfortunate as it would have allowed the research to utilize the principles of the VSD framework more fully.

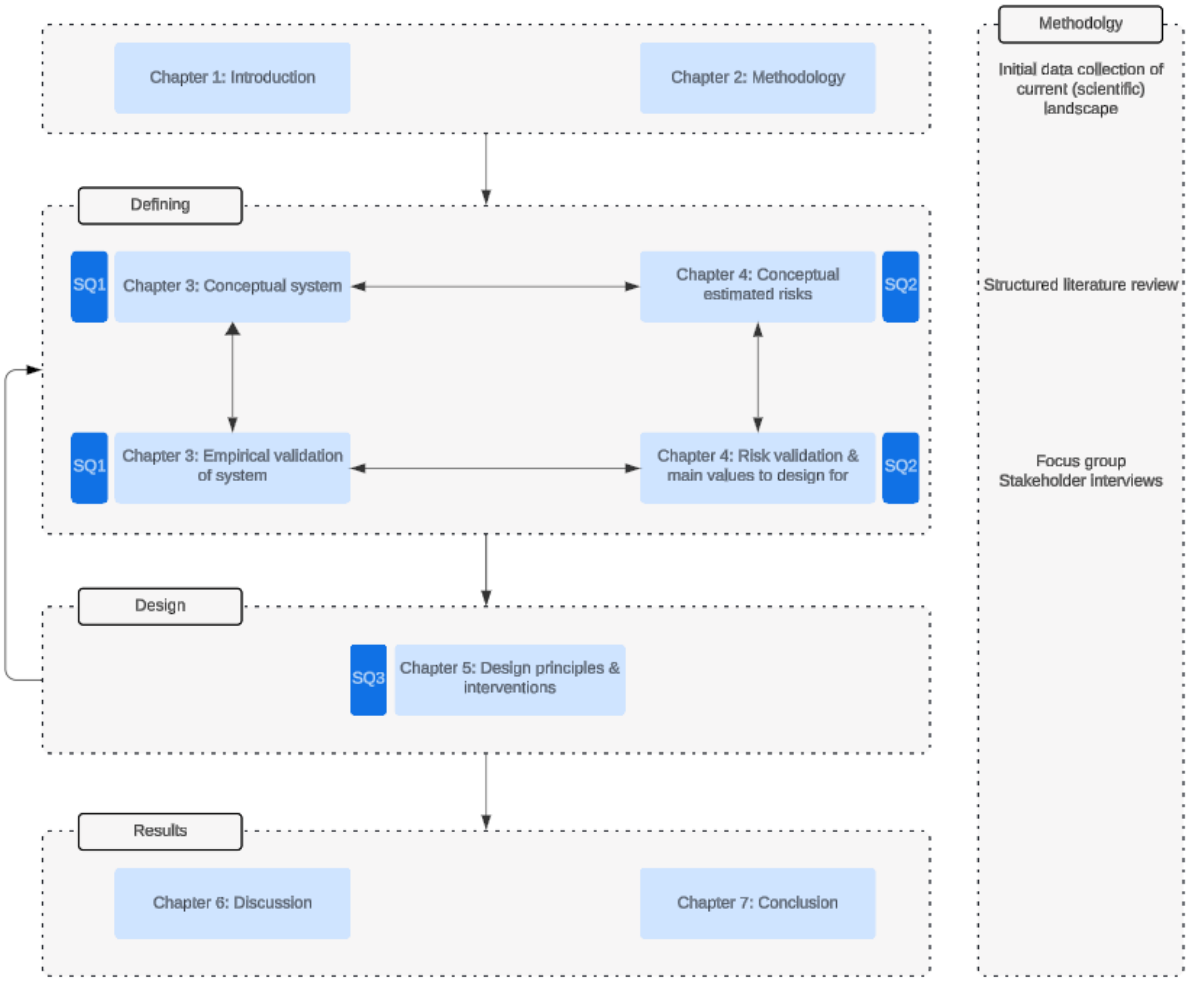


Figure 2.4 Research Flow Diagram

3. The System

First and foremost, an understanding of the underlying complex socio-technical system must be identified to address the main research question. The analysis will guide in assessing the stakeholders involved. Indirect as well as direct stakeholders in the system will be identified and evaluated. Researching the complexity of the system and stakeholder dynamics is a crucial first step in identifying the design space. This chapter will start with defining the concepts of social media and nutritional supplements. This chapter addresses the influence of social media on adolescent and young adult health behaviors. Later, the chapter looks into the nutritional supplements industry and the influences outside of social media on nutritional behavior. The institutional and legal aspects of the socio-technical system are discussed to grasp this aspect of the system in the Dutch context. The investigations together are combined to provide an answer to what the social-technical system looks like. Lastly, this system will be explained together with the stakeholders involved, mainly through two formal charts.

3.1 Defining Social Media and Nutritional Supplements

Before starting the structured literature review, this section will define the two main concepts within the review. Firstly, the concept of social media and social media platforms are further defined. Secondly, the concept of nutritional supplements is defined. These definitions will ensure the reader understands the research topic better and introduce the rest of the literature review.

3.1.1 Social Media Platforms

Social media has completely changed the way we engage with one another, communicate, and consume information within our daily lives. Social media refers to digital platforms and technologies that allow users to create, share, and interact with content online within their social networks (Mróz-Gorgoń & Peszko, 2016; Sarode & Hajare, 2017). These online platforms enable social interactions, information sharing, and participation in online communities (Subhashini, 2023; Valkenburg, 2022), where the platforms continuously evolve to meet user preferences (Rhee et al., 2021). The platforms facilitate user interaction through communities for sharing user-created content (Högberg, 2018; Subhashini, 2023) through text, images, videos, and other forms of media (Rhee et al., 2021). Social media users can actively engage by posting content or passively consume information by browsing (Valkenburg, 2022).

Social media has been ever-evolving and has exceeded the original range of purposes. Social media has evolved with the rise of Web 2.0 technologies, which support creating and exchanging user-generated content (Hall, 2016). While social media existed before the Web 2.0 era, it is commonly associated with major platforms like Facebook and X (Hall, 2016). These platforms are hubs for accessing news, personal messages, and cultural content that reflect shared values and interests (Howard & Parks, 2012). Current major platforms include Facebook, Instagram, YouTube, TikTok, WhatsApp, and Snapchat and all have unique features for users to connect and share content. For the scope of this research, image and video platforms like Instagram, TikTok, and YouTube will be central to the investigation. These three social media platforms are among the top three most popular among Dutch 14-29-year-olds (Jonker et al., 2024), making it a suitable scope for this research.

Social media platforms are essential for organizations to engage with customers, build relationships, and promote products and services (Kapoor et al., 2017). Social media platforms allow businesses to reach diverse audiences and create a sense of community around their brand (Kapoor et al., 2017). The unique environment of social media platforms allows companies to tailor marketing strategies to meet

customer needs, while social media platform algorithms allow businesses to drive brand engagement (Kapoor et al., 2017).

Social media platforms also impact broader societal trends and behaviors by influencing opinions and shaping public discourse (Zhou et al., 2022). Furthermore, social media platforms play a significant role in political movements and social change by amplifying voices and facilitating collective action (Howard & Parks, 2012), where user-generated content can have significant effects, shaping narratives and perceptions (Zhou et al., 2022).

3.1.2 Nutritional Supplements

Nutritional supplements, also named dietary supplements, complement a diet by providing additional nutrients such as vitamins and minerals (Pilegaard et al., 2022). Nutritional supplements are intended to complement a proper diet but not to replace parts of a diet (Walsh & Wright, 2016). Nutritional supplements can be bought in various forms, including pills and powders (Walsh & Wright, 2016). In recent years, the nutritional supplement market has grown into a multibillion-dollar industry worldwide (Gabriels et al., 2020). The development of the market is attributed to several factors, including increased awareness of health, the desire for convenience, and the interest in improving well-being (Walsh & Wright, 2016). For this research, nutritional supplements are considered products that claim to supplement nutritional intake.

Nutritional supplement companies utilize various marketing strategies to stimulate the massive growth of the market (Walsh & Wright, 2016). The industry targets consumer needs, such as managing nutrient deficiencies and promising sports and life performance benefits (Maughan et al., 2018). Due to this broad marketing approach, nutritional supplements are widely used, particularly among athletes and highly active individuals (Gabriels et al., 2020; Maughan et al., 2018). However, the content and quality of these supplements can vary, with contamination and adulteration with doping substances reported in the literature (Geyer et al., 2008), which poses a significant health risk associated with supplements.

The nutritional supplement market is not only driven by consumers and companies but also by commercial players such as gyms and fitness centers (Pilegaard et al., 2022), where other studies show an increase in the use of nutritional supplements among gym-goers (Alebiosu, 2024; Gabriels et al., 2020). A broader demographic, including individuals seeking to address specific health concerns or compensate for dietary deficiencies, now use nutritional supplements (Gabriels et al., 2020). Moreover, the availability of supplements tailored to different consumer needs and preferences contributes to the popularity of the supplements (Walsh & Wright, 2016). The increasing availability and marketing of supplements in diverse settings contribute to their widespread use and acceptance as part of a healthy lifestyle or a fitness regime. In addition, nutritional supplements can play a role in managing specific health conditions (Tie et al., 2016; Yu et al., 2014).

Despite the popularity of nutritional supplements, concerns exist regarding the regulation, labeling, and quality control. Issues such as misleading label information, inconsistent product quality, and the potential for contamination with banned or undeclared substances highlight the importance of transparency and safety in the supplement industry (Geyer et al., 2008). Other critiques of the nutritional supplements market are the misleading marketing strategies and the fact that individuals widely view supplements as a substitute for a proper diet. Professionals advise people to prioritize a proper diet to achieve proper dietary intake and to view nutritional supplements as a supplementation to a proper diet (Close et al., 2022).

3.2 Information Dissemination on Social Media

A systematic literature review has been carried out using the PRISMA protocol. The review addresses the first sub-question and focuses mainly on uncovering the socio-technical system related to supplement misinformation, public health, and social media. During the literature search, it was concluded that one search query would not yield proper results about the entire system regarding nutritional supplements. Therefore, it was decided that the literature search needed to be split into two separate parts. First, a part in which the online influences of social media on nutrition behavior are assessed as nutritional supplements are widely marketed and discussed on social media platforms. The second part investigates the industry and outside social media influences on supplement use to assess the relationship between adolescents and young adults and the industrial stakeholders. Combining both parts shows all the influences within the system and is a solid base for depicting the system. While executing both parts, it was concluded that VSD had not been used before for the research topic. Later in this chapter, both structured literature reviews will be combined with the institutional investigation conducted later in this chapter to display the socio-technical system.

3.2.1 Influence of Social Media

A search query was designed to evaluate the influence of social media on adolescent and young adult health behavior. The library search engine Scopus was utilized to carry out the literature review. The investigation was carried out on June 28th, 2024. The keywords and their synonyms which were used for this literature review are shown in Table 3.1. First, the search was broadened from supplements to nutrition, food, and health as supplements did not yield useful results. During the search, the Netherlands and its synonyms were incorporated, but the search did not yield results. To specifically narrow down the search and bring the search more toward the overall research aim, the term adolescent and their synonyms are included in the search query. The keywords in Table 3.1 are horizontally denoted with the operator 'OR' to include the synonyms, and vertically, the keywords are denoted with the search operator 'AND' to combine the terms. The keywords are searched throughout the document, so the keywords are not limited to titles, abstracts, etc.

Table 3.1 Search Query 1

Keyword	Synonyms
Social media	Digital platform, Online network, influencer, Social network
Influence	Nudge, stimulant
Adolescent	young adult, teenager, juvenile, youth
Behavior	Conduct, actions
Nutrition	Diet, Food

Inclusion and Exclusion Criteria

As social media is a relatively recent and ever-evolving concept, literature was included if it was published in the last ten years (2014 – 2024). Solely peer-reviewed articles, book chapters, books, and conference papers were included. Also, literature that is behind a paywall or is in languages other than English or Dutch is excluded. After considering these inclusion and exclusion criteria, the abstracts are scanned to assess their includability. During this process, literature not relevant to the specified population, namely young adults and adolescents, is excluded. In addition, literature that does not discuss the influences of sorts on social media on nutrition behavior is excluded. After the abstracts were scanned and a selection of articles was made, the full text was read to assess whether the articles could be included. Figure 3.1 shows the PRISMA Flow Diagram of this literature search strategy. Subsequently, Table 3.2 shows an overview of the included literature.

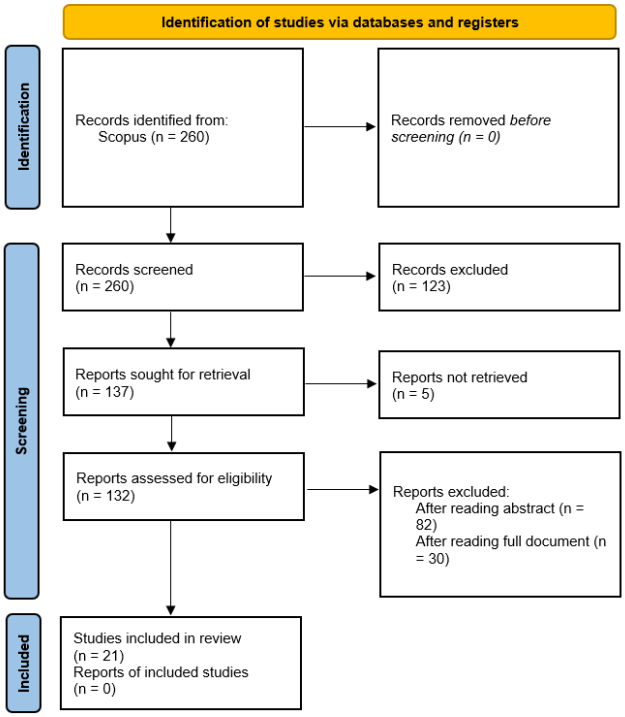


Figure 3.1 PRISMA table first review

Table 3.2 Overview of used literature in the first review

Author's	Year	Title
Aleid et al.	2024	The role of social media advertisement and physical activity on eating behaviors among the general population in Saudi Arabia
Allman-Farinelli et al.	2019	The role of supportive food environments to enable healthier choices when eating meals prepared outside the home: Findings from focus groups of 18 to 30-year-olds
Bailey et al.	2023	Australian adolescents' views about healthy eating and the effects of food advertising on dietary behaviour: Perspectives of athletes and non-athletes
Carrotte, et al.	2015	Predictors of "liking" three types of health and fitness-related content on social media: A cross-sectional study
Charry & Tessitore	2021	I tweet, they follow, you eat: Number of followers as nudge on social media to eat more healthily
Cheshire et al.	2020	What are the key features of orthorexia nervosa and influences on its development? A qualitative investigation
Dunlop et al.	2016	Marketing to youth in the digital age: The promotion of unhealthy products and health-promoting behaviors on social media
Easton et al.	2018	Young people's experiences of viewing the fitspiration social media trend: Qualitative study
Freeman et al.	2016	Young adults: Beloved by food and drink marketers and forgotten by public health?
Friedman et al.	2022	The use of social media as a persuasive platform to facilitate nutrition and health behavior change in young adults: Web-based conversation study
Goodyear & Armour	2018	Young people's perspectives on and experiences of health-related social media, apps, and wearable health devices
Harmon et al.	2016	Perceived influence and college students' diet and physical activity behaviors: An examination of ego-centric social networks

Hawkins et al.	2021	Does exposure to socially endorsed food images on social media influence food intake?
Kucharczuk & Oliver	2022	The perceived influence of food and beverage posts on social media during the COVID-19 pandemic: An exploratory study with U.S. adolescents and their parents
Modrzejewska et al.	2022	#childhoodobesity – A brief literature review of the role of social media in body image shaping and eating patterns among children and adolescents
Molenaar et al.	2021	Effects of advertising: A qualitative analysis of young adults' engagement with social media about food
Perakslis & Quintana	2023	Social media is addictive and influences behavior: Should it be regulated as a digital therapeutic?
Qutteina et al.	2019	What do adolescents see on social media? A diary study of food marketing images on social media
Raggatt et al.	2018	"I aspire to look and feel healthy like the posts convey": Engagement with fitness inspiration on social media and perceptions of its influence on health and wellbeing
Serrano-Fuentes et al.	2024	Beyond individual responsibility: Exploring lay understandings of the contribution of environments on personal trajectories of obesity.
Turner & Lefevre	2017	Instagram use is linked to increased symptoms of orthorexia nervosa

Analysis of the Literature

Young people have access to various health-related content on social media that is produced, disseminated, and promoted by governmental and health agencies, commercial companies, influencers, and peers (Goodyear & Armour, 2018). Social media platforms are major venues for advertising, predominantly marketing unhealthy foods to increase brand reach, targeting young adults who frequently utilize social media to control their diet without reading nutrition labels (Aleid et al., 2024). The ways social media can influence adolescent and young adult health behaviors can take on multiple forms, which will be explained in the following text. First, the design of social media and its algorithms is discussed. The other main themes identified are overall advertisement, peer influence, fitspiration content, and influencer influence. Lastly, the risk of social media and health literacy is discussed.

The algorithms behind social media shape people's information access. Users pick which accounts to follow on social media and are constantly exposed to similar content created by these accounts (Turner & Lefevre, 2017). Due to the limited exposure, users may experience social pressure to conform to certain behaviors, believing that the behavior is more common or normal than it is (Turner & Lefevre, 2017). Furthermore, through exposure to images and interpersonal interactions on the platform, undesirable behaviors may be continuously reinforced (Turner & Lefevre, 2017). Moreover, social media algorithms significantly impact adolescents' awareness, body image, and eating patterns, reinforcing perceived social norms (Modrzejewska et al., 2022).

Advertisement

First and foremost, people are targeted with advertisements via social media. The advertisements have been shown to have a significant impact on people's nutrition-related behaviors. The desire to try foods seen in advertisements increases among those who regularly watch food ads on social media (Aleid et al., 2024). Particularly persuasive fast food advertisements prompt purchases due to promotions emphasizing taste, affordability, and convenience (Friedman et al., 2022; Molenaar et al., 2021). Young adults are major targets for unhealthy nutrition marketing due to several factors influencing their food choices, including gaining responsibility away from parents and low nutrition literacy (Allman-Farinelli et al., 2019). The advertisers of nutrition brands utilize several ways to influence the behaviors of

adolescents and young adults. Adolescents often develop brand preferences based on social media advertisements (Kucharczuk & Oliver, 2022). In contrast, young adults living at home are still influenced by their parents' purchasing decisions (Kucharczuk & Oliver, 2022), mitigating the effects of unhealthy food marketing. In addition, the constant exposure to fast-food advertisements makes young people more conscious of dietary choices (Friedman et al., 2022).

Large companies are noted as particularly persuasive regarding food advertisements (Friedman et al., 2022). Non-core foods are promoted on social media through various marketing strategies by peers, influencers, and marketers, spreading food norms that encourage overconsumption (Qutteina et al., 2019), especially by employing high-frequency visually appealing promotions that are particularly effective among young adults (Molenaar et al., 2021). Global brands leverage social media to their advantage across borders, overshadowing local public health efforts with substantial marketing budgets (Dunlop et al., 2016). In contrast, health-promoting social media campaigns are generally local and underfunded, limiting their reach and impact (Dunlop et al., 2016). Indicating that locally addressing unhealthy food promotion on social media is ineffective.

Healthy food marketing also comes with its limitations. Social standards concerning nutrition and health are greatly influenced by the online environment outside of schools (Bailey et al., 2024). Young adults position healthy food as the ‘right choice’ (Cheshire et al., 2020), pointing to influences from a society where the social value of personal healthism is considered important. However, healthy food is disadvantaged as unhealthy food enjoys a more significant social value, and healthy food advertisement fails to convince people to change their current nutritional intake (Charry & Tessitore, 2021). Thus, addressing the social value of foods is a way in which nutrition behavior can be changed. This section highlights the significant ways social media advertising can shape nutrition behavior.

Peers

Another aspect of social media by which the nutrition behavior of adolescents and young adults is shaped is peer influence. Young adults’ dietary behaviors are influenced by their social networks, which shift from family-centric to including peers and significant others during young adulthood (Harmon et al., 2016). This shift emphasizes the role of peer influence in dietary choices and health behaviors. During adolescence, the developmental challenge of forming personal identities distinct from their parents increases adolescents' susceptibility to peer pressure and self-consciousness, making adolescents more receptive to emotionally appealing marketing (Freeman et al., 2015). Therefore, marketers align messages with social norms projected by peers, family, and social institutions using marketing strategies such as viral marketing and celebrity endorsements (Freeman et al., 2015).

Through direct online communication and exposure to content posted by peers on social media platforms, peers impact the health behaviors of individuals both positively and negatively (Friedman et al., 2022). When peers share positive changes on social media, young adults are motivated to alter their health-related behaviors (Friedman et al., 2022). However, peers can influence the social norm of unhealthy eating behaviors. Observing peers consume large quantities of unhealthy food can reinforce the idea that unhealthy eating is normal, encouraging adolescents to engage in unhealthy eating habits (Qutteina et al., 2019).

Fitspiration

An aspect of this peer influence is translated into the influence of fitspiration. Fitspiration is the concept of sharing fitness and health-related content on social media, intended to inspire physical fitness and promote health. Where fitspiration can have a positive impact on nutrition behavior, the negative effects

are higher. Fitspiration content can provide young adults with ideas for healthy recipes, workouts, and exercise techniques, boosting positive health behaviors (Easton et al., 2018). However, fitspiration content can be seen as unrealistic and difficult to relate to, adversely affecting goal-setting and persistence due to social pressure (Easton et al., 2018). Fitspiration posts often provoke peer comparisons that lead to feelings of guilt, shifting their focus from health to appearance and peer approval (Easton et al., 2018; Raggat et al., 2018).

Regulating potentially harmful content like fitspiration could mitigate adverse effects similar to the approach taken with thinspiration content (Carrotte et al., 2015). However, such regulations face challenges, as the regulations are often seen as breaches of privacy or assaults on personal rights, such as the right to freedom of speech (Perakslis & Quintana, 2023). There is thus a very difficult issue in regulating the fitspiration content on social media. Targeting social networks to increase healthy behaviors seems to be a better way to mitigate the adverse effects of fitspiration content.

Influencer

According to Turner and Lefevre (2017), social media users with a vast following base are viewed as an authority, which enables "celebrities" to influence a significant number of people by constantly exposing followers to images that promote a particular diet or behavior. The users of social media with a large following base are referred to as social media influencers. The number of followers of a social media account indirectly serves as a nudge to increase eating intentions, by the increase of the perceived social value of both unhealthy and healthy food (Charry & Tessitore, 2021). Influencers are a big part of the fitspiration landscape on social media and are widely utilized within the marketing strategy of companies. Where influencer marketing can further influence the social norm perceptions of nutrition-related behaviors (Qutteina et al., 2019). Influencers can have a positive effect on young adults, where influencers diffuse relevant health-related information (Serrano-Fuentes et al., 2024).

However, the social comparison of individuals with social media influencers is a major problem. Social media content related to health and fitness created by influencers can be motivational but also overwhelming. Images and videos of peers and influencers engaging in physical activity often inspire young people to engage in healthy behaviors (Goodyear & Armour, 2018). However, the coexistence of health-focused content and fast-food advertisements can create cognitive dissonance and guilt among young people trying to adhere to healthier lifestyles, especially when young adults cannot follow the health advice from influencers (Friedman et al., 2022).

Literacy

A major risk found within the literature that allows social media to have a greater effect on young adults is the lack of social media and health literacy. Before acting on health-related information, young adults evaluate its relevance to individual needs and health state, with variances in critical skills influenced by peer networks and digital, family, and school practices related to health (Goodyear & Armour, 2018). Social media's role in promoting social norms about food can nudge individuals toward healthier or unhealthier eating patterns by using posts of food that are socially supported (Hawkins et al., 2021). Social media literacy and health literacy are essential due to the unavoidable and normalized presence of health and fitness-related content on social media platforms (Carrotte et al., 2015).

Conclusion

It is thus of utmost importance to consider the risk of literacy within the system of nutritional supplement misinformation, social media, and public health. The discussed influences and the risk of literacy will be used to primarily assess the socio-technical system's social side, which will be depicted

at the end of this chapter. The analysis links stakeholders within the system and helps bring forward the most critical stakeholders within the social media environment. Also, the discussed influences are used to discuss the expected values within the system for the most important stakeholders in Chapter 4.

3.2.2 Industry and Offline Analysis

A search query was designed to address the nutritional supplements industry and the outside social media influences on nutritional behavior regarding adolescents and young adults. The library search engine Scopus was utilized to carry out the literature review. The investigation was carried out on June 28th, 2024. The keywords and their synonyms which were used for this literature review are shown in Table 3.3. During the search, the Netherlands and its synonyms were incorporated however, the search did not yield results.

Table 3.3 Search Query 2

Keyword	Synonyms
Social media	Digital platform, Online network, influencer, Social network
Supplement	Nutraceutical
Market	Industry, Competition

Inclusion and Exclusion Criteria

As in the previous search, literature was included if it was published in the last ten years (2014 – 2024). Solely peer-reviewed articles, book chapters, books, and conference papers were included. Also, literature that is behind a paywall or is in languages other than English or Dutch is excluded. After considering these inclusion and exclusion criteria, the abstracts were scanned to assess their includability. During this process, literature not relevant to the industry or influences on nutritional behavior is excluded. In addition, articles solely discussing social media influences were excluded as those are covered in the previous literature review. After the abstracts were scanned and a selection of articles was made, the full text was read to assess whether the articles could be included. Figure 3.2 shows the PRISMA Flow Diagram of this literature search strategy. Subsequently, Table 3.4 shows an overview of the included literature.

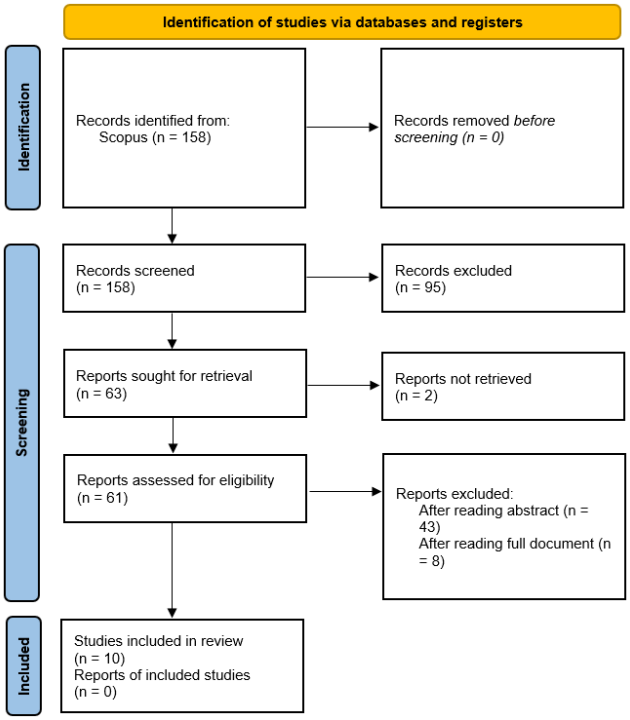


Figure 3.2 PRISMA table second review

Table 3.4 Overview of used literature in the second review

Author's	Year	Title
Briciu et al.	2024	Online marketing strategies used in the promotion of dietary supplements in Romania
Castro-Arteta et al.	2022	Structural characterization of sports supplement market
Catalani et al.	2021	The market of sport supplements in the digital era: A netnographic analysis of perceived risks, side-effects and other safety issues
Derkatch & Crowe	2023	Supplements as symbols: Public arguments against natural health product regulation in Canada
Helal et al.	2018	Social media brand perceptions of millennials
Memişoğlu & Bilen	2021	Strategic analysis of the Turkish over-the-counter drugs and non-pharmaceutical products market
Paoli & Cox	2024	Across the spectrum of legality: The market activities of influencers specialized in steroids and other performance and image enhancing drugs
Sadek et al.	2022	Dietary supplements use among athletes in Lebanon: Knowledge, attitudes, practices, and correlates
Sfodera et al.	2020	Social networks feed the food supplements shadow market
Turnock & Gibbs	2023	Click, click, buy: The market for novel synthetic peptide hormones on mainstream e-commerce platforms in the UK

Analysis of the Literature

In the literature, multiple trends within the industry and in marketing outside of social media are discovered. The analysis will start with a discussion of the marketing strategies utilized by nutritional supplement companies, which includes the intersection of marketing on and off social media regarding brand perception. The analysis will follow by covering an assessment of the supplement industry. In addition, the analysis will assess concerns related to social media and public health. Lastly, the analysis will cover regulatory issues, consumer education, and awareness.

Online Marketing and Brand Perception

In general, the sale of nutritional supplements is made through pharmacies, supermarkets, and the Internet (Briciu et al., 2024). Supplement companies have increasingly relied on sophisticated online marketing strategies to reach consumers. These strategies include the use of social networks, blogs, podcasts, forums, and other digital spaces to promote supplements (Briciu et al., 2024). In addition, supplement companies use digital marketing techniques such as search engine optimization (SEO), data mining through platforms like Google Analytics, and cookies to tailor marketing efforts (Briciu et al., 2024). Integrating these digital marketing reinforces the legitimacy and accessibility of supplement products. However, this digital proliferation also raises concerns about the dissemination of misleading information and the potential for consumers to encounter unregulated or unsafe products online.

Within online marketing strategies, social media has become an integral resource. The influence of social media, particularly Instagram, in shaping brand perception and creating lifestyle images is well documented. Instagram's visual power is instrumental in allowing brands to craft a lifestyle image that resonates with consumers (Helal et al., 2018). This engagement on social media platforms continually influences brand perceptions and strengthens the connection between brands and consumers (Briciu et al., 2024; Helal et al., 2018). In addition, brand prestige in the supplement industry is significantly influenced by athletes' endorsement and the role of sports center coaches, who serve as trusted sources of information for consumers (Castro-Arteta et al., 2022). Additionally, processes for the purchase, improvement, or self-production of illegal supplements to enhance body image-related factors are made possible by social media platforms (Sfodera et al., 2020).

For millennials, social media interactions are perceived as informal, yet marketers must ensure that these exchanges align with the brand's overall image outside of social media (Helal et al., 2018). Marketers should treat social media as an integral resource for delivering marketing strategies, particularly for engaging millennials who view communication on social media as fundamental to brand perception (Helal et al., 2018). Millennials desire symbolic relationships that extend beyond the consumption of a product, allowing brands to influence social identities through brand associations (Helal et al., 2018). Social media has allowed this influence to grow by relaying social identities through lifestyle and brand consumption on a vast public scale (Helal et al., 2018). Social media is thus an extension of the existing marketing strategies utilized by nutritional supplement companies.

Supplement Industry

Consumer awareness and self-care are two important factors that influence the nutritional supplement industry, which is characterized by its high degree of variety and multifaceted nature (Memişoğlu & Bilen, 2021). There are potential health risks within the industry due to supplement misuse and drug-drug interactions (Memişoğlu & Bilen, 2021). Another major risk within the industry is that not all nutritional supplements are manufactured to high-quality standards (Memişoğlu & Bilen, 2021). Furthermore, the unrestricted online availability of supplements poses significant concerns, including the possibility of tampering with products and misleading advertisements (Catalani et al., 2021). The severity of the risks is increased because consumers are mostly unaware of the potentially serious risks and side effects linked to using nutritional supplements (Catalani et al., 2021). However, rather than the supplements themselves, manufacturers blame intolerance or other subjective variables unique to each user for the side effects of particular supplements (Catalani et al., 2021).

Nutritional supplement users consider online sources and coaches trustworthy for gathering information on supplement use, but only a few users consult with doctors or nutritionists (Catalani et al., 2021; Sadek et al., 2022). People frequently struggle to interpret scientific information and instead rely on

influencers or other peers for guidance, which can lead to the dissemination of misinformation (Catalani et al., 2021). Mainly, new nutritional supplement users rely on online sources such as influencers for health advice, which makes them prone to being influenced by misleading marketing strategies encouraging supplement usage of a high-risk and uninformed nature (Catalani et al., 2021). Therefore, the supplement industry faces a significant challenge in ensuring consumers know the risks associated with supplements, particularly in online marketing (Catalani et al., 2021). The poorly regulated online diffusion of untested supplements represents a new major challenge that requires prompt responses to safeguard the health and safety of supplement users (Catalani et al., 2021).

E-commerce and Fitness Culture

The expansion of fitness culture and e-commerce are closely associated with the growth of the sports supplement sector. Training facilities are, in fact, one of the major players that can allow the development and creation of a better sports culture (Castro-Arteta et al., 2022), highlighting the potential influences of sports centers and coaches on supplement intake. In addition, the expansion of e-commerce platforms has significantly contributed to the industry's economic development (Castro-Arteta et al., 2022). Consumers prefer purchasing supplements online due to the availability of low prices and extensive product portfolios. Consumer awareness about regulatory standards is also critical in the supplement industry, as consumers seek assurance that purchased supplements meet safety and quality standards (Castro-Arteta et al., 2022).

Additionally, the availability of services on e-commerce websites that offer customized labels and packaging for nutritional supplements suggests that sellers are actively facilitating the sale of potentially misleading products and brands (Turnock & Gibbs, 2023). Resellers utilize misleading labeling and branding to create a feeling that the brand is reliable and the resold products are medically legitimated (Turnock & Gibbs, 2023), highlighting a significant risk within the supplement industry. The role of e-commerce platforms in the distribution of nutritional supplements further complicates the regulatory landscape. Consumers are probably not aware of the potential harms and (il)legalities of the broader supply chain (Turnock & Gibbs, 2023). The cultural familiarity of e-commerce platforms adds to this issue, as the legitimacy and trustworthiness of these sites are the basis for the credibility of sellers, and the platforms are therefore seen as appropriate places to gather information about supplements (Sfodera et al., 2020; Turnock & Gibbs, 2023). The preference for these marketplaces underscores the critical need for accurate information and regulation within these digital spaces to ensure consumer safety.

Public Health and Regulatory Challenges

The primary opposition against legislating the availability of nutritional supplements, found in a case study in Canada by Derkatch and Crowe (2023), includes concerns about personal freedom and the right to choose what individuals consume. People desire autonomy and freedom in what they consume and feel it is not a task of the government or another legislative authority (Derkatch & Crowe, 2023). This resistance highlights the broader tension between regulatory efforts to protect public health and the desire for individual autonomy in nutritional choices.

Even within the EU, the market for supplements is not uniformly regulated across member states (Paoli & Cox, 2024). The lack of regulatory harmonization within the EU has facilitated the emergence of a shadow market comprising unnotified and illegal products (Sfodera et al., 2020). The ease of online distribution allows companies to bypass national regulations, making it possible to sell supplements that may be prohibited in certain countries (Sfodera et al., 2020). The absence of harmonized regulations has also led to the proliferation of unethical behaviors among companies, particularly in the realms of product information, labeling, and health claims. The regulatory vacuum has also allowed consumers

to engage in potentially unhealthy behaviors, driven by ambitions for rapid physical transformation and improved sports performance (Sfodera et al., 2020). The shift in the patient-doctor dynamic, where patients now view themselves as health consumers and doctors as health suppliers, adds another layer of complexity to regulatory efforts (Sfodera et al., 2020). Grasping the regulatory challenges is essential while considering the system and the possible values and risks within the system, which will be further explored later.

Consumer Education and Awareness

Consumer health literacy is contested by supplement companies' forceful and deceptive marketing (Memişoğlu & Bilen, 2021). Sadek et al. (2022) emphasize the lack of people who consult with healthcare professionals regarding using nutritional supplements, fueling dangerous supplementation practices. Regarding safety laws and (side) effects of nutritional supplements, there are evident gaps in the knowledge of many people (Sadek et al., 2022). Most consumers rely on brand perceptions of the supplement brand and are unfamiliar with platforms to verify the safety and quality of nutritional supplements (Sadek et al., 2022), exacerbating the negative consequences of the lack of consumer awareness. Therefore, consumers lack the knowledge and proper guidance concerning supplement intake, underscoring the need for improved education and awareness among consumers.

Conclusion

This literature review has shown the industry of nutritional supplements and its influences on consumers to highlight the industry's role and outside social media influences within the system of nutritional supplements and public health. A lot of risks and challenges are highlighted by the literature review, which future interventions should target. The main trends within the risks and challenges are related to regulatory challenges, awareness, brand perception, and consumer literacy. The analysis has further laid out social, technical, and institutional influences and stakeholders of the socio-technical system regarding nutritional supplements, social media, and public health. The analysis will be direct input for the system diagrams at the end of this chapter and will serve as input for the next chapter. In addition, the institutional aspects will first be further collaborated on in the following subchapter to show the specific EU and Dutch institutional context, which the structured literature reviews did not cover. Also, the aspects discussed in this section will serve as input for the most important stakeholders and corresponding expected values.

3.3 Institutional Investigation

To further dive into the socio-technical system of nutritional supplements, the institutional actors are investigated, where the social and technical aspects have been discussed in the previous subchapter. This section will collaborate further on the institutional aspects discussed in Chapter 1. The specific context of nutritional supplements is considered within the institutional Dutch and European contexts. The investigation within this context is done utilizing policy documents and governmental websites. This section will follow by first going over the stakeholders and previously mentioned policies. Following, the section naming the European regulations and later the Dutch regulations specific to nutritional supplements.

As mentioned in the introduction, the Netherlands is situated in the EU, where the EC has made steps to address misinformation, mainly through the deployment of the DSA and the founding of EDMO. The Netherlands is also incorporating online misinformation into the educational system, as instructed by the EC. The EU has several rules regarding nutritional supplements; there are rules in place for the production, marketing, packaging, and importing of the supplements, whereas the Netherlands has also

implemented some of its own rules regarding nutritional supplements. The EC thus influences the system of nutritional supplement misinformation on social media within the Netherlands.

The so-called Good Manufacturing Practice (GMP) is one of the measures that ensures the quality of nutritional supplements on a European level. The GMP guarantees that nutritional supplements are consistently manufactured and monitored in compliance with quality requirements. The European Medicines Agency (EMA), a decentralized agency of the EU, harmonizes GMP activities across the EU and arranges inspections to confirm adherence to the GMP standards. Another EU agency that offers impartial scientific advice on nutritional supplement safety and hazards throughout the whole supply chain is the European Food Safety Authority (EFSA). The EFSA also provides the scientific foundation for rules and regulations protecting European consumers. Most of EFSA's tasks are based on requests from the EC, the European Parliament, and EU Member States like the Netherlands.

Delving deeper into the Netherlands, the Dutch political system is divided into three main layers of government. The country is divided into 12 provinces, and within those 12 provinces, there are 342 municipalities in total. The municipalities are checked by the provinces and the national government, and the provinces are in turn also checked by the national government. Dutch municipalities are responsible for youth health. The municipalities are instructed by the implementation of the 'jeugdhulpwet' and adhere to the responsibilities of this law by mainly making use of the 'Gemeentelijke Gezondheidsdienst' (GGD). The GGD is divided into 25 areas within the Netherlands that carry out the local public healthcare duties of the municipalities. The Dutch national government is made up of several ministries, which each carry a different area of responsibility. The relevant ministries for this research will be named and explained. The Dutch ministries are structured following the naming of the cabinet of Rutte IV.

The educational system in the Netherlands falls under the responsibilities of the Ministry of 'Onderwijs, Cultuur en Wetenschap' (OCW). This is the ministry responsible for implementing the educational curriculum changes that the EC necessitates as explained previously in this section. The strategy to combat online misinformation in the Netherlands, as mentioned in the first chapter, has been developed by the Ministry of 'Binnenlandse Zaken en Koninkrijksrelaties' (BZK). Lastly, the most relevant ministry to this system is the Ministry of 'Volksgezondheid, Welzijn en Sport' (VWS). The Ministry of VWS is mainly concerned with public health within the Netherlands and acts accordingly to maximize public health.

Two Dutch agencies that fall under the Ministry of VWS are responsible for checking the quality and marketing of supplements. The agencies are the 'Rijksinstituut voor Volksgezondheid en Milieu' (RIVM) and the 'Nederlandse Voedsel- & Warenautoriteit' (NVWA). In the Netherlands, the NVWA is responsible for monitoring compliance with laws and regulations governing nutritional supplements and the marketing of these products. The NVWA has the authority to penalize stakeholders who do not meet relegations within their jurisdiction. Manufacturers and importers of supplements must comply with production and hygiene regulations and must ensure that their products are registered and meet quality requirements. The NVWA can utilize the RIVM to test nutritional supplements to make sure the supplements comply with all regulations. The enforcement of legislation regarding nutritional supplements remains a challenge. Due to the large quantity of products and the rapid growth of the market, it is difficult for the NVWA to monitor everything continuously. Online sales, especially from foreign websites, make enforcement even more complicated as products that do not meet Dutch requirements can still reach consumers. The NVWA works with other European regulators to ensure compliance, but this remains a complex task.

In the Netherlands, the amount of vitamins and minerals in nutritional supplements must supplement the normal diet while at the same time being safe. Minimum and maximum intake levels considered safe will apply to the permitted vitamins and minerals. The maximum levels are determined based on so-called tolerable upper intake levels for vitamins and minerals. The EFSA Panel on Dietetic Products, Nutrition, and Allergies advises on tolerable upper intake levels and dietary reference values for vitamins and minerals while assessing health claims. The 'Gezondheidsraad' draws up nutritional standards and upper levels for the Netherlands. The 'Gezondheidsraad' has recommended adopting the Upper Levels of EFSA, which has been adopted by the Ministry of VWS. In addition, the 'Gezondheidsraad' draws up guidelines for proper dietary intake. Lastly, the 'Voedingscentrum'(the Nutrition Center) informs the Dutch public to adhere to a proper diet, focusing on vitamins, minerals, and supplements, among other topics.

3.3.1 EU Directives

As mentioned in the previous section, the regulation of supplements within the EU is not uniform, with significant national differences. Various EU directives may apply within the system, depending on the type of nutritional supplement. First and foremost, the General Food Law applies to nutritional supplements (European Parliament and Council, 2002/2022). Specifically for nutritional supplements, Directive 2002/46/EC applies, which mentions specific vitamins and minerals in its Annex that may be sold without a prescription (European Parliament and Council, 2002/2022). It forbids labeling or marketing that suggests supplements can cure illnesses (Art. 6), as well as the sale of supplements containing unapproved substances (Art. 15) (European Parliament and Council, 2002/2022). The more stringent Directive 2001/83/EC may also apply in some situations, mainly regarding medicinal products (European Parliament and Council, 2001/2022). When aimed at the general public, this directive forbids the advertising of psychotropic or narcotic substances, prescription-only medications, and "any advertising of a medicinal product for which a marketing authorization has not been granted under Community law" (Art. 87) (European Parliament and Council, 2001/2022). Additionally, according to the European Court of Justice's (1991) ruling, "medicinal products" are defined broadly as "any substance or combination of substances presented for treating or preventing disease in human beings" (Art. 1), which is mentioned in the Directive (Paoli & Cox, 2024).

In addition, two European regulations are considered in the context of this research. Regulation (EC) 1925/2006 stipulates which substances or food derivatives can be added to nutritional supplements. Regulation (EC) 1924/2006 applies to nutrition and health claims on nutritional supplements. This directive aims to do two things: firstly, harmonize the legal and administrative law provisions of the Member States relating to nutrition and health claims to ensure the proper functioning of the internal market while ensuring a high level of consumer protection; secondly, it aims to target nutrition and health claims made in the marketing, labeling or presentation of nutritional supplements. The above-mentioned European regulations and directives mostly shape the Dutch directives.

3.3.2 Dutch Directives

In the Netherlands, all food and drink, including nutritional supplements, are covered under the 'Warenwet' (the commodities act). The NVWA (2022) has a handbook on nutritional supplements that various stakeholders can use to learn what the market and regulations in the Netherlands look like. First and foremost, article 10 of 'Warenwetbesluit Bereiding en behandeling van levensmiddelen' needs to be adhered to in the Netherlands to ensure proper production and handling of nutritional supplements. The EC directive 2002/46/EC is translated in the Netherlands into the 'Warenwetbesluit

voedingssupplementen' (Food Supplements Commodities Act Decree) and the 'Warenwetregeling voedingssupplementen' (Food Supplements Commodities Legislation). These Dutch acts only cover nutritional supplements, including vitamins and minerals. Maximum levels for vitamins A, D, and B6 are laid down in the 'Warenwetregeling vrijstelling vitaminepreparaten' (Commodities Legislation on Exemption from Vitamin Preparations).

Nutritional supplements containing vitamins and minerals may be brought to market without prior approval if they only contain permitted ingredients listed in Directive 2002/46/EC. The supplements must also comply with the Dutch acts: 'Warenwetbesluit voedingssupplementen', 'Warenwetregeling voedingssupplementen', and 'Warenwetregeling vrijstelling voedingssupplementen'. An exemption can be applied for nutritional supplements that do not comply with the 'Warenwetregeling vrijstelling voedingssupplementen', but which have been lawfully brought to market in another EU member state, a state in a customs union or free trade zone with the Netherlands. This is stated in Article 13d of the 'Warenwet'. Lastly, a health claim on food supplements is permitted in the Netherlands, provided that the consumer is not misled and that Regulation (EC) 1924/2006 is complied with. Regulation (EU) 432/2012 includes the list of permitted health claims for nutritional supplements that do not relate to disease risk reduction or the development and health of children, which also has to be complied with within the EU and the Netherlands. The regulations mentioned in this subsection are the most relevant within the Dutch context.

3.4 The System

Previously in this chapter, the influences of social and technical aspects have been identified by analyzing literature and the institutional aspects in the previous section. By bringing these analyses together, the socio-technical system surrounding nutritional supplements, social media, and public health can be properly identified and assessed. To clearly define and explain the system, a divide will be made between the technical and social aspects and the institutional aspects. Unfortunately, the systems are not merged or linked, as that would provide a too broad picture and make the figures too complicated to interpret properly. The links between the two figures are discussed in this chapter's previous sections. The two figures are based on the formal chart, as discussed in the book by Enserink et al. (2022). Mapping the formal institutions in a formal chart is a solid starting point for sketching the formal environment and forms a basis for understanding informal relations (Enserink et al.,2022). When drawing up a formal chart, first, the institutional stakeholders and formal relationships have to be mapped, which are relevant to the context of the research topic; not all actual formal relationships have to be depicted in the formal chart (Enserink et al.,2022).

The institutional formal chart will be a typical formal chart that includes all institutional stakeholders and mostly shows formal relationships. A dotted arrow indicates an informal relationship in the institutional formal chart. However, the social/technical formal chart will show the formal and informal relationships between stakeholders, which are not necessarily institutions and all links are non-dotted lines. The chart used for the social/technical environment is thus based on the formal chart but is not a typical formal chart due to the informal nature of most links. Both the formal charts take into account the structured literature reviews and the analysis of the institutional stakeholders, and the links depicted in the formal charts are better explained in those analyses.

3.4.1 System Diagrams

Following both the literature reviews and the previously identified information, Figure 3.3 has been designed to show the social and technical stakeholders of the system. The diagram shows the divide between the social media environment and outside of the social media environment, which stipulates the importance of performing both structured literature reviews. Looking at the links within the figure, the links to adolescents and young adults depict an influence on nutrition-related behavior. However, the other links are formal relations between actors. Due to the age level of adolescents and young adults, the family and parents are an important influence outside the social media environment.

The divide between manufacturers of nutritional supplements and the sellers of nutritional supplements highlights the triangular relationship between the seller, the manufacturer, and the e-commerce platforms. The Internet is also an indirect link between e-commerce platforms and adolescents and young adults, as e-commerce platforms are part of the Internet. Healthcare actors, gyms, and coaches are actors who can influence adolescents and young adults via social media and outside of social media. These actors are widely active on social media and can provide adolescents and young adults with professional advice. However, these actors are also able to influence adolescents and young adults outside of social media, as they are easily accessed and can come into contact with adolescents and young adults on a normal day-to-day basis.

Furthermore, adolescents and young adults could be influencers themselves, which is not explicitly mentioned in the figure. Lastly, social media platforms are also added as a separate actor, as the way the platforms are designed, like the functioning of the algorithms, can shape the behavior of adolescents and young adults. The platforms can also influence other actors, but this would overcomplicate the diagram for this research.

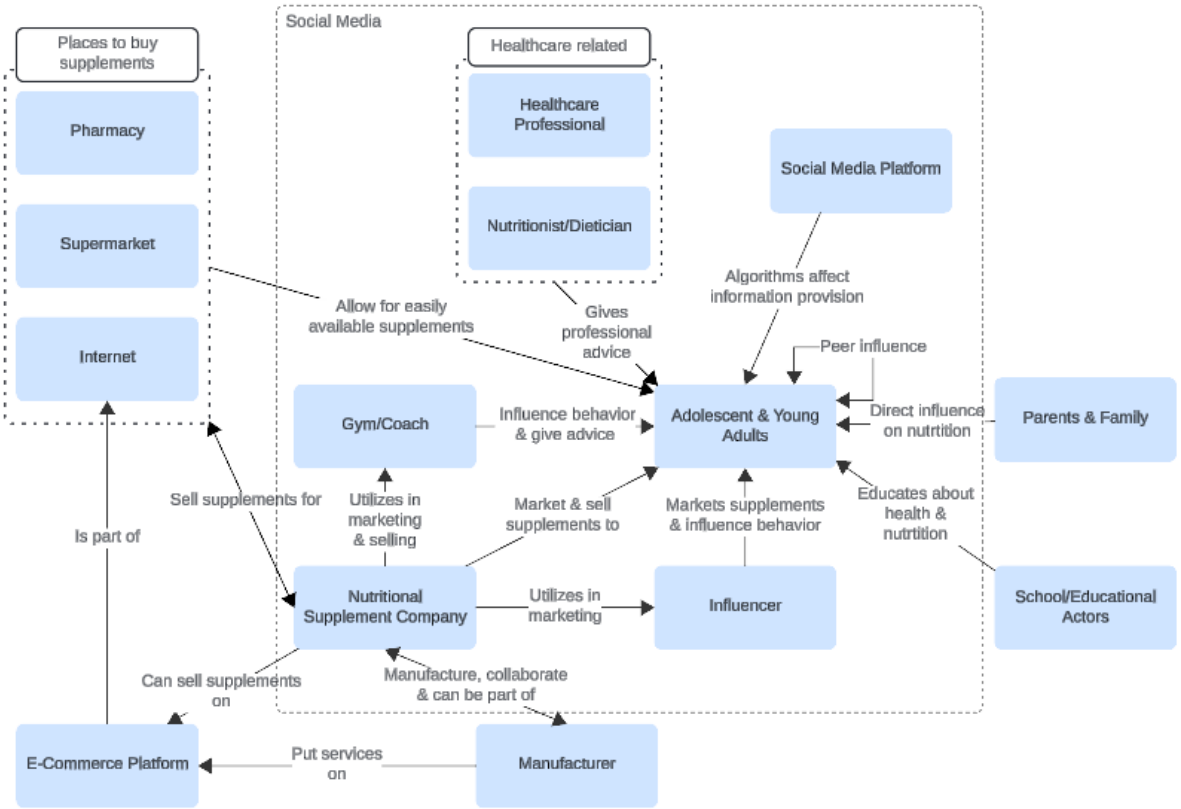


Figure 3.3 Formal chart of social and technical system

By considering the earlier identified institutional stakeholders and regulations, a formal chart of institutional stakeholders is depicted in Figure 3.4. The formal chart will include all the mentioned stakeholders and the relationships between them. The overall institutional system is discussed in Section 3.3, so only a brief explanation will follow on the relationship between the stakeholders and eventual relations to the social and technical aspects of the system. Figure 3.4 shows a clear divide between the European and Dutch actors and a section of independent actors who are not directly related to another actor within the system. The actors in the independent section advise on specific topics and are utilized by certain institutional actors.

The links that exist in the system mostly show the direct institutional relations between the stakeholders, like the connection between the Dutch government and the ministries, as the ministries fall under the Dutch government. On the other hand, the EFSA and NVWA are not actors who are directly institutionally related but depend on each other for advice and notifications to act on, like contaminated nutritional supplements. The formal chart shows many indirect relationships exist, where the EU is eventually linked to even the GGD. This shows the complex interplay and wide range of the European and Dutch institutional systems related to the subject. The complex nature and interdependencies need to be considered when further considering the institutional system.

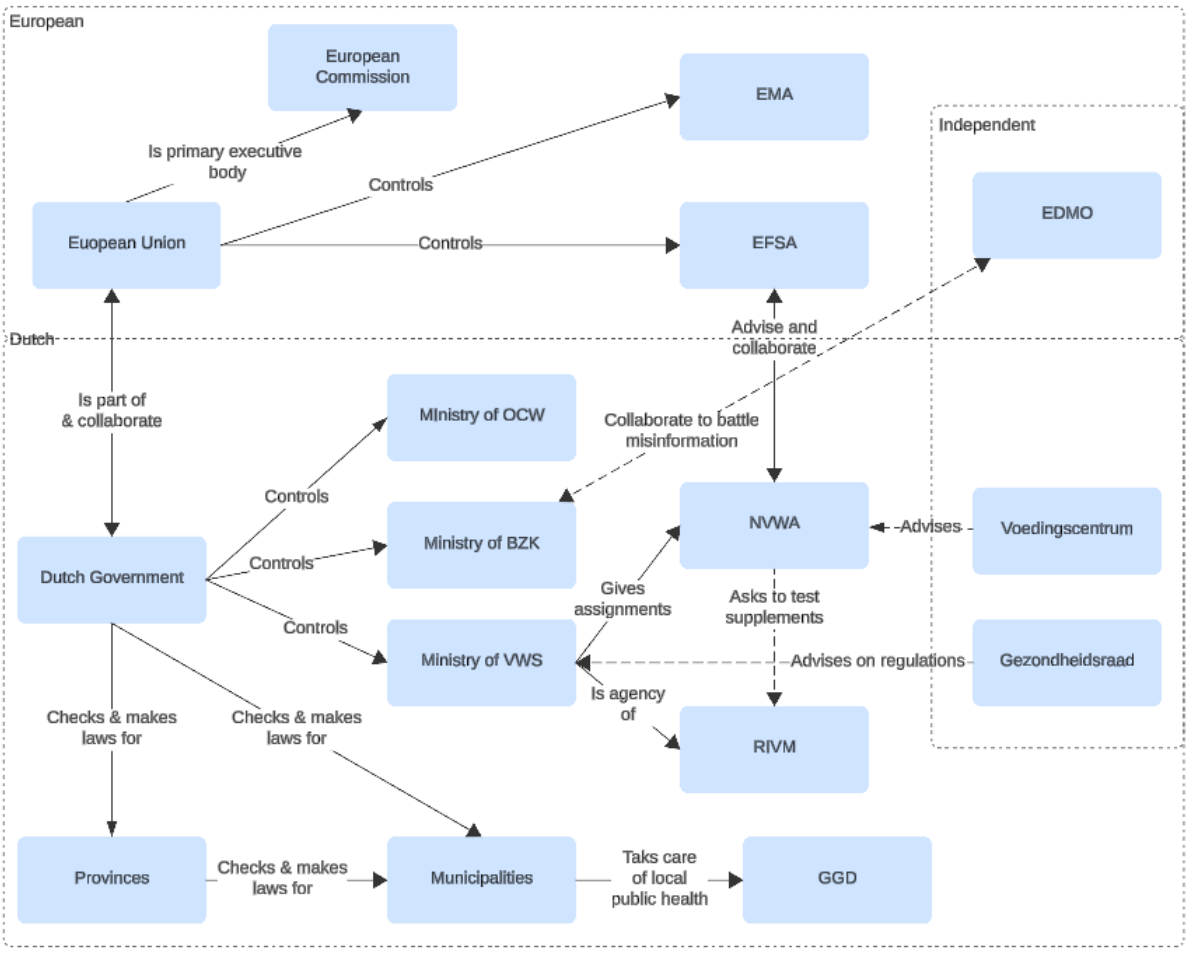


Figure 3.4 Formal chart of institutional stakeholders

3.4.3 Concluding Remarks

This chapter has answered the first sub-research question by explaining the socio-technical system related to supplement misinformation, public health, and social media function and the identification of key stakeholders. Indirect as well as direct stakeholders in the system are identified, which is also essential while using the VSD framework. The stakeholder classifications are shown in Table A.1. Showing the complexity of the system and stakeholder dynamics is a crucial first step in this research. The chapter began by showing the complexity of the socio-technical system as discussed in the literature and institutional settings. While analyzing the system and stakeholders, this chapter highlights the need for solid interventions within the system to combat misinformation and maximize public health.

The next chapter will use the stakeholders identified within this chapter to analyze the most important stakeholders more deeply, based on the discussion of influences and stakeholders within this chapter. The most important stakeholders need to be identified to discover which stakeholders should be interviewed and how to interpret the results of the interviews. Chapter 4 will also use the discussed literature in this chapter to discover expected values and risks within the socio-technical system. In addition, the information and literature discussed in this chapter guide the other chapters to come to solid results and conclusions.

4. Relevant Risks and Main Values

This chapter dives deeper into the socio-technical system discussed in the previous chapter and mainly targets the values to consider when developing interventions and design requirements in Chapter 5. Firstly, this chapter will highlight and classify the most important stakeholders and expected values and risks to consider when designing interventions in the socio-technical system, concluding the VSD framework's conceptual phase. The chapter will follow by explaining the process of conducting the stakeholder interviews as well as the focus group. This chapter dives into the empirical phase of the VSD framework. A co-occurrence analysis of the values discussed during the interviews and the relationship between values is further elaborated on using a value map. Later a co-occurrence analysis is conducted between the values and risks identified during the interviews. Whereafter, the values and risks identified in the focus group are considered and compared to the results of the interviews. Lastly, the values to design for are stated.

4.1 Stakeholder Analysis and Expected Values

Stakeholder analysis connected to social media, public health, and nutritional supplements identifies direct and indirect stakeholders throughout the conceptual investigation of Value Sensitive Design. As previously said, VSD emphasizes that interacting with direct and indirect stakeholders is an essential part of the design process and the investigation of values. Direct actors in this research are the actors who have a direct influence on the previously identified system for the Dutch context. In contrast, indirect actors are those who, despite having a vested interest, are not directly engaged in the specific Dutch system or are not of primary influence within the social media environment.

To better understand the stakeholder dynamics of the most direct stakeholders within the system a power-interest matrix will be utilized to map these stakeholders. The power-interest matrix is a vital tool in stakeholder analysis, particularly in contexts where the dynamics of power and interest among various stakeholders can significantly influence outcomes (Reyes-Alcázar et al., 2012). This matrix categorizes stakeholders based on their level of power and interest within the system, allowing effective prioritization of intervention strategies. The concept of the power-interest matrix is rooted in stakeholder theory, which says that understanding the motivations and influences of different stakeholders is crucial for successful policy implementation (Reyes-Alcázar et al., 2012). The categorization of stakeholders helps identify the main values to design for and ensure that the values of influential stakeholders are met. Based on the categorization above and previously identified information, the power-interest matrix was constructed, as depicted in Figure 4.1.

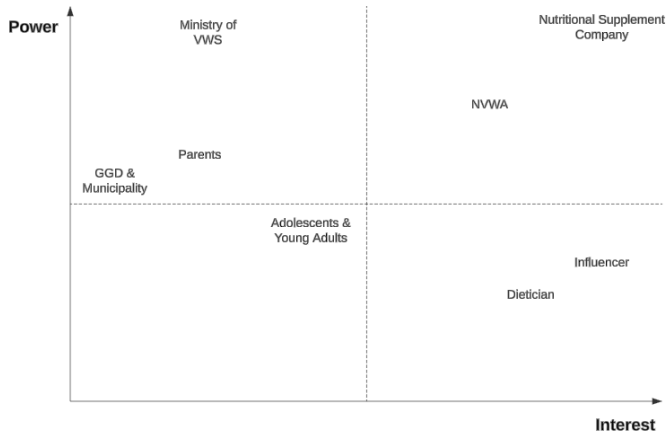


Figure 4.1 Power-interest matrix

A brief explanation of the stakeholders mentioned in Figure 4.1 is provided below, along with a motivation for their placement within the power-interest matrix.

Adolescents and Young Adults
This stakeholder group is the main targeted group of this research and is thus the most important direct stakeholder. They widely use social media to interact and be influenced by other stakeholders within the system; they can also influence each other on and off social media platforms. Their nutritional supplement intake can thus be influenced by the whole system, direct as well as indirect. Also, their power is relatively low, as they are the masses who are steered within the system and are not able to make significant changes to other stakeholders within the system.

Influencers
This stakeholder group can also be made up of adolescents and young adults, as influencers can also fall within this age gap. The influencers have a high vested interest in the system, as they can gain monetarily from the system. This monetary gain is achieved by being sponsored by nutritional supplement companies to promote their products or by random advertisements like the money earned from YouTube videos. The social influence on adolescents and young adults within the previously identified Fitspiration setting can also be relatively high, but their power within the broader system is really limited. Influencers have limited power due to the many existing influencers, so an influencer is easily replaceable.

Nutritional Supplement Companies
As the main research topic is nutritional supplements, the companies that sell the supplements and post information on social media are some of the most important stakeholders within the system. The interest of the stakeholder is high, as is their power. The companies can shape the information provision, choose which influencers to utilize, and have the power to change the entire system investigated in this research. The stakeholder can make massive monetary gains within the system, which shows their major interest.

Parents
Parents are responsible for their children, especially until the age of 18. Also, when adolescents and young adults are still living at home, parents significantly influence their behavior, including nutritional intake. Parents have high power over public health but not social media in adolescents and young adults. The interest in their health is high; however, the interest specifically in nutritional supplements, the information about the supplements, and social media seems to be low, as parents do not see the same aspects of it as adolescents and young adults.

NVWA
The interest of the NVWA is relatively high in the system, as the NVWA has a division that specifically addresses nutritional supplements. The NVWA is an authority that can penalize supplement companies for wrongful claims as well as not adhering to other regulations. Therefore, the NVWA has quite some power within the system. The NVWA addresses both the misinformation as well as the nutritional supplements themselves.

The Ministry of VWS
The ministry is moderately interested in the system as the issues of the system are relatively new, and the ministry also has a lot more urgent matters to attend to. In addition, the institution tends to address the issue more generally by targeting misinformation more broadly. However, the power of the ministry is high due to the rules and sanctions they can place within the system and put on certain players within

the system. Also, the ministry has much power to pressure other institutional players within the system to address the issue, directly as well as indirectly.

GGD & Municipality
The municipalities and GGD are merged in the power-interest matrix as the stakeholders are both responsible for the provision of local public health services, which are also related to the targeted research group. The interest in the specific topic is low, as both the institutional players do not specifically address misinformation or nutritional supplements. However, their power can be relatively high due to the pressure they could put on other institutions to address the issues in the system.

Dietician-Nutritionist-Healthcare professional
The dietician, nutritionist, and healthcare professional are merged into the power-interest matrix due to their similar interests and powers. The power of the stakeholders is quite low, as they cannot significantly change the system, especially the information provision. The stakeholders can only affect specific cases or can affect part of the population via social media. However, as the implications of the wrongful information and its consequences can have significant effects on public health, these health-related stakeholders have a high interest in the system.

4.1.1 Expected Values of the Stakeholders

This section will cover the most important expected design values of the stakeholders mentioned in the previous section. The most important expected values will be based on the two structured literature reviews performed in the previous chapter. The expected values are briefly explained, while in the value conceptualization later in this chapter, the values will be further elaborated on.

Public Health
The most important design value within this research is public health as the target of this research is to eventually maximize public health in the context of the investigated socio-technical system as is depicted in Chapter 3. Public health is also discussed in the underlying two literature reviews in the third chapter. Every designed intervention or design principle in the next chapter should focus on maximizing the value of public health. Public health in the context of this research is considered the health of the population as a whole of the Netherlands, especially the health of 16–25-year-olds.

Profit
As in every industry, the primary focus of commercial players is profit maximization. This is therefore the second most important value to consider within the system as the most influential and interested stakeholder is a commercial player, as well as the influencers. This is not to say that everything has to go except profit, which is the most important; however, it is the primary value of both commercial stakeholders. The marketing efforts mentioned in Chapter 3 are the primary examples of how industrial players try to maximize profit. During designing the interventions and design requirements, this value has to be kept in mind but should serve as a primary value to be addressed as most interventions could lead to lower profit. If interventions would lower profit too much, the industry will fiercely reject or contest the interventions if applied.

Freedom of Speech
Freedom of speech has been mentioned multiple times in the previous chapter to consider, especially regarding misinformation. Misinformation could be a form of freedom of speech when social media content is not sponsored. Social media content is also a form of speech and should be considered within

the system to avoid the breach of this right (Perakslis & Quintana, 2023). It is therefore really important to consider the value of freedom of speech when designing interventions, as freedom of speech is a fundamental right within the Netherlands. Freedom of speech is important for all stakeholders, but this research is significant for stakeholders within the social media environment.

Freedom of Choice

The autonomy of what to put in one's own body as discussed in Chapter 3 is the primary driver to consider within the value of freedom of choice. Especially while considering policy interventions, people highly value freedom of choice in what to put in one's body (Derkatch & Crowe, 2023). This value is thus very important to the targeted population of this research and will therefore be an important value to consider when designing within the system.

Awareness

Awareness about influence and how aware consumers or stakeholders are of the intent of information on social media. Awareness also refers to the self-consciousness of consumers. Both aspects of awareness are discussed in Chapter 3. Awareness not only refers to how aware consumers are but also how aware other stakeholders are of the influence of social media or advertisement on behavior. Thus, awareness also refers to the ability to discern information and consumer literacy (Sadek et al., 2022).

Knowledgeability

Knowledgeability refers to how much people know about supplements and the associated working or risks. As discussed in Chapter 3, new supplement users are more susceptible to social media marketing to buy supplements than more advanced supplement users (Catalani et al., 2021). More knowledgeable individuals or stakeholders seem to be better equipped against the possible effects of misinformation, and knowledgeability could, therefore, be considered a significant value when designing within the system. Thus, knowledgeability is related to consumer literacy, as mentioned in Chapter 3.

Expertise

Expertise is the amount of expertise a person has within the system, which can serve as a base for authority within information provision. It is related to knowledgeability, but it differs in that expertise refers to scientific and professional knowledge rather than overall knowledge about supplements. Expertise is essential for institutional and healthcare stakeholders, as expertise about the subject investigated mainly lies within their interests. This value is essential as young adults should seek professional advice (Sadek et al., 2022) from people with high expertise.

Convenience

The value of convenience is two-sided. First and foremost, convenience refers to the ease by which information about supplements can accessed. Young adults access information primarily through social media, as social media platforms are conventional places for information (Goodyear & Armour, 2018). Convenience also refers to the ease by which nutritional supplements can be bought and used. The convenience of buying supplements is high due to its wide online availability (Catalani et al., 2021).

Scientific Evidence-based

Information about nutritional supplements should be scientifically backed to be completely reliable. When information is properly scientifically backed, it means the information can be considered 'true'. Therefore, scientific substantiation is essential when considering the information about supplements, but it can also be seen as a highly important value in designing interventions. By considering the value, the interventions have a higher risk of success.

4.1.2 Expected Risks & Value Tensions

In this section, (expected) risks and value tensions stemming from the literature review in Chapter 3, as well as the previously mentioned expected values, will be discussed. First and foremost, the first literature review in Chapter 3 ends with discussing the risk of a lack of consumer literacy, which refers to the value of awareness and knowledgeability. This risk seems significant within the system, as explained in Chapter 3. This risk is similarly mentioned later in the second literature review by mentioning the system's lack of consumer education and awareness. A lack of consumer education and awareness poses health risks as adolescents and young adults rely on social media and influencers for advice about nutritional supplements. The advice on social media mostly also lacks expertise and scientific backing, exacerbating the health risks.

Health risks are, therefore, also a primary concern when designing in the system, as most lower-level risks can impact health outcomes. This is because most risks relate to the misuse of supplements or the possible use of illegal or contaminated supplements. This risk mainly concerns the value of public health. It can be positively related to most other identified values, as the other values, except for profit, seem to impact public health directly or indirectly positively. There is thus also a value tension between profit and public health. The other significant risk within the system is the spread of misinformation. Scientific evidence-based and freedom of speech are significant value tension, as people can say what they want and put information on social media that is not scientifically backed. When not sponsored, the information being put on social media can be completely false because freedom of speech is essential in the Netherlands. Freedom of speech can, therefore, also be related to public health. However, by deploying other values, the relationship between freedom of speech and public health can be positive and negative.

Another significant risk within the system is believing in a false authority, as already touched upon at the start of this section. The risk of false authority has two sides, namely, one in which the authority granted by a large following base allows influencers to promote products that can have other effects than those mentioned by the influencers. The other side of the risk is that false authorities can be utilized within overall marketing strategies deployed by the industry to increase brand prestige and positive brand association. Marketing strategies can be misleading and lead to the unnecessary purchase of supplements. False authority mainly has a value tension between the value of expertise on one side and the values of profit, knowledgeability, and scientific evidence-based on the other.

The last significant risk in the literature reviews in Chapter 3 is resistance against legislation and the lack of harmonization with regulations. Due to freedom of choice and freedom of speech, there is resistance within the public against limiting the availability of supplements and censoring social media content, as people have the right to autonomy within these two values. In addition, the lack of harmonization within the EU is a risk for the Netherlands. With open borders and the internet, non-illegal supplements in other EU member states that are illegal in the Netherlands could enter the Netherlands quickly and negatively impact the value of public health. The risks in this section are the main expected risks within the system, which should be considered in the design process.

4.2 Interviews & Focus Group

To address research sub-questions two and three, both stakeholder expert stakeholder interviews and a focus group are utilized. The initial interviews will be the main sources of input on values. At the same time, the focus group will focus more on validating the interview results and design principles and

interventions in the next chapter. These methods will validate the previously identified values and risks. So, the initial stakeholder expert interviews are mainly used to address the second research question and be an inspiration for the third research question. The focus group focuses on both the second and third research questions. The interviews will dive into the exploration of the problem at hand, provide the values of the leading expert stakeholders, and look into the possible interventions desired by stakeholders. This approach allows for a deep dive into the exploration of the system identified in the previous chapter and a solid base for the interventions. The main stakeholder-centered insights come from the focus group, while expert perspectives offer a foundational understanding to inform and support proposed design interventions. The following sections outline the design and execution of both the interviews and the focus group.

4.2.1 Interviews

As VSD emphasizes the importance of involving both direct and indirect stakeholders, ideally multiple people from each stakeholder group as identified in the previous section and chapter would be interviewed. However, due to this research's limited time and scope, this was not possible, as many people related to the power/interest matrix were selected. Table 4.1 provides an overview of the interview respondents. Due to the specific scope of nutritional supplements, specific stakeholders related to misinformation and nutritional supplements were not able to be identified and interviewed. Therefore, a focus was laid on nutritional supplement stakeholders to provide a holistic view of stakeholders within the system of nutritional supplements, as the expectation was that they would have the most fruitful insights in the context of this research. The interview respondents range from the institutional side to people within the industry to provide insights from multiple sides.

Table 4.1 Interviewees

Interviewee	Expertise
I-P1	A representative of the Ministry of VWS
I-P2	A representative of the NPN, the trade association of Nutritional supplements
I-P3	An NVWA employee with a job related to nutritional supplements
I-P4	An Influencer and co-owner of a sports supplement company
I-P5	Former managing director of a nutritional supplement company
I-P6	A local alderman related to (youth) health
I-P7	An influencer promoting nutritional supplements
I-P8	A nutrition communication expert from the Voedingscentrum
I-P9	A public health professor with expertise in nutrition

Multiple channels were utilized to search for interview participants. Firstly, the 4TU project network in which this thesis's second supervisor and chairperson are involved was looked at for possible interview participants. This led to finding a public health professor specializing in nutrition. Secondly, a public LinkedIn post was utilized with a description of some of the experts needed for this MSc thesis and mentioned the subject of the thesis and interview. However, this strategy only yielded one result: the former managing director of a nutritional supplement company. Also, multiple public health organizations and the Voedingscentrum were contacted to participate in the interviews, with the NVWA and Voedingscenturm open to an interview. The national government and some local municipalities were contacted via e-mail, which led to the participation of the alderman and a representative of the Ministry of VWS. The NPN was reached out to via e-mail as well. Instagram was utilized to find the influencer and the co-owner of the supplement company. By searching through the platform, these two stakeholders were identified, and multiple were contacted via Instagram, LinkedIn, and e-mail, which resulted in their participation.

The interviews with the influencer, the co-owner of the supplement company, the NPN representative, and the former managing director will provide insights into the motivations of the industry stakeholders who gain from selling nutritional supplements. While the interview with the nutrition and communication expert of the Voedingscentrum provides insight into nutrition and how social media can play a role in influencing the diets of adolescents and young adults, the public health professor provides insight on the most important things when designing to maximize public health within the context of this research. The NVWA, the alderman, and the representative of the Ministry of VWS will provide insights from institutional players that can influence the identified system. The alderman and representative are more specialized in what can be done and what is important to consider when thinking about the interventions. The NVWA employee will provide insight into an institutional player dealing daily with nutritional supplements. The semi-structured interview questions have been uniformly designed to gather the most appropriate insights from all stakeholders and to be able to generalize the findings for this research. The insights will be based on their point of view and outside of the interviewee's role. The questions focus on the stakeholders' values when designing interventions according to the VSD framework.

In the semi-structured interview format, the sequence of questions is strategic, and the subjects of the questions are to be followed, so there is flexibility to deviate from the questions. The questions will begin to look into the role of the interviewee related to social media, public health, and nutritional supplements and how they view the subject studied in this research. Subsequently, the interviews will take a deep dive into analyzing the values at hand within the system from the perspective of the interview participant. The questions cover the values deemed important but also address possible value tensions and risks. At the end of the interview, possible strategies and interventions are discussed that could improve the studied problem. The interview protocol can be found in Appendix B. The nine interviews conducted for this research were thought to attain adequate data saturation. Recurring themes and insights emerged from these interviews, suggesting that more interviews with comparable institutional experts were unlikely to produce essentially new insights important to this research. Nevertheless, talking to more stakeholders—for example, more professionals and experts in the nutritional supplement sector—might reveal new themes and insights.

4.2.2 Focus Group

Due to the novelty of this research and the specific focus on nutritional supplements and social media, the focus group is explorative. The results of the focus group are compared to the results of the stakeholder interviews. The focus group focuses on identifying the values of the main target of this research, 16–25-year-olds. This focus of the research allowed the research to specifically address the target group within the focus group. The focus group is not only utilized to assess the value of the targeted group but also to brainstorm about interventions that could eventually improve public health in the context of the system identified in the previous chapter. The focus group allows for a proper evaluation of the interventions by multiple stakeholders within the targeted group.

The focus group includes six people aged 19–25 years old, who fall in the target group of this entire research. Because of this target group, who are likely also gymgoers, a poster was designed that included a QR code to sign up for the focus group. This poster was hung in a variety of gyms. Furthermore, the outreach was broadened to a wider audience via Instagram stories. This approach aimed to diversify the group beyond just the researcher’s network and to not only include students. As a result, only one of the

participants is enrolled at TU Delft, the rest have a variety of backgrounds. Table 4.2 provides an overview of the focus group participants.

Table 4.2 Participants focus group

Participant	Age	Education/Profession	Supplement use
F-P1	19	Finance student	Low use (1-2)
F-P2	24	Administrative/financial employee	Moderate use (3-4)
F-P3	21	TU Delft student	Low use (1-2)
F-P4	21	Healthcare student	High use of (5-6)
F-P5	25	Junior Financial Consultant	Moderate use (3-4)
F-P6	24	Carpenter	Very high use (7<)

The focus group begins with an icebreaker where participants share stories about their favorite social media platforms. This led to a warm-up activity in which all participants shared stories about how they engage with information about nutritional supplements on social media and other sources of information they utilize. A brainstorming activity followed this to think of and rank the most important values within the system, which ultimately led to a discussion about the value tensions and risks. The session concluded with a brainstorming and presentation exercise focused on the interventions mentioned in the interviews as inspiration. These interventions for the system were then discussed, and a ranking of the best alternatives was agreed upon. An overview of the focus group protocol can be found in Appendix C. In addition, the main conclusions from the focus group can be found in Appendix E.

4.3 Value Analysis

This subchapter will explain the value analysis within the context of nutritional supplements, social media, and public health, which will be done based on stakeholder interviews. The subchapter will first explain grounded theory which is used to analyze the interviews and the coding process. It will follow with a conceptualization of the main identified values. The focus of the value analysis in this subchapter is to identify the main values at stake within the identified system, which intends to show the main values for which to design the interventions. By utilizing the Atlas.ti software the interview transcripts were first analyzed, later the focus group was analyzed following the same code book and with inspiration from the interviews. The analysis was conducted through the use of the grounded theory approach.

4.3.1 Coding Process

Grounded theory is used to analyze the interviews as it is well-suited for the interview analysis within the VSD framework, as grounded theory supports the discovery and understanding of values and underlying needs directly and indirectly from stakeholder input (Charmaz, 2016). Both methods consider iterative and flexible processes that complement each other to continuously refine the value understanding. Furthermore, using grounded theory aids in uncovering not-explicit values mentioned by the interviewed stakeholders (Charmaz, 2016). Thus, grounded theory is a powerful tool for analyzing interviews within the VSD framework. Grounded theory is a qualitative research method that aims to systematically gather and analyze data. This methodology uses data through interviews, as is the case in this research, to analyze and develop so-called grounded theories (Charmaz & Belgrave, 2015). Coding interviews while utilizing grounded theory follows some key steps namely, open coding, axial coding, and lastly selective coding (Charmaz & Belgrave, 2015). The coding steps within this research will be further explained below.

Open Coding

Within the open coding phase, the interviews are explored and openly coded without thinking of connections between the codes. Based on the topic discussed within a quote, codes are thought off and assigned. The initial round of codes was very diverse, so the codes were considered again after the first round of open coding. During this reconsideration, codes that meant the same or followed previously identified expected values were renamed or merged. Codes were merged if the codes discussed meant the same within the context of the codes. All interviews were looked at again so nothing would be missed. The intention was still not to connect codes but to provide a comprehensive and analyzable code book that would be useful for the next coding steps as well as the conceptualization of the codes.

Axial Coding

During the axial coding phase, codes are assigned to categories to address the values and the interrelationships. The categories identified within the interviews and logically defined beforehand are risks & problems; values; and interventions. The categories follow the interviews' structure and intent, making the code categories easier to understand. The codebook with the codes and its assigned categories can be found in Appendix D. 'Values' is the category that resembles the values considered within the system by the stakeholders and can be considered as the design values within the VSD. 'Risks & problems' is the category that refers to the risks within the system and the risks considered in the category 'interventions'. The 'Interventions' category resembles the ideas of the interventions or design principle ideas gathered in the interviews. During the axial coding phase, the connections and relationships between codes are discovered.

Selective Coding

During the selective coding phase, the intention is to bring categories or codes together into an overarching category that captures the essence of the research. After establishing the overarching category, a link must be made with the rest of the codes and data to connect the conclusion. For this research, the overarching categories will be the interventions and design principles which are discussed in Chapter 5. During this phase, the results from the focus group are also taken into account. The data of both methods are brought together to make suitable conclusions and the so-called overarching categories. For the overarching categories, the codes from the Interventions category are utilized as inspiration. During the selective phase, the interventions mentioned in the interviews and the ones discussed during the focus group may or may not turn into a worked-out intervention. During the selective coding phase, the conclusion was made that including all 33 values identified in interviews was too much. Therefore, values with more than ten mentions were included in the analysis. Freedom of choice and freedom of speech, as identified in the expected values and during the interviews, were not included in the value analysis as both values were extracted ten or fewer times. Also, convenience was not found to be a value within the interviews and is therefore left out of the value analysis. The values not identified in Section 4.1.1 are explained in the value conceptualization in the next section. As most risks like contamination, overdosing, and undeclared substances are linked to health risks in broader terms, the health risks will be used as an overarching risk within the analysis of the risks. In addition, the risks were included in the risk analysis if the risk was identified more than eight times within the interviews. Within the code groups of 'Interventions', a distinction is made between higher- and lower-level interventions, explained in Chapter 5.

4.3.2 Value Conceptualization

Within the VSD framework, it is essential to define values clearly, as values are not always universally applicable. Therefore, an additional explanation of the non-covered values in the expected values will

be conducted in this section. As shown in the codebook in Appendix D, most expected values were indeed found within the interviews. Values included within the analysis are present more than ten times within the interviews. The values found in the interviews but not covered in the expected values will be explained in this section using quotes from the interviews. The explanation of the values includes quotes from the interviews to back the conceptualization for the context of the interviews. The definitions do not stem from just one interview but are an overall interpretation.

Accuracy

Value accuracy refers to the accuracy of information about supplements, policies, and information provision by stakeholders. As mentioned in the quote, the accuracy of policies targeting the maximum acceptable levels of nutrients. The Netherlands has different eating patterns than more southern countries in the EU, so the harmonized regulations of the EU, which are also used in the Netherlands, as explained earlier, could lack accuracy.

> I-P1: *"There is often a huge amount of study behind it, huh by EFSA before, it is implemented of course as well huh? The eating patterns in the northern countries of Europe are different from those in the southern countries, so it is quite difficult to have a harmonized system."*

Accuracy, therefore, does not only refer to the accuracy of information regarding supplements, which would be a more logical assumption. The quote below refers to the accuracy of information. The quote refers to the accuracy of the self-test provided by the supplement companies, which gives the feeling that the recommendations of the self-test are accurate for a personal situation. However, the information is, in fact, not accurate.

> I-P8: *"Then you get very much the feeling that the results are really tailored to your specific personal situation. But yes, that requires so much more than just a questionnaire. However, it gives the feeling of being really accurate for your own situation."*

Effectiveness

Effectiveness within the context of this analysis refers to the possible effect of supplements and the effect information can have on nutrition-related behaviors, especially when considering nutritional supplements. Effectiveness in the interviews mainly addressed the possible effects the information provided by influencers has on young adults and the effectiveness of supplements within overexaggerated marketing strategies. The quote below addresses the effect of influencers' content on social media and the possible effects of this content. The quote also mentions that influencers probably do not know how effective the content can be on people who view it.

> I-P6: *"But actually, responsibility may also lie with those who make the videos. That they are aware of a certain effect their actions can have. And you may not discuss enough about that. That you talk more about what the effect of that information is and how you can do something about that with the user."*

The effectiveness of the content provided by influencers and companies is considered chiefly within the value of effectiveness. However, exacerbating the effectiveness of supplements within the information provision of the stakeholders is also considered widely within the interviews. The following quote shows the exacerbation of claims made on social media, leading consumers to be misled.

> I-P3: *"TikTok is also full of claims about what is good for you. But then it's about the effect, whether or not it contributes to the improvement of your life. And the problem there, of course, is that often there is no such effect."*

Healthy lifestyle

The value of a healthy lifestyle refers to the fact that supplements add to a healthy lifestyle when an individual lacks a particular nutrient in his diet. However, supplements are more widely used to

substitute parts of a proper diet. Focusing on a healthy lifestyle within the system is thus a significant value to maximize public health. The value of a healthy lifestyle supports the overall health of an individual. The quote below shows that many supplements are unnecessary when considering people with a healthy lifestyle.

> I-P5: *"But actually a lot of supplements that are available now are, well, unnecessary. It's better if you just get it through your diet. Instead of taking that in via a lot of supplements. But that's a very popular thing now."*

Even stakeholder I-P5, a former managing director of a supplement company, mentioned that supplements should not be prioritized over a proper diet and that people should aim to get all nutrients from a regular diet. The influencer also mentioned this, as seen in the quote below.

> I-P7: *"Well I think that's also mainly problem. That people may also start to see it as a substitute for a normal diet. Yes. I do think so. I also see that in the questions I receive in my DM's."*

Quality of information

The quality of information derived from the words is the quality of the information about supplements and, therefore, does not need extra explanation. The quote below shows the relationship between the quality of information and scientific backing. The quote mentions that having a single scientific study does not prove the quality of the information for the entire population and system. It shows an overreliance on one's expertise when sharing a single study.

> I-P8: *"But if someone happens to have found a nice study on PubMed that shows something, that may be a very nice study, but that doesn't mean that it really changes the advice for the general population. So sometimes it's kind of an overestimation, of one's ability."*

Regulatory compliance

Regulatory compliance refers to many aspects of compliance with regulations, from adhering to marketing rules to adhering to safety rules in supplements. Influencers and nutritional supplement companies should, for example, adhere to marketing rules when promoting a product. As mentioned in the quote below, the simple fact is that companies have to adhere to regulations. Companies are not allowed to put unsafe on the market and should therefore adhere to the regulations.

> I-P1: *"Yes and those who have a company, of course, just have to comply with the existing regulations. Well, first of all, you cannot put an unsafe product on the market, huh"*

However, in the interviews, many stakeholders mentioned ways by which regulatory compliance is avoided, mainly by the internet, where illegal supplements from diverse e-commerce websites can be bought and supplements from third countries that could have undeclared substances or are contaminated. Also, due to the lack of regulating capacity, the regulatory compliance of influencers is hard to achieve within the system, as mentioned in the quote below.

> I-P2: *"And yes then we actually also see that the current enforcement apparatus in the Netherlands is not equipped to enforce this amount of marketing through influencers."*

Responsibility

The value of responsibility represents the responsibility for executing policies and adverse events within the system. It differs, however, for consumer responsibility, as it refers to the consumer's responsibility in buying and using supplements. The quote below shows an example of an event in the Netherlands where a girl with an underlying disease was advised to use a supplement by a so-called self-test provided by a nutritional supplement company. The value of responsibility seems unclear within the provided example in the quote.

> I-P5: *"And when you already have a liver condition and you take ashwagandha, well, an effect may occur that can make you very sick. But from that test, she was advised to take*

ashwagandha. So then you get into a tricky playing field. A girl got very sick. Where does the blame lie? Is that your own responsibility? Does that also lie with the manufacturer or the brand?"

In the interviews, there was a consensus that the producers of social media content and information about supplements should also be more accountable for the information they produce. Also mentioned by the ealdorman in the quote below is that the execution of policies related to misinformation and policies is complex to address on a local level and should not lie with the municipalities.

I-P6: *"Because to what extent can you, especially as a local government, influence social media use? And how the algorithm works? And you, I think even The Hague, can and should do something about that. It would be best if you had the bigger parties for that. And those are the Facebooks, the Instagrams, I know it all, the TikToks."*

Safety

The value of safety refers to how safe a nutritional supplement product is. The supplements on the market should be safe, but as described earlier in this section, there is a possibility that unsafe products with health risks can enter the market and cannot be perfectly regulated. An unsafe product equals health risks, as mentioned in the quote below, as the product could contain illegal substances when sold online.

I-P2: *"There are constructions to obtain products that normally cannot be obtained in stores and thus do not have clear oversight from the NVWA. There could be something with the content there. So, if that product itself is not safe, then I see risks. That banned substances are traded in that way as well.."*

The quote above refers more to supplements that can intentionally be unsafe. However, the most significant risks related to safety, as mentioned in the interviews, are contamination and the unknown effects of undeclared substances, as referred to in the quote below.

I-P3: *"And added substances are often chemical and synthetic and can have a real effect. But their risks are often actually not well known. Which we see, for example, in weight-loss agents."*

Transparency

Transparency refers to informational transparency of the contents of supplements and their possible effects. In addition, transparency refers to how transparent an influencer considers the promotion of supplements and clearly shows that a supplement company sponsors them. Lastly, transparency refers to how transparent an influencer is in showing everyday life and health-related behaviors to give a transparent view into their lives.

I-P4: *"Transparency is the most important as far as I am concerned, it can certainly conflict with our profitability as a company but also that of influencers because we both risk selling less products. But this could also work the other way around by making this transparency clear in our marketing. So we could create more trust with consumers."*

The quote above shows that an industrial stakeholder sees transparency as a value that can positively or negatively influence profit. Transparency could lead to fewer sales as people could see that not all supplements are necessary and overabundant. However, the stakeholder mentions the possible effect transparency can have on consumers' trust in a brand or influencer. The influencer further explains the importance of transparency in the quote below, stating that transparency about advertising and selling a supplement is essential in information provision.

I-P7: *"Yes, because it is freedom of expression, I guess. But if it's an advertisement... Then surely people must always realize that... Yeah, you are basically selling something, you know. And then that should also be clear to the consumer in the communication."*

4.4 Value Dynamics

After a deep dive into the concept of values, this section will analyze the values identified earlier. The analysis of value dynamics starts in this section with a co-occurrence analysis of the values derived from the interviews. The co-occurrence analysis will show the interrelationship between values and how often values co-occur within the stakeholder interviews. The basis for the relationship between values comes forward by conducting the co-occurrence analysis. The nature of the relationship will later be clarified with a value map. The co-occurrence analysis is depicted in Figure 4.2, where the number in a box shows the number of times a value co-exists. The red line goes through the boxes where the values cross themselves, and no connection exists between the boxes, as the boxes regard the same values. Both sides of the red line clearly show the same data but are mirrored. Later in this subchapter, the risks and value tensions will be discussed, as well as the analysis of the focus group values and risks.

	Values: Accuracy	Values: Awareness	Values: Effectiven...	Values: Expertise	Values: Knowledg...	Values: Lifestyle	Values: Profit	Values: Public hea...	Values: Quality of...	Values: Regulator...	Values: Responsib...	Values: Safety	Values: Scientific s...	Values: The truth	Values: Transpare...
Values: Accuracy		2	3	7	2	2	3	3	4	1	1	2	4	6	2
Values: Awareness	2		4	10	8	4	5	3	1	1	1	3	6	4	4
Values: Effectiveness	3	4		6	3		1			1	1	5	2	1	2
Values: Expertise	7	10	6		5	2	1	1	5	1	2	2	7	1	3
Values: Knowledgability	2	8	3	5		1	2	2	2	2		1	3		3
Values: Lifestyle	2	4		2	1		1	1	1					3	1
Values: Profit	3	5	1	1	2	1		2		5	2	2		1	9
Values: Public health	3	3		1	2	1	2			1		5	2	1	2
Values: Quality of information	4	1		5	2	1				2		1	4	1	4
Values: Regulatory compliance	1	1	1	1	2		5	1	2		1	5	2		5
Values: Responsibility	1	1	1	2			2			1		1		1	1
Values: Safety	2	3	5	2	1		2	5	1	5	1				5
Values: Scientific substantiation	4	6	2	7	3			2	4	2				2	4
Values: The truth	6	4	1	1		3	1	1	1		1		2		2
Values: Transparency	2	4	2	3	3	1	9	2	4	5	1	5	4	2	

Figure 4.2 Co-occurrence analysis of values

The co-occurrence analysis in Figure 4.2 shows the number of times that values co-occur, which is easily interpretable in the diagram. The values which were included were discussed earlier in this chapter. Some of these values are subsets of others, occasionally conflicting with or complementing one another. Furthermore, the nature of values can be very similar. The focus group results show similar values to those used within the co-occurrence analysis, as seen in Appendix E.

A value map will be developed to show the links between values graphically. For the value map, the frequency of 1 to 4 of the co-occurrence analysis is neglected as the value map would not be interpretable due to the number of links within the map. The value map will also show the nature of the value relationships. The value map is depicted in Figure 4.3. The types of relationships between values that are identified were already available in the Atlas.ti software and are explained as follows:

Is associated with: Two values that are related within the interviews, but the relationship between the values cannot be further described.
Contradicts: Two values contradicting one another; increasing one value will lead to a decrease in the other.
Is part of: One value is part of another value; therefore, there is a link between the two values.
Is cause of: When a value is the cause of the existence of a value or causes the other value to increase in a one-way fashion.

The values and links between values were established based on the mentioned criteria, so not all values and relationships considered in the interviews are included. To show the importance of values more clearly, the labels of values are colored according to groundedness, as seen in the legend in Figure 4.3. The next step in the analysis was assessing the nature of the relationships. As the values of public health and profit contradict according to this thesis, the contradictory relationship between the two values is depicted as an exemption from the rule of the criteria. The other relationships between values were based on the interviews.

Figure 4.3 Value map

The value map in Figure 4.3 mainly shows the value tensions within the system. The value tensions will be explained in the next section while considering the identified risks within the system. The contradictory relationships within the value map are mainly utilized in this research. This is due to the nature of the VSD framework, which deems the conflict between values essential. However, conflicts between values do not need to be the sole value tensions to consider. For example, the lack of expertise within the system influences many other important values. Therefore, a lack of awareness, a lack of expertise, the maximization of profit, and the abundance of safety are considered within the system as causes of value tensions as these values relate to 4 or more other values.

4.4.1 Value Tensions & Major Risks

As discussed in the explanation of the value map, the value map shows value tensions within the system, which will be further explained in this section. The relationship between the values of profit and public health will not be further discussed as it is inherent to the nature of this research and amounts to the overarching value of public health. In addition, the role of profit maximization, which negatively impacts public health within the system, is also not further explained. For the value tensions, the interview data was utilized. The focus group results are considered after a co-occurrence analysis of the risks and values within the interviews.

Lack of expertise and lack of awareness

Within the data of the interviews, a lack of consumer awareness seems to exacerbate the effect of a lack of expertise within the system and vice-versa. Both values are linked to many values, so a lack of both values can negatively affect most values within the system. Profit seems to be gained from a lack of both values. In addition, the values even have a threefold relationship with the value of knowledgeability and with the value of scientific backing. So, the values of knowledgeability and scientific backing can indirectly impact the relationship between the levels of values of expertise and awareness.

> I-P2: *"I have the impression that young adults are not very critical of the source of the information they seek. But very much look to see if they can identify with the source of information. And, that is also what makes it so dangerous."*

The quote above mentions the interrelationship between awareness and expertise itself. Where consumers, in this quote, young adults, are less critical and aware of the source of information about supplements. Young adults seem to rely on identifying with the source of information who are seen as experts on the subject and thus seem to be experts to the young adults. A lack of awareness thus can allow for a lack of expertise to have a more significant effect on nutrition-related behavior.

Abundance of safety

The safety of nutritional supplements relates to diverse other values, and the relationships seem to come forward very clearly from the interviews. As mentioned in the quote below, the safety and effectiveness of products can be unsure due to the unique mixes of nutrients in supplements of new companies within the system. This shows that the effectiveness of a supplement can be contested with the value of safety.

> I-P2: *"And you see all kinds of new companies coming up that are doing something there and sometimes also yes, and I am feeling that they are doing something to have a unique selling point, so there is a slightly different composition than a competitor has and that you do not know at all what that does and whether that is safe."*

In addition, safety is part of the value of public health, as the safety of nutritional supplements directly affects the health of supplement users. Therefore, safety should be considered when designing for public health, and the abundance of safety is a risk within the system. Safety within the system is also directly influenced by the adherence to the value of regulatory compliance. The link between safety and regulatory compliance is also quoted to explain the value of safety. The better stakeholders comply with regulations, the higher the safety is within the system. This is also depicted by the link in the value map, where regulatory compliance is a part of the safety within the system. The abundance of regulatory compliance by several players can also lead to an abundance of safety within the system.

The tension between profit and transparency

Within the interviews, the intersection between transparency and profit is mentioned a significant amount of times. Most interviewees only mentioned the contradictory nature of both values. First and foremost, influencers are not always transparent in the monetary nature of their content regarding

supplements. Also, the product labeling is not always fully transparent, among others, intentionally to boost profit, which is a risk with significant occurrences within the interviews. However, as mentioned in the quote by I-P4 below, the relationship between both values could also be positive, to where the transparency of a brand or company could be utilized in the marketing of supplement brands. The value tension could, therefore, be changed into a favorable value combination.

> I-P4: "*Transparency is the most important as far as I am concerned, it can certainly conflict with our profitability as a company but also that of influencers because we both risk selling less products. But this could also work the other way around by making this transparency clear in our marketing. So we could create more trust with consumers."*

The tension between effectiveness and expertise

The effectiveness of supplements and communication seem to clash mainly with the value of expertise. Expertise can but does not necessarily have to impact the effectiveness of the communication of a stakeholder. Expertise can give credibility to a source. However, this is not the most important value when trusting and adopting information. The effectiveness of the information relies more on familiarity with the source, whereas most institutional stakeholders with much expertise lack familiarity. The quote below even indicates that the effectiveness of the information does not have to rely on the expertise of the source of information.

> I-P5: *"It is also true that research has shown that young people are more likely to adopt information, even when it comes to medical information, from social influencers than from doctors and people who do know about it."*

After considering the value tensions discovered utilizing the co-occurrence analysis of the values and the value map. The next step is to address the risks found within the interviews and their relationship to the values. The risks included in the analysis must adhere to the criteria discussed in the coding process. A co-occurrence analysis between the values and risks within the interviews shows the frequency of the relationship between values and risks within the stakeholder interviews. The co-occurrence analysis is depicted in Figure 4.4, where the number in a box shows the number of times a value co-exists with a risk. Bringing together the important risks within the co-occurrence analysis and the previously discussed values and value tensions will address the main values for which to design.

Most risks named within the interviews were also discovered earlier in the literature, as seen in Chapter 3. A brief explanation follows to explain some risks which need further explanation. The risks of small companies are that many emerging companies lack expertise and are a risk to the system as the small companies seem to struggle to comply with regulatory requirements. In addition, small companies could emerge on e-commerce platforms where the companies can sell illegal supplements. This, in turn, relates to the availability of supplements; with the widespread availability of non-tested and illegal supplements, among others, provided by small companies, there is an increase in health risks and regulatory enforcement. Abundance of necessity refers to the risk that a supplement is not needed. Thus, a consumer unnecessarily spends money on the supplements, possibly due to misinformation within the system. Lastly, combination refers to the health risks of combining supplements with or without medical products.

	Values: Accuracy	Values: Awareness	Values: Effectiven...	Values: Expertise	Values: Knowledg...	Values: Lifestyle	Values: Profit	Values: Public hea...	Values: Quality of...	Values: Regulator...	Values: Responsib...	Values: Safety	Values: Scientific s...	Values: The truth	Values: Transpare...
Risks & Problems: Abundance of necessity		1		1		7	1		1						1
Risks & Problems: Availability of supplements			1	1		1	1	1		1		2			
Risks & Problems: Claims	1	2	3				3	1	1	3		1	3		3
Risks & Problems: Combination	2	2	4	4				1				2	1		
Risks & Problems: Enforcement		2		1			3	3		11	1	3			2
Risks & Problems: Fake expert	2	7	3	9	3			1	2		1	1	4	1	2
Risks & Problems: Labeling, declaration of content	1		1							2		2	1	2	3
Risks & Problems: Lack of knowledge company...			1	6	1			1	1	4		2			1
Risks & Problems: Lacking regulations		1		1	1	1	1	1		2	1		1		
Risks & Problems: Misinformation spread	2	4	1	3				1	1	3	4	1	5	3	
Risks & Problems: Overdosing					1	1		2		1		1			
Risks & Problems: Regulatory capacity								2		7	2				
Risks & Problems: Small companies	1	1	2	5	2	1	1			2		2		1	
Risks & Problems: Social comparison	1	3	1	4	1	1	1	1	2			1	1		3
Risks & Problems: Third countries		1		1	1					5		2			
Risks & Problems: Undeclared substances	2	1			1		1	1		3		4		2	1

Figure 4.4 Co-occurrence analysis of risks and values

While interpreting the co-occurrence analysis, some values not mentioned within the value tensions come forward as significant within some of the risks identified by stakeholders. First, some values were mentioned within the most important values and tensions, namely awareness and expertise, which are significantly related to the risks identified within the interviews. However, the values of a healthy lifestyle, scientific backing, and regulatory compliance are significantly related to at least one risk and are not mentioned in the value tensions. This does not directly imply that the three values are values to design for.

Looking at risks that have significant relationships with values, the main risks come forward. The criteria to consider a risk a main risk are risks that have two or more significant links with different values (frequency 4<) or risks that have a significant link and three or more moderate links (frequency 3-4). The main risks are, therefore, the risk of a lack of regulatory enforcement, the fake expert risk, and the risk of the spread of misinformation. The health risk is seen as the main risk overall within the system. Most expected risks were also identified within the interviews, especially considering the values discussed in the expected risks.

4.4.2 Focus Group Analysis

After considering and analyzing the values and risks stemming from the interviews, now the focus group values and risks will be discussed. As mentioned before, the focus group summary can be found in Appendix E. After an overall discussion of values, everyone wrote down five values that the individual deemed important. The process of writing down and counting the values was executed anonymously. Four values were most frequently mentioned, discussed, and voted on. Two of them are the values of scientific backing and expertise, which were also prominent in the interviews. Widely mentioned in the discussion of values was the lack of expertise of influencers where the influencers are very influential on supplement use and body image, as mentioned in the quote below, which also mentions a health risk.

> F-P6: *"People who are paid to promote that probably actually don't even know what they themselves are promoting. And then I think a lot of young people think, oh yeah, you need this, you need this, you need this. And then they just swallow ten of these supplements a day. Yeah, I don't think that's very good for your health."*

The values of reliability and independence were the other two most mentioned values in the focus group. Considering the definition of value mentioned in the focus group, the value of reliability is partly explained as accuracy. Therefore, the value of reliability mainly strengthens the importance of the value of accuracy. The focus group participants agreed that it is important to look for information about supplements from independent individuals who provide scientifically backed information, as mentioned in the quote below:

> F-P2: *"No, I don't watch government websites, but other guests on YouTube who are not sponsored by corporations. But who just clearly explain everything with scientific justification. I watch that a lot."*

Considering the most important values in the focus group, only independence was not mentioned before. Independence in the context of this research and the focus group amounts to the independence of information providers like influencers. The other values found in the focus group mainly relate to values such as awareness. For example, the understandability and interpretability of information are partially related to the values of knowledgeability and awareness. In addition, well-substantiated information mainly relates to (scientific) evidence-based. The other mentioned and discussed values in the focus group are not further discussed due to a lack of votes for the values within the focus group.

After the value discussion, the risks were discussed. The participants were randomly divided into three groups after the overall discussion and had to write down three risks that needed to be considered in the system. Health and financial risks were deemed the most important risks to consider. The financial risk is related to the abundance of necessity of supplements where individuals spend money on supplements that the individuals do not need. Within health risks, the participants made a distinction between mental health risks and physical health risks, and both health risks were mentioned equally. The physical health risks were considered based on the effects of the supplements on physical health, as mentioned in the expected risks. The mental health risk is similar to the risk of social comparison within the co-occurrence analysis in Figure 4.4. The quote below mentions the possible mental health risks.

> F-P3: *"Well, I very much think that because of all the content from others and influencers that people start thinking that's how I should look too. Which is often based on a distorted and false image which is not applicable to everyone. By not being able to achieve this image, I think people even get deeply depressed thoughts."*

Lastly, also the earlier-mentioned risk of misinformation spread was discussed within the focus group but was deemed the least important among the four identified risks within the focus group. This risk is targeted to be tackled by this research and is therefore inherently considered in the interventions.

Within the focus group, when considering risks, awareness, the expertise of influencers, and knowledgeability were seen as important values to consider in mitigation strategies. Noting that awareness and knowledgeability seem to be discussed as the same value. Furthermore, the values of transparency and effectiveness were also discussed within the risks and mitigation strategies, highlighting the importance of both values.

Combining the results of the co-occurrence analysis and the focus group guide to the conclusion of which values to include in the values to design for. When considering the main risks and significant links to values, the values of awareness, expertise, scientific backing, and regulatory compliance are identified as the main values to design for. The focus group confirms the importance of most of these values. In addition, when considering the value tensions, the importance of the values of transparency and effectiveness is confirmed by the focus group. Unfortunately, the values of reliability and independence discovered as important within the focus group did not clearly cooccur in the interview with the other values and could, therefore, not be included in the value map.

4.4.3 Values to Design for

Following the analysis in this chapter, the most important values to design for are awareness, expertise, (scientific) evidence-based, transparency, profit, effectiveness, safety, and regulatory compliance. These values all intend to contribute to maximizing public health within the system. The design principles and the interventions thus inherently target maximizing this overarching value. Looking at the first subchapter of this chapter, the expected values are mostly values to design for, except convenience, freedom of choice, and freedom of speech. However, as freedom of choice and speech are fundamental rights within the Netherlands, both values must be considered when designing interventions. The values to design for are further explained within the next chapter according to value hierarchies. The value hierarchies aid in constructing sound design principles and interventions.

The next step in the analysis will be to operationalize the main values for which to design. Values will be further considered to develop design requirements by utilizing value hierarchies; the values not mentioned in this section will not be further explored. During the designing of the interventions, it could be that a value that will not be further explored is addressed by the interventions.

5. Interventions

This chapter will outline how the policy interventions are designed. Constructing the design requirements and interventions in this chapter will be entirely based on the data readily gathered in this research. First and foremost, this chapter will discuss the interventions mentioned in the interviews and how the focus group considered them. To conclude the empirical phase and start the technical phase of the VSD framework, the design requirements are derived from the main values to design for while keeping in mind the interventions mentioned during the interviews. Value hierarchies are utilized as a base for the design principles according to the VSD framework and mentioned in Chapter 2. Lastly, this chapter will look at the data gathered in the previous chapters to match the interventions and design requirements to specifically target nutritional supplement misinformation on social media and its effect on Dutch adolescents and young adults. This chapter will end the research phases of the VSD framework for this research.

5.1 Interventions

The ideas for the interventions stemmed from the interviews and were further elaborated on during the focus group. The interventions mentioned within the interviews have two classifications; a higher-level intervention is more related to a design principle. As seen in Figure 5.1, prevention is seen as an overarching higher-level intervention to consumer education and, in turn, to education campaigns. Only interventions discussed in two or more interviews were considered in the co-occurrence analysis. To differentiate between interventions and design requirements, interventions propose actions to address the issues at hand, while design requirements are criteria to employ in the interventions.

5.1.1 Describing Interventions

During the interviews, stakeholders mentioned several interventions that could address the issue of misinformation about nutritional supplements and their effects on public health. The higher-level interventions considered in the interviews are educating influencers, consumer education, social media interventions, and prevention. These are seen as overarching themes for the more tangible lower-level interventions. The lower-level interventions will be discussed in this section and explained using interview quotes. Prevention is most commonly mentioned as the most effective means to combat the issues within the system, mainly due to the rapidly changing environments of the industry and social media.

Certificating Influencers

An intervention related to educating influencers is that of certificating influencers. The interviews concluded that there are current rules for certificating influencers and that influencers can get a certification. Most stakeholders see the certification as promising, as the quote below mentions.

> I-P8: *"Yes, I think that everything that's being done now, that it is good to explore how much that will bring, I do not know exactly. But I think the certification is very interesting for the influencers anyway because they can show that they are kind of like an advisory influencer."*

However, other stakeholders also mentioned the current/upcoming rules for certificating influencers are lacking. Influencers are not obliged to get the certification; the certification lacks depth, and especially for smaller influencers, the rules are minimal. The NPN said in the interview that they want to extend the certification rules by potentially only allowing companies to work with certified influencers and

extend the education about the rules. Only allowing companies to work with certified influencers would contribute to ethically sound marketing.

> I-P2: *"We are looking at what whether to say to companies there. You are only allowed to work with influencers who are certified. And that influencers can get certified and for that certification, they also have to do courses and take an exam where they understand the rules. But the exam that exists now only covers that first piece so make known that they are advertising. There has to be an extension to it."*

Counter Campaigns

Another intervention related to influencers is the intervention of a type of counter-campaign. The counter-campaign entails the spread of 'true' information through a multitude of possible communication channels to counterbalance the misinformation on social media. It was mainly acknowledged within the interviews that there should be a sound against the misinformation within the system. This is not to debunk the misinformation, as debunking has been shown not to work in practice but to provide scientifically backed information. This fact is also mentioned in the quote below.

> I-P8: *"That is an initiative where there are I believe, six specialists and two general practitioners on TikTok. And yes, making videos about, well, things that live on TikTok. They do not act like debunkers or fact-checkers but just show how something is or just explain it more. Because I think that is the only way also that we can counter, just by explaining it and letting so not opposing each other, but just explaining how it is."*

When designing the counter-campaigns, policymakers should consider how to reach young adults and adolescents optimally. Adolescents and young adults have social media as a primary information source, as covered in Chapters 1 and 3, so offline counter campaigns do not have to be considered. This also includes the intervention of using the proper communication channels. Most stakeholders suggesting this counter-campaign also mentioned that influencers should be a significant part of providing this alternative voice, as mentioned in the quote below.

> I-P1: *"But the NVWA also tries, maybe they also told you, with influencers to counterbalance a bit. Because otherwise, you do not reach certain target groups. Like the Voedingscentrum, the information there is absolutely fine, but whether it always reaches the target group that you would like, yes, then they also have to think more and more of exploring the possibilities of using influencers."*

However, as influencers are sponsored mainly by companies, conflicts of interest can exist, as mentioned in the quote below. The foremost conflict of interest could arise between the profit influencers can make and, conversely, providing non-commercial, reliable, or scientific information about supplements on social media. Also, independence cannot be guaranteed.

> I-P9: *"So then again, you need an influencer. Well, find a nice influencer who will tell good things about diets on TikTok or on insta that is what we should have. but then there actually should be no other interest, but then you quickly find yourself with a conflict in interests. Yes, you do not want to do that either."*

Educational Campaigns

A significant part of prevention and consumer education, which together were the most prominent mentioned themes of interventions, is the intervention of educational campaigns, which can be conducted online and offline. As mentioned during the interviews, educational campaigns should target the public to increase consumer awareness and knowledgeability, and the role of a healthy lifestyle has to be more prominent. The quote below mentions the importance of educating the public about a healthy lifestyle, starting in schools.

I-P2: *"So we are seeing more and more what nutrition and lifestyle can achieve, right? Like dealing well with stress and sleep. And, I think that that starts with schools, but we really need to go much more into that."*

Most stakeholders mentioned that the educational campaigns could be delivered to the public via social media. However, the education of the public about supplements, misinformation, and the influence of social media has to start at school. The quote below even mentions the means of gamification to engage students properly.

I-P9: *"There are also healthy eating curriculums or taste classes in schools for elementary school to eat more fruits and vegetables. You could also do things with other things like supplements. You can use gamification for the younger kids. Also, for the high schools of course, you have other kinds of gamification, but you could do something with that as well."*

Monitoring Tool

During the interviews with institutional stakeholders, a monitoring tool that the Stichting Reclame Code has developed was discovered. IP-2 suggested that the monitoring tool could be turned into an enforcement tool to help institutions act upon misinformation in an automated manner. The way the monitoring tool could work is mentioned in the quote below.

I-P2: *"Stichting Reclame Code has developed a monitor tool to search spoken messages and moving images. So, where you can search for violations, for example, based on combinations of keywords. And, which can search through a multitude of channels like Instagram, TikTok, YouTube. So we are already trials of that."*

The quote below mentions the importance and effectiveness of the potential enforcement tool in the system. Due to its automated nature, the regulatory capacity risk is mitigated, leading to better enforcement of regulations and, therefore, more regulatory compliance.

I-P3: *"For example, a monitoring system in which certain messages and certain sales of products in which we can get on top of the nasty business somehow. That would be nice if that goes well at a given moment. Then you are moving towards automation because if we have to check every message on social media ourselves to see if something is not acceptable, we will have to hire 10,000 people, and that is impossible."*

The public health expert also mentioned using an AI tool differently, as mentioned in the quote below. The AI tool could also be utilized to avoid identifying dangerous content for law enforcement. However, as mentioned in the quote below, it could also address the content directly on social media platforms by placing an attention mark on misinformation in the content to make consumers aware.

I-P9: *"Exactly, somebody has to find and check that. Well, you apply AI to that. So, possibly an automated tool as well. But yes, then again, the legality is, of course, an issue. That is I think, yeah how can you then oblige a TikTok or an insta to put a message with it?"*

Quality mark

A quality mark for supplements and supplement companies was also considered in the interviews. This quality mark could relate to the supplements' quality, safety, or transparency, as the interviewees mentioned. However, in the interviews, the risks and issues of the quality marks were mainly discussed. The quote below mentions risks and issues with setting up a quality mark for supplements.

I-P1: *"In itself, I think it would help if such a thing existed. The question is, who should give out that quality mark? That is then something huh, what the industry itself could go and do. But of course, there are already a lot of quality marks. Consumers sometimes already are overwhelmed with all the different quality marks that exist."*

The quote below shows that the former managing director of a supplement company thinks that a quality mark is mainly for marketing purposes.

I-P5: *"Yes, but a quality mark is often just another marketing thing huh. If you put money on the table, you get the label. So I don't really believe in that either."*

Self-regulation of the industry

As mentioned in the interviews, the industry could also improve the provision of information on social media. As mentioned within the first quote of the quality mark intervention, self-regulation of the industry could take the form of creating a quality mark by the industry. The same risks and issues are present in the self-regulation of a quality mark. As stressed in the quote below, the companies should take responsibility for their supplements and should properly inform influencers about supplements the influencers have to promote.

I-P7: *"But when they say there is a new product being launched. And influencers don't know what's in it and then they go and promote it. Yeah, I think there should always be something about it, that you know what you are saying. That you also have to put a responsibility on the company. Yes, you do have to bring it out that way."*

Stricter regulations

Within the interviews, a significant issue within the industry that came forward was the lack of regulations, mostly because regulations are not up to date. Most stakeholders suggested stricter regulations but did not mention who should enforce them due to the lack of regulatory capacity. As the quote below mentions, the NVWA thinks more specific and strict regulations should exist.

I-P3: *"So there should also be legislation that you can enforce. But for nutritional supplements, there is very little specific legislation. A lot of substances are risky, but they are not in the law as banned or capped."*

Stricter regulations and enforcement should be applied for the supplements and the information about supplements on social media. As the quote below mentions, social media platforms could take a similar approach to handling misinformation as Google.

I-P5: *"When it comes to nutritional supplements, medical information, et cetera… you have to be able to force people not to spread misinformation. How to do that with social media is a question I do not know the answer to. But I do know that Google has that very well sorted out. And it should be the same on other platforms. That you are punished when you do not comply."*

Marketing supplements on social media could also adhere to more strict marketing guidelines, as with other media like TV. The alderman mentioned this, as shown in the quote below; the alderman also acknowledged the complexity of stricter regulations.

I-P6: *"On TV, advertisements are somewhat more regulated. But on social media, it is not or less so. As a result, it can take off in a big way. And regular TV I do not think those young people watch much of it anymore. It is more what comes to you through the Internet anyway."*

5.1.2 Analyses of Interventions

After explaining the interventions mentioned in the interviews in the previous section, a co-occurrence analysis is conducted. To align the later designed design requirements with the interventions, this section includes a co-occurrence analysis of higher- and lower-level interventions mentioned in the previous section, which came from the interviews and the main values to design for. The co-occurrence analysis intends to align the design principles to interventions based on the connected values to interventions. This alignment is discussed in the following subchapter of this chapter. The values to design for, as mentioned in section 4.3.3, are utilized within the co-occurrence analysis.

	Values: Aware...	Values: Effectiv...	Values: Expertise	Values: Profit	Values: Public...	Values: Regula...	Values: Safety	Values: Scientif...	Values: The truth	Values: Transp...
Interventions: Certificating influencers	1		1	1	1	1		2		2
Interventions: Consumer Education	9	1	1		1	1	2	1	2	1
Interventions: Counter campaign	5	1	3	4	3			4	2	1
Interventions: Educating influencers	1	2	1	2	1	1		1	1	1
Interventions: Educational campaigns	6	2	1	1	1			1		2
Interventions: Monitoring tool	1			3		3	2			2
Interventions: Prevention	6	2		1	2		1	1		1
Interventions: Proper communication chann...	3	2	1		1			2	1	
Interventions: Quality mark	1			1		1				1
Interventions: Self regulation industry	1			3		3				2
Interventions: Social Media Intervention	1	2				2	2	2	1	
Interventions: Stricter regulations	1			2		2				2

Figure 5.1 Co-occurrence analysis of interventions and values

A strange conclusion can be drawn considering the co-occurrence analysis in Figure 5.5. Namely, the interventions of certificating and educating influencers almost do not co-occur with the value of expertise. However, given the context of where the interventions were named, expertise was not directly present. Certification was mainly discussed in the context of people who already had expertise and did not need to gain additional expertise or certificates. Therefore, the intervention can stimulate expertise in practice but was not co-occurring with the value. In addition, considering the co-occurrence analysis, prevention , and prevention types of interventions are linked consistently to the value of awareness. To increase awareness within the system, prevention interventions have to be considered. Overall, prevention interventions are linked more widely to the different values within the interviews.

5.1.3 Focus Group Discussion

The three best interventions named in the interviews were discussed within the focus group. The interventions were to certificate influencers, turn the monitoring tool into an enforcement tool, and conduct educational campaigns within the context of education. The quality mark was briefly discussed as a possible member of the best three interventions; however, eventually, a consensus among focus group participants was established that quality marks on products are often overlooked and the intent of quality marks on products is not always straightforward due to their widespread availability. In addition, focus group participants agreed that focusing on prevention interventions was the most promising, as mentioned in the quote below.

> F-P5: *"Educate people and teach it in school already. Be careful where you look on the Internet. Nothing is what it seems. Look at agencies that are reliable, such as government agencies and Nutrition Centers. And that way... Teaches kids that not everything on the Internet is reliable."*

During the focus group, the six participants were divided into three groups. All three groups chose an intervention from the established top three to work out the intervention and considered the positives and negatives of the interventions. Later, the groups presented the interventions to one another to discuss the interventions further. Eventually, turning the monitoring tool into an enforcement tool was considered the most promising intervention within the focus group.

5.2 Design Requirements

Value hierarchies are utilized to develop design principles. The value hierarchies are explained in Chapter 2. As the list of main values to design for is extensive, some values are merged or considered in the same value hierarchies discussed in this section. Firstly, profit is not exactly a value to design for; it is, however, a significant value to consider within the design principles and interventions. If interventions hurt profit margins too hard, the most influential and interested stakeholders, the supplement companies, will block or resist the interventions. Therefore, interventions would not be

feasible. In addition, maximizing the value of public health always has to be considered within the design requirements and interventions. Also, freedom of choice and speech must be considered within the design process, as mentioned in the previous chapter. Within the value hierarchies, the norms and design requirements are based on the context insights in which the values were mentioned within the interviews. According to Van de Poel (2013), norms in VSD do not need to be quantitatively measured; norms should steer the design process to respect human values. The earlier-mentioned interventions were also kept in mind while constructing the value hierarchies.

Awareness

The value hierarchy for the value of awareness is depicted in Figure 5.2. When delving further into the design requirements stemming from this value hierarchy, the lack of awareness, as identified in the value tensions, is of primary concern. Table 5.1 below the figure will explain how the design requirements aim to address the lack of awareness.

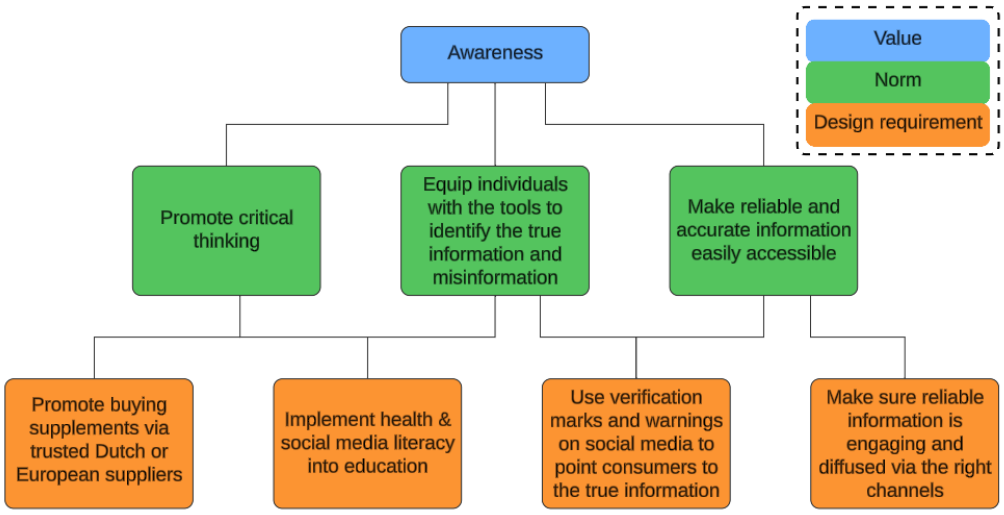


Figure 5.2 Value hierarchy awareness

Table 5.1 Design requirements awareness

Design Requirement	Increasing awareness
Promote buying supplements via trusted Dutch or European suppliers.	By focusing on buying supplements from trusted suppliers, consumers are made aware of supplements' potential benefits and risks, as the institutional stakeholders can ensure regulatory compliance of marketing and labeling when the suppliers are Dutch or European.
Implement health and social media literacy into education.	By implementing health and social media literacy into education, individuals are made aware of the risks within the system and are more aware of how to act within the system.
Use verification marks and warnings on social media to point consumers to the proper information.	Using marks and warnings makes it easier for consumers to be aware of potential benefits, risks, and misinformation. The requirement mainly aims to make proper information easier to discern and make consumers better aware.
Make sure reliable information is engaging and diffused via the proper channels.	By going to the consumer and engaging properly via the proper channels, like influencers, the information diffused by institutional stakeholders will reach consumers better. Consumers will be made better aware of proper information within the system.

Expertise, Scientific Evidence-based, and Effectiveness

The value expertise, prominent within interviews and focus group, is considered within the same value hierarchy as (scientific) evidence-based and effectiveness. Effectiveness as there is a value tension between effectiveness and expertise, where increasing expertise of low expertise but highly effective influencing stakeholders is a way to solve the value tension. In addition, (scientific) evidence-based could increase proper information dissemination of highly effective stakeholders and be a basis for expertise. (Scientific) evidence-based is within this value hierarchy related to the scientific aspect and the overall substantiation of information on social media. The value hierarchy is depicted in Figure 5.3. The value tension between effectiveness and expertise is considered in Table 5.2, where the lack of expertise and lack of effectiveness of communication are considered.

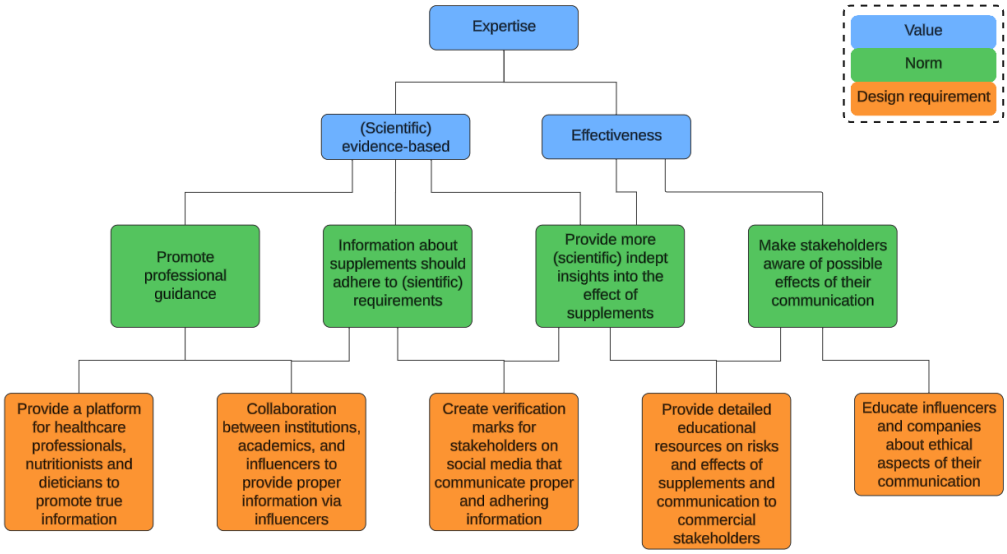


Figure 5.3 Value hierarchy expertise

Table 5.2 Design requirements expertise & effectiveness

Design Requirement	Increasing expertise	Increasing effectiveness
Provide a platform for health-related stakeholders to promote scientifically backed information.	Increasing the presence of stakeholders with expertise in the topic increases the overall expertise within the system.	By providing a platform for stakeholders who are currently ineffective in communication, their effectiveness will increase.
Collaboration between institutions, academics, and influencers to provide proper information via influencers.	By guiding the currently highly effective communicators within the system, namely the influencers, the expertise is increased within the system without lowering effectiveness.	Turning effective communicators into stakeholders with increased expertise does not influence the effectiveness of the stakeholder, but it increases the effectiveness of the scientifically backed information.
Create verification marks for stakeholders on social media that communicate proper and adhering information.	By creating verification marks, it is easier for consumers to differentiate between stakeholders with expertise, which eventually leads to influencers wanting to have expertise to get a mark.	The effectiveness of the scientifically backed information within the system will eventually increase because influencers will be diffusing proper information due to the mark. Also, the mark can serve as an effective cue for consumers.

Provide educational resources on the risks and effects of supplements and communication to commercial stakeholders.	Expertise will increase in the expertise about supplements and stakeholders' expertise about communication effects.	The effectiveness of the scientifically backed information within the system will eventually increase as commercial stakeholders become aware of the effects of supplements and the spread of misinformation.
Educate influencers and companies about the ethical aspects of their communication.	The expertise of stakeholders about the effects of ethical communication will increase.	The effectiveness of the scientifically backed information within the system will eventually increase as commercial stakeholders will be aware of the ethics of spreading misinformation.

Safety & Transparency

Transparency and safety had a significant co-occurrence within the interviews and are therefore considered within the same value tree. As depicted in Figure 5.4, a clear combination of the values within norms and design requirements exists. As mentioned before, profit is a value that must be considered within the interventions. Therefore, the value tension between profit and transparency is not fully included in Table 5.3. However, Table 5.3 includes the abundance of safety and transparency to link to the design requirements.

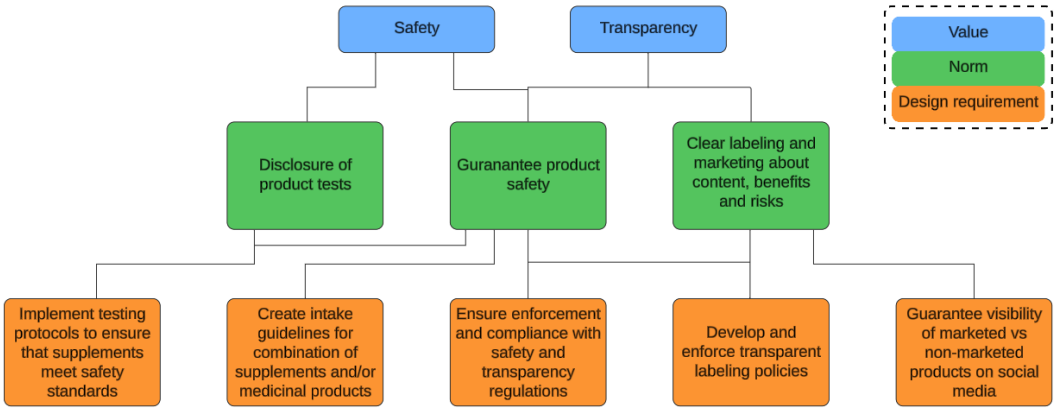


Figure 5.4 Value hierarchy safety & transparency

Table 5.3 Design requirements safety & transparency

Design Requirement	Increasing safety	Increasing transparency
Implement testing protocols to ensure that supplements meet safety standards.	Obligating that supplements on the market need to be tested according to protocols ensures the safety of the supplements.	The testing protocols and the tests should made public by an institutional stakeholder to ensure transparency about tests.
Create intake guidelines for a combination of supplements and/or medicinal products.	Having standardized tested guidelines about the effects of a combination of substances increases the chance of safe use.	By having the guidelines for the combination of supplements, only transparency about safety increases.
Ensure enforcement and compliance with safety and transparency regulations.	As enforcement of safety regulations is currently lacking in the system, ensuring enforcement leads to a safer system.	As enforcement of health claim regulations is currently lacking, ensuring enforcement leads to a more transparent system.

Develop and enforce transparent labeling policies.	By having transparent labels that adhere to regulations, the products' information will better address unsafe use.	Transparent and standardized labels will inherently increase transparency within the system.
Guarantee visibility of marketed vs non-marketed products on social media	By showing the visibility of marketing, consumers are more aware that content on social media is endorsed, which leads to safer consumer choices.	By showing the visibility of marketing, the transparency in the system increases, and consumers become more aware that content on social media is endorsed.

Regulatory Compliance

The value hierarchy for the value of regulatory compliance is depicted in Figure 5.5. The value of regulatory compliance did not occur in a value tension. However, there are risks within the system that are linked to regulatory compliance. The value of regulatory compliance must be increased to combat these risks. Table 5.4 shows the link between the design requirements and how the design requirements lead to an increase in the value of regulatory compliance.

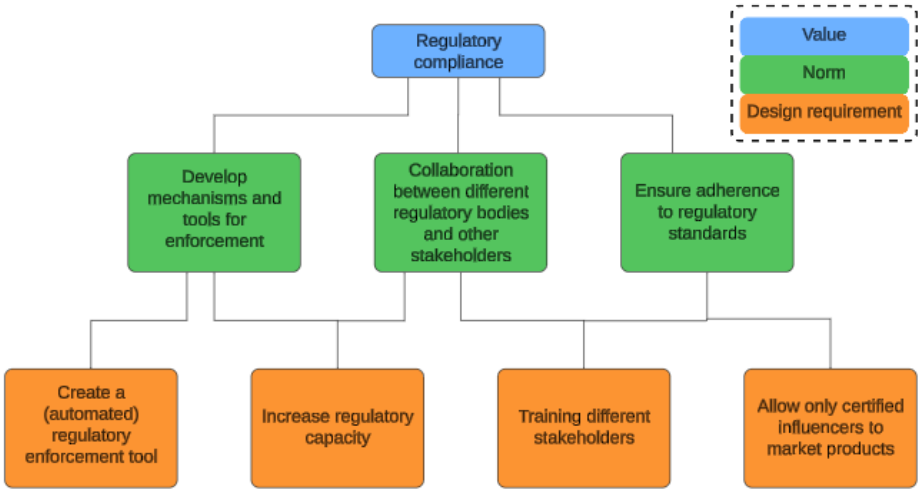


Figure 5.5 Value hierarchy regulatory compliance

Table 5.4 Design requirements regulatory compliance

Design Requirement	Increasing regulatory compliance
Create a (automated) regulatory enforcement tool.	Having an (automated) enforcement tool will make it easier for institutional stakeholders to enforce compliance with regulations.
Increase regulatory capacity	A significant risk in the system is the lack of capacity for the institutional stakeholders; increasing the capacity leads to more possibilities for enforcement, leading to increased regulatory compliance.
Training different stakeholders	By training different stakeholders about the regulatory aspects of the system, stakeholders will be more aware of what is allowed within the system, which could lead to better regulatory compliance.
Allow only certified influencers to market products	By allowing only certified influencers to market products, influencers have to adhere to specific regulations. They are trained in the regulatory aspects and are thus inclined to comply with regulations.

5.3 Proposed Interventions

Following the values hierarchies, the co-occurrence analysis, and the proposed interventions, this chapter will end by explaining the four most promising interventions identified. The further explained interventions are linked to the design requirements within the value hierarchies. Due to the results of the focus group, the interviews, and the nature of this research, the top three interventions of the focus group and counter campaigns will be considered. Stricter regulations entail drawing up precise policies and regulations that are out of the scope of this research. Self-regulation by the industry could be included in other interventions, but it is hard to work out by itself. In addition, the quality mark is seen as a too complex and not working intervention and is therefore not recommended by this research. All the excluded interventions also have limited links with values within the interviews, as seen in Figure 5.1. However, the interventions that are not further explained could be considered in practice but are considered out of the scope of this research.

The co-occurrence analysis within this chapter and the previously identified information has formed Table F.1, found in Appendix F. The design requirements are linked to the interventions based on the links to values and include other design requirements that can further solidify an intervention. The further elaborated interventions are explained based on how the interventions mitigate the effects of supplement misinformation on social media among Dutch adolescents and young adults. The interventions are guidelines on how to structure and what to include in the interventions, but they will not propose tangible or direct policy implications.

As seen in Appendix F, two design requirements are not linked to interventions, as both requirements seem unable to be implemented within the interventions. Namely, develop and enforce transparent labeling policies and implement testing protocols to ensure that supplements meet safety standards. It is not to say that these design requirements should be abandoned. However, neither design requirement is further elaborated on within the interventions for this research.

Certificating Influencers

Firstly, influencer certification exists, as mentioned in the interviews. However, the certification is non-binding, lacks specificity for the researched topic, and the rules attached are only strict for influencers with more than five hundred thousand followers. Therefore, this research suggests to extend the certification of influencers. Influencers must be educated and have access to educational resources not only about supplements and the possible effect of their content on consumers but also about the ethical aspects of communication and regulatory standards. Ensuring influencers are more aware of risks associated with supplements and social media content leads to a more transparent and safe system.

As mentioned within the design requirements, only certified influencers should be able to market the product. Allowing only certified influencers to market leads to marketing by stakeholders who are aware, transparent, and have regulatory compliance; the stakeholders will have more expertise while safeguarding the profit. Verification marks paired with certified influencers could be a less rigorous option than only allowing influencers with certification to market products, which could be a possibility to consider within the intervention. The option of only putting a verification mark next to influencers is also more complex due to the reliance on social media platforms to implement this mark.

The certification should also be enforced, which can be done by the enforcement tool. There should be penalties when certified influencers breach the conditions of the certification to ensure compliance. These penalties could be losing certification, needing to repeat the certification process, or monetary

penalties. All three measures could influence the profit of the influencers. Thus, the influencer has a big incentive to adhere to the regulations. Lastly, utilizing certified influencers within marketing strategies or counter campaigns can lead to greater information dissemination. Furthermore, influencers have a greater reach than institutions and mostly bring information more engagingly, which could help institutions diffuse scientifically backed information.

Counter Campaigns

As mentioned previously, counter campaigns intend to educate the public about supplements and the associated risks. As discussed, the campaigns must use social media to reach the target group conveniently. Several aspects must be considered within the counter campaigns when new guidelines like the combination of substances are designed. These should be communicated through the counter campaigns to ensure up-to-date and accurate information while providing a coherent information stream to limit misinterpretation and confusion. Furthermore, another informative aspect of the campaigns should be informing the consumers about differentiating between marketed and non-marketed supplements. Verification marks could also be used within this intervention, but it brings much complexity.

In addition, as mentioned in certificating influencers above, influencers must be utilized within the counter campaigns to bring the information to the target group engagingly and conveniently. Including collaboration between institutional and commercial stakeholders within the campaigns increases the overall expertise of the information provision. Where, in turn, the increased expertise is more effectively diffused within the system. To further increase the expertise, health-related stakeholders should be the main stakeholders to consider including in the counter campaigns. Within the counter campaigns, there should be considered to push people to buy supplements via Dutch or European suppliers. There are two main reasons. People who want to use supplements will use them when they know the risks. In addition, this ensures regulatory compliance within the system as these supplements and the associated marketing can be enforced by Dutch institutions.

Educational Campaigns

Educational campaigns are considered within the school environment to differentiate from the counter-campaign and optimally reach young adults and adolescents. Health and social media literacy should be implemented within the Dutch education system to increase consumer awareness and knowledgeability at a younger age. This results in more informed choices, considering which information to believe and how to live a healthy lifestyle. Courses should be dedicated to these subjects; however, as the educational curriculums are already overfull, it has to say how the subjects can be implemented into Dutch education. The educational campaigns should specifically address nutritional supplements but focus on overall health and social media literacy. In addition, educational campaigns should also be engaging to have a better effect on the children; it could include gamification, as mentioned in the interviews.

Within education, it should also be considered that buying nutritional products from trusted Dutch or European suppliers is essential to ensure regulatory compliance, transparency, and safety. The trusted suppliers must adhere to Dutch regulations considering all aspects of nutritional supplements and their marketing. Social media marketing guidelines are also essential to discuss within educational campaigns. Lastly, educational campaigns should inform individuals that certain verification marks may exist and that influencers can be certified.

Enforcement Tool

As mentioned in the interviews, it would be nice to have an (automated) enforcement tool to ensure regulatory compliance and mitigate the risk of lacking regulatory compliance. The enforcement tool does not have a prevention aspect but is intended only to enforce existing and upcoming regulations. The current monitoring tool developed by Stichting Reclame Code would be an ideal basis for the enforcement tool. The enforcement tool should address compliance with safety and transparency regulations regarding supplement marketing or information provision on social media. To enforce the enforcement tool, regulatory capacity has to be increased as people need to manage the tool.

However, this enforcement tool cannot be entirely automated as the information on social media can be marketed, which should be clear to the consumers, or a form of freedom of speech when someone says something about a supplement. Therefore, it is essential to consider enforcing mainly the marketed vs non-marketed information on social media and check this difference. The enforcement tool should first check whether the content is marketed and thus should enforce when it is not clear to consumers that the content is marketed. In addition, the enforcement tool should enforce the regulations within the marketed products to ensure regulatory compliance, transparency, and safety within the system. Lastly, the enforcement tool could enforce the possible obligations of certified influencers.

5.3.1 Concluding Remarks

This chapter aims to answer the third research question by discussing and developing interventions that maximize public health within the context of this research. First, the interviews and focus group results led to an exploration and specification of interventions to end the empirical phase of the VSD framework. Later, the technical investigation of the VSD framework started by using the main values to design for, as identified in Chapter 4, to construct value hierarchies. The value hierarchies intend to translate the values into the design of interventions. The discussed interventions were then linked to the design requirements to optimize the identified values and eventually maximize public health. Important to note is that the interventions are not tested yet. The identified interventions with the incorporated design requirements offer solid strategies in addressing misinformation about nutritional supplements while incorporating the identified stakeholder values as intended within the VSD framework. Incorporating the values contributes to making the interventions practical and ethically grounded.

6. Discussion

This thesis investigated the socio-technical system of nutritional supplements, social media, and public health. By assessing stakeholder values, this thesis has introduced possible interventions to mitigate the effect of nutritional supplement misinformation on social media and maximize public health among adolescents and young adults. This chapter will start by critically assessing the interventions. This chapter discusses the scientific research contributions and the theoretical, policy, and societal implications. The chapter ends with a discussion of the limitations of the research.

6.1 Intervention Validation

To validate and further delve into the four elaborated interventions within Subchapter 5.3, literature is considered to evaluate similar interventions to consider in the implementation and refinement of the proposed interventions. The interventions are also further elaborated on.

Certificating Influencers

Certification of influencers is a relatively new concept in the battle against misinformation. Current certification programs address issues of responsibility and transparency in influencer marketing and provide influencers with a reliable information resource (Antoniou, 2024). Certification awareness can be fostered by making certification an industry-wide standard and displaying certification marks on influencer profiles (Antoniou, 2024). Thus, the certification should be made an industry standard to improve the values of accuracy, transparency, awareness, and expertise targeted by this intervention. However, incomplete credibility standards undermine consumer trust, and ineffective certification marketing causes certifications to fail (Jahn et al., 2005). Certification of influencers should, therefore, rely on credible standards to support consumer trust. Certification can be controversial due to governmental support (World Health Organization, 2022), but it could be effective if it meets consumer needs, as mentioned in the WHO toolkit.

The current certification for influencers within the Netherlands is supported by governmental agencies, independent organizations, and the industry and should continue to be done so. Therefore, not only the government is responsible for enforcement, but also the industrial stakeholders and social media platforms themselves, which contribute to boosting consumer trust and the effectiveness of the intervention. Governmental agencies, like the NVWA, should ensure that all regulations are met considering the provision of certificates and the certifications rules themselves, where the current independent organization itself should teach about and grant the certificate to influencers to ensure consumer trust. The industry should be made accountable for utilizing certified influencers, where both the industry and influencers can be penalized for breaching the rules to ensure better enforcement and accountability.

By achieving higher rates of regulatory compliance, the value tension of an abundance of safety is partly solved as the industry and influencers are more inclined to adhere to regulations regarding the marketing of supplements. In addition, by making influencers obliged to be certified, influencers (a highly effective marketing and information provision stakeholder group) gain a higher level of expertise in the topic that the influencer markets and are more transparent in the marketing of supplements. This balances the value tensions between transparency and profit and between expertise and effectiveness.

In conclusion, the current certification initiative should be made stricter to ensure the certification of all influencers on social media, where the government's support through stricter regulations and

collaboration with social media platforms and the industry ensures regulatory compliance and effectiveness. Thus, the intervention could be quickly deployed in the system as the basis already exists. Within the current certification, the training and certification could be attached to specific subjects, making the certification more specifically applicable regarding various topics. Thus, the intervention could also combat misinformation related to other subjects. The intervention should be prioritized first because it is broadly applicable and targets many values and value tensions.

Counter Campaigns

Within an overall misinformation context, interventions emphasizing awareness of misinformation tactics can reduce an individual's susceptibility to misinformation (Roozenbeek et al., 2020). Such counter-campaigns have successfully boosted vaccination rates about public health misinformation (Kumar et al., 2021). Moreover, campaigns boosting media literacy and awareness encourage people to interact critically with information sources to protect against misleading information (Pereira et al., 2023). Overall, counter campaigns regarding misinformation, mainly health misinformation, seem to work in practice to enhance awareness and limit the effect of misinformation. This seems to be able to be generalized to nutritional supplement misinformation as well.

However, making the counter-campaign intervention work requires meeting some criteria. Previous attempts, like the information campaigns during COVID-19, have failed to effectively address parts of the population due to uncertainty and a lack of trust in governments (Sauer et al., 2021). Due to social dynamics and psychological biases, those who have embraced misinformation are more hesitant towards counter-campaigns (Pagoto et al., 2019). Counter-campaigns must, therefore, be designed to specifically address the targeted population's ideas and beliefs (Okholm, 2024). Considering previous attempts, the counter-campaigns should specifically spread a coherent message and address the concerns and beliefs of adolescents and young adults to limit uncertainty about the information provided and boost the effectiveness of the intervention.

Influencers present a promising new avenue for public health promotion, especially for populations who are otherwise more complicated to reach, but it is hard to evaluate the different current practices (Michel et al., 2024). Influencers can increase the impressions and engagement of public health messages because of their sizeable following base (Gough et al., 2017). However, public health organizations should determine if messages align with the content and beliefs of influencers and their followers and not choose influencers based on their substantial following base (Gough et al., 2017). So, when influencers are considered in the counter campaigns, as suggested by this research, careful consideration in the choice of influencers is necessary. Considering using influencers the risk of failing due to a lack of trust in governments is mitigated as the influencers are non-governmental stakeholders.

Counter campaigns specifically target the values of awareness and expertise, the most important values in the value analysis. By mainly targeting the values of expertise and awareness, the counter campaigns aim to solve two value tensions. Namely, the tension between a lack of expertise and a lack of awareness is solved by increasing both values due to increasing awareness among consumers and increasing expertise of influencers used in the campaigns. The other value tension it addresses is the tension between effectiveness and expertise. This value tension is fully addressed by increasing the expertise of highly effective communicators and utilizing the high amount of expertise of less effective communicators to mitigate both negative sides of the value tension.

In conclusion, counter campaigns could be quickly deployed by governmental collaboration with the NVWA, voedingscentrum, and influencers to provide a source of scientifically backed information on

social media via influencers who are already operating in the context of supplements. To design the campaigns, the Ministry of VWS should deploy coherent, relevant, up-to-date, and scientifically backed information provided by the NVWA and Voedingscentrum. The NVWA and Voedinscentrum should also advise on what topics to cover that are relevant at that time. The Ministry has to seek independent influencers to spread this information in an engaging manner, where collaboration with the industry and credible influencers could significantly limit the lack of trust in the campaigns. The choice of influencer could be easier if the intervention of certificating influencers is also in place. Similar to the certification, the intervention could also be used in different contexts of misinformation, which stresses the importance of prioritizing this intervention. The recommendation is to roll out the interventions quickly and simultaneously to target a broad range of values and boost the effectiveness of both interventions.

Educational Campaigns

As mentioned in Chapters 1 and 3, within the EU and the Netherlands, social media literacy is implemented into the education curriculum as decided by the EC. The persuasive power of social media content can be decreased by increasing social media literacy (Polanco-Levicán & Salvo-Garrido, 2022), particularly by increasing social media literacy within the school environment (Taibi et al., 2021). While health literacy is widely studied, even in the Netherlands, people seem to have limited health literacy (van der Heide et al., 2013). Therefore, there is a need and possibility to boost both health and social media literacy.

Considering the current educational efforts, these seem to be ineffective and have a limited effect on individuals' social media literacy. Consequently, research should identify strategies for developing the proper social media literacy abilities (Cho et al., 2024). Thorough testing and comparison with previous efforts are necessary to assess the results of new educational endeavors (Cho et al., 2024). Education must focus on combining cognitive, practical, and affective competencies to deal with social media content and its possible consequences (Vanwynsberghe & Verdegem, 2013). The competencies can be translated into concrete, measurable indicators to aid in developing better social media literacy education (Vanwynsberghe & Verdegem, 2013). Combining these three competencies within the educational campaigns is thus of utmost importance.

The educational campaigns mainly aim to boost consumers' awareness and knowledgeability while also addressing potential influencers' expertise. This intervention mainly balances the value tension between a lack of awareness and expertise, but only to a limited extent considering the current targeted research group. Where the intervention primarily targets consumer awareness, the educational campaigns do not address the current lack of awareness and expertise outside the school environment and of young adults who have almost finished school. Therefore, the intervention only partly balances the value tension.

Considering the current educational curriculum, the educational campaigns must be carefully designed and implemented. Therefore, this intervention can be deployed but not in the short term. The Ministry of OCW is responsible for carefully designing the educational campaigns to ensure coherence with the educational curriculum and adequately address the issue. A wide spread of other stakeholders like the Ministry of VWS and the Ministry of BZK, as well as educational institutions and governmental agencies like the NVWA, should be included in the design phase of the campaigns to address health and social media literacy correctly. The educational campaigns should first be tested by the Ministry of OCW in a handful of schools, and a proper manner of implementing the intervention in education needs to be considered. This intervention should, therefore, first be specified and refined before being used in practice while accounting for as many values mentioned in this research as possible.

In conclusion, this research acknowledges that designing a separate educational campaign or course for every health-related or misinformation-related topic is impossible. Therefore, nutritional supplements should be included in health and nutrition topics while considering the abovementioned criteria, where a focus should be on having a healthy lifestyle. Careful considerations need to be made when designing the campaigns, and therefore, this research concludes that this intervention should be carefully researched before starting the design of such campaigns. Thus, implementing this intervention is not of primary direct importance.

Enforcement Tool

As discussed throughout this thesis, the Stichting Reclame Code has developed and tested a monitoring tool that allows the monitoring of social media content on various platforms. Other tools have been developed and implemented to monitor and flag social media content, especially regarding hate speech, fake news, and COVID misinformation. Two kinds of fake news detection can be effective: context-based and content-based (Hangloo & Arora, 2021). While context-based approaches consider the publisher's legitimacy and the structure of dissemination, content-based methods focus on the textual and visual content (Hangloo & Arora, 2021). Due to the nature of health and nutritional supplement information communication being relatively consistent, both methods could work well in the detection aspect of the enforcement tool. Similar automated systems identify and remove fake content and misinformation (Gorwa et al., 2020). However, the complexity of human language and context nuances frequently undermine these technologies' effectiveness in content moderation (Gorwa et al., 2020).

As mentioned in the toolkit of the WHO (2022), an application named logically.ai exists, which aims to detect and address misinformation on a large scale by using AI. While AI ensures the application's scalability, efficiency, and consistency, humans assist in continuously improving the algorithms and ensuring the application works as intended (World Health Organization, 2022). This highlights the potential of using AI in the automated enforcement tool while still needing humans to check the tool's working. Therefore, this thesis advises using the monitoring tool from the Stichting Reclame Code and combining it with the competencies of logically.ai to create an automated enforcement tool.

To oversee the intervention, the Dutch government should provide the NVWA with appropriately increased regulatory capacity, where there is a current lack of it. Ideally, social media platforms should execute and monitor the intervention to boost its effectiveness globally. However, when social media platforms only support or facilitate the enforcement tool, the NVWA should be the stakeholder in executing and monitoring the tool, considering health-related topics. If the enforcement tool is implemented on a more overall misinformation scale, the Dutch government should consider appointing a different stakeholder who is responsible for executing and facilitating the enforcement tool, which can limit the overall need for increasing regulatory capacity at different governmental agencies.

As the enforcement tool mainly increases regulatory compliance, the effect of the value tension of the abundance of safety is limited. As the industry and influencers are better regulated regarding marketing and the promotion of illegal supplements by the enforcement tool, the overall safety within the system increases. The enforcement tool also improves transparency and expertise in the system, as information providers are more inclined to adhere to regulations to show they are sponsored and refrain from spreading misleading information. Therefore, the intervention partly balances the value tensions of a lack of expertise and a lack of awareness and the value tension between effectiveness and expertise by indirectly increasing the expertise within the system. More effective communicators are more inclined to spread information based on sources with high levels of expertise.

In conclusion, creating the exact tool and regulatory capacity takes time and is complex, where the intervention can potentially address many values and value tensions. This has to be done before it is possible to roll out this intervention within the system. Whereas limiting this intervention to just nutritional supplements is not advised, the enforcement tool has the potential to enforce a far broader scope of topics, contributing to the necessity and effectiveness of such a tool. This research shows the potential for the broader Dutch and European systems to operate such a tool, which could make enforcement a more central task and decrease the overall needed regulatory capacity. This intervention should thus be put into practice, but only after carefully considering the tool's regulatory capacity and other potential uses.

6.2 Research Implications

First of all, this thesis has some scientific contributions and theoretical implications for the field of CoSEM, particularly considering the area of VSD. The research has shown how to address nutritional supplement misinformation on social media by novelty applying the VSD framework and by implementing the human values of stakeholders into the design process. This research has shown that VSD can aid design in addressing a societal and policy issue, where VSD originally stems from technology design (Friedman et al., 2006). The thesis, therefore, shows an extension to traditional research related to the VSD framework into social media and public health contexts.

In addition, addressing nutritional supplement misinformation on social media has not been widely explored in literature, as seen in the structured literature review in Chapter 3. This research contributes to addressing the issue. By deploying the VSD framework and a multidisciplinary perspective, this research has shown the underlying socio-technical system and associated values by incorporating qualitative research methods. Identifying the underlying system can be used as solid ground for further research considering the issue of nutritional supplement misinformation on social media. In addition, this thesis provides grounded interventions to offer novel perspectives in addressing nutritional supplement misinformation.

Besides scientific contributions and theoretical implications, this thesis also yields policy and societal implications. Due to the nature of the research focusing on policy interventions, it is inherent to this thesis that it has policy implications. First and foremost, this thesis identified a lack of policies and regulations related to nutritional supplements and misinformation on social media. The policies implied by the study are within the context of the Netherlands but could also be considered internationally, especially within the EU, due to the similar regulatory landscapes. Reflecting on the proposed interventions, the interventions can also be specified for other contexts due to the current lack of specification.

As prevention is widely considered within most of the interventions proposed in this thesis, societal aspects are widely considered. The interventions have the potential to shift societal norms and trust, especially among adolescents and young adults, when considering nutritional supplement information on social media. However, the societal implications can be far more comprehensive as the interventions and results of the analyses within this thesis can also fuel the broader problem of health misinformation and other problems related to nutritional supplements. The research shows the need for better awareness and education concerning health and social media. Lastly, this research also fuels the discussion of the responsibility of social media platforms and other industrial stakeholders within the identified socio-technical system.

6.3 Limitations

This research identifies some limitations considering the research process and results. These limitations should be considered when interpreting the results of the thesis. The limitations will be explained below.

First of all, due to the wide variety of stakeholders and interrelationships, creating one system diagram would limit the understandability of the system diagram. However, the relationships between the two depicted diagrams and the stakeholders in different diagrams are not explicitly depicted or described. This limits the comprehensiveness of the system analysis. Also, the Stichting Reclame Code was missed in the conceptual analysis of the research, while the stakeholder plays a significant role in enforcing Dutch marketing regulations. In the empirical phase of the research, this stakeholder was introduced by interviewees; by then, it was not possible to interview this stakeholder within the research schedule. The stakeholder, thus, is not included in the socio-technical system diagram of the institutional stakeholders, limiting the comprehensiveness of the system analysis. However, due to the complex nature of the system and the interplay of sponsored content by influencers, utilizing the stakeholder further could be an opportunity to exploit in further research. Another limitation in the conceptual phase is that the expected values and risks could have been better backed by scientific sources, and the conceptualization could have been extended after considering the interviews. Therefore, the definition of the values can still be up for debate considering the value definition within the value analysis.

Considering the empirical phase of the research, the interviews in this research did not include participants who are directly involved or experts in misinformation. Where two participants were related to communication and social media, specific insights from misinformation and social media experts could have strengthened the findings of this research. This limitation of stakeholders is not entirely in line with the VSD framework, as the framework intends to include all stakeholders involved. The interventions are now based on stakeholder values related to health due to the intent of this research. Another limitation of the research methods was that the focus group only included persons between the ages of 19-25. Therefore, the younger ages of the targeted group are not included in the research analysis. Thus, generalizing the results to the entire population of 16-25 could be an issue. In addition, due to the limited time and scope of this research, no more than one focus group has been conducted, undermining the significance of the focus group results. Also, the identified knowledge gap of a lack of an understanding of the values of adolescents and young adults considering social media is therefore only slightly covered.

Lastly, the interventions proposed by the interviewees and later refined based on the design requirements and literature are not validated or tested. Within VSD, it is appropriate to go back to the interviewed stakeholders to validate the results and recommendations from the analysis and strengthen the conclusions. Where the validation first was intended to be covered within the thesis due to time constraints and the participants not responding, the validation was left out of the thesis. Not having the validation limits the feasibility and effectiveness of the interventions.

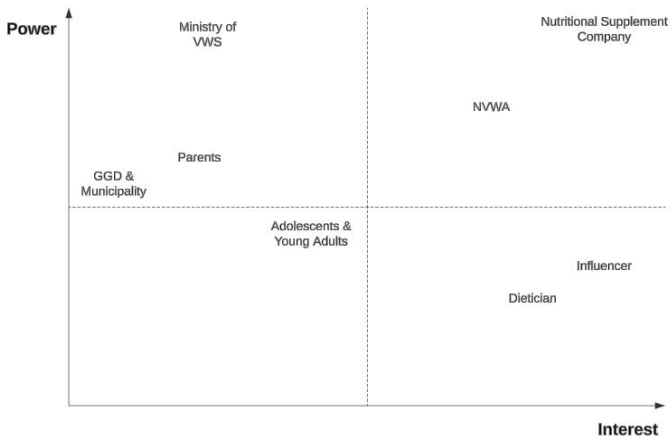
7. Conclusion

This chapter wraps up this thesis document. This study delved into the socio-technical system of nutritional supplement misinformation, social media, and public health by employing the VSD framework. Within this socio-technical system, the most influential stakeholders and their associated values were identified in Chapter 4. Chapter 4 ended with assessing the risks and value tensions within the system, which led to identifying the main values to design for. Chapter 5 delved into the values to design and develop sound interventions to mitigate the effects of nutritional supplement misinformation among Dutch adolescents and young adults and to maximize public health. The chapter will start by answering the sub-research questions and, eventually, the main research question. Lastly, the chapter will discuss the directions for future research.

7.1 Answering Research Questions

> *SQ1: 'How does the socio-technical system related to supplement misinformation, public health, and social media function and who are the key stakeholders involved?'*

Chapter 3 has answered the first sub-research question by explaining the socio-technical system related to supplement misinformation, public health, and social media. Indirect and direct stakeholders in the system were identified, which is essential while using the VSD framework. The socio-technical system is highly complex, mainly due to interdependencies among the involved stakeholders, where social media plays a current role in providing information for Dutch adolescents and young adults, which exaggerates the possible effect of misinformation dissemination. Showing the complexity of the system and stakeholder dynamics was a crucial first step in this research. The third chapter showed the complexity of the socio-technical system as discussed in the literature and institutional settings. Chapter 4 identified the most important and influential stakeholders, as depicted in a power-interest matrix in Figure 4.1. This power-interest matrix was based on the identified system and literature in Chapter 3.



Researching the complexity of the system and stakeholder dynamics was a crucial first step in identifying the design space within the conceptual phase of the research. While considering the system's most influential and important stakeholders, expected values and risks were identified. The persons to be interviewed were identified based on the power-interest matrix to identify the critical values at stake in guiding the design of interventions addressing supplement misinformation.

SQ2: 'What are the main risks in this socio-technical system, and what values should be designed for?'

After a broad conceptual identification of the entire system with the involved stakeholders and values, the values to consider in the system were empirically identified in Chapter 4. The relation to these values and their prioritization was identified in this sub-question, and the primary value tensions and conflicts that arise when designing within the identified system were highlighted. The main risks and value tensions were identified by considering the literature, the interviews, the focus group, and the identified values. The main identified risks were:

- Health risks: physical health risks by the improper consumption of supplements and mental health risks mainly due to social comparison. There is, therefore, a lack of safety within the system.
- A lack of regulatory enforcement due to a limited enforcement capacity of institutional stakeholders. Transparency in marketing can, therefore, not be assured for sponsored posts of nutritional supplement content.
- Fake expert risk due to influencers or companies pretending or insinuating to have expertise or are regarded as experts considering nutritional supplements and health. Where information providers with a lack of expertise seem to have higher effectiveness.
- The spread of misinformation is mainly fueled and exacerbated by a lack of awareness, transparency, and knowledgeability within the system.

Following the empirical analysis of the values and risks from the interviews and focus group, the most important values to design for are awareness, expertise, (scientific) evidence-based, transparency, profit, effectiveness, safety, regulatory compliance, and healthy lifestyle. These values contribute to maximizing public health within the identified system. In addition, as freedom of choice and speech are fundamental rights within the Netherlands, both values were considered when designing interventions, considering the next sub-question. Chapter 4 mainly covered the empirical part of the research by identifying all the values and risks to answer SQ2. The design principles and the interventions thus inherently target maximizing these two overarching values. The values to design for are further explained in the fifth chapter according to value hierarchies. The value hierarchies aided in constructing sound design principles and interventions.

SQ3: 'What specific design principles and strategies can be developed to integrate the identified values into interventions to maximize public health, targeting supplement misinformation among Dutch adolescents and young adults?'

The next step in the analysis was to operationalize the main values to design for into the interventions to address SQ3. The interventions proposed to maximize public health outcomes in the identified socio-technical system are grounded in the VSD approach to ensure integration of the main values to design for. After assessing all values, possible value tensions, and the main risks, the core design requirements for designing interventions in the identified complex system were developed. In addition, the possible interventions were identified from the stakeholder interviews and discussed in the focus group, as mentioned in Chapter 5. This concluded the empirical part of the research. The technical phase started, in which the design requirements were identified based on the main values for which to design. These were linked to the most promising identified interventions to ensure sound and value-based interventions. The table showing the link between design requirements and interventions can be found in Appendix F. Lastly, the most promising interventions were also assessed based on the literature in

Chapter 6, and it was concluded that all the interventions could be suitable to put into practice. The counter campaigns and the certificating of influencers seem to be the first interventions that can be put into practice as they require the least time to refine and implement and are regulatory the least complex. The educational campaigns would take significant time to be tested and broadly applied, where the enforcement tool requires restructuring regulatory enforcement and regulatory capacity. However, all the interventions should be put into practice. The refinement and how to implement the proposed interventions were out of scope for this thesis due to time constraints. The most promising interventions identified in this research are:

- Certificating influencers: The certification of influencers exists but is non-binding and lacks specificity for the researched topic. The certification of influencers should be extended, where influencers must be educated and have access to educational resources about supplements, the effects of content on consumers, and the ethical aspects and regulatory standards.
- Counter campaigns: Counter campaigns should intend to educate the public about supplements and the associated risks. The campaigns must go via social media to reach the target group; more specifically, influencers should be utilized within the communication. The counter campaigns should ensure up-to-date and accurate information provision
- Educational campaigns: To differentiate from the counter-campaign and optimally reach young adults and adolescents, educational campaigns are considered within the school environment. Within the Dutch education system, health and social media literacy should be implemented to increase consumer awareness and knowledgeability at a younger age to ensure more informed choices considering which information to believe and how to go about a healthy lifestyle.
- Enforcement tool: An (automated) enforcement tool could ensure regulatory compliance and mitigate the risk of lacking regulatory compliance. The current monitoring tool developed by Stichting Reclame Code would be an ideal basis for the enforcement tool. The enforcement tool should address compliance with safety and transparency regulations regarding supplement marketing or information provision on social media.

  Main research question*: 'How can public health outcomes relating to supplement misinformation inside the complex system formed by social media platforms, public health agencies, and local governance be maximized?'*

In order to optimize public health, this thesis established a multifaceted strategy that tackles the system's complexity and the numerous value conflicts that exist by employing the research phases of the VSD framework. The main answer is to combine regulatory, educational, and cooperative measures that aim at the origins of disinformation and enable consumers to assess the material they come across critically. Therefore, the main driver for maximizing public health lies within prevention types of interventions, where better enforcement should not be neglected. The identified values, risks, design requirements, and interventions within this thesis could be used to explore additional ways to maximize public health within the given context. This thesis has identified the most promising interventions within the scope of this research; however, the values, design requirements, and interventions that have not been further explored could still be solid grounds for actual promising interventions. In conclusion, public health and overall health in the Netherlands can be improved by considering the most promising interventions identified in this thesis. Combining different interventions and further specifying the interventions in practice will lead to a more aware and healthy Netherlands overall.

7.2 Future Research

As mentioned in this thesis, this research is novel in multiple theoretical and practical manners. Firstly, due to the nature of the research topic, which has not seen much previous research. Also, applying the VSD within the context of policymaking and public health seems novel. This research, therefore, can serve as a base for future research on using VSD in a similar context and a base to further delve into the system of nutritional supplement misinformation on social media and appropriate interventions. The interventions are not validated, so future research could focus on involving expert stakeholders to refine the interventions further. As mentioned, the proposed interventions are not yet specified and tested as is customary in the technical investigation of VSD. Therefore, future research should focus on further specifying and appropriately testing the interventions in practice. This does not need to be done by scholars but could also be done by policymakers themselves, regulatory and public health agencies, or social media platforms. In addition, how the interventions can be implemented into the socio-technical system should be investigated. Accordingly, future research should also consider the responsible stakeholders implementing and operating the interventions.

Considering the knowledge gap identified in Chapter 1, this research has only slightly addressed the lack of research into preferences and behaviors of young adults considering nutrition information seeking behavior. Future research should specifically research the information seeking behaviors and preferences of adolescents and young adults to gain a deeper understanding which can also strengthen the development of the interventions mentioned in this thesis. The role of social media algorithms and the echo chamber phenomenon in information dissemination should be further investigated to explore their contribution to the spread of misinformation and the effectiveness of the interventions. This exploration could also contribute to finding ways to solve the lack of regulatory enforcement within the system. The exploration would also aid the development and use of the proposed enforcement tool in this research. In addition, future research should focus on exploring the development of automated tools to ensure better detection and easier enforcement of the regulations by using the enforcement tool.

Future research should also explore whether the conclusions and interventions from this research apply to a broader demographic. Younger and older demographics can be considered to have different values and preferences, considering the context, and this research cannot state if the interventions would work for the broader demographic. Therefore, future research can focus on eliciting values from other demographics and base interventions on those values or testing the interventions in the other demographics. Also, as this research has mainly investigated health-related stakeholders, future research should focus on misinformation and communication experts to assess their values concerning the socio-technical system to strengthen the conclusions of this research or seek alternative interventions. Lastly, considering the geographical scope of the Dutch context of the research, future research should focus on expanding beyond the Netherlands. The conclusions and interventions should be investigated to determine whether they apply in different cultural and regulatory settings, especially outside the EU.

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Appendix A. Stakeholders

Table A.1 Stakeholders

Stakeholder	Identified in	Explanation
Adolescents & Young Adults	Entire thesis	Direct; inherent to research
Parents & Family	Subsection 3.2.1	Direct; of direct influence, especially on younger people
School/educational actors	Subsection 3.2.1	Direct; of direct influence on knowledge of target group
Influencer	Subsection 3.2.1	Direct; major influence on individuals
Social Media Platform	Subsection 3.2.1	Indirect; concerned about misinformation as a whole not focused on supplements
Nutritional Supplement Company	Subsection 3.2.2	Direct; inherent to research
Supplement Manufacturer	Subsection 3.2.2	Indirect; is at the background of influence on the system
E-commerce platform	Subsection 3.2.2	Indirect; channel to buy supplements
Gym/Coaches	Subsection 3.2.2	Indirect; influences target group slightly
Nutritionist/Dietician	Subsection 3.2.2	Direct; influential with a broad knowledge of nutrition
Healthcare professional	Subsection 3.2.2	Indirect; only influential when there is a health issue
Pharmacies	Subsection 3.2.2	Indirect; channel to buy supplements
Supermarkets	Subsection 3.2.2	Indirect; channel to buy supplements
Internet	Subsection 3.2.1	Indirect; channel to buy supplements
European Commission	Chapter 1	Indirect institutional influence
European Union	Chapter 1	Indirect institutional influence
EMA	Subchapter 3.3	Indirect institutional influence
EFSA	Subchapter 3.3	Indirect institutional influence
EDMO	Chapter 1	Indirect institutional influence
Dutch government	Chapter 1	Indirect institutional influence
Ministry of OCW	Subchapter 3.3	Indirect institutional influence
Ministry of BZK	Subchapter 3.3	Indirect institutional influence
Ministry of VWS	Subchapter 3.3	Direct; public health is of their primary concern
Provinces	Subchapter 3.3	Indirect institutional influence
Municipalities	Subchapter 3.3	Direct; responsible for local and youth health
GGD	Subchapter 3.3	Direct; responsible for local public health
RIVM	Subchapter 3.3	Indirect; utilized to test supplements
NVWA	Subchapter 3.3	Direct; has a separate division related to supplements
Gezonheidsraad	Subchapter 3.3	Indirect; only a advisory body
Voedingscentrum	Subchapter 3.3	Direct; provides public advice on lifestyle and nutrition

Appendix B. Interview Protocol

Introduction (5 minutes)

- Hi, welkom bij dit interview, dit interview zal gaan over voedingssupplementen, de informatie hierover op sociale media en het effect hiervan op jong volwassenen (16-25 jarigen). Bedankt dat je aan dit interview mee wil werken. Ik zal nu eerst even het geïnformeerde toestemming document met je doornemen. Dit interview word opgenomen zoals genoemd in dit document en zal volgens de informatie in dit document ook verwerkt worden in mijn thesis waarin altijd de bescherming van je data voorop staat.

Background Information (10 minutes)

- Zou je jezelf even kunnen voorstellen en je functie beschrijven? (For the influencer role, the interview will also address how and why they became an influencer)
- Wat heeft je gemotiveerd om deze baan of deze richting te kiezen? (ice-breaker)
- Wat zijn je dagelijkse werkzaamheden die gerelateerd zijn aan supplementen of sociale media in jouw ervaring?
- Welke andere mensen beïnvloeden deze werkzaamheden?
- Hoe is jouw functie gerelateerd aan voedingssupplementen en publieke gezondheid of sociale media?
- Hoe zie jij het onderwerp dat ik onderzoek?
- Hoe is je functie gerelateerd aan andere belanghebbenden binnen de industrie/branche van voedingssupplementen, publieke gezondheid en sociale media?
- Zijn er andere mensen gerelateerd aan dit onderwerp die ik zou moeten interviewen?

Understanding Values (15 minutes)

- Hoe denk jij dat sociale media invloed kan hebben op de voeding van jong volwassenen?
- Welke waarden en prioriteiten vind je het meest belangrijk bij voedingssupplementen en de informatie hierover op sociale media?
- Hoe beïnvloeden deze waarden je acties of beslissingen binnen je rol?
- Zijn er prioriteiten die je moet stellen tussen bepaalde waarden of dingen die eventueel in conflict met elkaar komen? En moet je hier dan ooit compromissen in sluiten?

Value Tensions and Risks (15 minutes)

- Wat zijn de voornaamste risico's van voedingssupplement informatie op sociale media naar jouw mening?
- Wat zijn de voornaamste risico's van het verkeerde gebruik van voedingssuplementen? (denk hier bij aan verborgen ingrediënten of het verkeerd gebruik hiervan)
- Hoe beïnvloeden de zojuist besproken risico's de publieke gezondheid en individueel gedrag, voornamelijk kijkend naar jong volwassenen of kinderen?
- Zou je voorbeelden kunnen geven van conflicterende waarden of trade-offs die jij ervaart binnen jouw rol?

Design Principles and Interventions (15 minutes)

- Wat zou er gedaan kunnen worden tegen het onjuiste gebruik van voedingssupplementen en de informatie over voedingssuplementen in relatie tot sociale media? Je mag hier met creatieve ideeën komen, het gaat ook over het algemeen.
- Heb je specifieke ideeën over iets wat zou kunnen werken om onjuist gebruik van voedingssuplementen tegen te gaan?

- Zouden er binnen deze ideeën compromissen moeten worden gesloten of zie je problemen in het implementeren van deze oplossingen?
- Welke strategieën heeft u effectief of ineffectief gevonden bij het aanpakken van misinformatie? Misinformatie is in dit geval iedere vorm van foutieve informatie, dit kan ook op onvolledige informatie beslaan.
- Zijn er naar jouw weten binnen de industrie of vanuit de overheid interventies die dit probleem aanpakken
- Zijn deze effectief en wat zijn de sterke en zwakke punten?

Closing (5 minutes)

- Is er nog iets wat je zou willen zeggen waar we het niet over hebben gehad tijdens dit interview maar misschien nog wel relevant is?
- Bedankt voor je tijd en deelname aan dit interview, je deelname word zeer gewaardeerd.

Appendix C. Focus Group Protocol

Introduction (10 minutes)

- Hi, welkom bij deze focus groep, deze focus groep zal gaan over voedingssupplementen, de informatie hierover op sociale media en het effect hiervan op jong volwassenen (16-25 jarigen). Samen zullen we uiteindelijk interventies gaan bedenken om deze informatie te verbeteren of de negatieve invloeden hiervan in te perken. Allemaal bedankt dat jullie aan deze focus groep mee wil werken. Ik zal nu eerst even het geïnformeerde toestemming document met jullie doornemen. Deze focus groep word opgenomen zoals genoemd in dit document en zal volgens de informatie in dit document ook verwerkt worden in mijn thesis waarin altijd de bescherming van jullie data voorop staat.
- Zouden jullie je om beurten kunnen voorstellen en je favoriete social media platform kunnen noemen? (ice-breaker)

Warm-Up Activity (10 minutes) (An overall discussion)

- Hoe komt iedereen voedingssupplement tegen op social media, wat zijn jullie ervaringen hiermee en wat voor soort informatie komen jullie hierover tegen en hoe vaak?
- Als je informatie over voedingssupplementen tegenkomt, verifiëren jullie deze informatie dan en zo ja hoe?
- Gebruiken jullie ook andere bronnen van informatie over voedingssupplementen, zoals persoonlijke advies door een professional of overheidsinstantie?

Discussion on Values (20 minutes)

- Welke waarden vinden jullie belangrijk wanneer het komt tot informatie die je vind over voedingssuplementen op social media? Iedereen schrijft er 5 maal 1 op een post-it er gaat vervolgens blind gestemd worden met deze 5 waarden, we kunnen er dan ook samenvoegen als iedereen het ermee eens is. Je krijgt 5 minuten om deze 5 te bedenken en op te schrijven. Denk bij deze waarden aan wetenschappelijke onderbouwing, moet het van een gerenommeerd account komen, gaat het om het vertrouwen in de boodschapper of bijvoorbeeld de effectiviteit van de informatie. We zullen daarna nog even kort de waarden bespreken.
- Nu we ze hebben besproken en samengevoegd, zou iedereen een top 3 kunnen opstellen op 1 post-it. Deze top 3 gaat over welke waardes het belangrijkst zijn om de waarheid te beoordelen van de informatie en eventueel je gedrag zouden kunnen sturen om een supplement te kopen. Hier krijg je 3 minuten voor.

Exploring Value Tensions and Risks (20 minutes)

- Zijn jullie ooit tegenstrijdige informatie over supplementen tegengekomen op sociale media? Hoe bent u daarmee omgegaan? En heeft het uw beslissing over het gebruik van de supplementen beïnvloed?
- Welke risico's zien jullie in het verkrijgen van informatie over voedingssuplementen op social media en hoe zouden deze gemitigeerd kunnen worden? Jullie verdelen je in groepjes van 2, elk groepje moet 3 maal 1 risico op een post-it schrijven en hoe je dit risico zou kunnen mitigeren. Vervolgens zullen we deze allemaal bespreken, we kunnen er dan ook samenvoegen als iedereen het ermee eens is. Jullie krijgen 5 minuten om deze te bedenken en op te schrijven. We zullen daarna nog even kort de risico's bespreken.

Brainstorming Interventions (30 minutes)

- Heeft er iemand specifieke ideeën over hoe informatie over supplementen op social media betrouwbaarder kunnen maken?
- Hoe kunnen we deze zo maken dat ze in overeenstemming zijn met de voorgaand besproken waarden?
- Wat zouden jullie denken dat behulpzaam zou kunnen zijn in het evalueren van informatie over voedingssuplementen op social media.
- Hoe kunnen volksgezondheidsorganisaties, professionals, de industrie of sociale mediaplatforms ervoor zorgen dat de juiste informatie over supplementen te vinden is op sociale media en welke interventies kunnen worden geïmplementeerd om het probleem van onjuist supplementengebruik aan te pakken en misinformatie tegen te gaan? (De in interviews genoemde interventies zullen als inspiratie gedeeld worden met de deelnemers) Ik verdeel jullie in groepjes van 2, elk groepje moet 1 maal 1 idee hierover op een papier met een goede uitleg hierbij. Vervolgens krijgt elk groepje 5 minuten om beide ideeën te presenteren aan de rest.
- We eindigen deze focus groep met door in groepsdiscussie te ranken van deze interventies met democratische stemrecht. Zo gaan we de belangrijkste op 1 zetten en de minst belangrijk op nummer laatst.

Closing (10 minutes)

- We zullen even de hoofdlijnen bespreken die uit de focus groep zijn gekomen
- Heeft iemand nog verdere gedachten of opmerkingen die ze willen delen?
- Dan wil ik jullie nu allemaal hartelijk danken voor jullie medewerking aan deze focus groep.

Appendix D. Codebook

Table D.1 Codebook

Code group	Code	Grounded
Interventions	Certificating influencers	7
Interventions	Consumer Education	11
Interventions	Counter campaign	13
Interventions	Debunken	3
Interventions	Educating influencers	6
Interventions	Educational campaigns	7
Interventions	Local efforts	5
Interventions	Monitoring tool	8
Interventions	Overall healthcare change	1
Interventions	Prevention	12
Interventions	Proper communication channels	8
Interventions	Quality mark	6
Interventions	Regulating gyms	3
Interventions	Regulatory alignment & collaboration	5
Interventions	Self regulation industry	6
Interventions	Social Media Intervention	11
Interventions	Stricter regulations	10
Risks & Problems	Abundance of necessity	10
Risks & Problems	Adjusting behavior	4
Risks & Problems	Availability of supplements	10
Risks & Problems	Claims	11
Risks & Problems	Combination	12
Risks & Problems	Complexity of regulation	6
Risks & Problems	Contamination	4
Risks & Problems	Enforcement	18
Risks & Problems	Fake expert	11
Risks & Problems	Free trade	1
Risks & Problems	Group of believers	3
Risks & Problems	Health risks	33
Risks & Problems	Internet	7
Risks & Problems	Labeling, declaration of content	9
Risks & Problems	Lack of communication	2
Risks & Problems	Lack of knowledge company OR influencer	10
Risks & Problems	Lacking regulations	15
Risks & Problems	mental health	4
Risks & Problems	Misinformation spread	17
Risks & Problems	Overdosing	9
Risks & Problems	Regulatory capacity	11
Risks & Problems	Selftest	3
Risks & Problems	Small companies	9
Risks & Problems	Social comparison	12
Risks & Problems	Supplement vs. medicine	2
Risks & Problems	Third countries	9
Risks & Problems	Trust in government	3
Risks & Problems	Undeclared substances	11

Values	Accuracy	23
Values	Availability of scientific evidence	4
Values	Awareness	33
Values	Clear communication	10
Values	Confusion	5
Values	Consistency	4
Values	Consumer costs	6
Values	Consumer responsibility	8
Values	Controllability	3
Values	Effectiveness	19
Values	Effectiveness policy	8
Values	Ethical	4
Values	European alignment	2
Values	Expertise	34
Values	Freedom of choice	3
Values	Freedom of speech	10
Values	Independence	2
Values	Knowledgability	16
Values	Lifestyle	14
Values	Personal	7
Values	Positive effects	6
Values	Profit	27
Values	Public health	20
Values	Quality of information	12
Values	Quality of supplement	5
Values	Regulatory compliance	30
Values	Reliability	9
Values	Responsibility	12
Values	Risk assessement	1
Values	Safety	25
Values	Scientific evidence-based	23
Values	The truth	14
Values	Transparency	26

Appendix E. Results Focus Group

Table E.1 Focus group values

Value	Explanation	Votes
Reliability	A reliable source of information (not an influencer), information itself is also reliable.	IV
Scientific evidence-based	So, there is a scientific base for the information and the supplement is proven to work. The scientific base should best be explained in easy language. Not just one study but meta-analysis	IV
Neutrality/ independence	Sources of information should not be endorsed as their opinions will be related to the earnings they can make from selling supplements. So, a neutral source of information is needed.	IV
Familiarity/fame	Higher source on Google is considered before lower-ranked ones.	I
Easy to understand	Information should be easily interpretable.	II
Authority/expertise	A source has to understand what he talks about and has to have specific authority, so not an endorsed influencer	IV
Positive & Negative	Information should highlight positive and negative aspects.	II
Well substantiated	Experiences of others, scientific, more sides, independent, good spelling. Not too simple and not too complicated	II
Understandability	Straight to the point and right spelling, not too long	II
Up to date	Recent studies are more believable than older ones	I
Approved by authorities	Supplements must be approved, so there are no supplements with EU/Dutch illegal contexts.	I
Attractiveness	Nice layout and attractive text pull attention, also from an attractive influencer/person.	II
Accessibility	Everyone needs to have access to the information. Groups cannot be excluded.	I

Table E.2 Focus group risks

Risk	Explanation	Mitigation
Mental health risks (III votes)	Information can evoke emotional danger or thoughts by having fake expectations due to influencers.	Make sure influencers are fully transparent. Increasing consumer awareness.
Financial risks (II votes)	People waste money on things they do not need (lack of knowledge) because social media influence them.	Improve consumer awareness/ knowledgeability and stricter influencer and social media marketing regulations. Less promotional codes as these allow impulsive buying
Overall health risks (III votes)	Over usage of supplements, look at the contents of supplements. as some could be harmful (especially in illegal products).	Consumer education, increasing consumer awareness i.e. own consumer research, make information or advice more personal (need professional), better packaging showing possible effects and contents.
Prevalence misinformation (I vote)	Misinformation put on social media can lead other users or influencers to spread misinformation as well.	Influencer training before they can advertise supplements. Make the training mandatory.

Interventions

Certification influencers:

- Certification has to be obliged; a governmental body should hand out and enforce the certification. However, the education about the certification has to be carried out and maybe even funded by the companies.
- Advantage: Reliability information improves, probably more up-to-date and more scientific claiming, also approved by authorities
- Disadvantages: Extra costs in the industry will probably hurt consumers; who is responsible? There are a lot of extra regulations and trouble for companies or influencers to adhere to, so it increases complexity within the system.

Prevention through education:

- Starting within primary education children should be educated about lifestyle and how this is manageable. Within high school, this education should also focus on misinformation in general but also more focused on nutritional supplements as with other forms of nutritional information on social media platforms, as the current issues could be better managed by prevention during school.
- Advantage: Young consumer consciousness, reliable source of information, well substantiated and approved by government. Consumer better aware and more knowledgeable.
- Disadvantage: Costs of changing education. The prevention has to fit in an already over-full educational program. Who is going to teach this? Maybe a new sort of teacher is necessary.

Monitoring tool

- An authority has to check for misinformation and enforce warnings, fines, penalties, and taking away certifications or the ability to sell, for nutritional supplement companies as well as for influencers. Self-regulation from the industry is necessary to help combat the misinformation to uphold certifications within the industry and ensure that monitoring tool is operated. This has to lead to good information provision from the industry and influencers, and the industry has to provide sufficient counseling to influencers to be able to adhere to regulations and are not flagged by the monitoring tool.
- Advantages: expertise is challenged and will be improved, reliability and accuracy of information will improve, approved by authorities, easier to enforce regulations.
- Disadvantages: extra money to the responsible regulatory agency, where do weget the right people to check the information and who has the authority to act, so regulatory complexity is an issue, freedom of speech vs earnings vs truth has to be properly addressed but could be contested.

Appendix F. Interventions & Design Requirements

Table F.1 Linking interventions to design requirements

	Certificating influencers	Counter campaigns	Educational campaigns	Enforcement tool
Promote buying supplements via trusted Dutch or European suppliers		X	X	
Implement health & social media literacy into education			X	
Use verification marks and warnings on social media to point consumers to the true information	X	X	X	
Make sure reliable information is engaging and diffused via the right channels	X	X	X	
Provide a platform for health-related stakeholders to promote true information		X		
Collaboration between institutions, academics, and influencers to provide proper information via influencers	X	X	X	
Create verification marks for stakeholders on social media that communicate proper and adhering information	X	X		
Provide educational resources on the risks and effects of supplements and communication to commercial stakeholders	X			
Educate influencers and companies about the ethical aspects of their communication	X			
Implement testing protocols to ensure that supplements meet safety standards				
Create intake guidelines for a combination of supplements and/or medicinal products		X	X	
Ensure enforcement and compliance with safety and transparency regulations	X			X
Develop and enforce transparent labeling policies				
Guarantee visibility of marketed vs non-marketed products on social media	X	X	X	X

Create a (automated) regulatory enforcement tool	X			X
Increase regulatory capacity				X
Training different stakeholders	X		X	
Allow only certified influencers to market products	X			X